Final

Total Maximum Daily Load

for

Fecal Coliform

in

McKay Creek

WBID 1633B

May 2012

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for fecal coliform bacteria in McKay Creek in the Spring Coast Basin (WBID 1633B). Subsequent actions must be consistent with this TMDL.

/s/ 5/30/2012

James D. Giattina, Director Date

Water Protection Division

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LIST OF ABBREVIATIONS

BMAP	Basin Management Action Plan
BMP	Best Management Practices
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use Classification Code System
FS	Florida Statutes
HUC	Hydrologic Unit Code
IWR	Impaired Waters Rule
LA	Load Allocation
MGD	Million Gallons Per Day
ML/L	Milliliters Per Liter
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
N/A	Not Applicable
NASS	National Agriculture Statistics Service
NPDES	National Pollutant Discharge Elimination System
OSTD	Onsite Sewer Treatment and Disposal Systems
SEC/DAY	Seconds Per Day
STORET	STORage RETrieval database
SQ MI	Square Miles
SWFWMD	Southwest Florida Water Management District
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMD	Water Management District
WQS	Water Quality Standard
WWTP	Wastewater Treatment Plant

SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. 303(d) Listed Segment:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1633B	McKay Creek	Class III Freshwater	Springs Coast	03100207	Pinellas	Florida

2. TMDL Endpoints/Targets: Fecal Coliform

3. TMDL Technical Approach: Statistical approach using available water quality data.

4. TMDL Waste Load and Load Allocation:

Waterbody	WBID	WLA[1]		LA	TMDL
		Facility (MPN/day)	Stormwater/MS4 (% Reduction)[2]	(% Reduction)[2]	(% Reduction)[2]
McKay Creek	1633B	N/A	89%	89%	89%

Notes:
1. The WLA is typically separated into the components originating from continuous wastewater NPDES facilities (e.g. WWTPs) and from stormwater NPDES permitted facilities/public bodies (e.g. MS4s).
2. Overall percent reduction required to achieve the 400 counts/100 ml fecal coliform criterion. The MOS is implicit and does not take away from the TMDL value.

5. Endangered Species (yes or blank):

6. USEPA Lead TMDL or Other: USEPA

7. TMDL Considers Point Sources/Non Point Sources: Both

8. NPDES Discharge to surface water addressed in TMDL: Yes

Facility Name	NPDES No.	Facility Type	Receiving Stream
Pinellas County	FLS000005	MS4 (Phase I)	Multiple

Note: Numerous cities, towns, and other public bodies are listed as co-permittees under this NPDES Permit.

1. Introduction

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The state of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into five groups. Water quality is assessed in each group on a rotating five-year cycle. FDEP also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. McKay Creek is located in the Springs Coast River Basin and is a Group 5 waterbody managed by the Southwest Florida Water Management District (SWFWMD).

For the purpose of planning and management, the WMD divided the districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. McKay Creek is located within the Anclote River/Coastal Pinellas Planning Unit. These planning units contain smaller, hydrological based units called drainage basins, which are further divided by FDEP into "water segments." A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment. This TMDL report addresses WBID 1633B (McKay Creek).

2. Problem Definition

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (FAC). The IWR is FDEP's methodology for determining whether waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The TMDL addressed in this document is being proposed pursuant to commitments made by the United States Environmental Protection Agency (USEPA) in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). That Consent Decree established a schedule for TMDL development for waters listed on Florida's USEPA approved 1998 section 303(d) list. The 1998 section 303(d) list identified numerous WBIDs in the Springs Coast River Basin as not meeting WQS. After assessing all readily available water quality data, the USEPA is responsible for developing a TMDL for WBID 1633B (McKay Creek). The geographic location of this WBID is shown in Figure 1. The parameter addressed in this TMDL is fecal coliform.

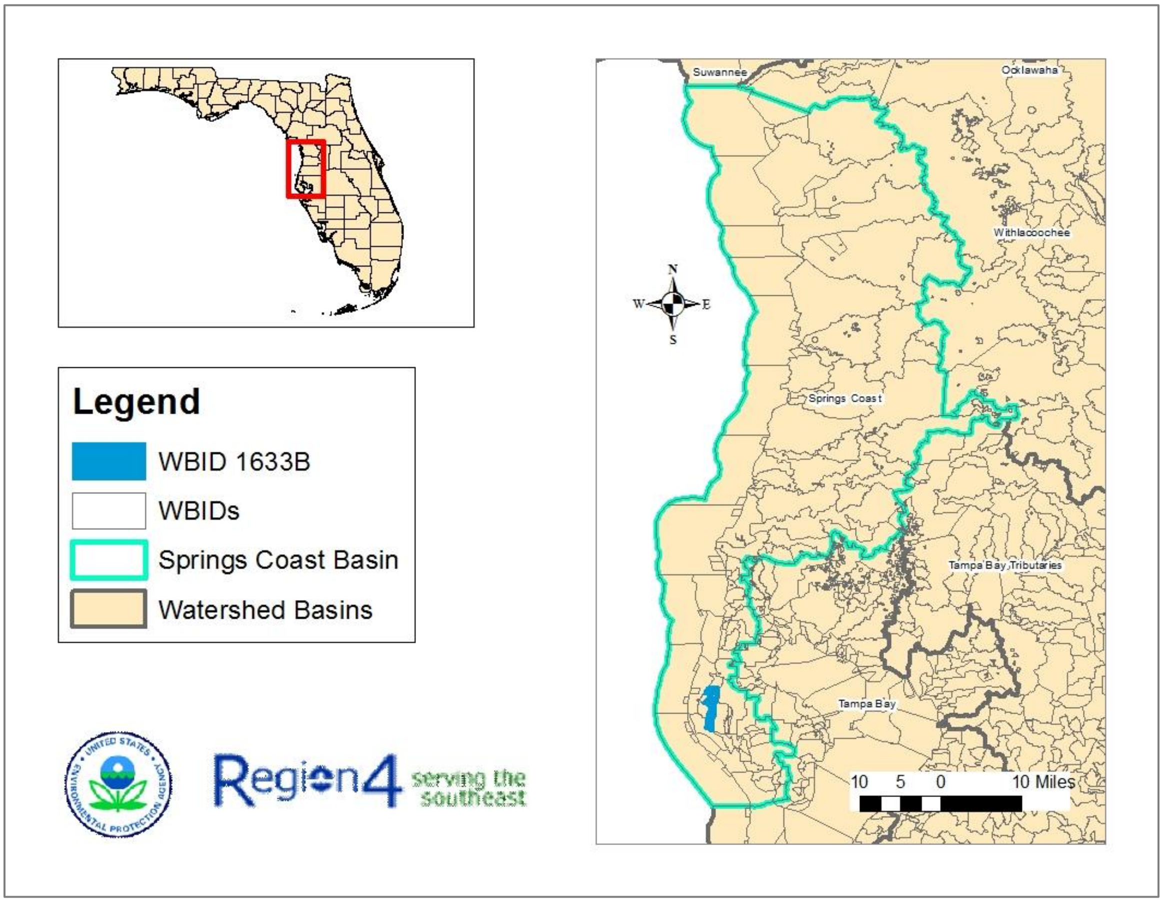

Figure 1 Location of WBID 1633B – McKay Creek

3. Watershed Description

McKay Creek, specifically WBID 1633B, is located in the western portion of Pinellas County, less than two miles upstream of the Gulf of Mexico. McKay Creek consists primarily of canals running alongside residential and commercial properties.

McKay Creek drains to McKay Creek Tidal (WBID 1633B) which then drains to the Gulf of Mexico. WBID 1633B drains approximately 4169 acres (6.51 mi^2) and consists primarily of urban/built-up land use (Figure 2). A breakdown of land use by acreage and percentage is provided below in Table 1. The latest landuse coverages were obtained from the FDEP FTP site. The landuses are based on 2004 land cover features and are classified using the Level 1 Florida Landuse Classification Code (FLUCC). Two lakes, the Taylor Lake and the Walsingham Reservoir, are both located within the perimeter of WBID 1633B but are treated as separate waterbodies with their own unique WBID numbers. For this reason, these lakes were not included in Figure 2 or Table 1. Each lake is surrounded by a public park, Taylor Park and Walsingham Park respectfully. Both parks include amenities such as multi-purpose trails, boat ramps and several picnic shelters. Walsingham Park's amenities also include a dog park.

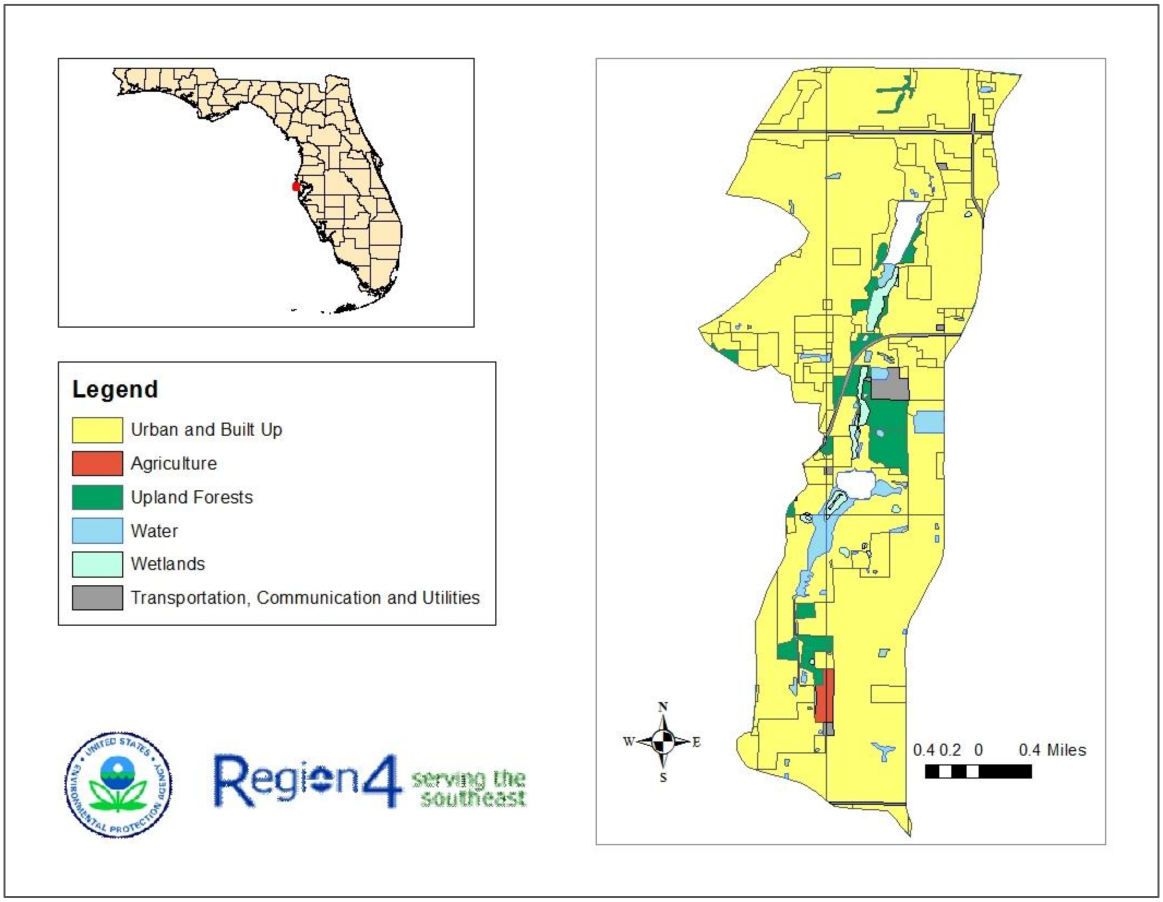

Figure 2 McKay Creek – WBID 1633B Landuse Distribution

Table 1 Landuse Distribution in WBID 1633B: McKay Creek

Impaired Waterbody	WBID(s)	Unit[1]	Urban Residential & Built-Up[2]	Agriculture	Forest	Water	Wetlands	Transportation & Utilities	Total
McKay Creek	1633B	acres	3632	27	220	140	59	91	4169
		percent	87.1%	0.6%	5.3%	3.4%	1.4%	2.2%	100%

Notes:
1. Areas in the table represent the watershed within WBID 1633B.
2. The urban/residential and built-up category includes commercial, industrial and extractive uses.

There is no known wastewater National Pollutant Discharge Elimination System (NPDES) permitted surface water discharge within the watershed. WBID 1633B lies within the Municipal Separate Storm Sewer System (MS4) permitted service area for Pinellas County (FLS000005), more specifically within the city of Largo, a co-permitee listed on the Phase I MS4 permit. The MS4 includes ditches, curbs, gutters, storm sewers, and similar means of collecting or conveying runoff that dooe not connect with a wastewater collection system or treatment plant.

4. Water Quality Standards/TMDL Targets

The waterbody in the McKay Creek WBID is Class III Freshwater with a designated use of Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. Designated use classifications are described in FAC Section 62-302.400(1), and water quality criteria for protection of all classes of waters are established in FAC Section 62-302.530. Individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 FAC. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative criteria are specified in FAC Section 62-302.530.

4.1. Fecal Coliform Bacteria (Class III Waters)

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. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period.

The geometric mean criteria reflect chronic or long-term water quality conditions, whereas the 400 and 800 values reflect acute or short-term conditions. It was not possible to assess against the geometric mean criteria due to insufficient fecal coliform data. The 400 count/100 ml criterion was selected as the TMDL endpoint. EPA believes implementation of the percent reduction required in this TMDL will achieve restoration of the waterbody. EPA assumes that the best management practices that will be used to achieve the prescribed reductions will ensure that all three parts of the standard will be met. Florida's continued monitoring and assessment of this waterbody will provide the data and information necessary to demonstrate whether the waterbody is fully restored.

5. Water Quality Assessment

WBID 1633B McKay Creek was listed as not attaining its designated uses on Florida's 1998 303(d) list for fecal coliform. To determine impairment an assessment of available data was conducted. The source for current ambient monitoring data for WBID 1633B McKay Creek was the IWR data Run 44. The IWR database contains data from various sources within the state of Florida, including the WMDs and counties.

5.1. Water Quality Data

The table and figures presented in this section provide the station locations and time series data for fecal coliform bacteria for McKay Creek. Table 2 provides a list of the water quality monitoring stations in WBID 1633B, including the data range of the observations and the number of observations. Figure 3 illustrates where the IWR stations are located within the WBID.

Table 2 Water Quality Monitoring Stations for WBID 1633B: McKay Creek

Station	Station Name	First Date	Last Date	No. Obs
21FLGW 35437	SW5-SS-2062 MCKAY CREEK	10/21/2008	10/21/2008	1
21FLPDEM27-03	McKay Creek	6/28/2005	3/22/2011	28
21FLPDEM27-09	McKay Creek	2/24/2005	3/22/2011	48
21FLPDEM27-10	McKay Creek	5/16/2005	3/22/2011	27
21FLTPA 27525378248329	TP294-McKay Creek	3/15/2004	1/3/2005	6
21FLTPA 27543408248589	TP295-McKay Creek	3/15/2004	1/3/2005	7
21FLTPA 27544608248480	TP296-McKay Creek	3/15/2004	1/3/2005	7
21FLTPA 27545608248150	TP297-McKay Creek	3/15/2004	1/3/2005	6
21FLTPA 27550008248318	TP293-McKay Creek	3/15/2004	1/3/2005	6

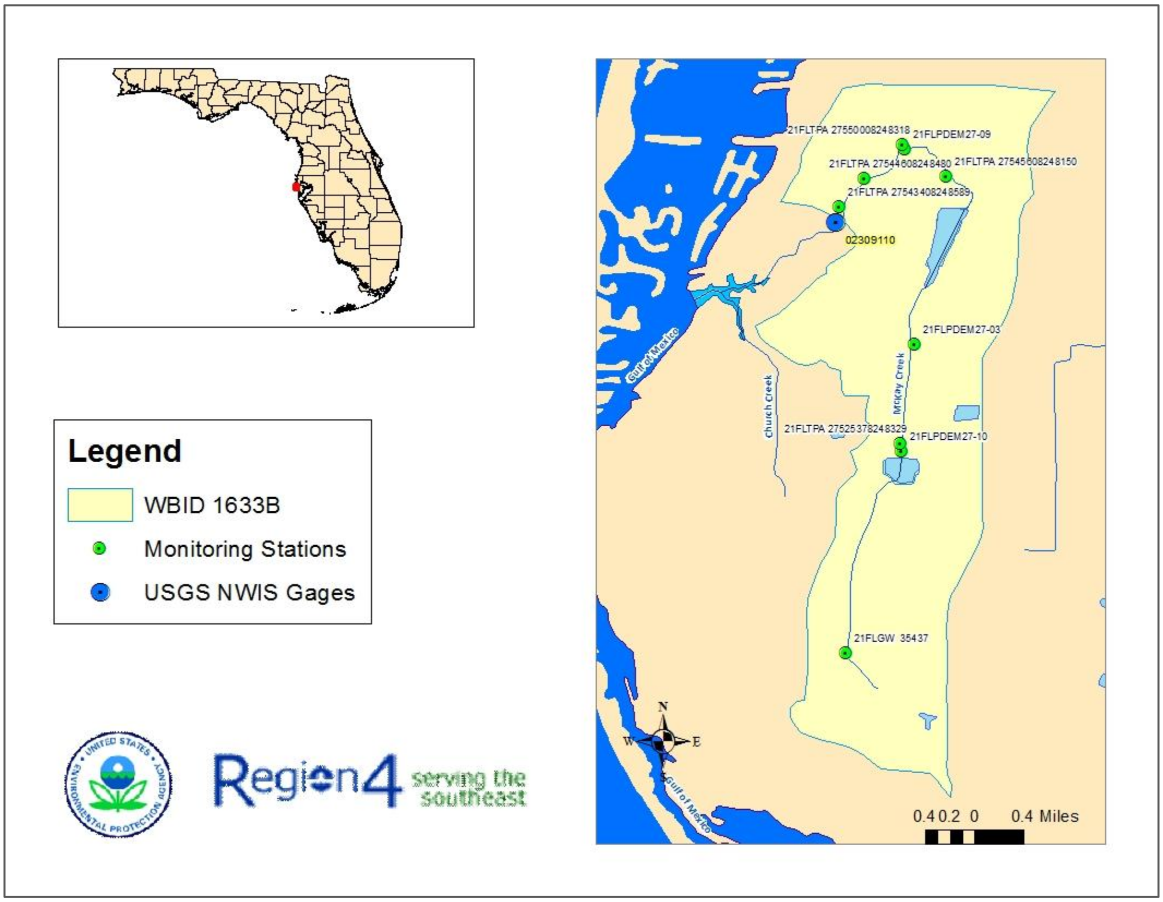

Figure 3 Station Locations for WBID 1633B: McKay Creek

Fecal Coliform

Figure 4 provides a time series plot of fecal coliform data in McKay Creek. There were 9 monitoring stations used in the assessment that included a total of 136 observations, of which 50 (37%) fell above the water quality standard of 400 counts/100 ml fecal coliform. Several samples were flagged with laboratory remark codes. The following laboratory remark codes were associated with at least one of the samples analyzed as part of this TMDL.

Remark Code B –The laboratory remark code B indicates that the sample result was based upon colony counts outside of the acceptable range. However, the colony counts were considered to be an accurate count and are acceptable for use in the TMDL analysis.

Remark Code L – The laboratory remark code L indicates that the sample result was off-scale high. The actual value is not known, but is known to be greater than the value shown. The sample result was included in the analysis as reported.

Remark Code M – The laboratory remark code M indicates that the presence of fecal coliform in the sample was verified, but not quantified. The detection was at a level too low to permit accurate quantification. The detection limit was used to represent the actual concentration present at the time of sampling. The detection limit for these samples is at least 4 times less than the fecal coliform criteria and does not increase the calculated TMDL percent reduction. Therefore, the samples were included in the TMDL analysis.

Remark Code U – The laboratory remark code U indicates that the sample was analyzed but fecal coliform was not detected. The value stored in the database is the detection limit and may be greater than the actual concentration present at the time of sampling. However, the detection limit for these samples is at least 10 times less than the fecal coliform criteria and does not increase the calculated TMDL percent reduction. Therefore, the sample was included in the TMDL analysis.

Appendix A provides the complete list of data results used in this TMDL analysis, along with laboratory remark codes, as applicable. Summary statistics for the fecal coliform data are provided in Table 3.

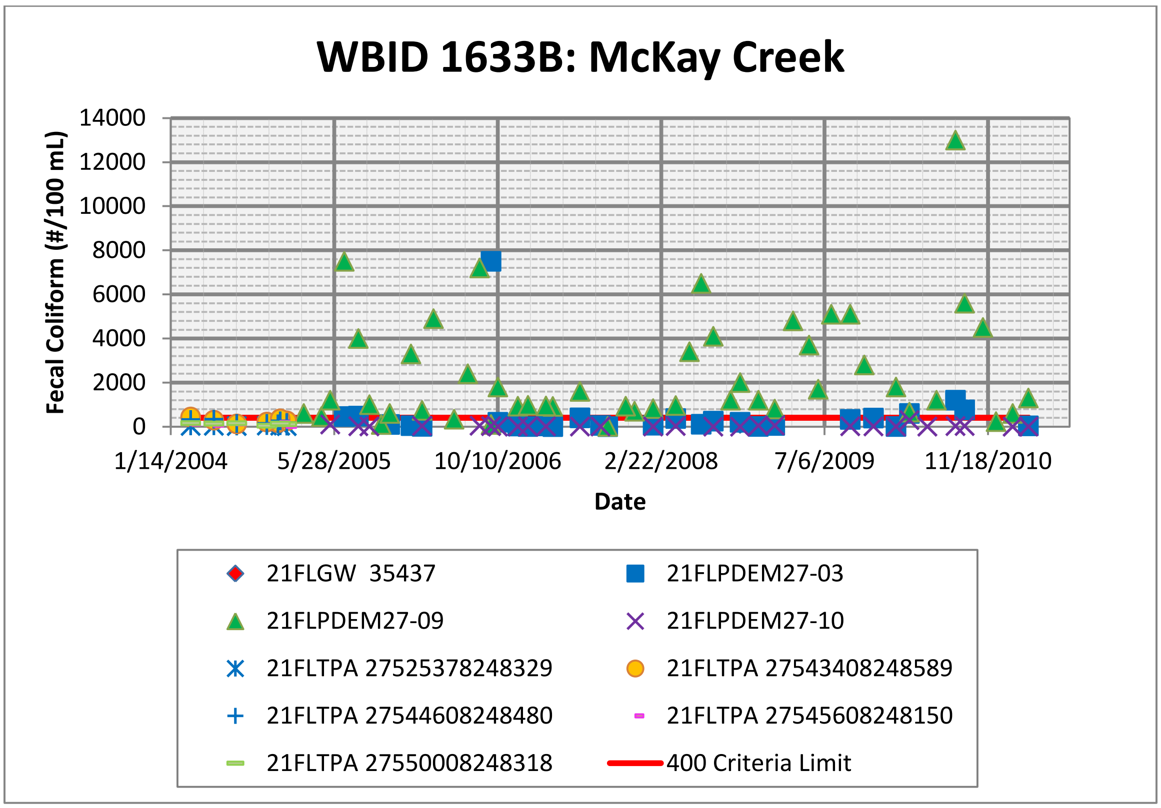

Figure 4 WBID 1633B: McKay Creek Measured Fecal Coliform

Table 3. Water Quality Statistics for Fecal Coliforms

Monitoring Station	Minimum Concentration (#/100ml)	Maximum Concentration (#/100ml)	Mean Concentration (#/100ml)	Standard Deviation (#/100ml)	# Samples >400 (#/100ml)	# Samples >800 (#/100ml)
21FLGW 35437[1]	150	150	150	N/A	0	0
21FLPDEM27-03	1	7500	490	1402	6	2
21FLPDEM27-09	14	13000	2423	2546	43	35
21FLPDEM27-10	1	300	32	58	0	0
21FLTPA 27525378248329	25	50	38	9	0	0
21FLTPA 27543408248589	125	440	267	108	1	0
21FLTPA 27544608248480	130	340	220	89	0	0
21FLTPA 27545608248150	30	175	105	57	0	0
21FLTPA 27550008248318	45	165	127	45	0	0

[1]Note: Standard Deviation was not calculated because only one sample was collected at this monitoring station.

Stream flow is an important factor affecting water quality, especially insofar as it can be used to correlate flow rate with observed exceedances and determine the available loading capacity for pollutants. Flow data was not available for the McKay Creek, specifically WBID 1633B. However, gage height data is available at USGS Gage 02309110 located on McKay Creek near Largo FL, immediately downstream of WBID 1633B (See Figure 3). Although it is necessary to know the stream's cross sectional area at the gaged location in order to calculate a corresponding flow rate from gage height data, gage height correlates with flow nonlinearly such that an increase in the height of water in the channel indicates an increase in flow and vice versa. The gage height data measured at Gage 02309110 was used to determine what relationship, if any, exists between observed exceedances of bacteria and stream levels in the McKay Creek.

The first step in evaluating this relationship is to create a duration curve for McKay Creek based on the gage height data (Figure 5). Again, since flow data is not available, gage height data was used to represent the increases and decreases in flow during the period of recorded data (2003-2011). The duration curve displays the cumulative frequency distribution of daily gage height measurements over the period of record. The curve relates the stream heights measured for a particular location on the stream to a duration interval representing the percent of time those measurements are equaled or exceeded. Values toward the right side of the plot indicate low stream heights (indicative of low flow conditions) that are surpassed with greater frequency. Values on the left side of the plot represent high stream heights (indicative of high flow conditions) that occur less frequently. For example, the level of water in the stream is expected to be equal to or greater than the gage height corresponding to a duration interval of 30 approximately

30 percent of the time, and less than that value approximately 70 percent of the time. Duration curves are limited to the period of record available at a gage.

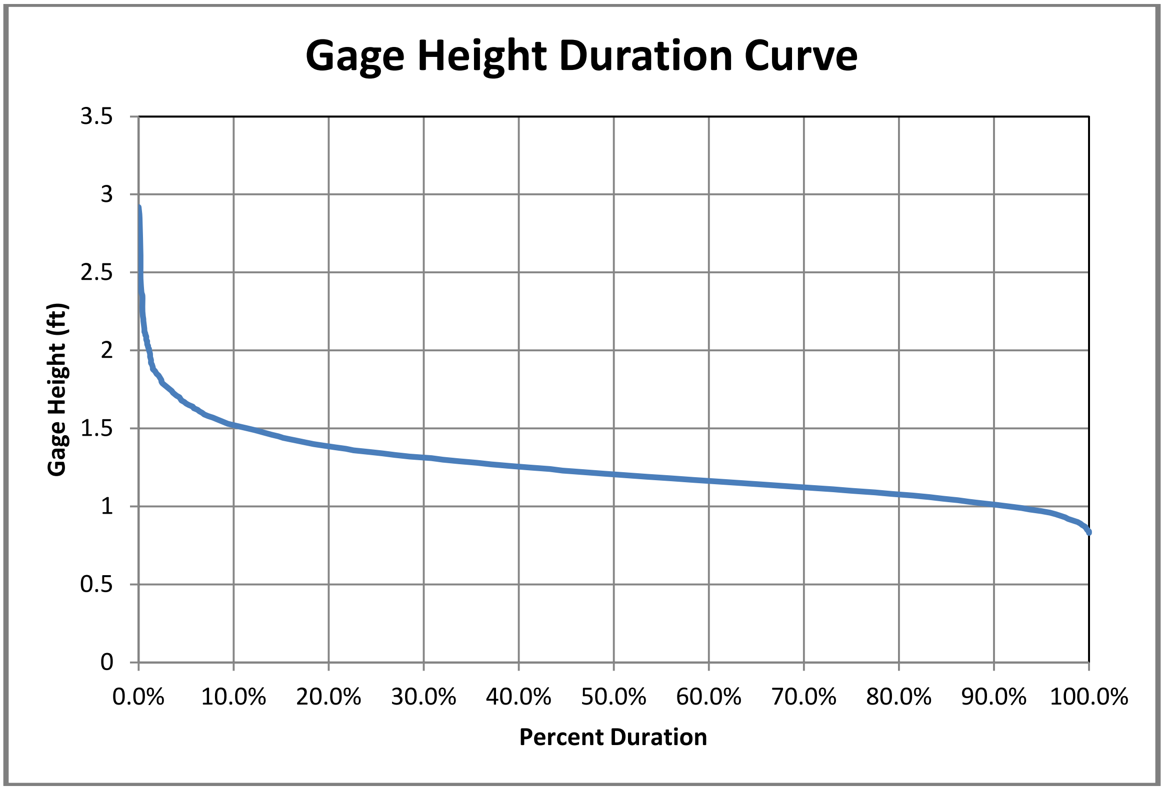

Figure 5. Gage Height Duration Curve for McKay Creek from 2003-2011 data at USGS Gage 02309110

Duration curve intervals may be grouped into broad categories, or zones, in order to characterize the conditions and patterns associated with impairment (Cleland, 2003). Load duration curves are typically divided into five flow zones. Although, a load duration curve cannot be calculated for this WBID, since no flow data exists, the same five flow zones were used to provide general insight into the patterns associated with impairment. As previously stated, gage height data can be used to infer high and low flow conditions. The five flow zones are as follows: high flows (0-10% duration), moist conditions (10-40% duration), median or mid-range flows (40-60% duration), dry conditions (60-90% duration), and low flow (90-100% duration). Note that in using these intervals, the 25th percentile is the midpoint of the moist zone, the 50th percentile is the midpoint of the mid-range zone, and the 75th percentile is the median of the dry zone. The 5th and 95th percentiles are the midpoints of the high and low flow zones, respectively. Data falling into the high and low flow zones are frequently considered to represent extreme conditions.

Fecal coliform data, from the three monitoring stations where exceedances were detected, were compared with the frequency distribution for the gage height measured on the same day each sample was collected (Figures 6-8). In general, violations appearing on the right side of the curve occurred during low flow conditions and are indicative of either continuous, direct pollutant sources and/or sources that contaminate the stream's baseflow, such as leaking collection lines or septic systems. Violations that appear on the left side of the curve occurred during high flow events, indicating that pollutant delivery is likely driven by rainfall. In the case of McKay Creek, exceedances that occur during higher flows, as measured at Gage 02309110, may also correlate with releases from the two reservoirs located along the creek.

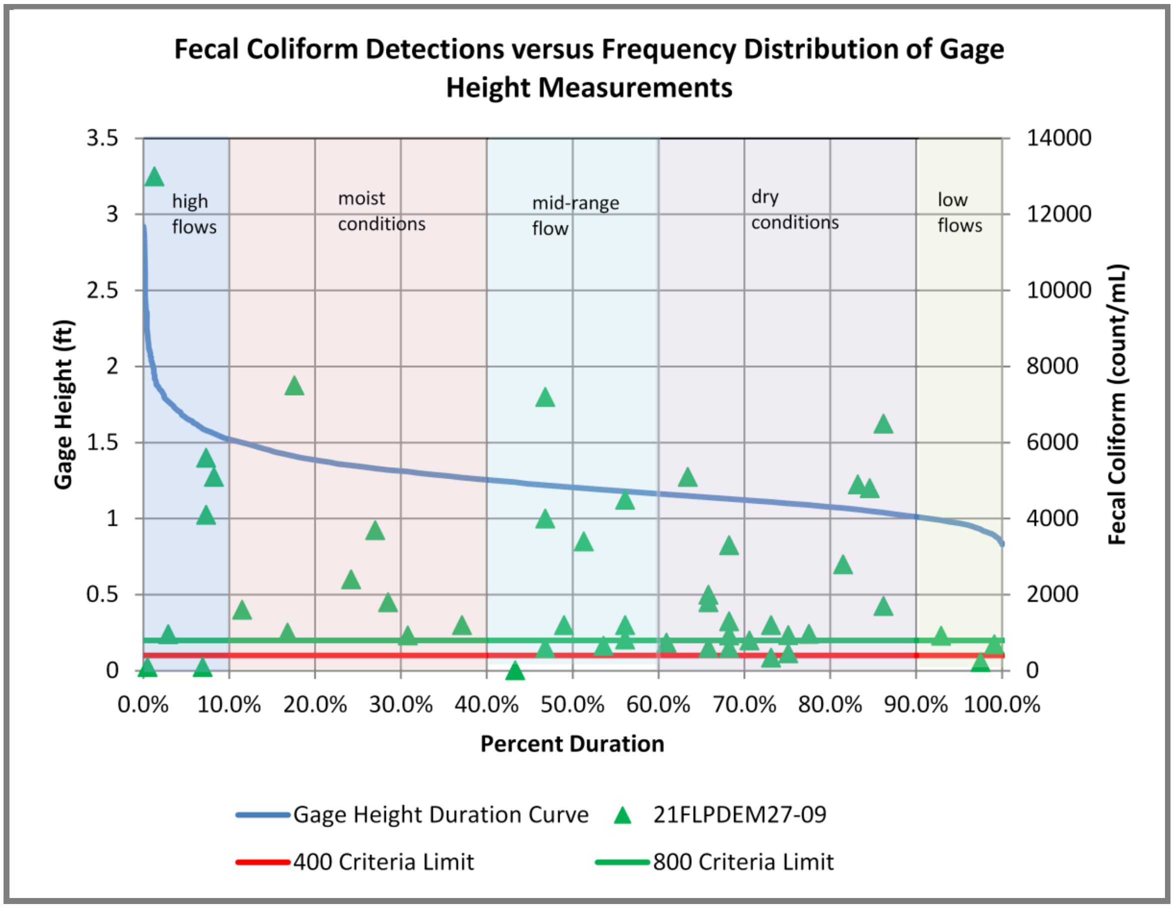

Figure 6 Monitoring Station 21FLPDEM27-09 Fecal Coliform Detections versus Frequency Distribution of Gage Height Measurements at USGS 02309110

Figure 6 illustrates that the exceedances detected at Monitoring Station 21 FLPDEM27-09 do not appear to be dependent on any one type of flow condition. Exceedances of both the 400 and 800 criterion were detected in all five flow zones.

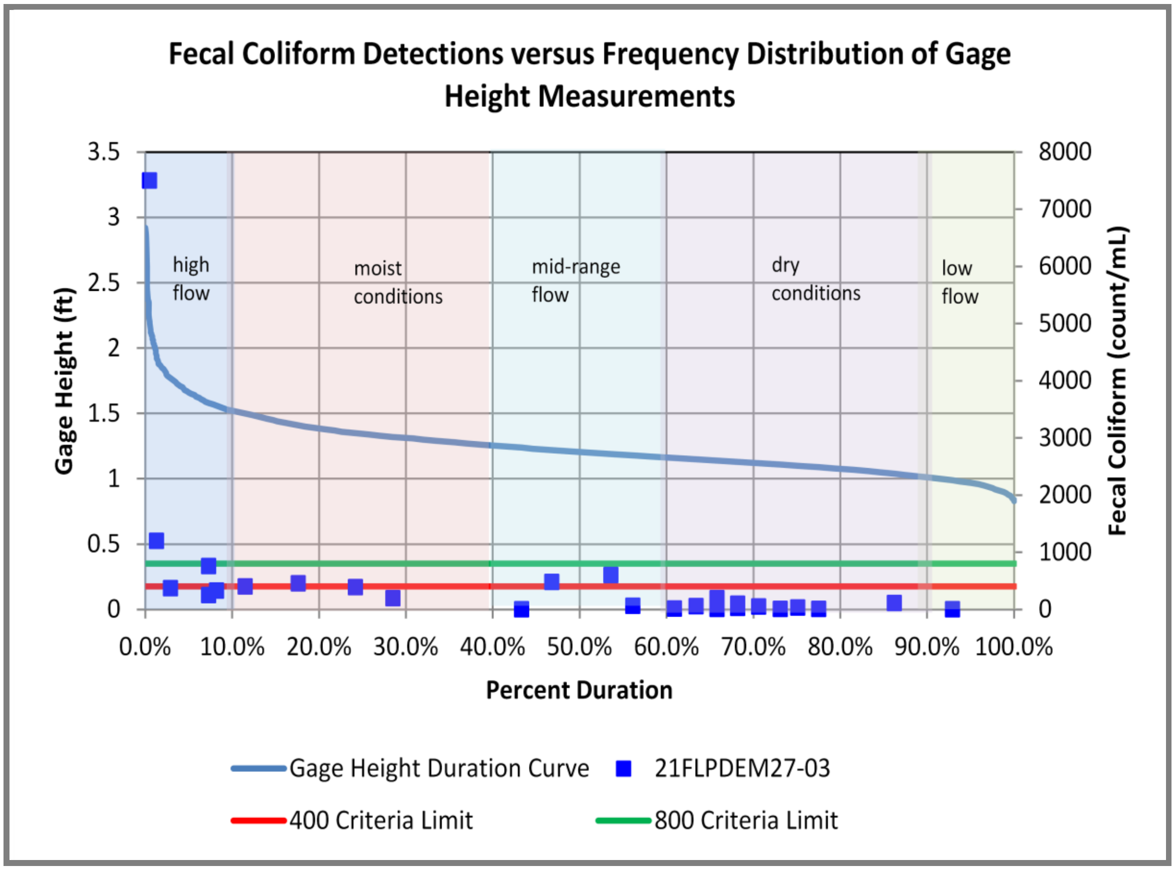

Figure 7. Monitoring Station 21FLPDEM27-03 Fecal Coliform Detections versus Frequency Distribution of Gage Height Measurements at USGS 02309110

Figure 7 illustrates that the exceedances detected at Monitoring Station 21 FLPDEM27-03 may be dependent on flow conditions. Exceedances of both the 400 and 800 criterion were detected in the high flow zone, while exceedances of only the 400 criteria was observed in the moist conditions and mid-range flow zones. No exceedances were observed in the dry conditions and low flow zones.

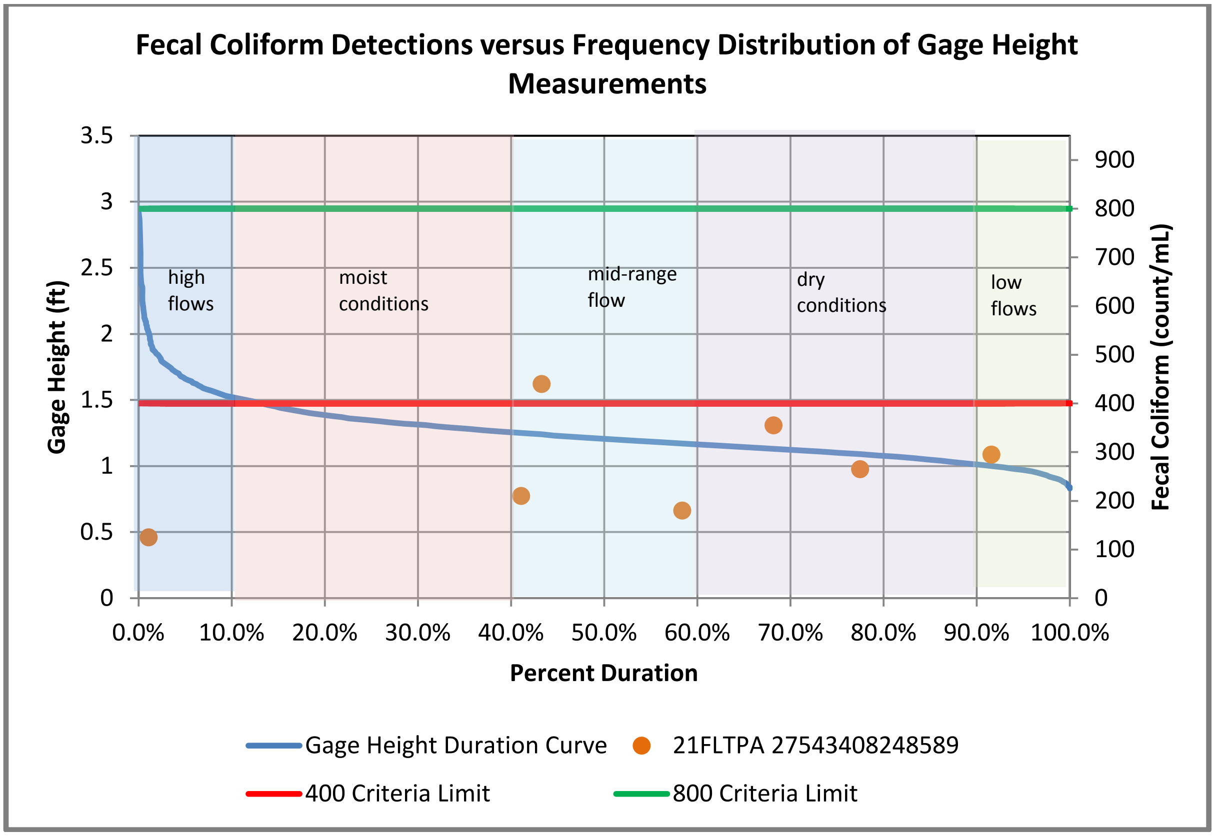

Figure 8. Monitoring Station 21 FLTPA 27543408248589 Fecal Coliform Detections versus Frequency Distribution of Gage Height Measurements at USGS 02309110

Figure 8 illustrates that only one exceedance of the 400 criteria was detected at Monitoring Station 21 FLTPA 27543408248589 during the mid-range flow zone. However, it should be noted that only one year of data was available for this monitoring station, and only one sample was collected during higher flow conditions.

Based on the information presented above, exceedances were detected during all five flow zones; therefore, implementation of this TMDL should address control of point and nonpoint sources during both wet and dry weather conditions. More information pertaining to the potential point and nonpoint sources of fecal coliform bacteria to McKay Creek WBID 1633B is provided in the following sections.

6. Source and Load Assessment

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources. Coliform bacteria can enter surface waters from both point and nonpoint sources.

6.1. Point Sources

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by NPDES permits. NPDES permitted discharges include continuous discharges such as wastewater treatment facilities as well as some stormwater driven sources such as MS4s, certain industrial facilities, and construction sites over one acre.

6.1.1. Wastewater/Industrial Permitted Facilities

There are no wastewater or industrial NPDES permitted facilities that discharge to or upstream of McKay Creek, specifically WBID 1633B.

6.1.2. Stormwater Permitted Facilities/MS4s

The 1987 amendments to the Clean Water Act designated certain stormwater discharges as point sources requiring NPDES stormwater permits. The regulated activities involve MS4s, construction sites over one acre, and specific industrial operations. Although these types of stormwater discharges are now considered point sources with respect to permitting and TMDLs, they behave similarly to nonpoint sources in that they are driven by rainfall-runoff processes leading to the intermittent discharge of pollutants from land use activities in response to storms.

According to 40 CFR 122.26(b)(8), an MS4 is "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

> (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States;
>
> (ii) Designed or used for collecting or conveying storm water;
>
> (iii) Which is not a combined sewer; and
>
> (iv) Which is not part of a Publicly Owned Treatment Works."

MS4s may discharge coliform bacteria and other pollutants to waterbodies in response to storm events. In 1990, USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of "medium" and "large" MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges from MS4s. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES stormwater program to certain "small" MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES stormwater program. Only a select subset of small MS4s, referred to as "regulated small MS4s", requires an NPDES stormwater permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of "urbanized areas" that are designated by NPDES permitting authorities.

In October 2000, USEPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (FS). The three major components of NPDES stormwater regulations are:

> • MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.
>
> • Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.
>
> • Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

McKay Creek, specifically WBID 1633B, lies within the Pinellas County MS4 permitted service area (Permit No. FLS000005). Pinellas County is a Phase I MS4 which consists of numerous co-permittees (23) representing cities, towns, villages, and other public bodies located within the Pinellas County area. Portions of WBID 1633B lie either within or adjacent to the city limits of Largo, Belleair Bluff and Seminole, co-permittees on the MS4 permit. A complete list of the co-permittees is provided in Appendix B.

Additionally, several facilities with minor Construction Stormwater Generic Permits and minor Industrial Stormwater Generic Permits are located within WBID 1633B; however, stormwater run-off from construction/industrial sites is not typically considered a significant source for coliform bacteria.

6.2. Non Point Sources

Nonpoint sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical nonpoint sources of coliform bacteria include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 permitted areas)

6.2.1. Wildlife

Wildlife contribute coliform bacteria by depositing feces onto land surfaces where it can be transported to nearby streams during storm events and by direct deposition to the waterbody by birds and other warm blooded animals. Bacteria originating from local wildlife are generally considered to represent natural background concentrations. In most impaired watersheds, the contribution from wildlife is small relative to the load from urban and agricultural areas. Five percent of the land area within WBID 1633B is designated as forested and approximately 5 percent of the land area is designated as water or wetlands. However, two lakes, the Taylor Lake and the Walsingham Reservoir, are located within the perimeter of WBID 1633B but have unique WBID numbers and were not included in the landuse designation. Wildlife, particularly birds and water fowl, could potentially be associated with these two lakes and therefore, could be potential sources of bacteria to McKay Creek, WBID 1633B.

6.2.2. Agriculture

Agriculture is a potential source of coliform delivery to streams, including runoff of manure from pastureland and cropland, and direct animal access to streams. Less than 1% of the total land area within WBID 1633B is designated as agricultural. Although agriculture represents only a small portion of the land use within the WBID, it could still be a potential source of pathogen loading to McKay Creek.

6.2.3. Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs), including septic tanks, are commonly used where providing sewer systems access is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients, pathogens, and other pollutants to both ground water and surface water.

The state of Florida Department of Health publishes data on new septic tank installations and the number of septic tank repair permits issued for each county in Florida. Table 4 summarizes the cumulative number of septic systems installed since the 1970 census and the total number of repair permits issued for years between 1991-92 and 2009-10. The data do not reflect septic tanks removed from service. Because these data are summarized at the county level, the extent to which these values pertain to the impaired watershed is not known.

Table 4 County Estimates of Septic Tanks and Repair Permits.

County	Number of Septic Tanks (1970- 2010)	Number of Repair Permits Issued (1991 – 2010)
Pinellas	23,869	3,015

Note: Source: http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

6.2.4. Urban Areas/Pervious

Urban areas include land uses such as residential, industrial, utility swaths, extractive and commercial. Fecal coliform loading from urban areas (whether within an MS4 jurisdiction or not) is attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

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 outlined in Chapter 403 FS, was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), FAC).

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of nonpoint source pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimization of impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

The area within the McKay Creek watershed, specifically WBID 1633B, consists primarily of urban land use (87 percent of the overall area) and is located within a permitted Phase I MS4. Two lakes, Taylor Lake and Walsingham Lake, are both located within the perimeter of WBID 1633B but have unique WBID numbers. Each lake is surrounded by a public park with amenities such as boat ramps and hiking trails. Walsingham Park also has a dog park. These types of amenities can be potential sources of bacteria from improper disposal of waste materials and domestic animals. Additionally, Monitoring Station 21 FLPDEM27-09, where 43 of the 50 exceedances were detected, is surrounded by both commercial and residential properties. As such, urban land use could be a relevant source of pathogen loading to the McKay Creek.

7. Analytical Approach

The approach for calculating fecal coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and concentration. Flow measurements were not available for WBID 1633B; therefore, this TMDL is expressed as a percent reduction.

7.1. Percent Reduction Approach for TMDL Development

Under this "percent reduction" method, the percent reduction needed to meet the applicable criterion is calculated based on a percentile of all measured concentrations. The (p X 100) percentile is the value with the cumulative probability of p. For example, the 90th percentile has a cumulative probability of 0.90. The 90th percentile is also called the 10 percent exceedance event because it will be exceeded with the probability of 0.10. Therefore, considering a set of water quality data, 90 percent of the measured values are lower than the 90th percentile concentration and 10 percent are higher. There are many formulas for determining the percentile and these can be found in many text books on statistics. The Hazen formula was used in this TMDL since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water. Application of the Hazen formula to data collected in WBID 1633B is provided in Appendix C.

The TMDL percent reduction required to meet the coliform criteria is based on the following equation:

$$\%\text{Reduction} = \left(\frac{[existing] - [criterion]}{[existing]} \right) \times 100$$

Where:
% Reduction = percent reduction
[*existing*] = existing concentration
[*criterion*] = criterion concentration (i.e. target)

8. TMDL Determination

A TMDL for a given pollutant and waterbody is comprised of the sum of individual waste load allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody and still achieve water quality standards and the waterbody's designated use. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be set and thereby provide the basis to establish water quality-based controls.

The percent reduction that meets the acute criteria for Class III waters was calculated by comparing the 90^{th} percentile value with the 400 counts/100 ml criterion. The calculated TMDL reduction for McKay Creek (WBID 1633B) is summarized in Table 5.

Table 5 Summary of TMDL Components.

Waterbody	WBID	WLA[1]		LA	TMDL
		Facility (MPN/day)	Stormwater/MS4 (% Reduction)[2]	(% Reduction)[2]	(% Reduction)[2]
McKay Creek	1633B	N/A	89%	89%	89%

Notes:

1. The WLA is typically separated into the components originating from continuous wastewater NPDES facilities (e.g. WWTPs) and from stormwater NPDES permitted facilities/public bodies (e.g. MS4s).
2. Overall percent reduction required to achieve the 400 counts/100 ml fecal coliform criterion. The MOS is implicit and does not take away from the TMDL value.

The TMDL is expressed as a daily load by multiplying the water quality target by an estimate of flow in the WBID. Flow data is not available for McKay Creek and it is not possible to estimate flow associated with the available data. However, it is recommended that flow be measured at the time of sampling to ensure compliance with the TMDL. The maximum load the stream can transport on any one day and maintain water quality standards is calculated by multiplying 800 counts/100 ml by the flow (in cubic feet per second), along with a conversion factor to obtain units of fecal coliform counts per day.

8.1. Critical Conditions and Seasonal Variation

The critical conditions can be defined as the environmental conditions requiring the largest reduction to meet standards. By achieving the reduction for critical conditions, water quality standards should be achieved during all other times. Seasonal variation must also be considered in TMDL development to ensure that water quality standards will be met during all seasons of the year.

The critical condition for nonpoint source coliform loading is typically an extended dry period followed by a rainfall-runoff event. During dry weather periods, coliforms build up on the land surface, and are washed off by subsequent rainfall. The critical condition for point source loading usually occurs during periods of low streamflow when dilution is minimized.

Flow data was not available for the McKay Creek, however, gage height data is available at USGS Gage 02309110 located on McKay Creek immediately downstream of WBID 1633B. The gage height data was used to determine what relationship, if any, existing between observed exceedances and measured stream levels in McKay Creek. Although gage height (i.e. stream height) does not provide the flow rate, it does correlate with flow in such that an increase in gage height would indicate an increase in flow and a decrease in gage height would indicate a decrease in flow. Fecal coliform data was compared with the duration curve for the gage height measurements. The duration curve represents the percent of time those measurements are equaled or exceeded. In order to characterize the conditions and patterns associated with impairment, the duration curve intervals were divided into five flow zones, assuming the relationship between gage height and flow exists as stated above. The five flow zones identified were high flows, moist conditions, mid-range flows, dry conditions, and low flows. Based on this analysis, exceedances were detected during all five flow zones. Therefore, critical conditions and seasonal variation are accounted for in the TMDL analysis for McKay Creek by selecting the largest percent reduction from the entire period of measured water quality data, and using it to represent the pollutant reduction required year-round, for the entire watershed.

8.2. Existing Conditions

Existing conditions represent the current water quality conditions of a waterbody. Existing conditions for WBID 1633B are being represented using the 90th percentile of measured concentrations. The 90th percentile and percent reduction required to meet the TMDL target are shown below in Table 6.

Table 6. Fecal Coliform Existing Conditions in McKay Creek (WBID 1633B).

90th Percentile Fecal Coliform Concentration	Percent Reduction to meet TMDL Target
3700	89 percent

Appendix A provides the complete list of data results used in this TMDL analysis, along with laboratory remark codes, as applicable.

8.3. Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative assumptions to develop TMDL allocations; or b) explicitly reserve a portion of the TMDL as the MOS and use the remainder for point and nonpoint source allocations. An implicit MOS was incorporated into the TMDL approach by including natural sources of fecal coliform bacteria in the calculation of existing conditions. This conservatively estimates the anthropogenic contributions and increases the required reduction for the TMDL.

8.4. Waste Load Allocations

Only MS4s and NPDES facilities discharging directly into water segments (or upstream tributaries of those segments) are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTPs) and MS4 areas, as the former discharges during all weather conditions, whereas the later discharges in response to storm events.

8.4.1. Wastewater/Industrial Permitted Facilities

There are no wastewater or industrial NPDES permitted facilities that discharge to McKay Creek, specifically WBID 1633B.

8.4.2. Stormwater Permitted Facilities/MS4s

The WLA for stormwater permitted facilities/MS4s are expressed in terms of percent reductions equivalent to the reductions required for nonpoint sources. Given the available data, it is not possible to estimate loadings coming exclusively from the stormwater permitted facilities and/or MS4 areas. Although the aggregate wasteload allocations for stormwater discharges are expressed in numeric form, i.e. percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow.

This TMDL assumes, for the reasons stated above, that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, this TMDL assumes that water quality-based effluent limitations for stormwater sources of nutrients derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that: (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these stormwater discharges; and (2) the state will perform ambient water quality monitoring for the purpose of determining whether the BMPs in fact are achieving such aggregate wasteload allocation.

McKay Creek, specifically WBID 1633B, lies within the Pinellas County MS4 permitted service area (Permit No. FLS000005). Pinellas County is a Phase I MS4 which consists of numerous co-permittees (23) representing cities, towns, villages, and other public bodies located within the Pinellas County area. A complete list of the co-permittees is provided in Appendix B.

Additionally, several facilities with minor Construction Stormwater Generic Permits and minor Industrial Stormwater Generic Permits are located within WBID 1633B; however, stormwater run-off from construction/industrial sites is not typically considered a source for coliform bacteria and were not included in the WLA.

8.5. Load Allocations

The load allocation for nonpoint sources was assigned a percent reduction from the current loadings coming into McKay Creek.

9. Recommendations

A majority of the fecal coliform bacteria exceedances were detected at one monitoring station located within an urban area. The initial step in implementing a pathogen TMDL is to more specifically locate the source(s) of bacteria in the watershed. Additional work to locate the source(s) in the area of Monitoring Station 21 FLPDEM27-09 is recommended.

FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the specified load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

10. References

Cleland, Bruce, 2003. *TMDL development from the "bottom up" – Part III: Duration curves and wet-weather assessments.* America's Clean Water Foundation, Washington, DC. September 15, 2003.

Florida Administrative Code. Chapter 62-302, Surface Water Quality Standards.

Florida Administrative Code. Chapter 62-303, Identification of Impaired Surface Waters.

P.R. Hunter. 2002. The Society for Applied Microbiology, Letters in Applied Microbiology. 34. 283–286.

USEPA, 1991. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

Appendix A

Fecal Coliform Measurements in McKay Creek (WBID 1633B)

Date	Time	Station	Fecal Coliform (count/100ml)	Remark Code
10/21/2008	1120	21FLGW 35437	150	B
6/28/2005	1223	21FLPDEM27-03	460	
8/10/2005	1017	21FLPDEM27-03	480	
11/14/2005	1245	21FLPDEM27-03	100	B
1/18/2006	1020	21FLPDEM27-03	47	B
2/21/2006	1325	21FLPDEM27-03	14	B
9/20/2006	925	21FLPDEM27-03	7500	B
10/11/2006	1158	21FLPDEM27-03	200	B
12/11/2006	1329	21FLPDEM27-03	29	B
1/11/2007	1102	21FLPDEM27-03	7	U
3/7/2007	1303	21FLPDEM27-03	34	B
3/28/2007	1053	21FLPDEM27-03	3	B
6/19/2007	942	21FLPDEM27-03	400	
8/21/2007	1342	21FLPDEM27-03	57	B
9/12/2007	1535	21FLPDEM27-03	1	M
1/29/2008	1028	21FLPDEM27-03	67	B
4/7/2008	1259	21FLPDEM27-03	370	B
6/24/2008	1242	21FLPDEM27-03	110	B
7/31/2008	1040	21FLPDEM27-03	250	
10/21/2008	1121	21FLPDEM27-03	200	
12/16/2008	1219	21FLPDEM27-03	11	B
2/4/2009	1015	21FLPDEM27-03	54	
9/23/2009	1138	21FLPDEM27-03	330	
12/3/2009	1304	21FLPDEM27-03	390	
2/10/2010	1137	21FLPDEM27-03	7	B
3/23/2010	1113	21FLPDEM27-03	600	
8/11/2010	1056	21FLPDEM27-03	1200	B
9/8/2010	1233	21FLPDEM27-03	760	
3/22/2011	1050	21FLPDEM27-03	37	
2/24/2005	910	21FLPDEM27-09	600	
4/19/2005	1218	21FLPDEM27-09	460	
5/16/2005	1210	21FLPDEM27-09	1200	
6/28/2005	1106	21FLPDEM27-09	7500	B
8/10/2005	832	21FLPDEM27-09	4000	
9/13/2005	1100	21FLPDEM27-09	1000	
10/19/2005	1134	21FLPDEM27-09	100	M
11/14/2005	1145	21FLPDEM27-09	600	B
1/18/2006	927	21FLPDEM27-09	3300	B
2/21/2006	1215	21FLPDEM27-09	740	
3/28/2006	928	21FLPDEM27-09	4900	
5/30/2006	1201	21FLPDEM27-09	340	B
7/11/2006	1118	21FLPDEM27-09	2400	
8/16/2006	1138	21FLPDEM27-09	7200	B

Date	Time	Station	Fecal Coliform (count/100ml)	Remark Code
9/20/2006	821	21FLPDEM27-09	100	M
10/11/2006	920	21FLPDEM27-09	1800	
12/11/2006	1149	21FLPDEM27-09	930	B
1/11/2007	1153	21FLPDEM27-09	970	
3/7/2007	1215	21FLPDEM27-09	940	
3/28/2007	1152	21FLPDEM27-09	920	
6/19/2007	1031	21FLPDEM27-09	1600	
9/12/2007	1321	21FLPDEM27-09	14	M
11/6/2007	1107	21FLPDEM27-09	930	B
12/3/2007	1102	21FLPDEM27-09	700	
1/29/2008	836	21FLPDEM27-09	820	
4/7/2008	1058	21FLPDEM27-09	960	
5/19/2008	858	21FLPDEM27-09	3400	B
6/24/2008	1158	21FLPDEM27-09	6500	B
7/31/2008	1122	21FLPDEM27-09	4100	
9/22/2008	1056	21FLPDEM27-09	1200	B
10/21/2008	903	21FLPDEM27-09	2000	
12/16/2008	1020	21FLPDEM27-09	1200	
2/4/2009	1053	21FLPDEM27-09	800	B
4/1/2009	1056	21FLPDEM27-09	4800	B
5/20/2009	1032	21FLPDEM27-09	3700	
6/17/2009	1211	21FLPDEM27-09	1700	
7/27/2009	917	21FLPDEM27-09	5100	B
9/23/2009	1052	21FLPDEM27-09	5100	
11/5/2009	1325	21FLPDEM27-09	2800	
2/10/2010	1032	21FLPDEM27-09	1800	
3/23/2010	1042	21FLPDEM27-09	660	
6/14/2010	1203	21FLPDEM27-09	1200	
8/11/2010	1135	21FLPDEM27-09	13000	B
9/8/2010	1541	21FLPDEM27-09	5600	
11/3/2010	1127	21FLPDEM27-09	4500	
12/13/2010	1123	21FLPDEM27-09	230	
2/2/2011	1217	21FLPDEM27-09	600	
3/22/2011	1342	21FLPDEM27-09	1300	
5/16/2005	1333	21FLPDEM27-10	100	B
8/10/2005	943	21FLPDEM27-10	20	B
9/13/2005	1300	21FLPDEM27-10	13	B
2/21/2006	1441	21FLPDEM27-10	34	U
8/16/2006	1020	21FLPDEM27-10	43	B
9/20/2006	909	21FLPDEM27-10	27	B
10/11/2006	1057	21FLPDEM27-10	3	B
12/11/2006	1257	21FLPDEM27-10	9	B
1/11/2007	937	21FLPDEM27-10	13	B
3/7/2007	1423	21FLPDEM27-10	12	B
6/19/2007	911	21FLPDEM27-10	7	B
8/21/2007	1444	21FLPDEM27-10	11	B
1/29/2008	953	21FLPDEM27-10	9	
4/7/2008	1231	21FLPDEM27-10	31	

Date	Time	Station	Fecal Coliform (count/100ml)	Remark Code
7/31/2008	1010	21FLPDEM27-10	2	
10/21/2008	1052	21FLPDEM27-10	1	
12/16/2008	1148	21FLPDEM27-10	52	
2/4/2009	858	21FLPDEM27-10	53	
9/23/2009	1233	21FLPDEM27-10	21	
12/3/2009	1207	21FLPDEM27-10	14	
2/10/2010	1235	21FLPDEM27-10	7	
3/23/2010	1135	21FLPDEM27-10	300	
5/17/2010	1223	21FLPDEM27-10	5	
8/11/2010	956	21FLPDEM27-10	28	
9/8/2010	1121	21FLPDEM27-10	32	
2/2/2011	1057	21FLPDEM27-10	1	B
3/22/2011	1143	21FLPDEM27-10	6	B
3/15/2004	945	21FLTPA 27525378248329	35	B
5/25/2004	1250	21FLTPA 27525378248329	40	B
8/3/2004	1100	21FLTPA 27525378248329	30	B
11/3/2004	915	21FLTPA 27525378248329	50	B
12/14/2004	1235	21FLTPA 27525378248329	45	B
1/3/2005	915	21FLTPA 27525378248329	25	B
3/15/2004	1015	21FLTPA 27543408248589	440	
5/25/2004	1115	21FLTPA 27543408248589	295	
8/3/2004	1005	21FLTPA 27543408248589	125	
11/3/2004	955	21FLTPA 27543408248589	210	
12/7/2004	1205	21FLTPA 27543408248589	180	
12/14/2004	1140	21FLTPA 27543408248589	355	L
1/3/2005	945	21FLTPA 27543408248589	265	
3/15/2004	1040	21FLTPA 27544608248480	325	B
5/25/2004	1135	21FLTPA 27544608248480	340	
8/3/2004	1020	21FLTPA 27544608248480	145	
11/3/2004	1010	21FLTPA 27544608248480	150	
12/7/2004	1220	21FLTPA 27544608248480	130	
12/14/2004	1155	21FLTPA 27544608248480	265	
1/3/2005	950	21FLTPA 27544608248480	185	
3/15/2004	1105	21FLTPA 27545608248150	140	
5/25/2004	1210	21FLTPA 27545608248150	85	B
8/3/2004	1045	21FLTPA 27545608248150	145	
11/3/2004	1030	21FLTPA 27545608248150	55	B
12/14/2004	1215	21FLTPA 27545608248150	175	
1/3/2005	1015	21FLTPA 27545608248150	30	B
3/15/2004	1050	21FLTPA 27550008248318	165	
5/25/2004	1155	21FLTPA 27550008248318	135	
8/3/2004	1030	21FLTPA 27550008248318	160	
11/3/2004	1020	21FLTPA 27550008248318	45	B
12/14/2004	1200	21FLTPA 27550008248318	145	
1/3/2005	1005	21FLTPA 27550008248318	110	

Appendix B

List Co-Permittees for the Pinellas County MS4 permit (FLS000005)

County	Permit/Co-permit Name	Permit ID Number	MS4 Type
Pinellas	City of Belleair Beach	FLS000005	Phase I
Pinellas	City of Belleair Bluffs	FLS000005	Phase I
Pinellas	City of Clearwater	FLS000005	Phase I
Pinellas	City of Dunedin	FLS000005	Phase I
Pinellas	City of Gulfport	FLS000005	Phase I
Pinellas	City of Indian Rocks Beach	FLS000005	Phase I
Pinellas	City of Largo	FLS000005	Phase I
Pinellas	City of Madeira Beach	FLS000005	Phase I
Pinellas	City of Oldsmar	FLS000005	Phase I
Pinellas	City of Pinellas Park	FLS000005	Phase I
Pinellas	City of Safety Harbor	FLS000005	Phase I
Pinellas	City of Seminole	FLS000005	Phase I
Pinellas	City of South Pasadena	FLS000005	Phase I
Pinellas	City of St. Pete Beach	FLS000005	Phase I
Pinellas	City of Tarpon Springs	FLS000005	Phase I
Pinellas	City of Treasure Island	FLS000005	Phase I
Pinellas	FDOT District 7	FLS000005	Phase I
Pinellas	Pinellas County Government	FLS000005	Phase I
Pinellas	Town of Belleair	FLS000005	Phase I
Pinellas	Town of Kenneth City	FLS000005	Phase I
Pinellas	Town of North Redington Beach	FLS000005	Phase I
Pinellas	Town of Redington Beach	FLS000005	Phase I
Pinellas	Town of Redington Shores	FLS000005	Phase I

Appendix C

Fecal Coliform Data and Percentiles for WBID 1633B

Date	Station	Result (counts/100mL)	Rank	Percentile by Hazen Method
9/12/2007	21FLPDEM27-03	1	1	0%
10/21/2008	21FLPDEM27-10	1	1	0%
2/2/2011	21FLPDEM27-10	1	1	0%
7/31/2008	21FLPDEM27-10	2	4	3%
3/28/2007	21FLPDEM27-03	3	5	3%
10/11/2006	21FLPDEM27-10	3	5	3%
5/17/2010	21FLPDEM27-10	5	7	5%
3/22/2011	21FLPDEM27-10	6	8	6%
1/11/2007	21FLPDEM27-03	7	9	6%
2/10/2010	21FLPDEM27-03	7	9	6%
6/19/2007	21FLPDEM27-10	7	9	6%
2/10/2010	21FLPDEM27-10	7	9	6%
12/11/2006	21FLPDEM27-10	9	13	9%
1/29/2008	21FLPDEM27-10	9	13	9%
12/16/2008	21FLPDEM27-03	11	15	11%
8/21/2007	21FLPDEM27-10	11	15	11%
3/7/2007	21FLPDEM27-10	12	17	12%
9/13/2005	21FLPDEM27-10	13	18	13%
1/11/2007	21FLPDEM27-10	13	18	13%
2/21/2006	21FLPDEM27-03	14	20	14%
9/12/2007	21FLPDEM27-09	14	20	14%
12/3/2009	21FLPDEM27-10	14	20	14%
8/10/2005	21FLPDEM27-10	20	23	17%
9/23/2009	21FLPDEM27-10	21	24	17%
1/3/2005	21FLTPA 27525378248329	25	25	18%
9/20/2006	21FLPDEM27-10	27	26	19%
8/11/2010	21FLPDEM27-10	28	27	19%
12/11/2006	21FLPDEM27-03	29	28	20%
8/3/2004	21FLTPA 27525378248329	30	29	21%
1/3/2005	21FLTPA 27545608248150	30	29	21%
4/7/2008	21FLPDEM27-10	31	31	22%
9/8/2010	21FLPDEM27-10	32	32	23%
3/7/2007	21FLPDEM27-03	34	33	24%
2/21/2006	21FLPDEM27-10	34	33	24%
3/15/2004	21FLTPA 27525378248329	35	35	25%
3/22/2011	21FLPDEM27-03	37	36	26%
5/25/2004	21FLTPA 27525378248329	40	37	27%
8/16/2006	21FLPDEM27-10	43	38	28%
12/14/2004	21FLTPA 27525378248329	45	39	28%
11/3/2004	21FLTPA 27550008248318	45	39	28%
1/18/2006	21FLPDEM27-03	47	41	30%
11/3/2004	21FLTPA 27525378248329	50	42	31%
12/16/2008	21FLPDEM27-10	52	43	31%

Date	Station	Result (counts/100mL)	Rank	Percentile by Hazen Method
2/4/2009	21FLPDEM27-10	53	44	32%
2/4/2009	21FLPDEM27-03	54	45	33%
11/3/2004	21FLTPA 27545608248150	55	46	33%
8/21/2007	21FLPDEM27-03	57	47	34%
1/29/2008	21FLPDEM27-03	67	48	35%
5/25/2004	21FLTPA 27545608248150	85	49	36%
11/14/2005	21FLPDEM27-03	100	50	36%
10/19/2005	21FLPDEM27-09	100	50	36%
9/20/2006	21FLPDEM27-09	100	50	36%
5/16/2005	21FLPDEM27-10	100	50	36%
6/24/2008	21FLPDEM27-03	110	54	39%
1/3/2005	21FLTPA 27550008248318	110	54	39%
8/3/2004	21FLTPA 27543408248589	125	56	41%
12/7/2004	21FLTPA 27544608248480	130	57	42%
5/25/2004	21FLTPA 27550008248318	135	58	42%
3/15/2004	21FLTPA 27545608248150	140	59	43%
8/3/2004	21FLTPA 27544608248480	145	60	44%
8/3/2004	21FLTPA 27545608248150	145	60	44%
12/14/2004	21FLTPA 27550008248318	145	60	44%
10/21/2008	21FLGW 35437	150	63	46%
11/3/2004	21FLTPA 27544608248480	150	63	46%
8/3/2004	21FLTPA 27550008248318	160	65	47%
3/15/2004	21FLTPA 27550008248318	165	66	48%
12/14/2004	21FLTPA 27545608248150	175	67	49%
12/7/2004	21FLTPA 27543408248589	180	68	50%
1/3/2005	21FLTPA 27544608248480	185	69	50%
10/11/2006	21FLPDEM27-03	200	70	51%
10/21/2008	21FLPDEM27-03	200	70	51%
11/3/2004	21FLTPA 27543408248589	210	72	53%
12/13/2010	21FLPDEM27-09	230	73	53%
7/31/2008	21FLPDEM27-03	250	74	54%
1/3/2005	21FLTPA 27543408248589	265	75	55%
12/14/2004	21FLTPA 27544608248480	265	75	55%
5/25/2004	21FLTPA 27543408248589	295	77	56%
3/23/2010	21FLPDEM27-10	300	78	57%
3/15/2004	21FLTPA 27544608248480	325	79	58%
9/23/2009	21FLPDEM27-03	330	80	58%
5/30/2006	21FLPDEM27-09	340	81	59%
5/25/2004	21FLTPA 27544608248480	340	81	59%
12/14/2004	21FLTPA 27543408248589	355	83	61%
4/7/2008	21FLPDEM27-03	370	84	61%
12/3/2009	21FLPDEM27-03	390	85	62%
6/19/2007	21FLPDEM27-03	400	86	63%
3/15/2004	21FLTPA 27543408248589	440	87	64%
6/28/2005	21FLPDEM27-03	460	88	64%
4/19/2005	21FLPDEM27-09	460	88	64%
8/10/2005	21FLPDEM27-03	480	90	66%

Date	Station	Result (counts/100mL)	Rank	Percentile by Hazen Method
3/23/2010	21FLPDEM27-03	600	91	67%
2/24/2005	21FLPDEM27-09	600	91	67%
11/14/2005	21FLPDEM27-09	600	91	67%
2/2/2011	21FLPDEM27-09	600	91	67%
3/23/2010	21FLPDEM27-09	660	95	69%
12/3/2007	21FLPDEM27-09	700	96	70%
2/21/2006	21FLPDEM27-09	740	97	71%
9/8/2010	21FLPDEM27-03	760	98	72%
2/4/2009	21FLPDEM27-09	800	99	72%
1/29/2008	21FLPDEM27-09	820	100	73%
3/28/2007	21FLPDEM27-09	920	101	74%
12/11/2006	21FLPDEM27-09	930	102	75%
11/6/2007	21FLPDEM27-09	930	102	75%
3/7/2007	21FLPDEM27-09	940	104	76%
4/7/2008	21FLPDEM27-09	960	105	77%
1/11/2007	21FLPDEM27-09	970	106	78%
9/13/2005	21FLPDEM27-09	1000	107	78%
8/11/2010	21FLPDEM27-03	1200	108	79%
5/16/2005	21FLPDEM27-09	1200	108	79%
9/22/2008	21FLPDEM27-09	1200	108	79%
12/16/2008	21FLPDEM27-09	1200	108	79%
6/14/2010	21FLPDEM27-09	1200	108	79%
3/22/2011	21FLPDEM27-09	1300	113	83%
6/19/2007	21FLPDEM27-09	1600	114	83%
6/17/2009	21FLPDEM27-09	1700	115	84%
10/11/2006	21FLPDEM27-09	1800	116	85%
2/10/2010	21FLPDEM27-09	1800	116	85%
10/21/2008	21FLPDEM27-09	2000	118	86%
7/11/2006	21FLPDEM27-09	2400	119	87%
11/5/2009	21FLPDEM27-09	2800	120	88%
1/18/2006	21FLPDEM27-09	3300	121	89%
5/19/2008	21FLPDEM27-09	3400	122	89%
5/20/2009	21FLPDEM27-09	3700	123	90%
8/10/2005	21FLPDEM27-09	4000	124	91%
7/31/2008	21FLPDEM27-09	4100	125	92%
11/3/2010	21FLPDEM27-09	4500	126	92%
4/1/2009	21FLPDEM27-09	4800	127	93%
3/28/2006	21FLPDEM27-09	4900	128	94%
7/27/2009	21FLPDEM27-09	5100	129	94%
9/23/2009	21FLPDEM27-09	5100	129	94%
9/8/2010	21FLPDEM27-09	5600	131	96%
6/24/2008	21FLPDEM27-09	6500	132	97%
8/16/2006	21FLPDEM27-09	7200	133	97%
9/20/2006	21FLPDEM27-03	7500	134	98%
6/28/2005	21FLPDEM27-09	7500	134	98%
8/11/2010	21FLPDEM27-09	13000	136	100%

In this TMDL the Hazen formula was used to calculate percentiles since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water. To calculate the percentile associated with the sample concentrations, the data is first sorted by concentration, lowest to highest. A ranking is assigned to each sample, with the lowest concentration having a rank of 1 and the highest concentration having a rank equivalent to the total number of samples collected. The percentile is calculated as follows:

Percentile = (Rank – 0.5)/ (total number of samples collected)

For example, for WBID 1633B on January 3, 2005, a fecal coliform concentration of 265 counts/100 ml was measured at station 21FLTPA 27543408248589. This concentration ranks number 75 out of 136 samples collected in WBID 1633B. The associated percentile is calculated as:

Percentile = (75-0.5)/136 = 0.55 = 55%

This implies that 55 percent of the time, the instream concentration is less than 265 counts/100 ml.