

**FINAL
TOTAL MAXIMUM DAILY LOAD (TMDL)**

**For
Fecal Coliform**

**In
E-4 Canal (WBID 3264D)**

Prepared by:

US EPA Region 4
61 Forsyth Street SW
Atlanta, Georgia 30303

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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 E-4 Canal in the Lake Worth Lagoon-Palm Beach Coast Basin (WBID 3264D). Subsequent actions must be consistent with this TMDL.

James D. Giattina, Director
Water Protection Division

Date

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LIST OF ABBREVIATIONS

BMAP	Basin Management Action Plan
BMP	Best Management Practices
CFS	Cubic Feet per Second
CFR	Code of Federal Regulations
DA	Drainage Area
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
L/Ft ³	Liter per Cubic Feet
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
SFWMD	South Florida Water Management District
STORET	STORage RETrieval database
SQ MI	Square Miles
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
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 Waterbody Information

State: Florida

Major River Basin: Lake Worth Lagoon – Palm Beach Coast (HUC 03090206)

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name	River Basin	County	Constituent(s)
3264D	E-4 Canal	Lake Worth Lagoon – Palm Beach Coast	Palm Beach	Fecal Coliform

2. TMDL Endpoint (i.e., Target)

Class III Waters (Fresh):

Fecal Coliform: 400 counts/100ml (not to be exceeded in $\geq 10\%$ of samples)

3. Fecal Coliform Allocations:

Waterbody	WBID	WLA ¹		LA (% Reduction) ²	TMDL (% Reduction) ²
		Facility (counts/day)	MS4 (% Reduction) ²		
E-4 Canal	3264D	N/A	59%	59%	59%

Notes:

- The WLA is typically separated into the components originating from continuous NPDES facilities (e.g. WWTPs) and from Municipal Separate Storm Sewer System (MS4s). AWLA for MS4s is provided because E-4 Canal is located within two MS4s.
- Overall percent reduction required to achieve the 400 counts/100ml fecal coliform criterion. The Margin of Safety is implicit and does not take away from the TMDL value. See Section 5.6 for information about how to convert the TMDL to a daily load.

4. Endangered Species (yes or blank):

5. EPA Lead on TMDL (EPA or blank): EPA

6. TMDL Considers Point Source, Nonpoint Source, or both: Both

1. Major NPDES Discharges to surface waters addressed in TMDLs: Yes

Facility Name	NPDES No.	Facility Type	Receiving Stream
Palm Beach County ¹	FLS000018	MS4 (Phase I)	Multiple
Florida Atlantic University	FLR04E094	MS4 (Phase II)	Multiple

Note:

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

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR FECAL COLIFORM IN E-4 CANAL (WBID 3264D)

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to compile a list of those waters within its boundaries for which technology based effluent limitations are not sufficient to protect water quality. A waterbody that does not meet any water quality standard applicable to it due to the presence of one or more pollutants is considered “impaired”. States are required to prioritize 303(d)-listed waters (i.e. impaired waters) with respect to their designated use classifications and the severity of pollution, and then develop Total Maximum Daily Loads (TMDLs) for them consistent with this prioritization. TMDLs determine the allowable loadings of pollutants or other quantifiable parameters based on the relationship between pollution sources and water quality conditions in the waterbody. States can then implement controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The Florida Department of Environmental Protection (FDEP) developed a statewide approach to managing water resources on the basis of natural boundaries, such as river basins, rather than political boundaries. This watershed management approach is the framework FDEP uses for developing and implementing TMDLs. The state’s 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. FDEP also established five Water Management Districts (WMDs) responsible for managing ground and surface water supplies in the counties encompassing their districts. The E-4 Canal is located in the Lake Worth Lagoon – Palm Beach Coast basin and is a Group 3 waterbody managed by the South Florida Water Management District (SFWMD).

For the purpose of planning and management, the WMDs divide their districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. The E-4 Canal is located within the Hillsboro Canal Planning Unit, which generally covers the area surrounding the Hillsboro Canal. Planning units contain smaller, hydrological based units called drainage basins, which are further divided into water segments. A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is typically about five square miles in area. Unique waterbody identification (WBIDs) numbers are assigned to each water segment. The canal segment addressed in this TMDL report is designated WBID 3264D (E-4 Canal). The geographic location of this WBID is shown in Figure 1.

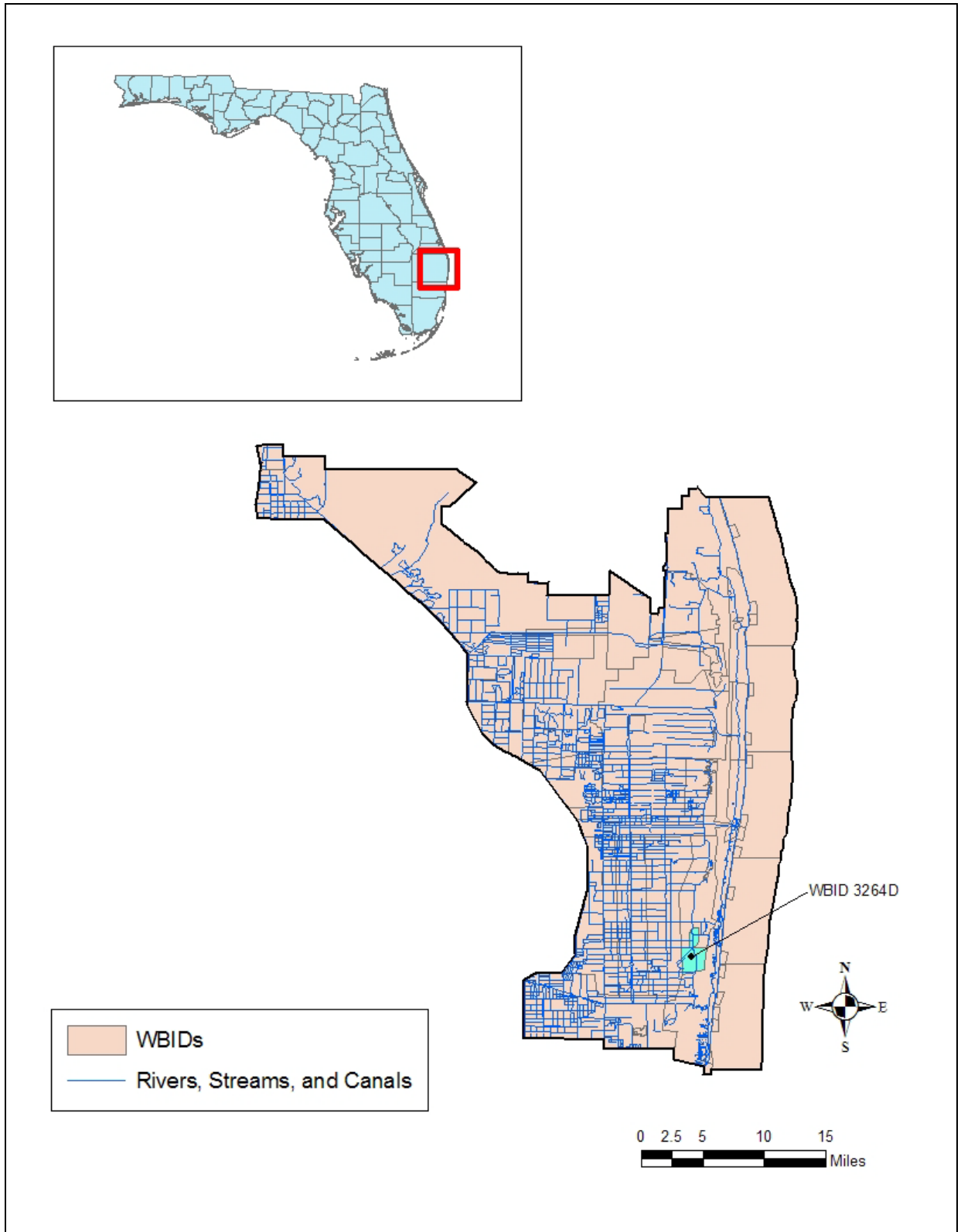


Figure 1. Location of WBID 3264D in the Lake Worth Lagoon – Palm Beach Coast Basin.

2. PROBLEM DEFINITION

To determine the status of surface water quality in the state of Florida, chemical data, biological data, and fish consumption advisories were evaluated for potential impairments. Florida's process for determining levels of water quality impairment is described in the Identification of Impaired Surface Waters Rule (IWR), in Section 62-303 of the Florida Administrative Code (FAC). The IWR defines threshold criteria for determining if a waterbody should be added to the state's planning list of potentially impaired waters. Once a waterbody is on the planning list, additional data and information are collected and assessed to determine if the water should be included on the state's verified list of water quality impairments.

Florida's final 1998 Section 303(d) list identified WBID 3264D in the Lake Worth-Palm Beach Coast Basin as potentially not supporting water quality standards (WQS) due to elevated concentrations of fecal coliforms. Fecal coliform bacteria are present in large numbers in the intestinal tracts of humans and other warm-blooded animals. With the exception of *Escherichia Coli*, most fecal coliform bacteria do not cause disease by themselves. However, high numbers of them in a waterbody indicate the presence of fecal material, and therefore the likely presence of other bacteria that are pathogenic. A 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) established a schedule by which EPA is committed to developing TMDLs. Since FDEP has not yet verified the fecal coliform impairment in this waterbody, EPA is responsible for assessing all readily available water quality data to determine whether a TMDL should be developed for it.

The format of the remainder of this report is as follows: Chapter 3 is a general description of the impaired watershed; Chapter 4 describes the water quality standards and target criteria; and Chapter 5 describes the data and source assessments, as well as the approach used to develop the TMDL.

3. WATERSHED DESCRIPTION

The E-4 Canal, also known as the El Rio Canal, (WBID 3264D) is located along the Palm Beach and Broward County line in Southeast Florida (Figure 2). The canal drains approximately 11.4 km² (4.4 mi²). The watershed primarily consists of urban and built-up land uses. A breakdown of land use by acreage and percentage is provided below in Table 1. There is no known wastewater National Pollutant Discharge Elimination System (NPDES) permitted surface water discharge within the watershed. Two domestic Wastewater Treatment Plants (WWTPs) located within and/or immediately upgradient to E-4 Canal hold active NPDES permits: the South Central Regional WWTP (FL0035980) and the City of Boca Raton WWTP (FL0026344). However, both facilities discharge to the Atlantic Ocean and not within the E-4 Canal watershed. The E-4 Canal watershed lies within two MS4 permitted service areas: Florida Atlantic University (FLR04E094) and Palm Beach County (FLS000018). The MS4s include ditches, curbs, gutters, storm sewers, and similar means of collecting or conveying runoff that do not connect with a wastewater collection system or treatment plant. The approximate location of the Florida Atlantic University is depicted in Figure 3.

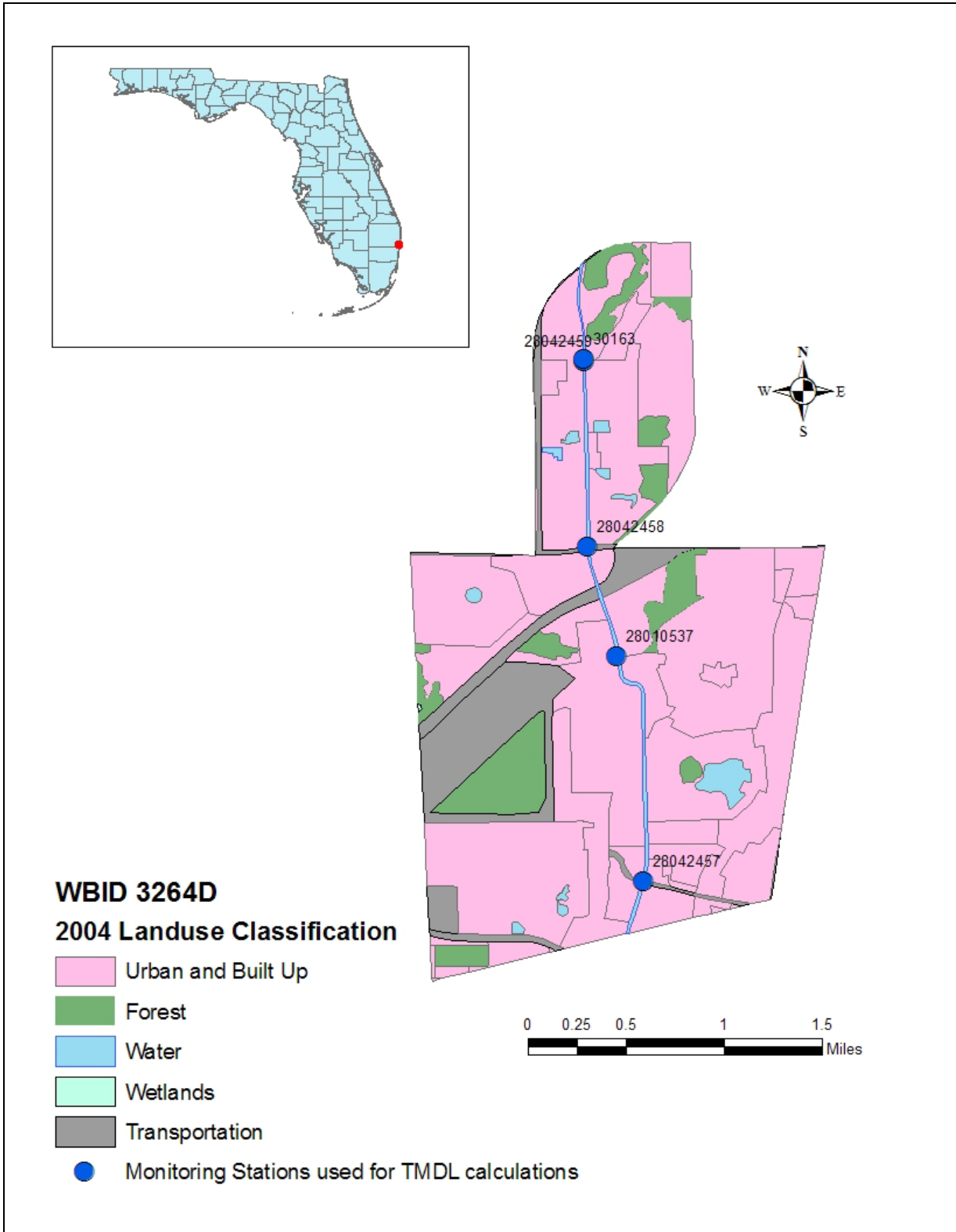


Figure 2. Land use and location of sampling stations in WBID 3264D.

Table 1. Land Cover Distribution for E-4 Canal.¹

Impaired Waterbody	WBID(s)	Unit ²	Urban Residential & Built-Up ³	Forest ⁴	Water	Wetlands	Transportation & Utilities	Total
E-4 Canal	3264D	Km ²	8.3 ⁴	1.5 ⁴	0.3	0.001	1.3	11.4
		percent	72.8%	13.2 %	2.6%	0.009%	11.4%	100%

Notes:

1. Land use data is based on 2004-05 SFWMD land cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). The features were photointerpreted from 2004-05 1:12,000 scale color infrared, RGB, and stereo panchromatic digital aerial photographs. Areas in the table represent the watershed within WBID 3264D.
2. Km²= square kilometers.
3. The urban/residential and built-up category includes commercial, industrial and extractive uses.
4. A portion of land along the northeast border of the WBID is depicted as urban but is actually a preserved wildlife refuge. The wildlife refuge was added to the Forest Land Cover acreage presented in this table.

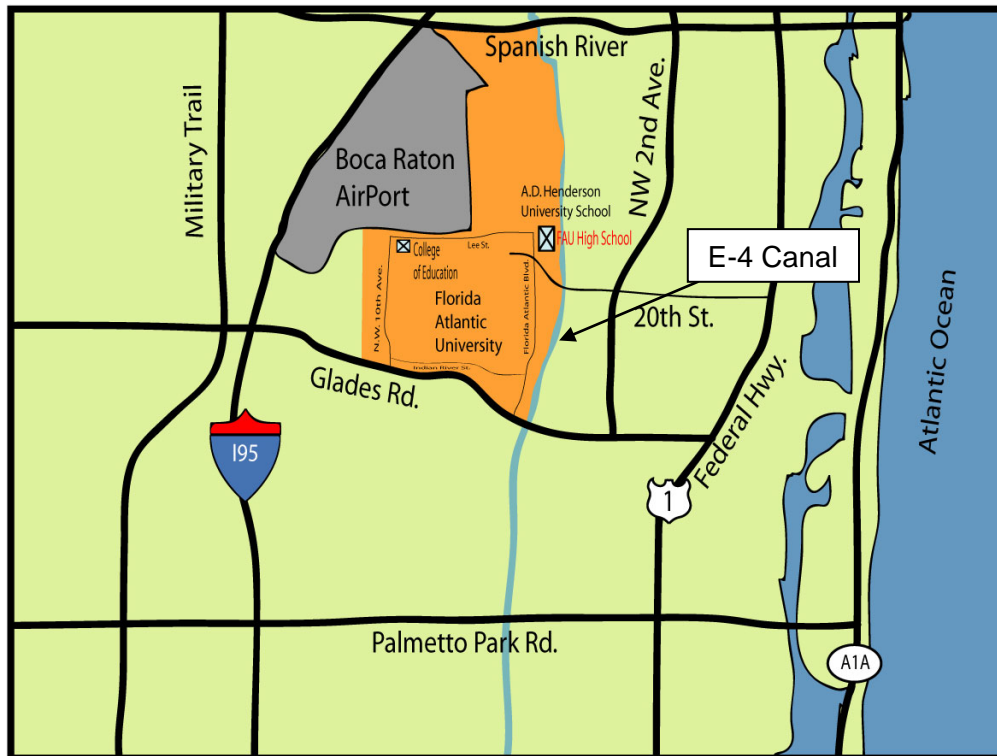


Figure 3. Florida Atlantic University

Note: Source: <http://www.adhus.fau.edu/map.htm>

4. WATER QUALITY STANDARD AND TARGET IDENTIFICATION

The E-4 Canal (WBID 3264D) is a Class III freshwater stream. The designated uses of Class III waters include recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in FAC Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards that apply to all waters, including Section 62-302.500 FAC [Surface Waters: Minimum Criteria, General Criteria], unless alternative or more stringent criteria are specified in FAC Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria addressed in this TMDL document are provided in the following section.

Fecal Coliform Bacteria (Class III Waters- Fresh and Marine)

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 shorter-term conditions. Ten samples were collected within a 30-day period as required by the Florida regulations for evaluation of the geometric mean; however, these samples were all collected on the same day and at various locations and depths throughout E-4 Canal and as such do not represent spatially and temporally independent measurements. The data set collected does not reasonably reflect the water quality of E-4 Canal during a 30-day period. For this reason, there was insufficient data to assess against the geometric mean criteria. Therefore, to determine the impairment status of the canal, available data were assessed against both components of the acute criteria. The 400 counts/100 ml criterion was selected as the endpoint for the TMDL, since this resulted in a more stringent reduction.

5. FECAL COLIFORM TMDL

This section of the report details the development of the fecal coliform TMDL. Fecal coliform bacteria are frequently used as indicators of fecal contamination since they are abundant in the intestines and feces of animals and people.

5.1 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

FDEP maintains ambient monitoring stations throughout the E-4 Canal basin and allows the public access to monitoring results via the internet in their IWR database. Data collected at monitoring stations within the impaired WBIDs and reported in IWR Run 42 were used in this TMDL analysis. Two samples, collected in the late 1980s, were not used in the TMDL analysis due to the potential

changes to both point and nonpoint sources since the date of collection. Twenty-seven fecal coliform samples were collected in the E-4 Canal throughout 2006 and 2007. However, on March 28, 2007, multiple samples were collected at the following stations: 21 FLWPB 28042457, 21 FLWPB 28042458, and 21 FL WPB 28010537. In order to accurately reflect water conditions in the E-4 Canal, samples collected at the same station at the same time were averaged and the resulting values were used in the TMDL analysis. Consequently, the dataset for fecal coliform in the E-4 Canal is 21 representative samples. Table 2 lists the monitoring stations used in the development of the TMDL. Summary statistics for the fecal coliform data are provided in Table 3.

Table 2. Monitoring Stations used in the development of the fecal coliform TMDL.

Station ID	Station Name	Available Sampling Period(s)	Number of Samples
21 FLGW 30163	SF-SS-2025	8/2006	1
21FLWPB 28042459	E-4 CANAL AT CLINTMORE ROAD	3/2007, 6/2007, 8/2007, 10/2007, 11/2007	5
21FLWPB 28042457	E-4 CANAL AT NW 20TH STREET	3/2007, 6/2007, 8/2007, 10/2007, 11/2007	5
21FLWPB 28042458	E-4 CANAL AT YAMATO ROAD	3/2007, 6/2007, 8/2007, 10/2007, 11/2007	5
21FLWPB 28010537	El Rio Canal (E4) at NW Spanish River Drive	3/2007, 6/2007, 8/2007, 10/2007, 11/2007	5

Note: Monitoring stations 21 FLGW 30163 and 21 FLWPB 28042459, are located in close proximity to each other.

Table 3. Water Quality Statistics for Fecal Coliform¹

Waterbody	Minimum Concentration (counts/100ml)	Maximum Concentration (counts/100ml)	Mean Concentration (counts/100ml)	Standard Deviation (counts/100ml)	# Samples >400 (counts/100ml)	# Samples >800 (counts/100ml)
21FLGW 30163 ²	930	930	N/A	N/A	1	1
21FLWPB 28042459	124	1070	529	416	2	2
21FLWPB 28042457	12	540	189	223	1	0
21FLWPB 28042458	3	432	242	183	1	0
21FLWPB 28010537	11	1070	337	442	2	1

Notes:

- 1) Geometric means were not evaluated, since there were insufficient data.
- 2) Only one sample was collected from this location; therefore, the mean concentration and standard deviation were not calculated.

Seven samples (33 percent) exceeded the 400 counts/100 ml criterion that should not be exceeded in more than 10 percent of measurements. Four samples also exceed the 800 counts/100 ml instantaneous criterion. As mentioned previously, the geometric mean could not be assessed.

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. However, flow data was not available for E-4 Canal. Depending on the source of the contamination, exceedances of the fecal coliform criteria can occur in response to rainfall events. Daily precipitation data collected at West Palm Beach Airport (WBAN 12844) was plotted with the fecal coliform results to identify the hydrologic conditions under which excursions above the criteria occurred (see Figure 4). Based on the available data, exceedances in the E-4 Canal appeared to have occurred during both wet and dry weather conditions. Therefore, implementation of this TMDL should address controlling point and nonpoint sources during both wet and dry weather conditions.

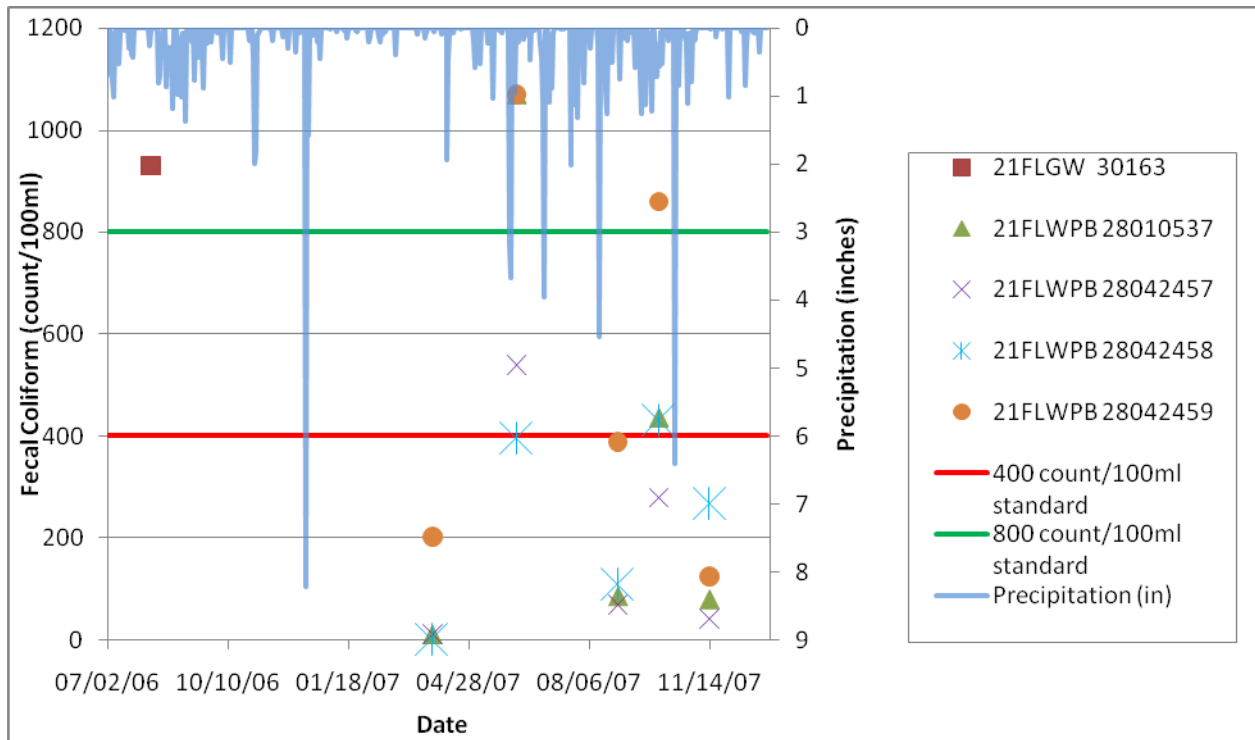


Figure 4. Comparison of Fecal Coliform Concentrations in E-4 Canal and Rainfall at West Palm Beach Airport (WBAN 12844).

5.2 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point sources or nonpoint 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 facilities, as well as certain urban stormwater discharges such as Municipal Separate Storm Sewer Systems (MS4) areas, some industrial facilities, and construction sites over one acre, are considered primary point sources of coliform bacteria. Typically, excursions of fecal coliform bacteria that occur during periods of reduced rainfall result from a lack of dilution for point source discharges or other sources located close to the waterbody.

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)

5.2.1 Point Sources

5.2.1.1 Permitted Facilities

A TMDL wasteload allocation (WLA) is given to NPDES permitted facilities discharging to surface waters within an impaired watershed. Facilities that dispose of wastewater by means other than a surface water discharge, such as spray irrigation or underground injection wells, typically treat wastewater to less stringent secondary standards. These facilities would be considered in the load allocation for nonpoint sources.

There are no known wastewater NPDES-permitted discharges within the watershed. Two domestic WWTPs located within or immediately upgradient of the area draining to the E-4 Canal hold active NPDES permits: the South Central Regional WWTP (FL0035980) and the City of Boca Raton WWTP (FL0026344). However, both facilities discharge to the ocean and not within the E-4 Canal watershed.

5.2.1.2 Municipal Separate Storm Sewer Systems Permits

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 defined as “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.”

In 1990, EPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants washed into MS4s by stormwater runoff, or dumped directly into them, from being delivered to local waterbodies. Phase I of the program required operators of “medium” and “large” MS4s (generally serving populations of 100,000 or more) to implement a stormwater management program as a means of controlling polluted discharges. 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, and hazardous waste treatment, etc. Because the master drainage systems of most local governments in Florida are interconnected, EPA implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities, Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria.

Phase II of the NPDES stormwater rule extended coverage to certain “small” MS4s and to construction sites between one and five acres. Small MS4s are defined as any municipal stormwater collection system that does not meet the criteria of a medium or large MS4 covered by Phase I. Only a select subset of small MS4s requires an NPDES stormwater permit. These “regulated small MS4s” include those located in “urbanized areas” as defined by the Bureau of Census, and other small MS4s designated by NPDES permitting authorities.

In October 2000, US EPA 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, of the 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.

The E-4 Canal watershed lies within two MS4 permitted service areas: Florida Atlantic University (FLR04E094) and Palm Beach County (FLS000018). Florida Atlantic University is a Phase II MS4. The approximate location of Florida Atlantic University is depicted in Figure 3. Palm Beach County is a Phase I MS4 which consists of numerous co-permittees (39) representing cities, towns, villages, and other public bodies located within the Palm Beach County area. A list of co-permittees is provided in Appendix A.

5.2.2 Nonpoint Sources

5.2.2.1 Agriculture

Agriculture is a potential source of coliform bacteria in streams, including runoff of manure from pastureland and cropland, and direct animal access to streams. However, no agricultural land uses were identified in WBID 3264D. As such, agricultural uses should not be considered a relevant source of pathogen loading to the E-4 Canal.

5.2.2.2 Wildlife

Wildlife contribute coliform bacteria by depositing feces onto land surfaces where it can be transported to nearby streams during storm events. Birds and other warm blooded animals also contribute bacteria to waterbodies through direct deposition in them. 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. Residential, industrial and commercial areas make up approximately 73 percent of the land area within WBID 3264D. However, it should be noted that the Yamato Scrub Natural Area, a 121-acre wildlife refuge, is located along the northeast border of the WBID. To determine what influence, if any, the wildlife refuge is having on water quality in the E-4 Canal, additional information must be collected.

5.2.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs), including septic tanks, are commonly used

where providing access to sewer systems 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. Approximately 17 percent of the land area within WBID 3264D is residential and used for medium and/or high density residential developments. Due to the residential land use in WBID 3264D, failure of septic systems, particularly in the medium-density residential developments, is a potential source of coliform bacteria in the E-4 Canal.

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 watersheds is not known.

Table 4. County Estimates of Septic Tanks and Repair Permits.

County	Number Septic Tanks (1970- 2010)	Number of Repair Permits Issued (1991 – 2010)
Palm Beach	80,319	12,345

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

5.2.2.4 Urban Development

Urban land uses include residential, industrial, extractive and commercial categories. 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 of the FS, was established as a technology-based program that relies upon the implementation of Best Management Practices (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 62-40-.432 (5) (c), FAC).

In 1994, state legislation created the Environmental Resource Permitting program to consolidate stormwater quantity, stormwater quality, and wetlands protection into a single permit. Presently, the majority of environmental resource permits are issued by the state’s water management districts, although DEP continues to issue permits for specific projects.

Nonstructural and structural BMPs are an integral part of Florida’s stormwater programs. Nonstructural BMPs, often referred to as “source controls”, are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing 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 E-4 Canal watersheds consists primarily of medium to high density urban areas that are within the jurisdictions of two permitted MS4s. As such, urban land use could be a relevant source of pathogen loading to E-4 Canal.

5.3 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 streamflow data are not available, TMDLs are frequently expressed as the percent reduction from existing conditions required to meet the TMDL target. Load duration curves may be used to develop TMDLs when sufficient data are available to develop a relationship between flow and concentration. Due to the lack of flow data for E-4 Canal WBID 3264D, the TMDL is expressed using the percent reduction approach.

5.3.1 Percent Reduction Approach for TMDL Development

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

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

Where:

% Reduction = percent reduction

[*existing*] = existing concentration

[*criterion*] = criterion concentration (i.e. target)

The water quality standard for fecal coliform bacteria states that up to 10 percent of samples are allowed to exceed a concentration of 400 counts/100ml. A 90th percentile concentration implies that

90 percent of the measured values are lower than this concentration, and 10 percent are higher. For this TMDL, the 90th percentile of fecal coliform measurements was calculated and compared against a target of 400 counts/100 ml. A percent reduction was also calculated using the maximum concentration measured to represent the existing condition and the 800 counts/100 ml criterion as the target. The larger of the two percent reduction values was selected as the TMDL. In this TMDL calculation, the existing condition is represented by the 90th percentile fecal coliform concentration, and the percent reduction is calculated to meet the 400 counts/100 ml acute criterion, since that resulted in a higher reduction. There are many formulas for calculating percentiles and these can be found in text books on statistics. The Hazen formula was used to calculate the 90th percentile, as it is recommended in Hunter's Applied Microbiology (2002) article on bacteria in water. Application of the Hazen formula to data collected at E-4 Canal is provided in Appendix B.

5.4 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be represented as the sum of all point source loads (WLA), nonpoint source loads (LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \sum WLA_s + \sum LA_s + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. The fecal coliform TMDL for E-4 Canal WBID 3264D is expressed as percent reduction.

5.4.1 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 fecal coliform loading is typically an extended dry period followed by a rainfall-runoff event. During dry weather periods, coliform bacteria build up on the land surface, and are washed off by subsequent rainfalls. The critical condition for point source loading usually occurs during periods of low streamflow when dilution is minimized. Daily precipitation data collected at West Palm Beach Airport (WBAN 12844) was plotted with the fecal coliform results to identify the hydrologic conditions under which violations occurred. Based on the available data, exceedances in the E-4 Canal appeared to have occurred during both wet and dry

weather conditions. Critical conditions and seasonal variation are accounted for in the TMDL analysis by using the largest percent reduction to represent the pollutant reduction required year-round, for the entire watershed. By achieving this reduction, water quality standards should be achieved during all other time periods.

5.4.2 Existing Conditions

Existing conditions represent the current water quality conditions of a waterbody. Existing conditions are being conservatively represented using the 90th percentile of measured concentrations. Fecal coliform samples collected in WBID 3264D, as well as the 90th percentile and percent reduction required to meet the TMDL target, are shown in Table 5.

Table 5. Fecal Coliform Measurements in E-4 Canal (WBID 3264D).

Date	Time	Station	Fecal Coliform (counts/100ml)	Remark Code
8/7/2006	1346	21FLGW 30163	930	B ² Q ³
3/28/2007	1245	21FLWPB 28042459	202	B
6/6/2007	1345	21FLWPB 28042459	1070	B
8/29/2007	1255	21FLWPB 28042459	388	B
10/2/2007	1000	21FLWPB 28042459	860	B
11/13/2007	1315	21FLWPB 28042459	124	B
3/28/2007	1200	21FLWPB 28042457	12 ¹	
6/6/2007	1245	21FLWPB 28042457	540	B
8/29/2007	1150	21FLWPB 28042457	70	
10/2/2007	1110	21FLWPB 28042457	280	B
11/13/2007	1200	21FLWPB 28042457	42	
3/28/2007	1230	21FLWPB 28042458	3 ¹	
6/6/2007	1325	21FLWPB 28042458	396	B
8/29/2007	1230	21FLWPB 28042458	112	
10/2/2007	1025	21FLWPB 28042458	432	B
11/13/2007	1300	21FLWPB 28042458	268	B
3/28/2007	1215	21FLWPB 28010537	11 ¹	
6/6/2007	1300	21FLWPB 28010537	1070	B
8/29/2007	1220	21FLWPB 28010537	86	
10/2/2007	1050	21FLWPB 28010537	436	B
11/13/2007	1230	21FLWPB 28010537	80	
90th Percentile Fecal Coliform Concentration			986	
Percent Reduction to meet TMDL Target			59 percent	

Notes:

1. These are averaged values from multiple samples collected at the same time.
2. Remark Code B means that the colony counts were made outside of the acceptable range.
3. Remark Code Q means the sample was held beyond normal holding time.

Several of the fecal coliform measurements in the E-4 Canal have a remark code of B. Samples having the laboratory remark code B were 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. Additionally, one sample has a laboratory remark code Q indicating the sample was held beyond normal holding time. However, holding samples on ice slows the metabolism of the organisms resulting in no appreciable growth. Actual concentration is expected to be at least as high as the value reported; therefore the sample was considered acceptable for use in the TMDL analysis.

5.5 MARGIN OF SAFETY

There are two methods for incorporating a 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.

5.6. DETERMINATION OF TMDL, LA AND WLA

The TMDL value represents the maximum load the canal can assimilate and still maintain water quality standards. The percent reduction that meets both acute criteria for Class III waters, was calculated using two methods. The first calculation compared the daily 800 counts/100ml WQS with the highest measured fecal coliform count. The second calculation compared the 90th percentile value with the 400 counts/100ml WQS. The 400 counts/100 ml criterion was selected as the endpoint, since this resulted in a more stringent reduction and will therefore meet both components of the acute criteria. The calculated TMDL reduction for E-4 Canal (WBID 3264D) is summarized in Table 6.

Table 6. Summary of TMDL Components.

Waterbody	WBID	WLA ¹		LA (% Reduction) ²	TMDL (% Reduction) ²
		Facility (counts/day)	MS4 (% Reduction) ²		
E-4 Canal	3264D	N/A	59%	59%	59%

Notes:

1. The WLA is typically separated into the components originating from continuous NPDES facilities (e.g. WWTPs) and from MS4. WLAs are provided because E-4 Canal is located within two MS4s.
2. Overall percent reduction required to achieve the 400 counts/100ml fecal coliform criterion. The MOS is implicit and does not take away from the TMDL value.

The TMDL may be expressed as a daily load by multiplying the water quality target by an estimate of flow in the stream. It is recommended that flow be measured at the time of sampling in order 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.

5.6.1 Waste Load Allocation

Only NPDES-permitted facilities discharging directly into streams and MS4-permitted urban areas are assigned a WLA. WLAs are expressed separately for municipal and industrial facilities (e.g., WWTPs) and MS4 areas as the former discharge during all weather conditions whereas the latter discharge in response to storm events.

There are no known wastewater NPDES-permitted discharges within the watershed. The E-4 Canal watershed lies within two MS4 permitted service areas: Florida Atlantic University (FLR04E094) and Palm Beach County (FLS000018). Florida Atlantic University is a Phase II MS4. The approximate location of the Florida Atlantic University is depicted in Figure 3. Palm Beach County is a Phase I MS4 which consists of numerous co-permittees (39) representing cities, towns, villages, and other public bodies located within the Palm Beach County area. See Appendix A for a list of co-permittees.

Any future NPDES facilities located within the watersheds will be assigned end-of-pipe discharge limits equal to the state Water Quality Standard for fecal coliform. Any future MS4s located within the boundaries of either watershed will be prescribed a WLA based on the percent reduction required in the TMDL. MS4 permittees will only be responsible for reducing the anthropogenic loads associated with stormwater outfalls they own or otherwise have responsible control over.

5.6.2 Load Allocation

There are two modes of transport for nonpoint source loading of fecal coliform bacteria into the stream. Direct loadings, such as failing septic systems and animals accessing the stream, are independent of precipitation events. The second mode of transport involves accumulation of bacteria on land surfaces and subsequent delivery to the stream during storm events.

The load allocation is expressed as the percent reduction required for the existing fecal coliform concentration to meet the water quality target. According to this data, the load allocation requires a 59 percent reduction in fecal coliforms in the E-4 Canal; this reduction should target both direct sources (i.e., failing septic tanks) and rainfall-driven sources, since violations occur during both wet and dry periods.

5.7 RECOMMENDATIONS

It is recommended that flow be measured at the time of sampling so that loads can be calculated. The initial step in implementing a pathogen TMDL is to more specifically locate source(s) of bacteria in the watershed. 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

REFERENCES

Florida Administrative Code (FAC). Chapter 62-40 Water Resource Implementation Rule.

Florida Administrative Code (FAC). Chapter 62-302 Surface Water Quality Standards.

Florida Administrative Code (FAC). Chapter 62-303 Identification of Impaired Surface Waters Rule (IWR).

Florida Administrative Code (FAC). Chapter 62-620 Wastewater Facilities and Activities Permitting.

Hunter, P.R. 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: PALM BEACH COUNTY MS4 CO-PERMITTEES

List of Co-Permittees on the Palm Beach County MS4 (FLS000018)

City of Atlantis
City of Belle Glade
City of Boca Raton
City of Boynton Beach
City of Delray Beach
City of Greenacres
City of Lake Worth
City of Pahokee
City of Palm Beach Gardens
City of Riviera Beach
City of South Bay
City of West Palm Beach
FDOT District 4
FDOT Turnpike District
Indian Trail Improvement District
Town of Lake Clark Shores
Northern Palm Beach County Improvement District
Palm Beach County ERM
South Indian River Water Control District
Town of Cloud Lake
Town of Gulf Stream
Town of Haverhill
Town of Highland Beach
Town of Juno Beach
Town of Jupiter
Town of Jupiter Inlet Colony
Town of Lake Park
Town of Lantana
Town of Manalapan
Town of Mangonia Park
Town of Ocean Ridge
Town of Palm Beach
Town of Palm Beach Shores
Town of South Palm Beach
Village of North Palm Beach
Village of Palm Springs
Village of Royal Palm Beach
Village of Tequesta
Village of Wellington

APPENDIX B: WATER QUALITY DATA ANALYSIS

Table B-1: Fecal Coliform Data and Percentiles for WBID 3264D

Date	Station	Result	Rank	Percentile by Hazen Method
3/28/2007	21FLWPB 28042458	3 ¹	1	2%
3/28/2007	21FLWPB 28010537	11 ¹	2	7%
3/28/2007	21FLWPB 28042457	12 ¹	3	12%
11/13/2007	21FLWPB 28042457	42	4	17%
8/29/2007	21FLWPB 28042457	70	5	21%
11/13/2007	21FLWPB 28010537	80	6	26%
8/29/2007	21FLWPB 28010537	86	7	31%
8/29/2007	21FLWPB 28042458	112	8	36%
11/13/2007	21FLWPB 28042459	124	9	40%
3/28/2007	21FLWPB 28042459	202	10	45%
11/13/2007	21FLWPB 28042458	268	11	50%
10/2/2007	21FLWPB 28042457	280	12	55%
8/29/2007	21FLWPB 28042459	388	13	60%
6/6/2007	21FLWPB 28042458	396	14	64%
10/2/2007	21FLWPB 28042458	432	15	69%
10/2/2007	21FLWPB 28010537	436	16	74%
6/6/2007	21FLWPB 28042457	540	17	79%
10/2/2007	21FLWPB 28042459	860	18	83%
8/7/2006	21FLGW 30163	930	19	88%
6/6/2007	21FLWPB 28010537	1070	20	93%
6/6/2007	21FLWPB 28042459	1070	20	93%

Note:

1. These are averaged values from multiple samples collected at the same time

In this TMDL the Hazen formula was used 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 are 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:

$$\text{Percentile} = (\text{Rank} - 0.5) / (\text{total number of samples collected})$$

For example, for WBID 3264D on November 13, 2007 a fecal coliform concentration of 268 counts/100mL was measured at station 21FLWPB 28042458. This concentration ranks number 11 out of 21 samples collected in WBID 3264D. The associated percentile is calculated as:

$$\text{Percentile} = (11-0.5)/21 = 0.50 = 50\%$$

This implies that 50 percent of the time the instream concentration is less than 268 counts/100mL.