FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

CENTRAL DISTRICT • MIDDLE ST. JOHNS RIVER BASIN

TMDL Report

Fecal Coliform and Total Coliform TMDLs for Long Branch (WBID 3030)

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Acknowledgments

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Florida Department of Environmental Protection, Bureau of Watershed Management

TMDL Program

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

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf

STORET Program

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

2002 305(b) Report

http://www.dep.state.fl.us/water/docs/2002_305b.pdf

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http://www.dep.state.fl.us/legal/rules/shared/62-302t.pdf

Basin Status Report for the Tampa Bay Tributaries Basin

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

Allocation Technical Advisory Committee (ATAC) Report

http://www.dep.state.fl.us/water/tmdl/docs/Allocation.pdf

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal and total coliform bacteria for Long Branch in the Middle St. Johns River Basin, within the Econlockhatchee planning unit. This stream was verified as impaired for fecal coliform and total coliform bacteria, and therefore was included on the Verified List of impaired waters for the Middle St. Johns River basin that was adopted by Secretarial Order on May 27, 2004. The TMDL establishes the allowable fecal coliform and total coliform loadings to Long Branch that would restore the waterbody so that it meets its applicable water quality criteria for fecal and total coliform bacteria.

1.2 Identification of Waterbody

Long Branch (WBID 3030) is located in the northeast part of Orange County. It flows primarily in a westerly direction into the Econlockhatchee River and drains an area of about 5.7 square miles **(Figure 1.1).** State Road 50 (SR 50) runs through the eastern part of the basin in a northwest to southeast direction, and County Road 13 (CR 13) runs through the central basin in a north to south direction. The majority of the development in the basin is in an area east of CR 13 and west of SR 50 in the northern part of the basin. The rest of the basin is dominated by pasturelands, pine flatwoods, and mixed wetland hardwoods.

According to the USGS 1:100,000 quadrangle map, the elevation decreases from about 20 feet (NAD 27) in the east to about 15 feet (NAD 27) at the outlet in the western part of the basin. The average slope for the basin is about 0.03%. More detailed information about the Long Branch basin can be found in the "Big Econlockhatchee River Basin Stormwater Management Master Plan" (CDM, 2003).

For assessment purposes, the Department has divided the Middle St. Johns River basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. This TMDL addresses **WBID 3030, Long Branch,** for fecal coliform and total coliform

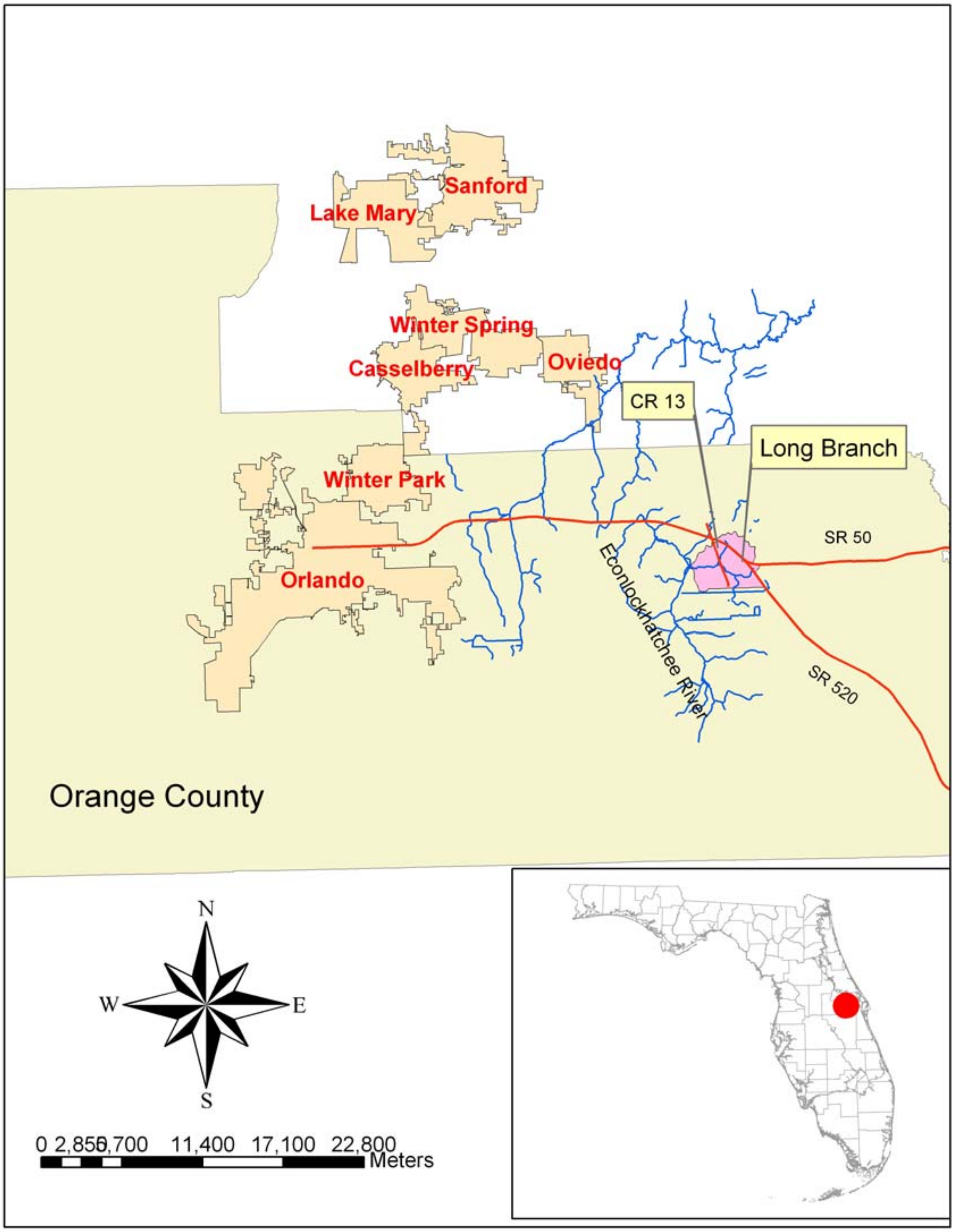
1.3 Background

This report was developed as part of the Florida Department of Environmental Protection's (Department) watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA, Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. TMDLs provide important water quality restoration goals that will guide restoration activities.

This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, to reduce the amount of fecal coliform and total coliform that caused the verified impairment of Long Branch. These activities will depend heavily on the active participation of St. Johns River Water Management District, Orange County government, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Figure 1.1: Location of Long Branch in Seminole and Orange Counties. The map also shows locations of SR 50 and SR 520 and City of Orlando and City of Winter Park.



Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

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

Florida's 1998 303(d) list included 22 waterbodies in the Middle St. Johns River basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Long Branch watershed and has verified that the stream is impaired for fecal coliform and total coliform bacteria. **Table 2.1** lists the priority and projected year for TMDL development for each parameter. The verification of impairment was based on the observations that 13 out of 26 fecal coliform samples and 11 out of 26 total coliform samples collected during the verified period (January 1, 1996 through June 30, 2003) exceeded Florida Surface water quality criteria (FAC 62-302). **Table 2.2** summarizes the fecal coliform and total coliform monitoring results for the verified period for Long Branch. As shown in **Table 2.1**, the projected year for both fecal coliform and total coliform bacteria TMDLs were 2004, but the Settlement Agreement between EPA and Earthjustice, which drives the TMDL development schedule for waters on the 1998 303(d) list, allows an additional nine months to complete the TMDLs. As such, this TMDL must be adopted and submitted to EPA by September 30, 2005**.**

Table 2.1. Verified Impairment for Fecal and Total Coliform in Long Branch, WBID 3030, TMDL Priority, and Projected Year for TMDL Development

WBID	Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development
3030	Fecal coliform	High	2004

WBID	Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development
	Total coliform	High	2004

Table 2.2. Summary of Fecal Coliform Monitoring Data for Long Branch, WBID 3030

WBID	Parameter	Fecal Coliform	Total Coliform
3030	Total number of samples	26	26
	IWR required number of exceedances for the verified list	6	6
	Number of observed exceedances	13	11
	Number of observed exceedances	13	15
	Number of seasons during which samples were collected	4	4
	Highest observation (MPN/100mL)*	1441	27000
	Lowest observation (MPN/100 mL)	8	434
	Median observation (MPN/100 mL)	405	2250
	Mean observation (MPN/100 mL)	504	3516
	FINAL ASSESSMENT	**Impaired**	**Impaired**

* Most probable number per 100 milliliters.

Figure 2.1 shows the locations of three water quality stations in Long Branch. **Figures 2.2a** and **2.2b** show the seasonal trends for fecal and total coliform concentrations at these sites in the verified period (1996 through 2003). Among all the water quality stations, the station located on the southern tributary (21FLCEN 20010384) had the highest fecal coliform concentration throughout all the sampling events in 2002, while the fecal coliform concentration at the main channel station (21FLCEN 20010395) was consistently the lowest among the three sites. In fact, the fecal coliform concentration at the main channel station never exceeded the water quality criteria. Fecal coliform concentrations at all three sites started low in the beginning of the year and reached the highest in the 4th quarter of the year (**Figure 2.2a**).

No obvious seasonal trend was observed for total coliform bacteria. Except for the 1st quarter in 2002, the lowest total coliform concentration was observed at the main channel station (940 counts/100 ml). This is consistent with the spatial trend of the fecal coliform. For 2002, no 1st quarter total coliform concentrations were available for the station located at the northern tributary (21FLCEN 20010374). For the 2nd quarter, the concentration at the southern tributary site was significantly higher than that of the northern tributary site, while the concentrations from these two sites are comparable for rest of the sampling events during the year (**Figure 2.2b**).

Figure 2.1. Principal Land Uses in Long Branch basin and locations of water quality stations

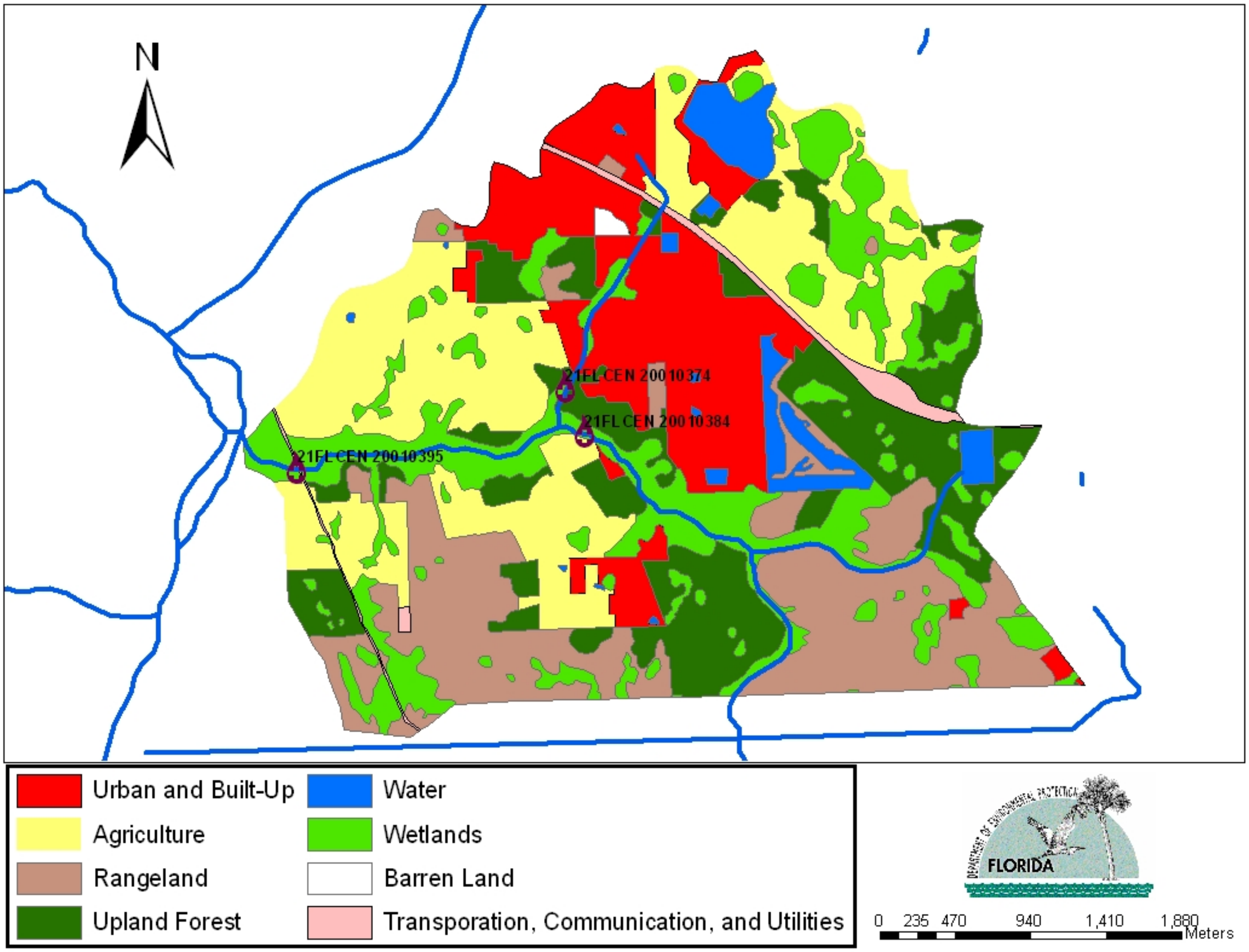


Figure 2.2a. Trend of Fecal Coliform Concentrations

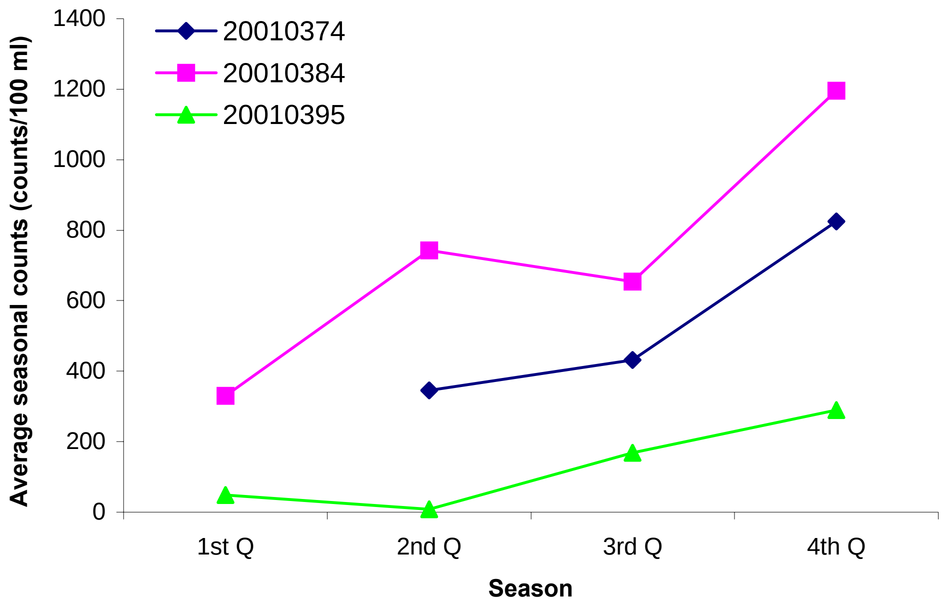
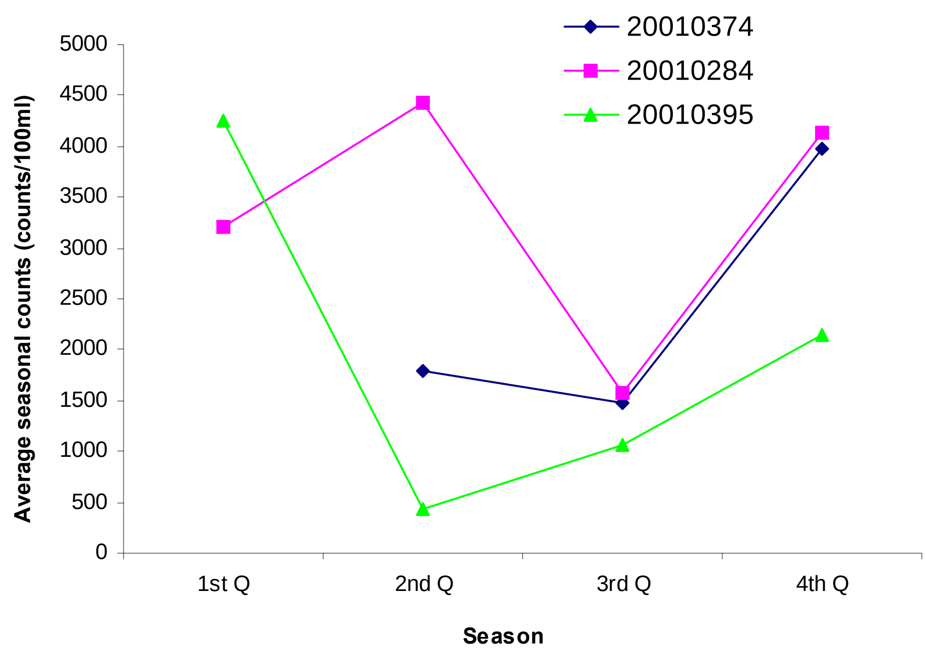


Figure 2.2b. Trend of Total Coliform Concentrations



Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Long Branch is a Class III waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The criteria applicable to this TMDL are the Class III criteria for fecal and total coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform and total coliform bacteria concentrations. The water quality criteria for protection of Class III waters, as established by Chapter 62-302, F.A.C., state the following:

Fecal Coliform Bacteria:

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

Total Coliform Bacteria:

The MPN or MF per 100 milliliters (mL) shall be less than or equal to 1,000 as a monthly average nor exceed 1,000 in more than 20 percent of the samples examined during any month; and less than or equal to 2,400 at any time.

The criteria state that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. During the development of load duration curves for the impaired stream (as described in subsequent chapters), there were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for either fecal coliform or total coliform bacteria. Therefore, the criteria selected for the

TMDLs were not to exceed 400 MPN/100 mL in any sampling event for fecal coliform, and not to exceed 2,400 MPN/100mL in any sampling event for total coliform. The 10 percent exceedance allowed by the water quality criterion for fecal coliform bacteria was not used directly in estimating the target load, but was included in the margin of safety (as described in subsequent chapters).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of pollutants and the amount of pollutant loadings contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

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

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

4.2 Potential Sources of Fecal Coliform and Total Coliform in the Long Branch basin

4.2.1 Point Sources

No NPDES wastewater facilities were identified in the Long Branch basin. There are four automobile junkyards in the basin, at the northwest end of SR 50 basin and north end of CR 13. These facilities, however, are not expected to discharge a significant amount of fecal or total coliform bacteria into ambient water.

Municipal Separate Storm Sewer System Permittees

The Long Branch basin is covered by the Orange County phase I Municipal Separate Storm Sewer System (MS4) permit. Orange County and Department of Transportation are co-permittees for the permit. No phase II MS4 permits were identified in the basin.

4.2.2 Land Uses and Nonpoint Sources

Land Uses

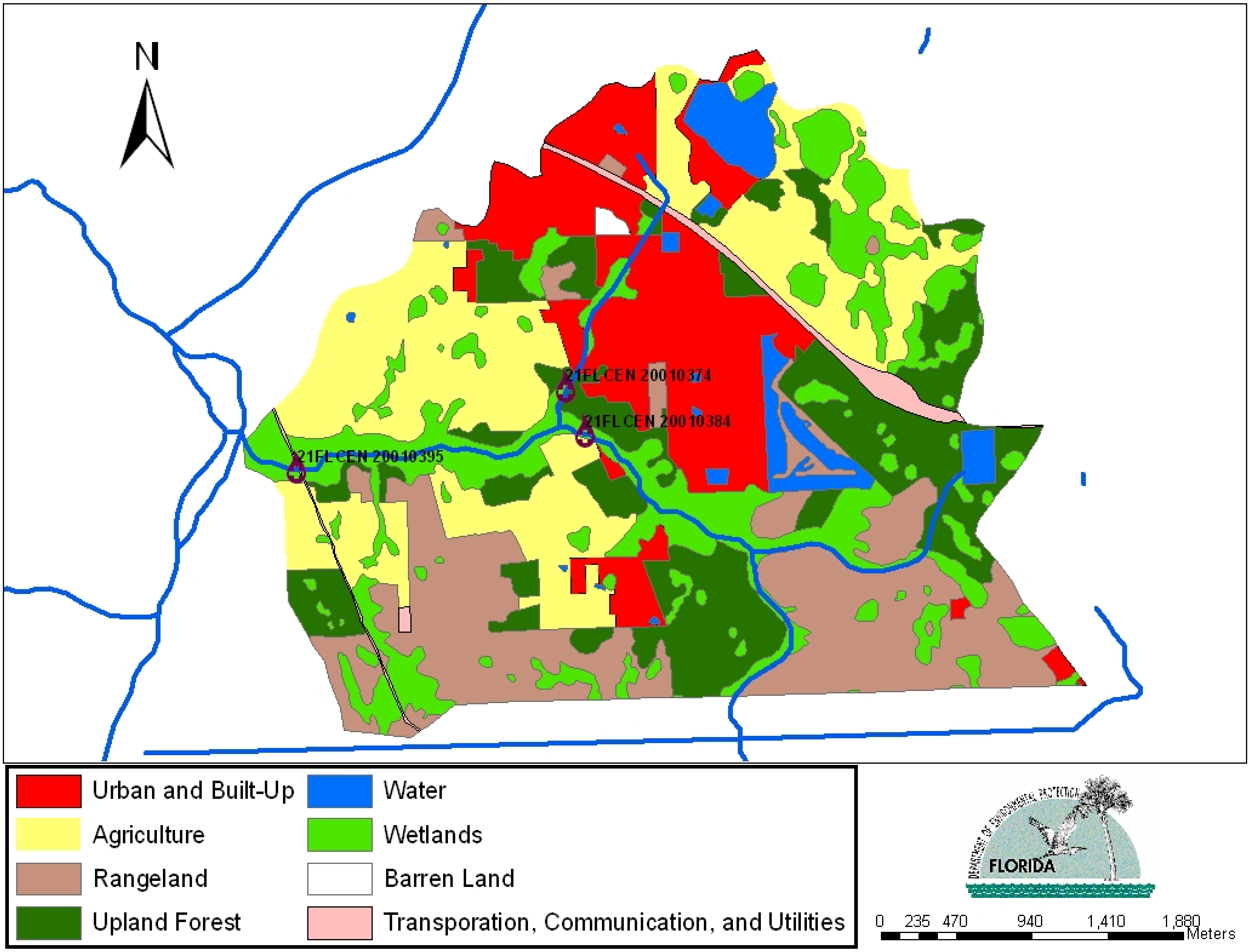
The spatial distribution and acreage of different land use categories were identified using the SJRWMD's year 2000 land use coverage (scale 1:40,000) contained in the Department's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the simplified Level 1 codes and tabulated in **Table 4.1. Figure 4.1** shows the acreage of the principal land uses in the watershed.

As shown in **Table 4.1,** the Long Branch drains about 3,628 acres of land. The dominant land use categories are agriculture and rangeland, which combined account for about 42% of the total basin area. Urban and build-up land, residential area, and area occupied by transportation, communication, and utilities (basically roads) claim about 18% of the basin area. About 36% of the basin area remains natural lands, including water/wetland and forest area.

Table 4.1. Classification of Land Use Categories in the Long Branch basin

Level 1 Code	Land Use	Acreage	Percent Acreage
1000	Urban and Build-Up	286	8%
	Low-density residential	27	1%
	Medium-density residential	245	7%
	Rural residential	54	1%
2000	Agriculture	827	23%
3000	Rangeland	689	19%
7000	Barren land	7	0%
8000	Transportation, communication, and utilities	54	1%
4000	Forest/rural open	615	17%
5000/6000	Water/wetland	685	19%
	TOTAL	3628	100%

Figure 4.1. Principal Land Uses in Long Branch basin and locations of water quality stations



Source Assessment

Because no traditional point sources were identified in the Long Branch basin, the primary loadings of fecal coliform and total coliform into the stream are generated by nonpoint sources in the watershed. Nonpoint sources of coliform bacteria generally, but not always, come from the accumulation of coliform bacteria on land surfaces that washes off as a result of storm events, and the contribution from groundwater from sources such as failed septic tanks and the improper land application of domestic wastewater residuals. Typical nonpoint sources of coliform bacteria include the following:

- Wildlife,
- Agricultural animals,
- Pets in residential areas,
- Onsite sewage treatment and disposal systems (septic tanks),
- Land application of domestic wastewater residuals, and
- Urban development (outside of Phase I or II MS4 discharges).

No data were available to specifically pinpoint and quantify the major source(s) for fecal and total coliform bacteria in the Long Branch basin. However, the spatial distribution and the extent and frequency of exceedances among sampling sites sheds some light on the possible sources for the bacteria pollution.

Figure 4.1 shows locations of the three sampling sites collected in the Long Branch basin. The STORET ID for these sites are 21FLCEN 20010374, 21FLCEN 20010384, and 21FLCEN 20010395, which are located in the northern tributary, southern tributary, and main stem of the Long Branch, respectively. The average fecal and total coliform concentrations from these sites and the frequencies at which fecal and total coliform concentrations at these sites exceeded the water quality criteria are listed in **Table 4.2**.

Table 4.2. Extent and frequency of exceedence of fecal and total coliform concentrations at each sampling site in Long Branch

Station ID	Fecal Coliform			Total Coliform		
	Range	Mean	Frequency	Range	Mean	Frequency
20010374	240 – 1020	519	57%	1130 – 5067	2279	29%
20010384	330 – 1441	748	80%	569 – 6222	3392	70%
20010395	8 – 293	163	0%	434 – 4250	1735	29%

Based on **Table 4.2**, the highest average concentrations and the highest frequency of exceedances for both fecal and total coliform were observed at 21FLCEN 20010384. As it was shown in **Figure 4.1**, this station was located on the southern tributary of Long Branch that drains the eastern, southeastern, and southern part of the Long Branch basin. According to the Orange County Environmental Protection Department (OCEPD), the majority of the southeastern basin area was a rangeland area with a significant livestock operation. However, Orange County purchased the land in this part of the basin in 2000, and the livestock operation had stopped. However, some horse farms still exist in the southern part of the basin. Animal droppings in this area could contribute a significant amount of bacteria through either surface runoff (wash off of animal droppings left on the land surface) or direct animal access to the tributary. In addition, a racing track, the Orlando SpeedWorld, is located in the eastern part of the watershed and also drains to the southern tributary of Long Branch.

The number of horses in the Long Branch basin was not available at the time this study was conducted. The number was therefore estimated based on the United States Department of Agriculture's (USDA) census of agriculture data and the landuse information for Long Branch basin and Orange County. Based on the USDA Census of Agriculture for 2002, about 1,491 horses were recorded for the entire Orange County. Based on the landuse GIS coverage from SJRWMD and SFWMD for 1995, the total area of pastureland in Orange County was about 49,050 acres. Based on this information, the countywide horse density was 0.03 horses/acre. The total pastureland area in Long Branch was about 787 acres based on the landuse coverage from SJRWMD. This translates into 24 horses for the Long Branch basin. Assuming that daily fecal coliform loading per horse is 4.3×10^9 counts/horse (MapTech 2000) and total coliform loading is 2.2×10^{12} counts/horse (USEPA 2001), the fecal and total coliform daily loadings to Long Branch are 1.03×10^{11} counts/day and 5.3×10^{13} counts/day, respectively. It should be noted that these estimates represent the load created by the basin and no transport attenuation rate was considered. The final loads that reach the stream could be significantly less than these estimates.

The site with the second most frequent fecal and total coliform exceedances is 21FLCEN 20010374. This site is located on the northern tributary of Long Branch, which drains the northern part of the Long Branch watershed. The most likely source of bacteria pollution in this area is the medium density residences located along both sides of CR 13 and the west side of SR50. According to OCEPD, this residential area mainly consists of mobile homes, and all of these dwellings are on septic tanks. A field recon conducted by the Department in May of 2005 found that the stormwater from the residential area is drained through ditches along the CR 13 and discharges directly into the northern tributary of Long Branch. If there are any septic tank failures in the area, the coliform bacteria brought to the land surface could be easily flushed into the stormwater ditches and be brought into the streams. In addition, dogs, **chickens, and other domestic animals** in this residential area could be another source of fecal pollution.

A rough estimate of fecal and total coliform loads from failed septic tanks in the Long Branch basin can be made using **Equation 4.1**:

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

Where,

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

Based on the year 1999 Digital Ortho Quarter Quads (DOQQ's) aerial photography, about 150 housing units were identified in the Long Branch basin. Given that the entire Long Branch basin is on septic tanks, this translates into about 150 septic tanks (*N*) in the studied area.

The discharge rate from each septic tank (*Q*) was calculated by multiplying the average household size by the per capita wastewater production rate per day. Based on the information published by US census bureau, the average household size for Orange County is about 2.5 people/household. The same population density was assumed for the Long Branch basin. A commonly cited value for per capita wastewater production rate is 70 gallons/day/person (USEPA, 2001).

The commonly cited concentrations (*C*) for septic tank discharge are 1×10^6 counts/100 ml and 2.3×10^7 counts/100 ml for fecal and total coliform (USEPA, 2001), respectively.

No measured septic tank failure rate data were available for the study area at the time this study was conducted. Therefore the failure rate was derived from the number of septic tank and septic tank repair permits for the county published by the Florida Department of Health (FDOH) (http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm). The number of septic tanks in the county were calculated assuming that none of the installed septic tanks will be removed after being installed (**Table 4.3**). Reported number of septic tank repair permits was also obtained from the FDOH website (**Table 4.3**). Based on this information, a discovery rate of failed septic tanks for each year between 1996 and 2003 was calculated and listed in **Table 4.3**. Based on **Table 4.3**, the average annual septic tank failure discovery rate for Orange County was about 1.1%. Assuming that failed septic tanks are not discovered for about 5 years, the estimated annual septic tank failure rate is about 5 times the discovery rate, which is equal to 5.3%.

Table 4.3. Estimated septic numbers and septic failure rate for Orange County

	1996	1997	1998	1999	2000	2001	Average
New installation (septic tanks)	996	557	441	589	728	902	702
Accumulated installation (septic tanks)	97536	98093	98534	99123	99851	100753	98982
Repair permit (septic tanks)	1601	803	970	665	1183	1117	1057
Failure discovery rate (%)	1.6	0.8	1.0	0.7	1.2	1.1	1.1
Failure rate (%)*	8.2	4.1	4.9	3.4	5.9	5.5	5.5

* Failure rate is 5 times the failure discovery rate.

Based on **Equation 4.1**, the estimated fecal and total coliform loadings from failed septic tanks in the study area are about 5.2×10^{10} and 1.2×10^{12} counts/day, respectively.

The lowest average concentration and frequency of exceedance of bacteria were observed at site 21 FLCEN 20010395. This is a downstream site on the main stem of Long Branch. The majority of the main stem is flanked by mixed wetland hardwoods. Both the St. Johns River Water Management District and Orange County purchased lands along the main stem of the stream. According to OCEPD, these purchased lands form a buffer zone along the main stem with about 500 feet on each side of the stream. Although some rangelands and livestock operations were observed in this part of the basin, direct discharge of fecal and total coliform bacteria into the main stem of the stream is not expected because of the wide buffer zone.. This may explain the low fecal and total coliform concentration observed at this site. The low bacteria concentrations at this site also suggests that the contribution from wildlife is not significant.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

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

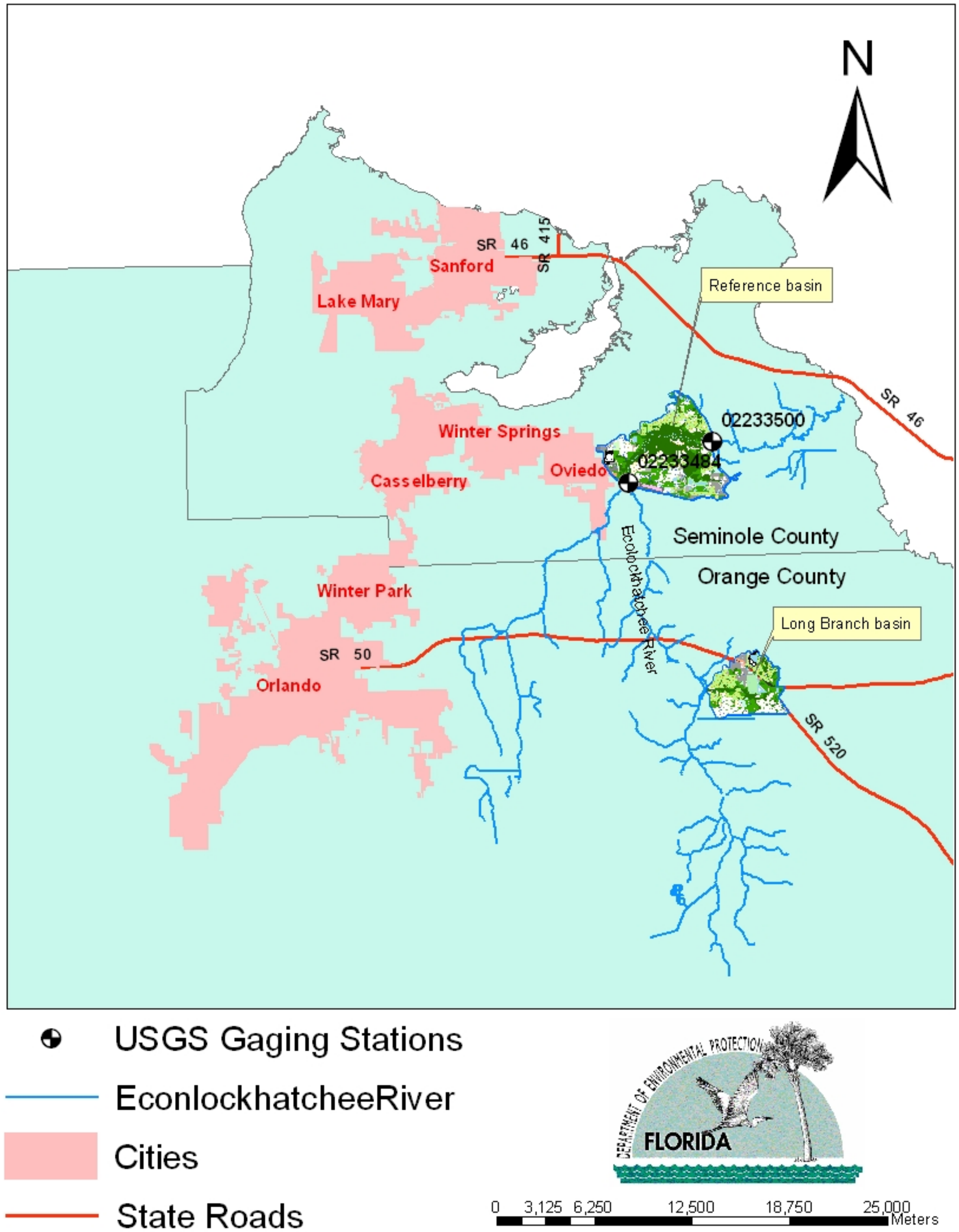
1. Develop the flow duration curve,
2. Develop the load duration curve for both the allowable load and existing loading,
3. Define the critical conditions, and
4. Establish the needed load reduction by comparing the existing loading with the allowable load under critical conditions.

5.1.1 Data Used in the Determination of the TMDL

Fecal coliform and total coliform concentrations and flow measurements were required to estimate both the allowable pollutant loading and existing loading to Long Branch. **Figure 4.1** shows the locations of the water quality stations from which fecal coliform and total coliform data were collected. No USGS gauging station is located in the Long Branch basin or neighboring basins with similar size and landuse characteristics. Therefore, the flow for the Long Branch basin was derived from two adjacent USGS gauging stations located on the Econlockhatchee River (USGS 02233484 and USGS 02233500) (Figure 5.1). Flow measurements from both USGS gauging stations were downloaded from the USGS water resource website (http://fl.water.usgs.gov). The detailed procedures used in this study to derive the flow for Long Branch based on flow measurements from these USGS gauging stations are described in the following sections.

Fecal and total coliform data collected during the Verified Period (1996 through 2003) were used in this study. During this period, there were 29 samples collected for both fecal and total coliform bacteria from 3 sampling stations located in the Long Branch basin. Data used for this TMDL report were retrieved from the Department's IWR database and were mainly provided by the Department's Central District office. Fecal and total coliform results from a field survey conducted by the Department in February of 2005 were also used in this study. Because of the limited number of observations of fecal and total coliform for each water quality station, fecal and total coliform measurements from all 3 stations were pooled together and one TMDL was developed for each parameter (fecal or total coliform) for the entire basin. .

Figure 5.1. Locations of USGS Gauging Stations from which flow measurements were used to derived the stream flow for Long Branch basin



5.1.2 TMDL Development Process

Develop the Flow Duration Curve

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

Because no measured flow was available for the Long Branch basin, flow measurements from two USGS gauging stations located on the Econlockhatchee River were used to derive the flow for Long Branch basin. As both gauging stations measure the main stem flow of the Ecolockhatchee River, the areas of the watersheds draining to these gauging stations are much larger than the Long Branch basin and the characteristics of these watersheds are different from the characteristics of Long Branch basin. According to the USGS water resource website, the watershed area draining to 02233484 is about 228.6 square miles, and the watershed area draining to 02233500 is about 241.0 square miles. The watershed area for Long Branch basin is about 5.7 square miles. Given these differences in watershed area, deriving the flow for Long Branch basin directly based on either one of these gauging stations would not be reasonable. However, as the 2 USGS gauging stations are located very close to each other, the difference in the measured flow for each stations is the surface runoff contributed by a relatively small basin, which was designated as the reference basin in this study (**Figure 5.1**). The area of the reference basin is 241 square miles minus 228.6 square miles, which is 12.4 square miles. The ratio of the area of the reference basin and the area of the Long Branch basin is then 12.4/5.7 = 2.2, which is allowable for applying the basin ratio method to develop the flow for an ungauged basin.

The landuse pattern of the reference basin was analysed and compared to that of the Long Branch basin. **Table 5.1** lists the percent landuse for both the reference basin and the Long Branch basin. The distribution of percent landuse between the two basins are generally similar except that the reference basin has more wetland area and the Long Branch basin has more rangeland area. Wetlands usually have a higher runoff coefficient than rangeland. Therefore, using the stream flow from the reference basin to derive the stream flow for the Long Branch basin may slightly overestimate the actual flow for Long Branch.

Table 5.1. Landuse patterns in Long Branch basin and the reference basin

FLUCCS Level 1	Description	Reference Basin	Long Branch Basin
1000	Urban and Built-up	10%	16%
2000	Agriculture	20%	24%
3000	Rangeland	6%	19%
4000	Upland Forest	19%	17%
5000	Water	3%	4%
6000	Wetland	41%	19%
7000	Barren Land	0%	0%
8000	Transporation	1%	1%

Hydrologic characteristics of the soil in both the Long Branch basin and the reference basin were also analyzed. For Long Branch, B/D, C, and D soils, which have relatively low permeability but high potential to produce surface runoff, account for about 98% of the area among all the soil acreages in the basin. Water and some unidentified soils account for the remaining 2% of the basin area. For the reference basin, B/D, C, and D soils account for about 84% of the basin area while A soil, which has relatively high permeability and low potential to produce surface runoff, account for 14% of the basin area. Waters and other unidentified soil account for the remaining 2% of the basin area. The higher percentage of B/D, C, and D soils in Long Branch basin than in the reference basin may result in more surface runoff being produced in Long Branch basin than in the reference basin. This trend tends to compensate the trend of the landuse pattern, which suggested that the reference basin may produce more runoff than the Long Branch basin because more wetland areas exist in the reference basin.

The total flow contributed by the reference basin (including surface runoff and baseflow) was calculated as the difference of flow measured at the two USGS gauging stations. Because the flow measurements at these two stations are substantially larger than the difference between the two stations, the estimates of the flow contribution from the reference basin will affected by any error of the flow measurements from these two stations. To minimize this interference, the following steps were taken:

(1) Annual average daily flows were calculated for both gauging stations.
(2) An average ratio between the long-term annual average daily flows for the two gauging stations was estimated.
(3) The long-term average ratio was multiplied by the daily flow measurement of the upstream gauging station (USGS 02233484) to produce the flow measurement for the downstream gauging station (USGS 02233500).
(4) The difference between the calculated flow at 02233500 (the downstream station) and measured flow at 02233484 (the upstream station) were considered the flow contribution from the reference basin.

Flow measurements in the period between January 1, 2000 and December 31, 2002 for both gauging stations were used in the analysis. **Table 5.2** lists the annual average daily flow and the ratio between the daily flows of the two USGS gauging stations. The long-term average ratio between annual average daily flows from the two gauging stations was calculated as the flow at USGS 02233500 divided by the flow at USGS 02233484, which is about 106%. The flow for USGS gauging station 02233500 was calculated by multiplying the flow measurement at the station 02233484 by the flow ratio. The flow contribution from the reference basin was calculated as the difference between the calculated flow at station 02233500 and measured flow at 02233484.

Table 5.2. Annual average daily flows and the ratio between annual average daily flows measured at USGS gauging stations 02233484 and 02233500

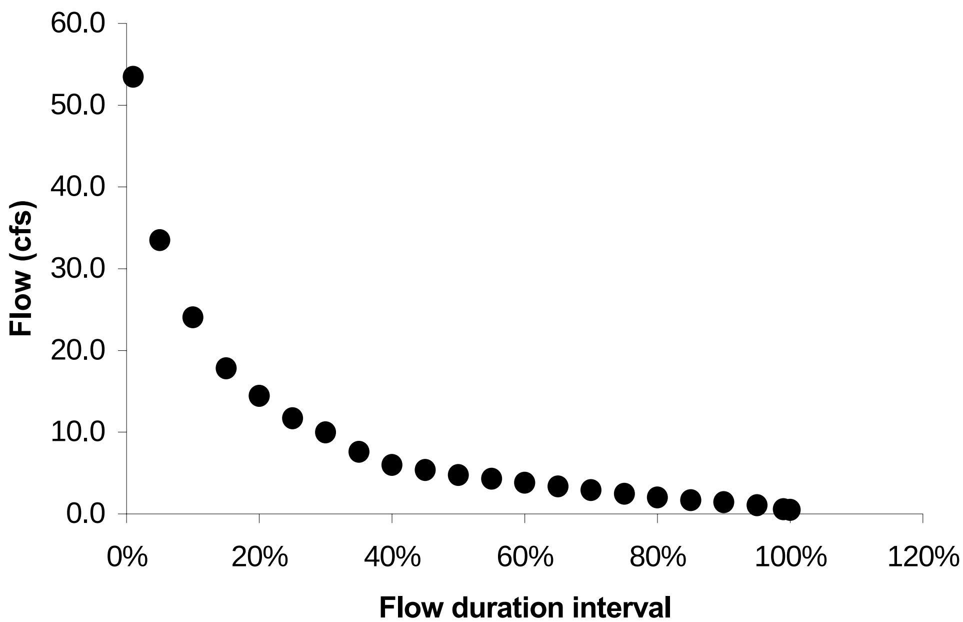
Year	Annual average daily flow for 02233484	Annual average daily flow for 02233500	Difference of average daily flow between the two stations	Ratio of average daily flow 02233500/02233484

2000	91	97	6	106%
2001	408	431	23	106%
2002	465	488	24	105%

Because the watershed area ratio between the reference basin and Long Branch basin is about 2.2, the daily flows at the outlet of Long Branch basin was derived from the flow of the reference basin by dividing the flow contribution of the reference basin by 2.2. The calculated daily flow at the outlet of Long Branch basin was used for the flow duration and load duration analyses described in the following text.

The flow duration curve was created by using the percentile function and the flow record to generate the flow at a given duration interval. For example, at the 90th duration interval, the percentile function calculates the flow that is equal or exceeded 90 percent of the time. **Figure 5.2** shows the flow duration curves for Long Branch generated from the calculated daily flow at the outlet of Long Branch basin using the method described above. Flows toward the right side

Figure 5.2. Flow Duration Curve for Long Branch, WBID 3030



of the plot are exceeded in greater frequency and are indicative of low-flow conditions. Flows on the left side of the plot represent high flows and occur less frequently.

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

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

Allowable load = (observed flow) x (conversion factor) x (state criteria) (2)

Existing loading = (observed flow) x (conversion factor) x (coliform measurement) (3)

On the load duration curve, allowable and existing loads are plotted against the flow duration ranking. The allowable load was calculated based on the water quality criterion and flow values from the flow duration curve, and the line drawn through the data points representing the allowable load is called the target line. The existing loads are based on the instream fecal coliform or total coliform concentrations measured during ambient monitoring and an estimate of flow in the stream at the time of sampling. As noted previously, because insufficient data were collected to evaluate the fecal coliform geometric mean, 400 MPN/100mL and 2,400 MPN/100 mL were used as target criteria for fecal coliform and total coliform, respectively. **Figures 5.3a** and **5.3b** show both the allowable loads and the existing loads over the flow duration ranking for Long Branch. The points of the existing load that were higher than the allowable load at a given flow duration ranking were considered an exceedance of the criteria.

As shown in **Figures 5.3a** and **5.3b,** exceedances of the fecal coliform and total coliform criteria in Long Branch basin occur across the entire span of the flow record. In general, exceedances on the right side of the curve typically occur during low-flow events, which implies a contribution from either point sources or baseflow, which could come from the load from failed septic tanks and sewerline leakage that interact with surficial water. The exceedances that appear on the left side of the curve usually represent loading from stormwater-related sources. In this case, the potential sources may include contributions from pets, such as dogs and cats, livestock, failed septic tanks, and sewer line leakage.

Define the Critical Condition

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

For the Long Branch basin, exceedances occurred across the entire span of the flow conditions. Because no major point sources were identified in the watershed, exceedances that appeared

Figure 5.3a. Load Duration Curves for Allowable Load and Existing Loading Capacity of Fecal Coliform

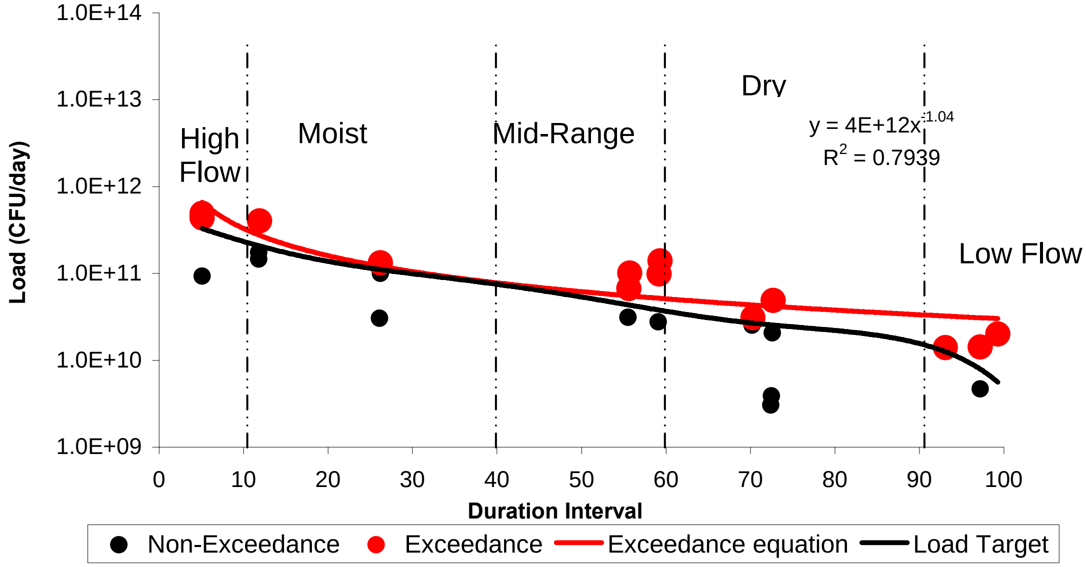
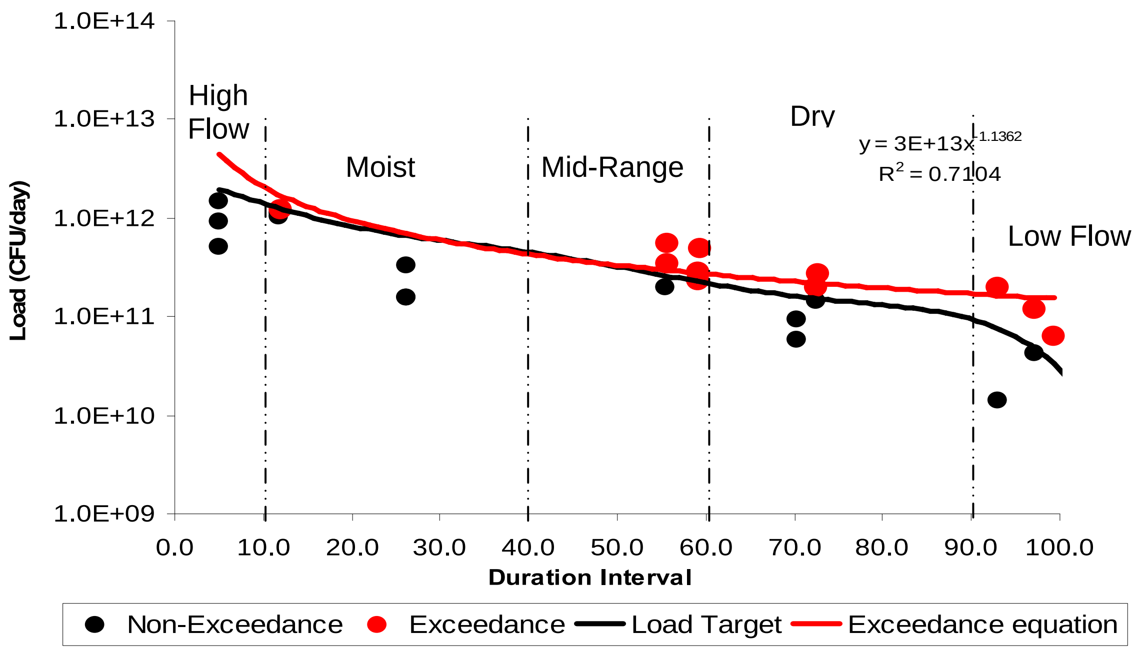


Figure 5.3b. Load Duration Curves for Allowable Load and Existing Loading Capacity of Total Coliform



in all these intervals were considered to be from nonpoint sources. Critical conditions are accounted for in the load curve analysis by using the flow records and water quality data available in the 10th to 90th percentile flow duration interval. Values for flows that are exceeded less than 10 percent of the time were not used because they represent abnormally high-flow events, and values for flows occurring greater than 90 percent of the time were not used because they are extreme low-flow events.

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

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

$$\textbf{Load reduction} = \frac{\textbf{Existing loading} - \textbf{Allowable loading}}{\textbf{Existing loading}} \times \textbf{100\%} \qquad \textbf{(4)}$$

The *Allowable loading* at each recurrence interval was calculated as the product of the water quality criterion and the flow corresponding to the given recurrence interval. To calculate the *Exisiting loading,* a trend line was fitted to the loads that exceeded the *Allowable loading*. Several types of trend lines were examined, and the power function was found to have the highest correlation coefficient for both fecal coliform loading ($R^2 = 0.7939$) and total coliform loading ($R^2 = 0.7104$). Therefore, power functions were used to predict the existing loads corresponding to the flow recurrence intervals used by the *Allowable loading.* The following are the power equations developed for fecal coliform and total coliform:

For fecal coliform: $Y = 4E + 12X^{-1.04}$ **(5)**

For total coliform: $Y = 3E + 13X^{-1.14}$ **(6)**

Where:

X is the flow recurrence interval between the 10th and 90th percentile and

Y is the predicted *Existing loading* for fecal coliform (Equation 5) and total coliform (Equation 6).

Figures 5.3a and **5.3b** show the trend lines and power equations for both fecal and total coliform bacteria. After the trend lines were developed, they were used to determine the percent reduction required to achieve the numeric criterion. At each recurrence interval between the 10th and 90th percentile (in increments of 5 percent), the equation of the trend line was used to estimate the *Existing loading*.

The percent reduction required to achieve the target load was then calculated at each interval, and the final percent reduction needed was the median of these values. The TMDL and percent reductions were calculated as the median of all the loads and percent reductions calculated at the various recurrence intervals between the 10th and 90th percentile. **Tables 5.3a** and **5.3b,** respectively, show the calculation of the TMDL and percent reductions for fecal coliform and total coliform in Long Branch basin.

Table 5.3a. Calculation of TMDL and Percent Reduction for Fecal Coliform in Long Branch basin, WBID 3030

Interval	Allowable Load (counts/day)	Existing Load[1] (counts/day)	Percent Reduction
90	1.43E+10	3.71E+10	61.6
85	1.66E+10	3.94E+10	57.9
80	1.99E+10	4.20E+10	52.7
75	2.40E+10	4.49E+10	46.6
70	2.86E+10	4.82E+10	40.7
65	3.29E+10	5.21E+10	36.8
60	3.74E+10	5.66E+10	34.0
55	4.23E+10	6.20E+10	31.7
50	4.64E+10	6.84E+10	32.1
45	5.27E+10	7.63E+10	31.0
40	5.87E+10	8.63E+10	31.9
35	7.43E+10	9.91E+10	25.1
30	9.76E+10	1.16E+11	16.1
25	1.14E+11	1.41E+11	18.7
20	1.41E+11	1.77E+11	20.3
15	1.74E+11	2.39E+11	27.2
10	2.35E+11	3.65E+11	35.5
Median	4.64E+10	6.84E+10	**32.1**

Table 5.3b. Calculation of TMDL and Percent Reduction for Total Coliform in Long Branch basin, WBID 3030

Interval	Allowable Load (counts/day)	Existing Load[1] (counts/day)	Percent Reduction
90	8.55E+10	1.81E+11	52.7
85	9.96E+10	1.93E+11	48.3
80	1.19E+11	2.07E+11	42.3
75	1.44E+11	2.22E+11	35.3
70	1.72E+11	2.40E+11	28.7
65	1.98E+11	2.62E+11	24.5
60	2.24E+11	2.87E+11	21.8
55	2.54E+11	3.16E+11	19.7
50	2.79E+11	3.52E+11	21.0
45	3.16E+11	3.97E+11	20.4
40	3.52E+11	4.54E+11	22.4
35	4.46E+11	5.29E+11	15.7
30	5.86E+11	6.30E+11	7.0

25	6.86E+11	7.75E+11	11.4
20	8.49E+11	9.98E+11	15.0
15	1.05E+12	1.38E+12	24.4
10	1.41E+12	2.19E+12	35.6
Median	**2.79E+11**	**3.52E+11**	**22.4**

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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

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

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

$$\mathbf{TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS}$$

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

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

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. TMDLs for Long Branch are expressed in terms of colonies/day and percent reduction, and represent the maximum daily fecal coliform and total coliform loads the stream can assimilate and maintain the fecal and total coliform criterion **(Table 6.1).**

Table 6.1. TMDL Components for Fecal Coliform and Total Coliform in Long Branch basin, WBID 3030

Parameter	TMDL (colonies/day)	WLA		LA (percent reduction)	MOS
		Wastewater (colonies/day)	NPDES Stormwater (percent reduction)		
Fecal coliform	4.64×10^{10}	N/A	32%	32 %	Implicit
Total coliform	2.79×10^{11}	N/A	22%	22%	Implicit

6.2 Load Allocation (LA)

Based on a loading duration curve approach similar to that developed by Kansas (Stiles, 2002), the load allocation is a 32 percent reduction in fecal coliforms from nonpoint sources and a 22 percent reduction in total coliforms from nonpoint sources. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A).**

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

There are currently no NPDES-permitted wastewater facilities with fecal or total coliform limits in the Long Branch basin. However, any future discharge permits issued within the Long Branch basin will be required to meet Class III criteria for fecal and total coliforms, which will also comply with this TMDL

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with an MS4 permit is a 32 percent and 22 percent reduction in current anthropogenic fecal coliform and total coliform loadings from the MS4, respectively. It should be noted that any MS4 permittee will only be responsible for reducing the loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety (MOS)

Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of this TMDL. For fecal coliform, an implicit MOS was inherently incorporated by using 400 MPN/100 mL as the water quality target for each and every sampling event, instead of setting the criteria as that no more than 10 percent of the samples exceeding 400 MPN/100 mL. For both fecal coliform and total coliform TMDLs, using the load duration curve method to develop TMDL assumes there is no in-stream decay of fecal or total coliform bacteria after the watershed loading reaches to the receiving waterbody, while in reality fecal and total coliform loadings could diminish through processes including death, grazing, and deposition. Therefore, the load duration curve method tends to underestimate allowable fecal and total coliform loadings that a given waterbody receives and is therefore more conservative in establishing the TMDL. In addition, the correlation lines used to estimate current loading were fitted through only the loadings that exceeded the allowable loadings, which tends to overestimate the actual existing loading and makes the estimation of percent load reduction required more conservative and thereby adds to the MOS.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan (BMAP) for the Manatee Basin. This document will be developed over the next year in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished. The BMAP will include the following:

- Appropriate allocations among the affected parties,
- A description of the load reduction activities to be undertaken,
- Timetables for project implementation and completion,
- Funding mechanisms that may be utilized,
- Any applicable signed agreement,
- Local ordinances defining actions to be taken or prohibited,
- Local water quality standards, permits, or load limitation agreements, and
- Monitoring and follow-up measures.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

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

Chapter 62-40 also requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG has been developed for Newnans Lake at the time this study was conducted.

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

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

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