FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHEAST DISTRICT • LOWER ST. JOHNS BASIN

Final TMDL Report
Fecal Coliform TMDL for Open Creek, WBID 2299

David Wainwright
John F. Hallas

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Wayne Magley, Ph.D., Jan Mandrup-Poulsen, and Linda Lord.

For additional information on the watershed management approach and impaired waters in the Lower St. Johns Basin, contact

Amy Tracy
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
amy.tracy@dep.state.fl.us
Phone: (850) 245–8506
Fax: (850) 245–8434

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

John Hallas
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Assessment Section
2600 Blair Stone Road, Mail Station 3555
Tallahassee, FL 32399-2400
john.hallas@dep.state.fl.us
Phone: (850) 245–8470
Fax: (850) 245–8536

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Florida Department of Environmental Protection, Bureau of Watershed Management

Total Maximum Daily Load (TMDL) Program

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Identification of Impaired Surface Waters Rule

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

STORET Program

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

2008 305(b) Report

http://www.dep.state.fl.us/water/docs/2008_Integrated_Report.pdf

Criteria for Surface Water Quality Classifications

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

Basin Status Report for the Lower St. Johns Basin

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

Water Quality Assessment Report for the Lower St. Johns Basin

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

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

http://www.epa.gov/region4/water/tmdl/florida/

National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal coliform for Open Creek in the Intracoastal Waterway Planning Unit of the Lower St. Johns Basin. The creek was verified as impaired for fecal coliform, and was included on the Verified List of impaired waters for the Lower St. Johns Basin that was adopted by Secretarial Order in May 2004. This TMDL establishes the allowable loadings to Open Creek that would restore the waterbody so that it meets its applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

Open Creek, located in Duval County in northeast Florida, has a drainage area of approximately 6.51 square miles (mi^2). The creek flows directly into Pablo Creek, which also serves as the Intracoastal Waterway (**Figures 1.1** and **1.2**). Open Creek is approximately 3.75 miles long and is a second-order stream. The Open Creek watershed is centrally located in the eastern part of Duval County, near the coast and the eastern edge of the city of Jacksonville and St. Johns County. It is situated on the western side of the Intracoastal Waterway and is tidally influenced. Additional information about the creek's hydrology and geology are available in the Basin Status Report for the Lower St. Johns Basin (Florida Department of Environmental Protection [Department], 2004).

For assessment purposes, the Department has divided the Lower St. Johns Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Open Creek consists of one segment, WBID 2299 (**Figure 1.2**), which this TMDL addresses.

Open Creek is part of the Intracoastal Waterway Planning Unit. Planning units are groups of smaller watersheds (WBIDs) that are part of a larger basin unit, in this case the Lower St. Johns Basin. The Intracoastal Waterway Planning Unit consists of 20 WBIDs. **Figure 1.3** shows Open Creek's location in the planning unit and the boundaries of the other WBIDs in the planning unit.

Figure 1.1. Location of Open Creek, WBID 2299, and Major Geopolitical Features in the Lower St. Johns Basin

Figure 1.2. Overview of the Open Creek Watershed, WBID 2299

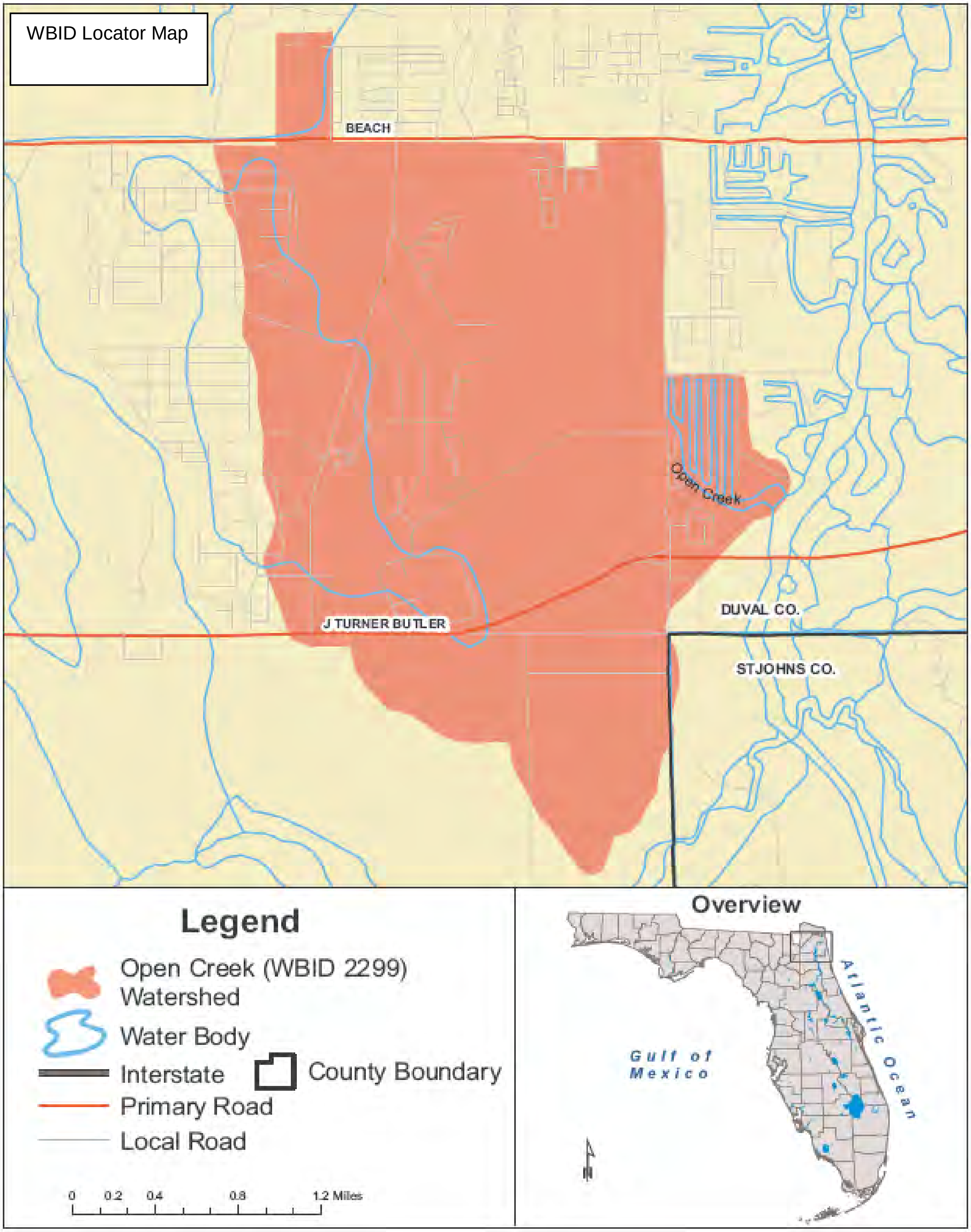


Figure 1.3. WBIDs in the Intracoastal Waterway Planning Unit

1.3 Background

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

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

This TMDL report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, to reduce the amount of fecal coliform that caused the verified impairment of the Open Creek. These activities will depend heavily on the active participation of the St. Johns River Water Management District (SJRWMD), city of Jacksonville, Jacksonville Electric Authority (JEA), local businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing impairment of these 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.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 55 waterbodies and 277 parameters in the Lower St. Johns 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 rule-making 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; the rule was amended in 2006 and again in 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Open Creek and has verified that the creek is impaired for fecal coliform based on data in the Department's IWR database. **Tables 2.1** through **2.3** provide summary results for fecal coliform data for the verification period (which for Group 2 waters was January 1, 1996, to June 30, 2003), by month, season, and year, respectively.

There is a 57.1 percent overall exceedance rate for fecal coliform in Open Creek. Exceedances occur in all months except February, July, and August, with 100 percent exceedances occurring in 6 different months (**Table 2.1**); however, the sample size for each month is small, with all months having fewer than 5 samples. There are 21 samples, ranging from 70 to 5,000 counts per 100 milliliters (counts/100mL).

When aggregating data by season, the greatest percentage of exceedances occurs in the spring (80 percent), followed by winter (75 percent); the lowest percentage occurs in the summer (20 percent) (**Table 2.2**). Considering that precipitation is typically higher in the summer months, this seems to indicate that exceedances are most likely not driven by precipitation and warmer weather.

By year, there appears to be no general trend in exceedances. However, sample size is very small, ranging from one to five, making it difficult to identify potential trends (**Table 2.3**).

There are two sites with historical data. One site has only 1 sample; the other has 20. Both sample sites are located in the same general area, but samples were collected by 2 agencies. **Section 5.1** discusses sampling stations further.

Table 2.1. Summary of Fecal Coliform Data by Month for the Verified Period (January 1, 1996–June 30, 2003)

Month	Number of Samples	Minimum	Maximum	Median	Mean	Number of Exceedances	% Exceedances	Mean Precipitation
January	2	500	5,000	2,750	2,750	2	100.0	2.39
February	1	210	210	210	210	0	0.0	3.14
March	1	688	688	688	688	1	100.0	3.95
April	1	1,300	1,300	1,300	1,300	1	100.0	2.80
May	2	140	500	320	320	2	100.0	1.61
June	2	700	700	700	700	1	50.0	7.40
July	1	184	184	184	184	0	0.0	6.72
August	1	230	230	230	230	0	0.0	6.72
September	3	70	2,000	130	733	1	33.3	9.94
October	4	170	500	180	258	1	25.0	3.39
November	1	500	500	500	500	1	100.0	1.81
December	2	700	1,200	950	950	2	100.0	3.12

Coliform counts are #/100mL.
Exceedances represent values above 400 counts/100mL.
Mean precipitation is for Jacksonville International Airport (JIA) in inches. Means are monthly means based on data from 1955 to 2008.

Table 2.2. Summary of Fecal Coliform Data by Season for the Verified Period (January 1, 1996–June 30, 2003)

Season	Number of Samples	Minimum	Maximum	Median	Mean	Number of Exceedances	% Exceedances	Mean Total Precipitation
Winter	4	210	5,000	1,600	594	3	75.0	10.72
Spring	5	140	1,300	668	700	4	80.0	12.41
Summer	5	70	2,000	523	184	1	20.0	21.15
Fall	7	170	1,200	490	500	4	57.1	8.34

Winter is January–March; spring is April–June; summer is July–September; fall is October–December.
Coliform counts are #/100mL.
Exceedances represent values above 400 counts/100mL.
Mean precipitation is for JIA in inches. Means are based on the 3 months that constitute each season from 1955 to 2008.

Table 2.3. Summary of Fecal Coliform Data by Year for the Verified Period (January 1, 1996–June 30, 2003)

Year	Number of Samples	Minimum	Maximum	Median	Mean	Number of Exceedances	% Exceedances	Mean Total Precipitation
1996	1	500	500	500	500	1	100.0	60.63
1998	3	230	700	500	477	2	66.7	56.72
1999	4	70	500	335	310	2	50.0	42.44
2000	4	1,200	5,000	1,650	2,375	4	100.0	39.77
2001	4	130	700	455	435	2	50.0	49.14
2002	5	140	688	180	274	1	20.0	54.72

Coliform counts are #/100mL.
Exceedances represent values above 400 counts/100mL.
Precipitation is for JIA in inches, and represents the total precipitation for the year shown.

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)**

Open Creek is a Class III fresh waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the impairment addressed by this TMDL is for fecal coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 Fecal Coliform Criterion

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

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

The criterion states that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. However, there were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for the TMDL was not to exceed 400.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

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

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

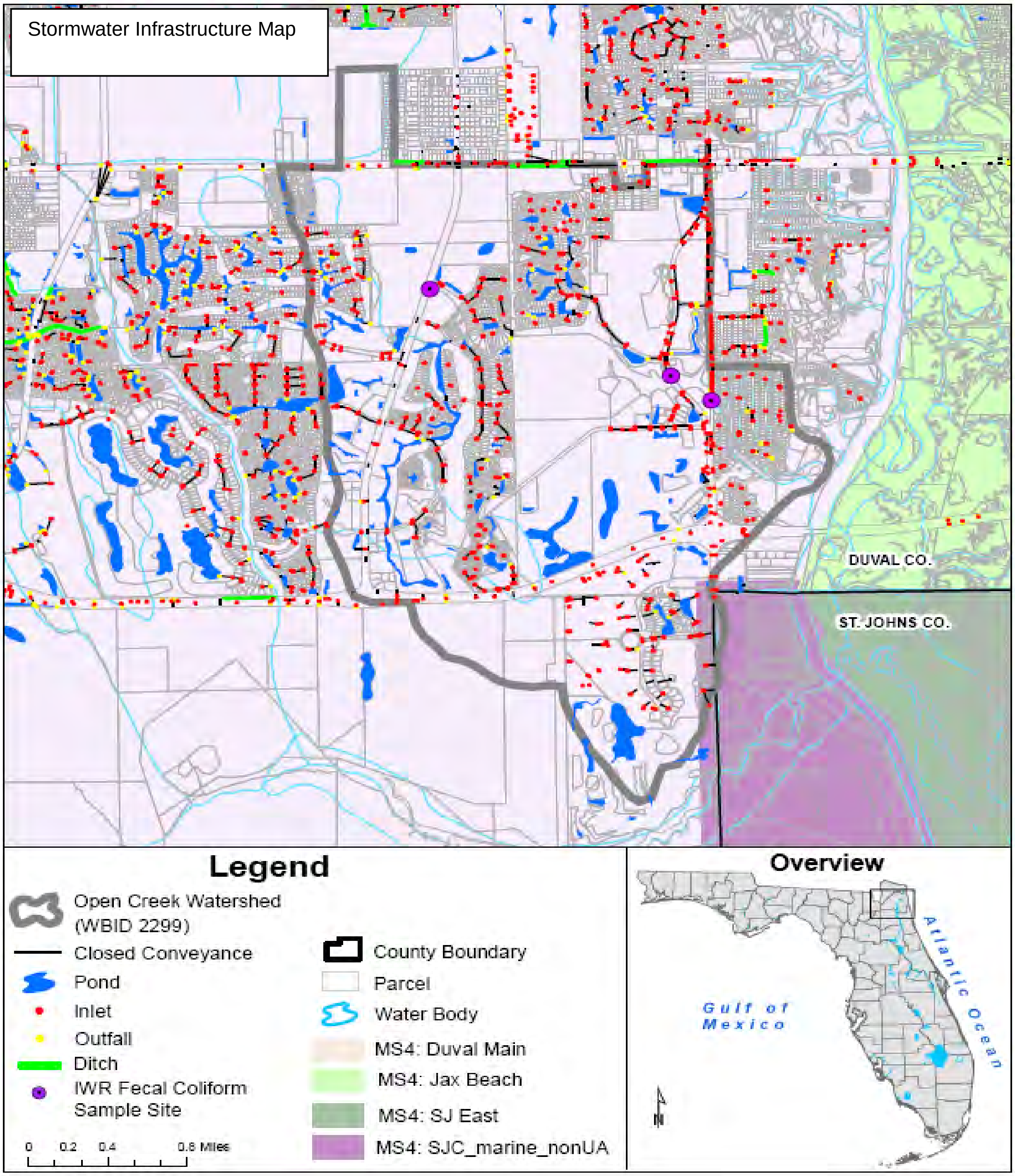
To be consistent with Clean Water Act definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) **AND** stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a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

4.2 Potential Sources of Coliform in the Open Creek Watershed

4.2.1 Point Sources

There are no permitted wastewater facilities located in the watershed; therefore, impacts from wastewater facilities are of minimal concern.

Figure 4.1. Stormwater Infrastructure in the Open Creek Watershed, WBID 2299



Municipal Separate Storm Sewer System Permittees

The city of Jacksonville and the Florida Department of Transportation (FDOT) District 2 are copermittees for a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000012) that covers the Open Creek watershed. FDOT and the cities of Jacksonville, Neptune Beach, and Atlantic Beach share responsibility for the permit.

Figure 4.1 shows the stormwater infrastructure of the watershed. Outfalls represent points where a conveyance of stormwater discharges into a separate stormwater system through a channelized or natural waterway. Inlets are a component of the stormwater system located along the curbed edge of paved surfaces or the low point of an area to provide for the collection of stormwater runoff, access for inspection and maintenance, pipe junctions, sediment traps, or conflicts with other utilities (K. Grable, personal communication, October 16, 2008). In the Open Creek watershed, there are 61 outfalls and 704 inlets.

4.2.2 Land Uses and Nonpoint Sources

Additional coliform loadings to Open Creek are generated from nonpoint sources in the watershed. Potential nonpoint sources of coliform include loadings from surface runoff, wildlife, pets, leaking or overflowing sewer lines, and leaking septic tanks.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the 2004 land use coverage contained in the Department's Geographic Information System (GIS) library, initially provided by the SJRWMD. Land use categories and acreages in the watershed were aggregated using the Level 2 codes tabulated in **Table 4.1. Figure 4.2** shows the principal Level 2 land uses in the watershed.

The Open Creek watershed is relatively small (6.5 mi^2). As **Table 4.1** shows, a large percentage of the land is natural (almost 2,400 acres, or 57 percent), with the largest single land use being upland forests (32.2 percent). Impacted areas occupy approximately 42.5 percent of the area, with residential areas occupying 22.4 percent. While most of the residential areas lie on the western side of the watershed, there are also some on the eastern edge near the Intracoastal Waterway. There are no agricultural areas.

Population

According to the U.S. Census Bureau, census block population densities in the Open Creek watershed in the year 2000 ranged from 0 to 10,725 people/mi^2, with an average of 1,100 people/mi^2 in the watershed (**Figure 4.3**). Based on this average, the estimated population in the Open Creek watershed is 7,165. The Census Bureau reports that, for all of Duval County, the total population for 2000 was approximately 780,000, with 329,778 housing units and an average occupancy rate of 92.1 percent (303,747 units). For all of Duval County, the Bureau reported a housing density of 426 houses per square mile. This places Duval County seventh in housing densities and population in Florida (U.S. Census Bureau Website, 2005). The estimated average housing density in Open Creek is 512 houses/mi^2 based on population, which is slightly higher than that of Duval County, but much of Duval County is rural.

Figure 4.2. Principal Level 2 Land Uses in the Open Creek Watershed, WBID 2299, in 2004

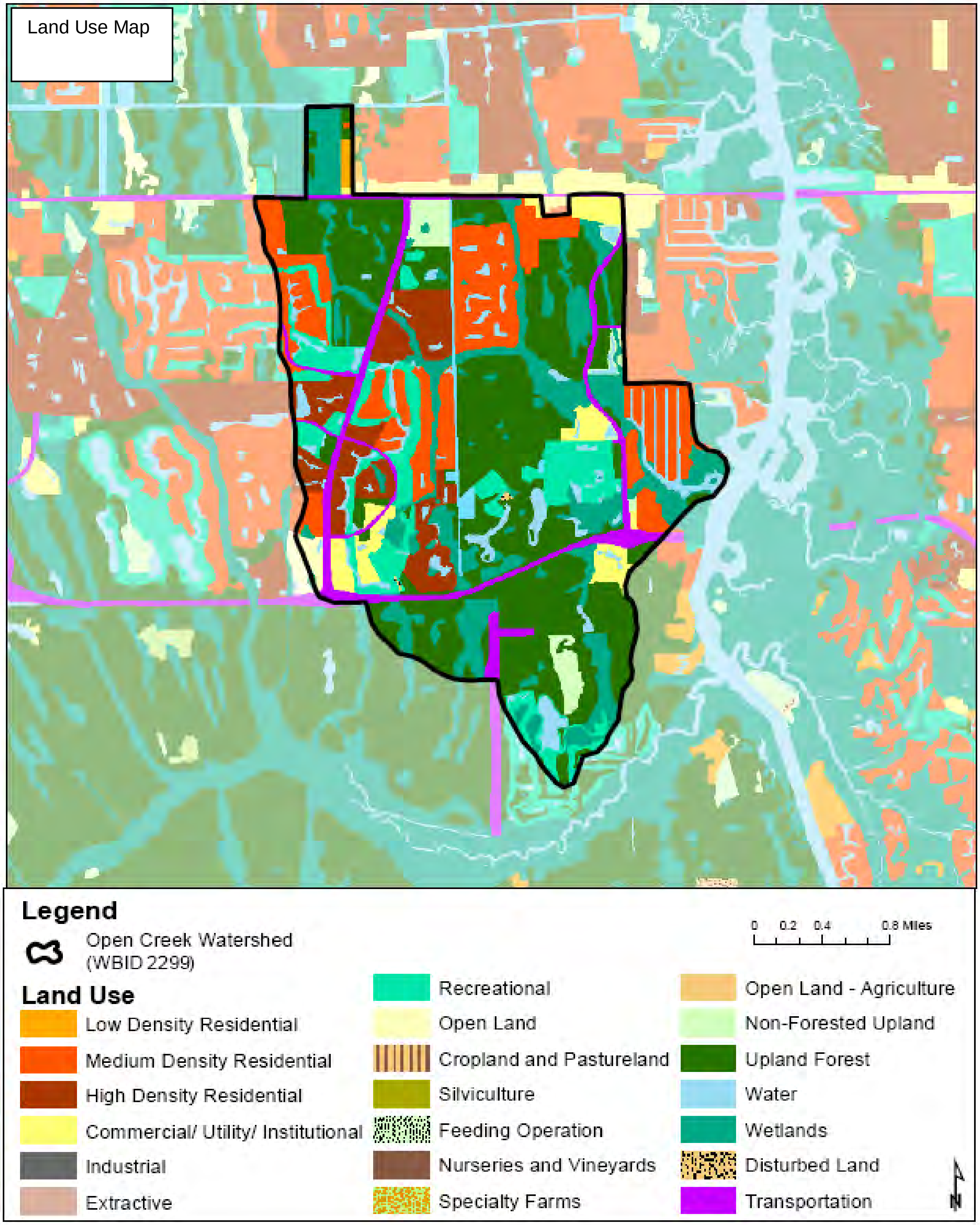
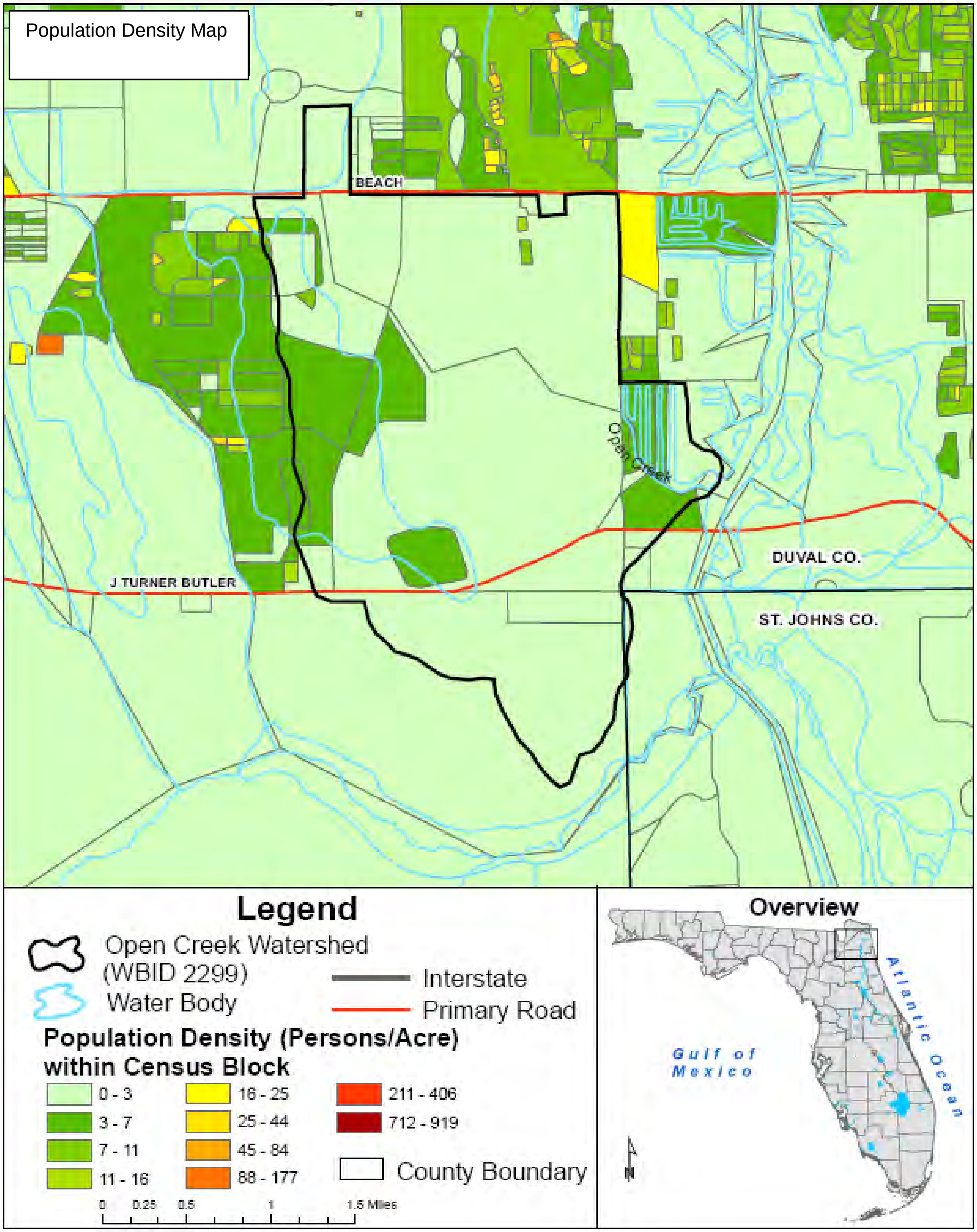


Table 4.1. Level 2 Land Use Categories in the Open Creek Watershed, WBID 2299, in 2004

2004 Land Use	Acres	% of Total
Upland Forest	1,343.2	32.2
Wetlands	700.8	16.8
Medium-Density Residential	610.9	14.7
Recreational	411.3	9.9
High-Density Residential	310.5	7.5
Transportation	236.3	5.7
Water	236.0	5.7
Commercial/Utility/Institutional	187.1	4.5
Nonforested Upland	94.1	2.3
Open Land	20.2	0.5
Low-Density Residential	13.0	0.3
Disturbed Land	2.8	0.1
TOTAL:	**4,166.3**	**100**

Figure 4.3. Population Density in the Open Creek Watershed, WBID 2299, in 2000



Septic Tanks

Approximately 78 percent of Duval County residences are connected to a wastewater treatment plant, while the rest use septic tanks (PBS&J, 2007; and Florida Department of Health [FDOH] Website, 2006b). The FDOH reports that as of fiscal year 2003–04, there were 88,834 permitted septic tanks in Duval County and for fiscal years 1993 to 2004, 5,479 permits for repairs were issued, or an average of approximately 457 repairs annually countywide.

As noted previously, there are about 1,100 persons/mi^2 in the WBID, or 7,163 people. The average household in the Open Creek watershed has 2.15 people (see **Table 4.2**). The Department obtained septic tank repair permit data from JEA for its service area, which includes the Open Creek watershed. The data include septic tank repair permit records issued from 1990 to 2007, areas serviced by a WWTF, and areas where large numbers of failing septic tanks are present. **Figure 4.4** presents this information in map form. The data show that 10 permits for repairs were issued during this time in the watershed, or an average of less than 1 (0.625) repair per year. This equates to an average of 0.625 permits issued per year, which can be rounded up to 1 (to allow for those septic tanks where failures may not be known or have not been repaired). With 1 septic tank failure, 2.15 people per household, and an estimate of 70 gallons/day/person (EPA, 2001), a potential loading of 5.7 x 10^9 fecal colonies/day is derived. This estimation is shown in **Table 4.3**.

None of the Open Creek watershed is in a septic tank phase-out area (an area with the highest priority to be sewered due to a high septic tank failure rate). Except for the extreme southeast corner, the watershed is serviced by the Arlington East WWTF.

Table 4.2. Estimated Average Household Size in the Open Creek Watershed, WBID 2299

Household Size	Number of Households	% of Total	Number of People
1-person household	993	29.77%	993
2-person household	1,449	43.44%	2,898
3-person household	459	13.76%	1,377
4-person household	322	9.65%	1,288
5-person household	83	2.49%	415
6-person household	18	0.54%	108
7-or-more-person household	12	0.36%	84
TOTAL:	**3,336**	**100.00%**	**7,163**
	AVERAGE HOUSEHOLD SIZE:		**2.15**

Data from U.S. Census Bureau Website, 2005, based on Duval County blocks present in the Open Creek watershed.

Table 4.3. Estimated Annual Fecal Coliform Loading from Failed Septic Tanks in the Open Creek Watershed, WBID 2299

Estimated Number of Tank Failures[1]	Estimated Number of Persons per Household[2]	Gallons/ Person/ Day[3]	Estimated Load from Failed Tanks[3]	Estimated Daily Load (counts/day)	Estimated Annual Load (counts/year)
1	2.15	70	1.00 x 10^4/mL	5.70 x 10^9	2.08 x 10^{12}

[1] Based on septic tank repair permits issued in the watershed from March 1990 to April 2004 (FDOH and JEA information); see text.

[2] From U.S Census Bureau; see **Table 4.2** for more information on this estimate.

[3] EPA, 2001.

Figure 4.4. Septic Tank Overflows in the Open Creek Watershed, WBID 2299, 2001–07

4.2.3 Other Potential Sources

Pets

Pets, especially dogs, may be having an impact on the waterbody. The Department has been unable to obtain data on the number of dogs in the area; however, estimates can be made using literature-based values of dog ownership rates (**Table 4.4**). For example, using household-to-dog ratio estimates from the American Veterinary Medical Association (AVMA), the approximate loading is 6.02 x 10^{11} organisms/day.

Table 4.4. Estimated Loading from Dogs in the Open Creek Watershed, WBID 2299

Estimated Number of Households in 2299	Estimated Household:Dog Ratio[1]	Estimated Dog Population in Watershed	Load Reaching Waterbody	Estimated Number of Dogs with Impact to Creek	Estimated Counts/ Dog/Day[2]	Estimated Daily Load (counts/day)	Estimated Annual Load (counts/year)
3,336	0.361	1,204	10%	120	5 x 10^{9}	6.02 x 10^{11}	2.20 X 10^{14}

[1] From the AVMA Website, which states the original source to be the *U.S. Pet Ownership and Demographics Sourcebook,* 2002.

[2] EPA, 2001.

Leaking or Overflowing Wastewater Collection Systems

As noted previously, about 78 percent of households in Duval County are connected to a wastewater facility. Assuming 3,336 homes in the watershed, with 2.15 people per home, and a 70-gallon-per-person-per day-discharge, and also assuming that the countywide average of 78 percent of households connected to a WWTF applies in Open Creek, a daily flow of approximately 1.48 x 10^{6} liters (L) is transported through the collection system. The EPA (Davis, 2002) suggests that a 5 percent leakage rate from collection systems is a realistic estimate. Based on this rate and EPA values for fecal coliform in raw sewage, the potential loadings of fecal coliform from leaking sewer lines are 3.71 x 10^{12} counts/day (**Table 4.5**).

Table 4.5. Estimated Loading from Wastewater Collection Systems in the Open Creek Watershed, WBID 2299

Estimated Homes on Central Sewer	Estimated Daily Flow (L)	Daily Leakage (L)	Raw Sewage (counts/100mL)	Estimated Daily Load (counts/day)	Estimated Annual Load (counts/year)
2,602	1.48 x 106	7.41 x 104	5 x 106	3.71 x 1012	1.35 X 1015

4.3 Source Summary

Table 4.6 summarizes the estimates from various sources. It is important to note that this is not a complete list (wildlife, for example, is missing) and represents estimates of potential loadings. Proximity to the waterbody, rainfall frequency and magnitude, and temperature are just a few of the factors that could influence and determine the actual loadings from these sources that reach Open Creek.

Table 4.6. Summary of Estimated Potential Coliform Loading from Various Sources in the Open Creek Watershed, WBID 2299

Source	Fecal Coliform	
	Estimated Daily Load (counts/day)	**Estimated Annual Load (counts/year)**
Permitted Facilities	N/A	N/A
Septic Tanks	5.70×10^{9}	2.08×10^{12}
Pets	6.02×10^{11}	2.20×10^{14}
Collection Systems	3.71×10^{12}	1.35×10^{15}

N/A – Not applicable

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The methodology used for this TMDL was the "percent reduction" methodology. The Department generally prefers to use the load duration curve or "Kansas" method for coliform TMDLs, but this method could not be used because there are no stream gauging stations on Open Creek. To determine the TMDL, the percent reduction that would be required for each of the exceedances to meet applicable criteria was determined, and the median value of all of these reductions for fecal coliform determined the overall required reduction, and is therefore the TMDL.

5.1.1 Data Used in the Determination of the TMDL

In addition to data in the Department's IWR database, the city of Jacksonville submitted additional data collected in the WBID after the verified period. These data are included below, and all were considered in TMDL development.

Three sampling stations on Open Creek have fecal coliform observations (**Figure 5.1**). **Table 5.1** shows data collection information for each of the stations, and **Figure 5.1** shows the location of the sample sites. **Table 5.2** shows observed historical data analysis, and **Appendix B** contains all of the historical fecal coliform observations from the sites for the planning and verified periods for Open Creek. **Figure 5.2** shows the historical observations visually over time.

The Department's sampling at Open Creek showed a 50 percent exceedance rate. The city of Jacksonville's sampling at Pablo Creek Road had a 75 percent exceedance rate. Both of these sites, differing slightly in their location, are near the mouth of the creek. Because there are no upstream data for comparison, it is unknown if fecal coliform concentrations are higher or lower upstream than at the mouth, and therefore it is difficult to identify any instream trends in Open Creek. All data were considered in developing the TMDL. **Appendix B** provides fecal coliform observations for the entire period of record from Open Creek.

Table 5.1. Sampling Station Summary for Open Creek, WBID 2299

STORET ID	Station	Station Owner	Year										
			1996	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Open Creek at San Pablo Road	21FLJXWQIWWF	City of Jacksonville						1					7
Open Creek at San Pablo Road	21FLA 20030695	Department											8
Open Creek at Hodges Blvd	21FLA 20030848	Department.	2	6	8	8	4	4	4	3	4	4	6
		N	**2**	**6**	**8**	**8**	**4**	**5**	**4**	**3**	**4**	**4**	**21**
		Total N	**69**										

Figure 5.1. Historical Sample Sites in Open Creek, WBID 2299

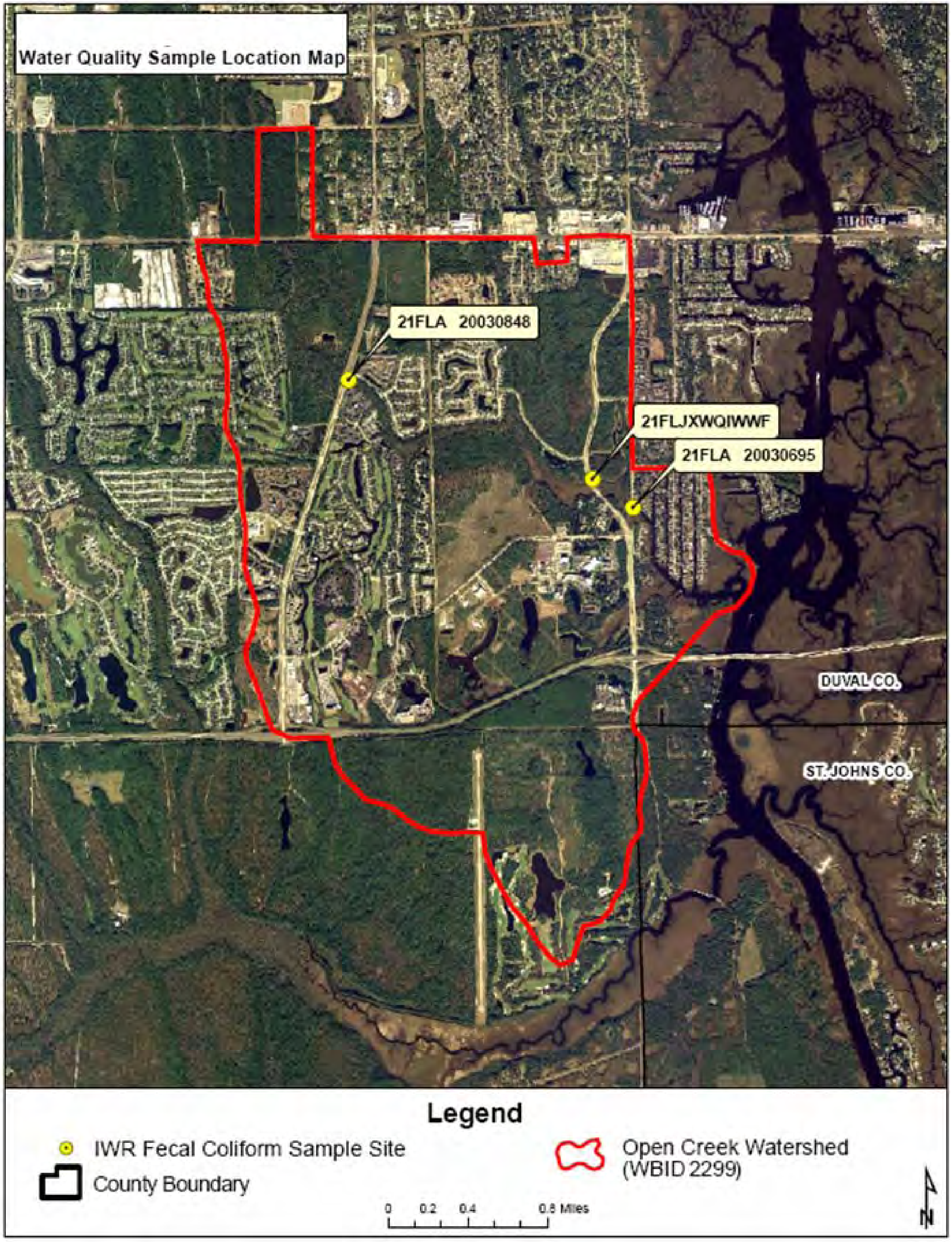


Figure 5.2. Historical Fecal Coliform Observations in Open Creek, WBID 2299

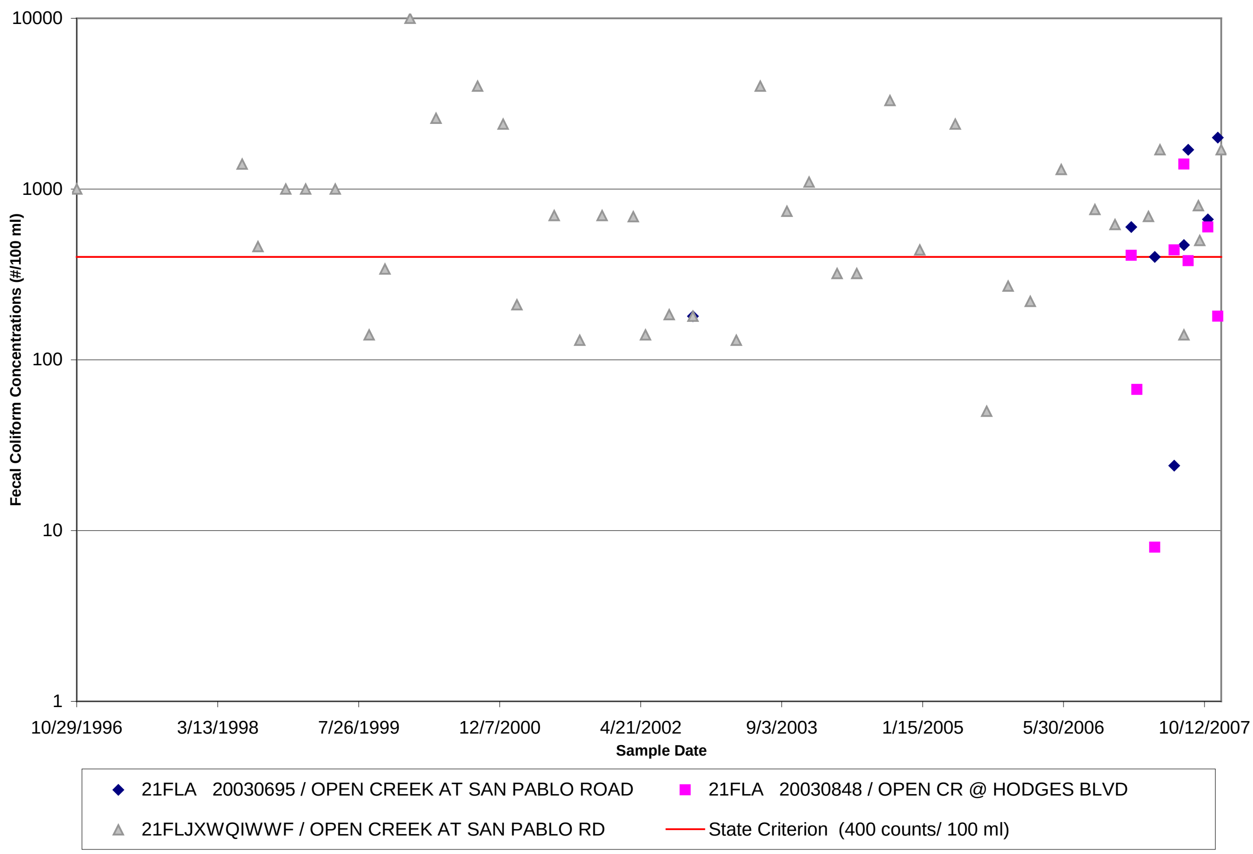


Table 5.2. Statistical Summary of Historical Data for Open Creek, WBID 2299

Station	N	Max	Min	Median	Number of Exceedances	% Exceedances
Open Creek at San Pablo Road	8	2,000	24	535	6	75.0
Open Creek at San Pablo Road	8	1,400	8	394.5	4	50.0
Open Creek at Hodges Blvd	53	5,000	50	500	35	66.0

Coliform concentrations are counts/100mL.

5.1.2 TMDL Development Process

Due to the lack of supporting flow information, a simple calculation was performed to determine the needed reduction. Exceedances of the state criterion were compared with the criterion of 400 counts/100mL. For each individual exceedance, an individual required reduction was calculated using the following:

$$\frac{[(\text{observed value}) - (\text{state criterion})] \times 100}{(\text{observed value})}$$

After the individual results were calculated, the median of the individual values was calculated, which is 60 percent in Open Creek. This means that in order to meet the state criterion of 400 counts/100mL in the creek, a 60 percent reduction in current loading is necessary and is therefore the TMDL for Open Creek. **Table 5.3** show the individual exceedances used in calculating the TMDL for Open Creek.

Table 5.3. Calculations To Determine the Fecal Coliform TMDL for Open Creek, WBID 2299

Sample Date	Location	Observed Exceedance	Required % Reduction
10/29/1996	Open Creek at San Pablo Rd	1,000	60.0%
6/8/1998	Open Creek at San Pablo Rd	1,400	71.4%
8/3/1998	Open Creek at San Pablo Rd	460	13.0%
11/9/1998	Open Creek at San Pablo Rd	1,000	60.0%
1/19/1999	Open Creek at San Pablo Rd	1,000	60.0%
5/4/1999	Open Creek at San Pablo Rd	1,000	60.0%
1/24/2000	Open Creek at San Pablo Rd	10,000	96.0%
4/25/2000	Open Creek at San Pablo Rd	2,600	84.6%
9/20/2000	Open Creek at San Pablo Rd	4,000	90.0%
12/19/2000	Open Creek at San Pablo Rd	2,400	83.3%
6/18/2001	Open Creek at San Pablo Rd	700	42.9%
12/5/2001	Open Creek at San Pablo Rd	700	42.9%
3/26/2002	Open Creek at San Pablo Rd	688	41.9%
6/19/2003	Open Creek at San Pablo Rd	4,000	90.0%
9/22/2003	Open Creek at San Pablo Rd	740	45.9%
12/9/2003	Open Creek at San Pablo Rd	1,100	63.6%
9/21/2004	Open Creek at San Pablo Rd	3,300	87.9%
1/5/2005	Open Creek at San Pablo Rd	440	9.1%
5/11/2005	Open Creek at San Pablo Rd	2,400	83.3%
5/22/2006	Open Creek at San Pablo Rd	1,300	69.2%
9/18/2006	Open Creek at San Pablo Rd	760	47.4%
11/28/2006	Open Creek at San Pablo Rd	620	35.5%
1/25/2007	Open Creek at San Pablo Road	600	33.3%
1/26/2007	Open Creek at Hodges Blvd	409	2.2%
3/27/2007	Open Creek at San Pablo Rd	690	42.0%
4/18/2007	Open Creek at San Pablo Road	400	0.0%
5/7/2007	Open Creek at San Pablo Rd	1,700	76.5%
5/8/2007	Open Creek at Hodges Blvd	440	9.1%
7/31/2007	Open Creek at San Pablo Road	470	14.9%
8/1/2007	Open Creek at Hodges Blvd	1,400	71.4%
8/15/2007	Open Creek at San Pablo Road	1,700	76.5%
9/20/2007	Open Creek at San Pablo Rd	800	50.0%
9/25/2007	Open Creek at San Pablo Rd	500	20.0%
10/24/2007	Open Creek at San Pablo Road	664	39.8%
10/25/2007	Open Creek at Hodges Blvd	600	33.3%
11/28/2007	Open Creek at San Pablo Road	2,000	80.0%
12/10/2007	Open Creek at San Pablo Rd	1,700	76.5%
	MEDIAN:	**1,000**	**60.0%**

Observed values are #/100mL.

5.1.3 Critical Conditions/Seasonality

Appendix B provides historical fecal coliform observations collected in Open Creek. Coliform data are presented by month, season, and year to determine whether certain patterns are evident in the dataset.

A nonparametric test (Kruskal-Wallis) was applied to the fecal coliform dataset to determine whether there were significant differences among months or seasons. At an alpha (α) level of 0.05, there are no significant differences among seasons or months (**Appendix C**). Grouping observations by season increased sample sizes for statistical comparison, as seen in **Table 2.2**. The greatest percentage of exceedances occurred in the fall (October to December) and summer (June to August). **Appendix D** presents comparisons of stations and seasons.

Rainfall records for JIA (**Appendix E** illustrates rainfall from 1990 to 2008) were used to determine the rainfall amounts associated with individual sampling dates. Rainfall recorded on the day of sampling (1D), the cumulative total for the day of and the previous 2 days (3D), the cumulative total for the day of and the previous 6 days (7D), the cumulative total for the day of and previous 29 days (30D) were all paired with the respective coliform observation. A Spearman correlation matrix was generated that summarized the simple correlation coefficients between the rainfall and coliform values (**Appendix F**). The simple correlations (r values in the Spearman correlation table) between both fecal coliform and the various rainfall totals were positive, suggesting that as rainfall (and possible runoff) increased, so did the number of coliform.

Simple linear regressions were performed between coliform observations and rainfall totals to determine whether any of the relationships were significant at an α level of 0.05. The r^2 values between fecal coliform and precipitation regimes showed no significance (**Appendix G**). A table of historical monthly average rainfall (**Appendix H**) indicates that monthly rainfall totals increase in June, peak in September, and by October return to the levels observed in February and March. The highest percentage of exceedances occurred in the fall (October to December; see **Table 2.2**). **Appendix I** includes a table of annual rainfall at JIA from 1955 to 2008; the long-term average was 52.47 inches over this period. There does not appear to be an obvious correlation between total annual precipitation and percent exceedance of fecal coliform.

Assessment of Hydrologic Conditions

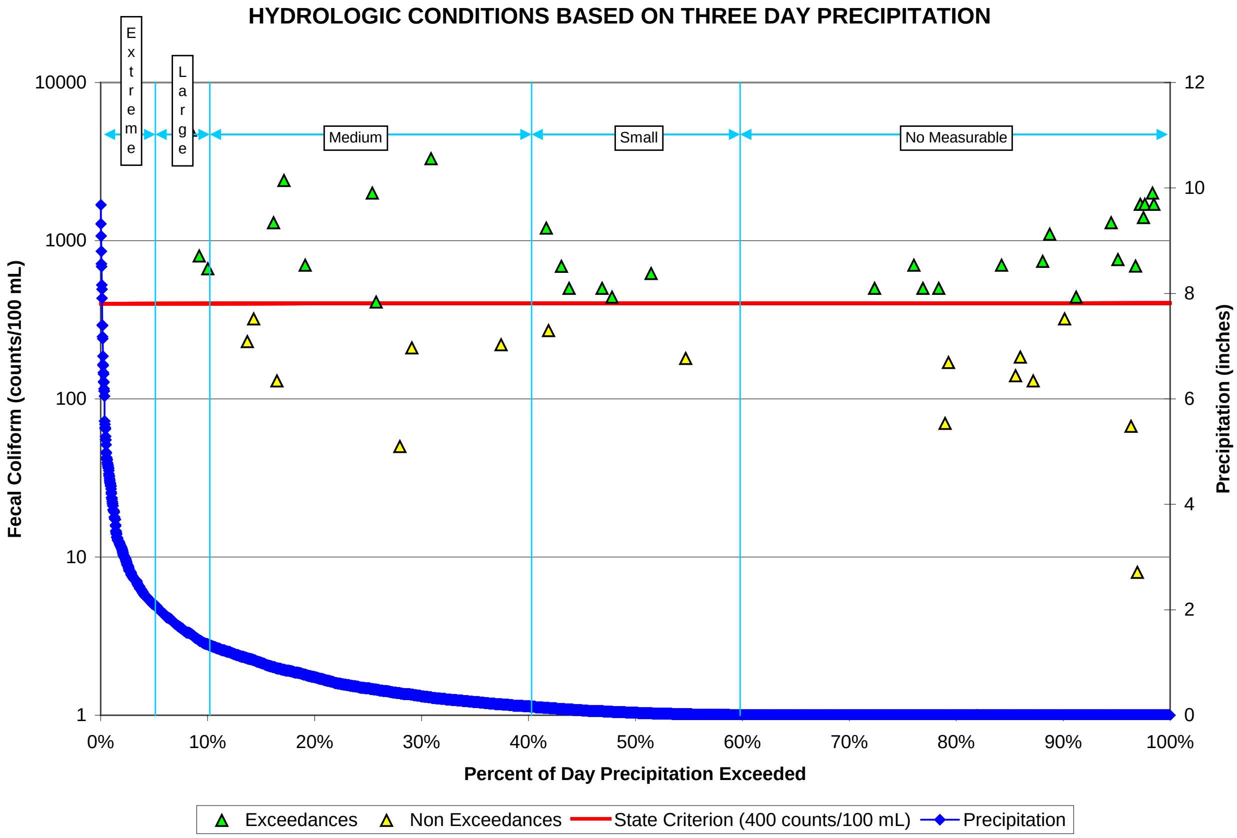
As no flow data were available, hydrologic conditions were analyzed using rainfall. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from JIA from 1990 to 2004. The chart was divided in the same manner as if flow were being analyzed, where extreme precipitation events represent the upper percentiles (0 to 5th percentile), followed by large precipitation events (5th to 10th percentile), medium precipitation events (10th to 40th percentile), small precipitation events (40th to 60th percentile), and no recordable precipitation events (60th to 100th percentile). Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis.

Data show that fecal coliform exceedances occurred over all hydrologic conditions for which data exist, and all have at least a 50 percent exceedance rate. However, the lowest percentage of exceedances (50 percent) occurred after medium precipitation events (0.18" to 1.33"). The highest percentage of exceedances (100 percent) occurred after large precipitation events. If a large percentage of exceedances occur during no measurable precipitation days, it is suspected that point sources are contributing. Likewise, if a large percentage of exceedances occur after large and extreme precipitation events, this may indicate that exceedances are nonpoint source driven; perhaps from stormwater conveyance systems or various land uses. It is difficult to draw conclusions without data from extreme event ranges; however, with the exceedances spread throughout the ranges in which data exist, it is most likely that they stem from a variety of both point and nonpoint sources. **Table 5.4** summarizes data and hydrologic conditions. **Figure 5.3** shows the same data visually.

Table 5.4. Summary of Fecal Coliform Data by Hydrologic Condition

Precipitation Event	Event Range (inches)	Total Number of Samples	Number of Exceedances	% Exceedance	Number of Nonexceedances	% Nonexceedances
Extreme	>2.1"	1	1	100.00%	0	0.00%
Large	1.33" - 2.1"	3	3	100.00%	0	0.00%
Medium	0.18" - 1.33"	12	6	50.00%	6	50.00%
Small	0.01" - 0.18"	8	6	75.00%	2	25.00%
None/ Not Measurable	<0.01"	24	16	66.67%	8	33.33%

Figure 5.3. Fecal Coliform by Hydrologic Flow Condition



Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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

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

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

$$TMDL \quad \Sigma\ WLAs_{wastewater} + \Sigma\ WLAs_{NPDES\ Stormwater} + \Sigma\ LAs + MOS$$

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 best management practices (BMPs).

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The TMDL for Open Creek is expressed in terms of both counts/100mL and percent reduction, and represents the maximum daily fecal coliform load the creek can assimilate and maintain the fecal coliform criterion (**Table 6.1**). Since the TMDL is a percent reduction, the reduction can be applied on a daily basis.

Table 6.1. TMDL Components for Open Creek, WBID 2299

WBID	Parameter	TMDL (counts/100mL)	WLA		LA (% reduction)	MOS.
			Wastewater (counts/day)	NPDES Stormwater		
2299	Fecal Coliform	400	N/A	60%	60	Implicit

N/A – Not applicable

6.2 Load Allocation

A fecal coliform reduction of 60 percent is required in WBID 2299 from nonpoint sources. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

While there are currently no NPDES-permitted facilities in the Open Creek watershed that require fecal coliform monitoring, any facilities seeking an NPDES permit to discharge to Open Creek in the future will be required to meet the limits set forth in their perspective permit. For fecal coliform, discharge concentrations will not exceed 200 counts/100mL as a monthly average, 400 counts/100mL in more than 10 percent of the samples, or 800 counts/100mL at any given time. Permitted limits will meet TMDL requirements and will therefore protect water quality.

6.3.2 NPDES Stormwater Discharges

The WLA for the city of Jacksonville and FDOT's MS4 permit is a 60 percent reduction in WBID 2299 in current anthropogenic fecal coliform loading. It should be noted that any MS4 permittee is only 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.

While the LA and WLA for fecal coliform are expressed as the percent reductions needed to attain the applicable Class III criterion, it is the combined reductions from both anthropogenic point and nonpoint sources that will result in the required reduction of instream fecal and total coliform concentrations. However, it is not the intent of this TMDL to abate natural background conditions.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, February 2001), an implicit MOS was assumed in the development of this TMDL by not allowing any exceedances of the state criterion, even though the actual criterion allows for 10 percent exceedances over the fecal coliform criterion of 400 counts/100mL.

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, or BMAP, for the TMDL. The first BMAP for the tributaries to the Lower St. Johns River will address the 10 worst-case impairments in the 55 tributaries impaired for fecal coliform. Any future BMAPs will address additional subsets of the tributaries listed for fecal coliform.

In addition to addressing failing septic tanks, the BMAP may include some sort of public education program about pet waste cleanup. As **Table 4.4** shows, potential impacts from dogs in the watershed could be significant. If pet owners are educated on the potential impacts their pets are having on Open Creek, and they are inclined to take action, this could potentially decrease a source load. When considering the significance of seven-day rainfall, this could be a potentially significant load to the stream.

Through the implementation of projects, activities, and additional source assessments in the BMAP, stakeholders expect the following outcomes:

Improved water quality trends in the tributaries of the Lower St. Johns River, which will also help improve water quality in the main stem of the river;

Decreased loading of the target pollutant (fecal coliform);

Enhanced public awareness of pollutant sources, pollutant impacts on water quality, and corresponding corrective actions;

Enhanced understanding of basin hydrology, water quality, and pollutant sources; and

The ability to evaluate management actions, estimate their benefits, and identify additional pollutant sources.

7.1.1 Determination of Worst-Case WBIDs

The initial determination of the worst-case WBIDs uses a ranking method that establishes the severity of bacterial contamination based on the number of exceedances of fecal coliform colony counts—i.e., the number of total fecal coliform samples in a waterbody during the period of record to indicate how many samples are over 800, 5,000, and 10,000 colony counts. A combined rank is then created based on the number of exceedances in each category. The WBIDs are sorted from worst to best to provide a guideline for assessment priorities, with the worst-case waterbody ranked first. Future BMAPs will continue to address the worst-case waters first, using the ranking method.

7.1.2 Identification of Probable Sources

Tributary Pollutant Assessment Project

Initial sampling for the study on the six initial WBIDs of highest concern began July 26, 2005, and was completed on February 1, 2006. The final deliverable (the *Tributary Pollutant Assessment Project Manual*) was submitted to JEA on June 1, 2006, and became available for public review and comment on June 16, 2006. Four types of fecal indicators (fecal coliform, *E. coli*., *Enterococci*, and coliphages) were studied. *Enterococcus faecalis* was also studied in an attempt to further identify potential sources of sewage, and samples were checked for human/ruminant primers.

The executive summary submitted to the Department by JEA and PBS&J is attached as **Appendix J**. The results of the study will be used to help guide the identification of restoration projects during BMAP development.

Technical Reports

In an effort to address the known impairments in the Lower St. Johns tributaries, the Department contracted with PBS&J to develop technical reports that describe and interpret the water quality, spatial, and geographic data from the Department, Duval County Health Department, city of Jacksonville, and JEA. The reports analyze the available data to identify the most probable sources of fecal coliform, which fall into five main categories, as follows: (1) stormwater, (2) onsite sewage treatment and disposal systems (OSTDS), (3) sewer infrastructure, (4) nonpoint sources such as pet waste, and (5) natural background such as wildlife. These reports were peer reviewed by technical stakeholders in the basin, who also provided additional input based on their knowledge of the tributaries.

7.1.3 Issues To Be Addressed in Future Watershed Management Cycles

The BMAP process identified the following items that should be addressed in future watershed management cycles to ensure that future BMAPs use the most accurate information:

> ***Source Identification****—Sources of fecal coliform impairment are particularly difficult to trace. For this reason, the BMAP includes source identification studies as management actions.*
>
> ***Septic Tanks****—The Department is implementing a study,* Evaluation of Septic Tank Influences on Nutrient Loading to the Lower St. Johns River Basin and Its Tributaries, *to better understand the nutrient and bacteria loading from septic tanks via ground water by monitoring conditions at representative sites. The study seeks to answer questions on potential OSTDS impacts and the attenuation of nitrogen, phosphorus, and bacteria (fecal coliform) by soil, under the range of conditions that represent typical OSTDS sites near impaired surface waters. It will also document the nutrients and bacteria in the receiving Lower St. Johns tributaries at each site. The results will provide information about the relative contribution of fecal coliform from septic tanks located near the impaired tributaries.*
>
> ***GIS Information****—During the BMAP process, the available GIS data, which provide a basis for some of the source analyses, have improved. As more information becomes available, the updated GIS database for the tributaries will be utilized to aid in source identification. This information will include determining the spatial locations for private wastewater systems and*

infrastructure, collecting jurisdictional or systemwide programs and activities on a WBID scale for future reporting and assessment, and systematically updating all GIS information databases used to compile the BMAP.

7.1.4 BMAP Implementation

The BMAP requires that all stakeholders implement their projects to achieve reductions as soon as practicable. However, the full implementation of the BMAP will be a long-term process. Some of the projects and activities in the BMAP are recently completed or currently ongoing, but several projects will require more time to design, secure funding, and construct. While funding the projects could be an issue, funding limitations do not affect the requirement that every entity must implement the activities listed in the BMAP.

Since BMAP implementation is a long-term process, the TMDL targets established for the Lower St. Johns Basin will not be achieved in the next five years. It may take even longer for the tributaries to respond to reduced loadings and fully meet applicable water quality standards. Regular follow-up and continued coordination and communication among the stakeholders will be essential to ensure the implementation of management strategies and the assessment of their incremental effects. Any additional management actions required to achieve TMDLs, if necessary, will be developed as part of BMAP follow-up.

References

American Veterinary Medical Association Website. 2006. Available: http://www.avma.org/reference/marketstats/default.asp.

Davis, M. December 19, 2002. Memo to Gail Mitchell, Draft Interoffice Memorandum, U.S. Environmental Protection Agency, Atlanta, GA.

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

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

Florida Department of Agriculture and Consumer Services. 2005. *Agriculture, Florida's economic engine; Florida agricultural statistical directory 2004.*

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

———. March 2003. *Lower St. Johns Basin status report.* Tallahassee, FL: Bureau of Watershed Management. Available: http://www.dep.state.fl.us/water/tmdl/stat_rep.htm.

Florida Department of Health Website. 2006a. Available: http://www.doh.state.fl.us/.

———. 2006b. Available: http://www.doh.state.fl.us/environment/ostds/statistics/newInstallations.pdf.

———. 2006c. Available: http://www.doh.state.fl.us/environment/ostds/statistics/repairs.pdf.

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

PBS&J. 2007. *JEA Water and Sewer Expansion Authority septic files.*

U.S. Census Bureau Website. 2005. Available: http://www.census.gov/.

U.S. Environmental Protection Agency. January 2001. *Protocol for determining pathogen TMDLs.* EPA 841-R-00-002. Washington, DC: Office of Water. Available: http://www.epa.gov/OWOW/TMDL/techsupp.html.

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 the stormwater flood control requirements of the state's water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations

Chapter 62-40, F.A.C., also requires the water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL.

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 stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the FDOT throughout the 15 counties meeting the population criteria. The EPA authorized the Department to implement the NPDES Stormwater Program (except for tribal lands) in October 2000.

An important difference between the federal 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 focuses on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 10,000 people. The revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution, such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Historical Fecal Coliform Observations in Open Creek, WBID 2299

Sample Date	Station	Location	Value (#/100mL)	Remark Code
10/29/1996	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
10/29/1996	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
6/8/1998	21FLJXWQIWWF	Open Creek at San Pablo Rd	700	
6/8/1998	21FLJXWQIWWF	Open Creek at San Pablo Rd	700	
8/3/1998	21FLJXWQIWWF	Open Creek at San Pablo Rd	230	
8/3/1998	21FLJXWQIWWF	Open Creek at San Pablo Rd	230	
11/9/1998	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
11/9/1998	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
1/19/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
1/19/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
5/4/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
5/4/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
9/1/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	70	
9/1/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	70	
10/27/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	170	
10/27/1999	21FLJXWQIWWF	Open Creek at San Pablo Rd	170	
1/24/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	5,000	
1/24/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	5,000	
4/25/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,300	
4/25/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,300	
9/20/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	2,000	
9/20/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	2,000	
12/19/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,200	
12/19/2000	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,200	
2/6/2001	21FLJXWQIWWF	Open Creek at San Pablo Rd	210	
6/18/2001	21FLJXWQIWWF	Open Creek at San Pablo Rd	700	
9/17/2001	21FLJXWQIWWF	Open Creek at San Pablo Rd	130	
12/5/2001	21FLJXWQIWWF	Open Creek at San Pablo Rd	700	
3/26/2002	21FLJXWQIWWF	Open Creek at San Pablo Rd	688	
5/8/2002	21FLJXWQIWWF	Open Creek at San Pablo Rd	140	
7/31/2002	21FLJXWQIWWF	Open Creek at San Pablo Rd	184	
10/23/2002	21FLJXWQIWWF	Open Creek at San Pablo Rd	180	
10/23/2002	21FLA 20030695	Open Creek at San Pablo Road	180	B
3/26/2003	21FLJXWQIWWF	Open Creek at San Pablo Rd	130	
6/19/2003	21FLJXWQIWWF	Open Creek at San Pablo Rd	4,000	B
9/22/2003	21FLJXWQIWWF	Open Creek at San Pablo Rd	740	
12/9/2003	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,100	
3/18/2004	21FLJXWQIWWF	Open Creek at San Pablo Rd	320	
5/26/2004	21FLJXWQIWWF	Open Creek at San Pablo Rd	320	
9/21/2004	21FLJXWQIWWF	Open Creek at San Pablo Rd	3,300	
1/5/2005	21FLJXWQIWWF	Open Creek at San Pablo Rd	440	
5/11/2005	21FLJXWQIWWF	Open Creek at San Pablo Rd	2,400	
8/30/2005	21FLJXWQIWWF	Open Creek at San Pablo Rd	50	
11/14/2005	21FLJXWQIWWF	Open Creek at San Pablo Rd	270	

Sample Date	Station	Location	Value (#/100mL)	Remark Code
2/1/2006	21FLJXWQIWWF	Open Creek at San Pablo Rd	220	
5/22/2006	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,300	Q
9/18/2006	21FLJXWQIWWF	Open Creek at San Pablo Rd	760	
11/28/2006	21FLJXWQIWWF	Open Creek at San Pablo Rd	620	Q
1/25/2007	21FLA 20030848	Open Cr @ Hodges Blvd	409	A
1/25/2007	21FLA 20030695	Open Creek at San Pablo Road	600	B
2/14/2007	21FLA 20030848	Open Cr @ Hodges Blvd	67	B
3/27/2007	21FLJXWQIWWF	Open Creek at San Pablo Rd	690	
4/18/2007	21FLA 20030848	Open Cr @ Hodges Blvd	8	U
4/18/2007	21FLA 20030695	Open Creek at San Pablo Road	400	
5/7/2007	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,700	Q
6/26/2007	21FLA 20030848	Open Cr @ Hodges Blvd	440	
6/26/2007	21FLA 20030695	Open Creek at San Pablo Road	24	B
7/31/2007	21FLA 20030848	Open Cr @ Hodges Blvd	1,400	
7/31/2007	21FLA 20030695	Open Creek at San Pablo Road	470	A
7/31/2007	21FLJXWQIWWF	Open Creek at San Pablo Rd	140	
8/15/2007	21FLA 20030695	Open Creek at San Pablo Road	1,700	B
8/15/2007	21FLA 20030848	Open Cr @ Hodges Blvd	380	
9/20/2007	21FLJXWQIWWF	Open Creek at San Pablo Rd	800	
9/25/2007	21FLJXWQIWWF	Open Creek at San Pablo Rd	500	
10/24/2007	21FLA 20030695	Open Creek at San Pablo Road	664	A
10/24/2007	21FLA 20030848	Open Cr @ Hodges Blvd	600	
11/28/2007	21FLA 20030695	Open Creek at San Pablo Road	2,000	
11/28/2007	21FLA 20030848	Open Cr @ Hodges Blvd	180	A
12/10/2007	21FLJXWQIWWF	Open Creek at San Pablo Rd	1,700	Q

Shaded cells represent values that exceed 400 counts/100mL.

Remark Code:

A	Value reported is the mean of two or more determinations.
B	Results based on colony counts outside the acceptable range.
K	Off-scale low. Actual value not known, but known to be less than value shown.
L	Off-scale high. Actual value not known, but known to be greater than value shown.
P	Too numerous to count.
Q	Sample held beyond normal holding time.
U	Material was analyzed for, but not detected. Value stored is the limit of detection for the process in use. In the case of species, undetermined sex.

Appendix C: Kruskal–Wallis Analysis of Fecal Coliform Observations versus Season and Month in Open Creek, WBID 2299

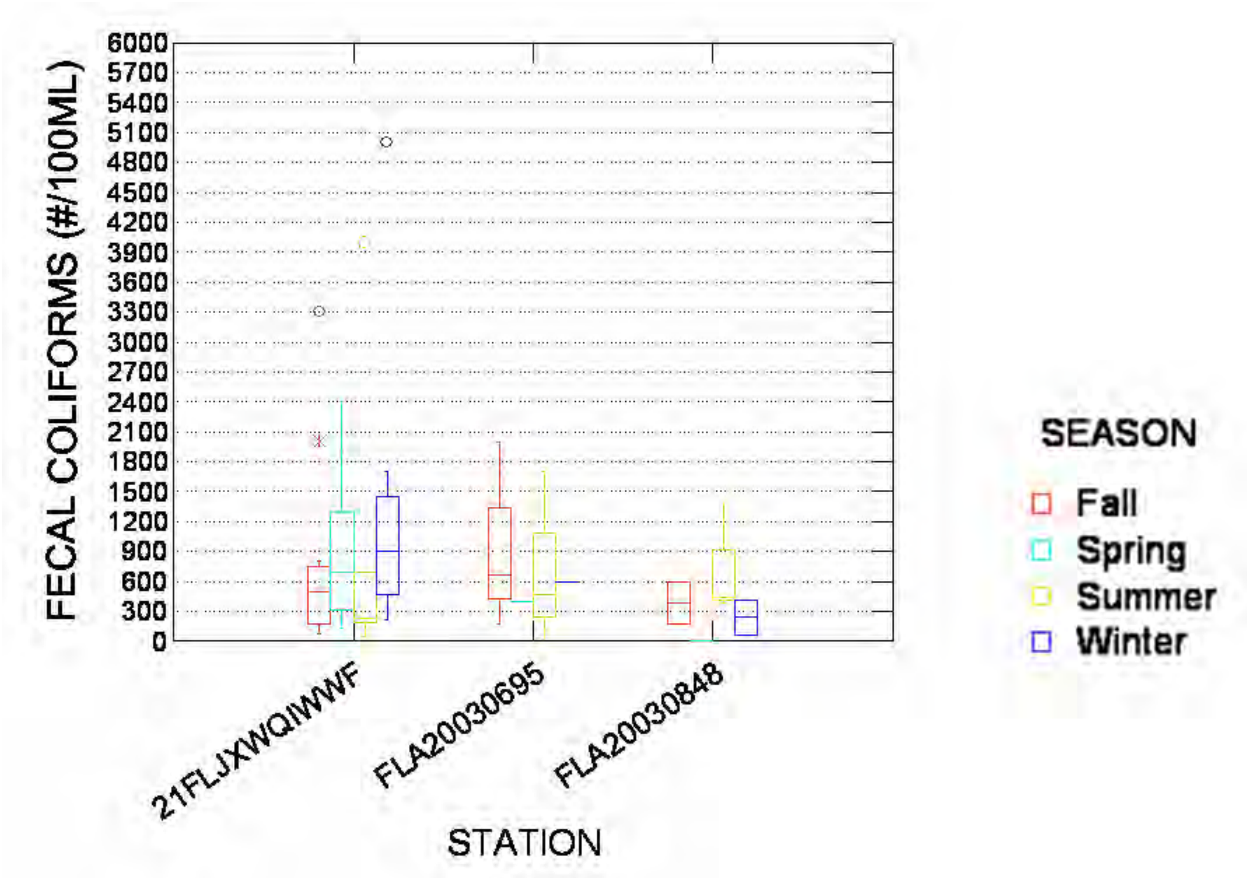
Group	Count	Rank Sum
Fall	24	802.000
Spring	15	536.000
Summer	15	474.500
Winter	15	602.500

Kruskal-Wallis Test Statistic = 1.591
Probability is 0.661 assuming Chi-square distribution with 3 df

Group	Count	Rank Sum
January	7	298
February	3	39
March	4	117
April	4	138
May	7	281
June	6	236
July	4	112.5
August	5	126
September	10	394.5
October	8	200.5
November	6	207
December	5	265.5

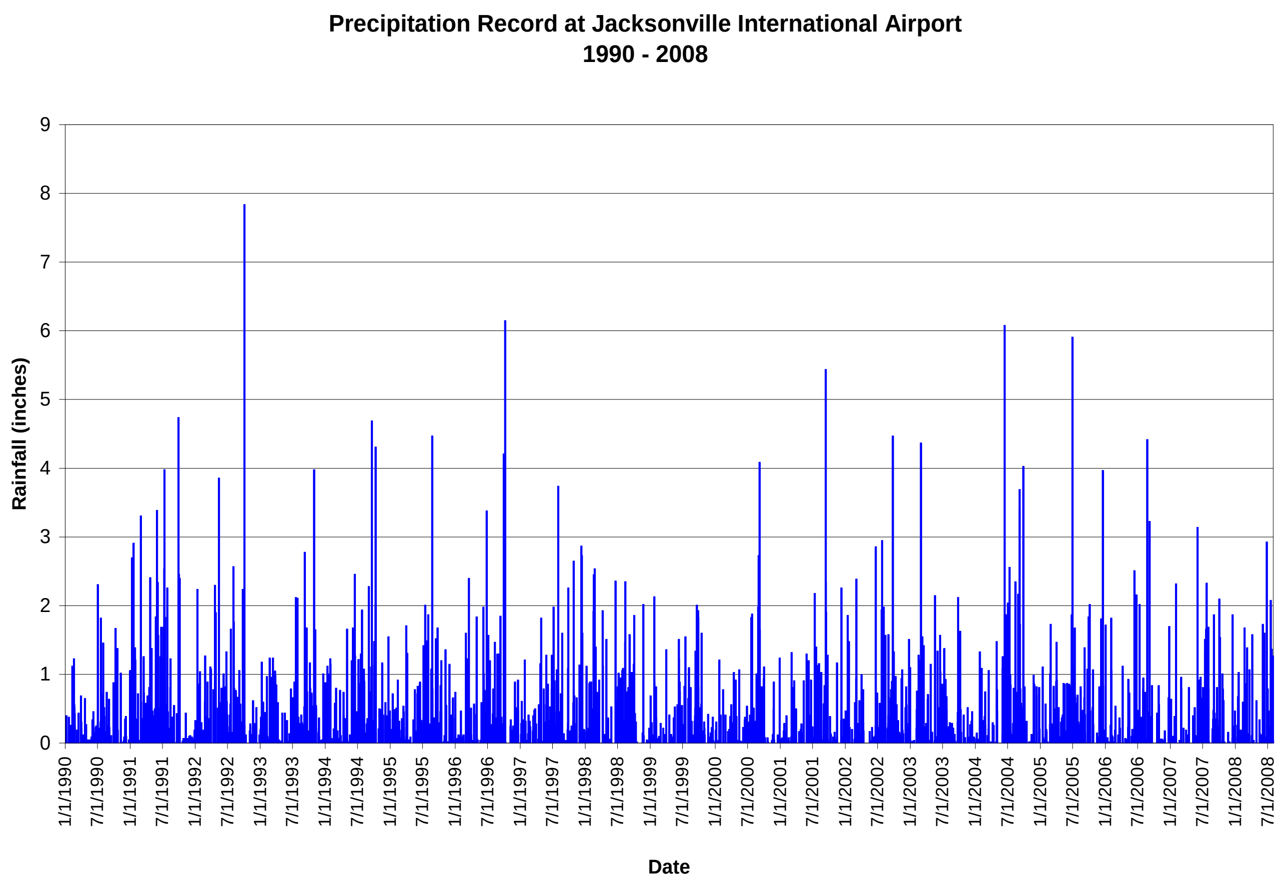
Kruskal-Wallis Test Statistic = 13.906
Probability is 0.238 assuming Chi-square distribution with 11 df

Appendix D: Chart of Fecal Coliform Observations by Season and Station in Open Creek, WBID 2299



STORET ID	Station
21FLJXWQIWWF	Open Creek at San Pablo Road
21FLA 20030695	Open Creek at San Pablo Road
21FLA 20030848	Open Creek at Hodges Blvd

Appendix E: Chart of Biannual Rainfall for JIA, 1990–2008



Appendix F: Spearman Correlation Matrix Analysis for Precipitation and Fecal Coliform in Open Creek, WBID 2299

	YEAR	MONTH	FECALS	V1DAYPRECIP	V3DAYPRECIP	V7DAYPRECIP	CUMULATIVET
YEAR	1						
MONTH	-0.104	1					
FECALS	0.001	0.059	1				
V1DAYPRECIP	0.205	0.023	0.368	1			
V3DAYPRECIP	-0.046	-0.18	0.257	0.625	1		
V7DAYPRECIP	0.082	-0.149	0.014	0.495	0.741	1	
CUMULATIVET	-0.175	0.099	-0.025	0.179	0.239	0.376	1

Appendix G: Analysis of Fecal Coliform Observations and Precipitation in Open Creek, WBID 2299

FECAL COLIFORM DATA VERSUS DAY OF SAMPLING PRECIPITATION

Multiple R: 0.397 Squared multiple R: 0.157

Adjusted squared multiple R: 0.145 Standard error of estimate: 963.439

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	662.505	128.655	0	.	5.149	0
V1DAYPRECIP	2219.14	627.707	0.397	1	3.535	0.001

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	1.16E+07	1	1.16E+07	12.498	0.001
Residual	6.22E+07	67	928215.102		

Durbin-Watson D Statistic 1.506
First Order Autocorrelation 0.238

FECAL COLIFORM DATA VERSUS DAY OF SAMPLING AND 2 DAYS PRIOR PRECIPITATION

Multiple R: 0.542 Squared multiple R: 0.294

Adjusted squared multiple R: 0.283 Standard error of estimate: 881.900

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	523.438	123.769	0	.	4.229	0
V3DAYPRECIP	1065.111	201.724	0.542	1	5.28	0

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2.17E+07	1	2.17E+07	27.879	0
Residual	5.21E+07	67	777747.338		

Durbin-Watson D Statistic 1.663
First Order Autocorrelation 0.155

FECAL COLIFORM DATA VERSUS DAY OF SAMPLING AND 6 DAYS PRIOR PRECIPITATION

Multiple R: 0.079   Squared multiple R: 0.006

Adjusted squared multiple R: 0.000   Standard error of estimate: 1046.195

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	816.602	142.199	0	.	5.743	0
V7DAYPRECIP	53.134	82.087	0.079	1	0.647	0.52

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	458589.948	1	458589.948	0.419	0.52
Residual	7.33E+07	67	1094523.961		

Durbin-Watson D Statistic 1.553
First Order Autocorrelation 0.218

FECAL COLIFORM DATA VERSUS DAY OF SAMPLING AND 29 DAYS PRIOR PRECIPITATION

Dep Var: FECALS N: 122 Multiple R: 0.024 Squared multiple R: 0.001

Adjusted squared multiple R: 0.000 Standard error of estimate: 1049.150

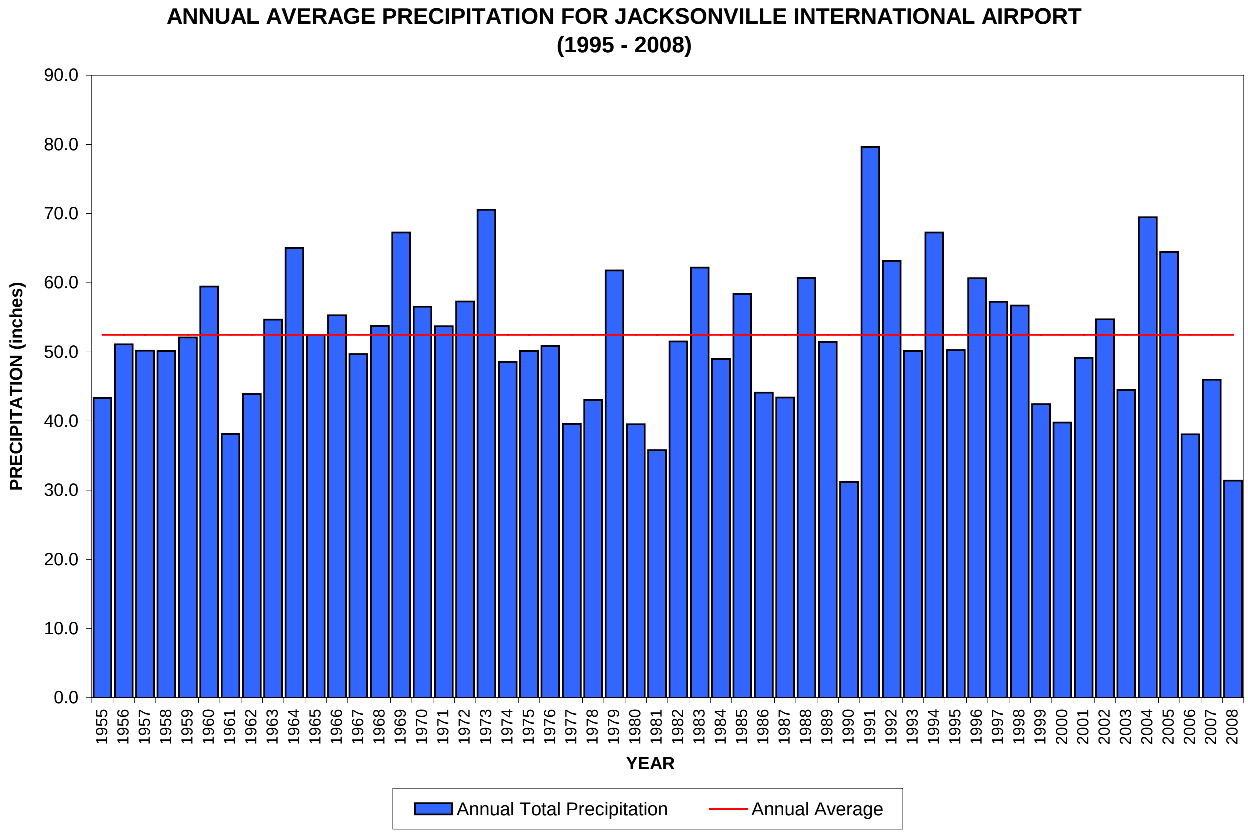
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	829.326	196.42	0	.	4.222	0
CUMULATIVET	6.207	31.115	0.024	1	0.199	0.842

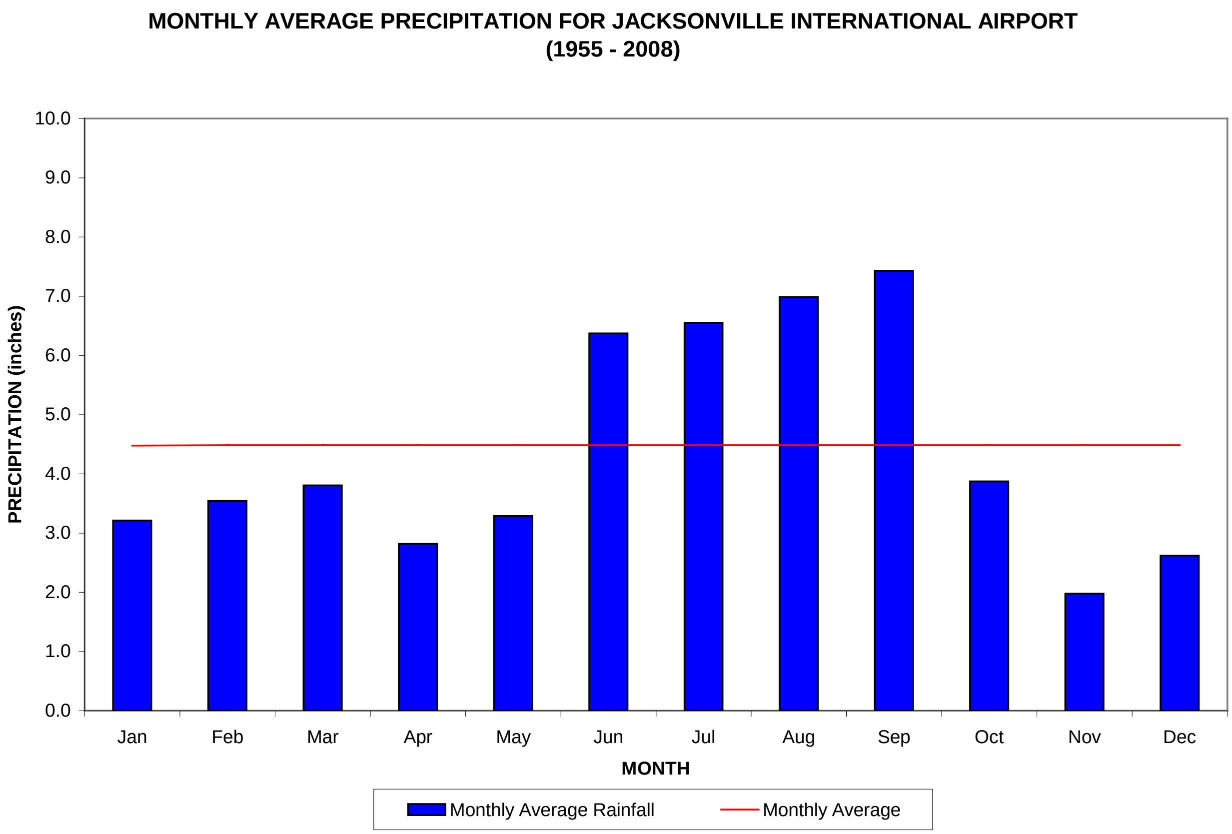
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	43800.717	1	43800.717	0.04	0.842
Residual	7.37E+07	67	1100714.845		

Durbin-Watson D Statistic 1.550
First Order Autocorrelation 0.219

Appendix H: Annual and Monthly Average Precipitation at JIA




MONTHLY AVERAGE PRECIPITATION FOR JACKSONVILLE INTERNATIONAL AIRPORT
(1955 - 2008)
PRECIPITATION (inches)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
MONTH
Monthly Average Rainfall
Monthly Average

Appendix I: Monthly and Annual Precipitation from JIA, 1955–2008

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1955	3.1	2.46	1.66	1.5	4.51	2.7	5.53	3.85	10.6	5.36	1.9	0.2	**43.33**
1956	2.9	2.94	0.81	2.33	3.98	7.87	8.25	5.24	2.89	13.4	0.4	0	**51.08**
1957	0.3	1.69	3.87	1.61	5.25	7.1	12.3	3.3	8.33	3.5	1.6	1.3	**50.18**
1958	3.4	3.74	3.38	8.24	3.79	3.96	4.37	4.67	4.75	5.07	2	2.8	**50.14**
1959	3	5.22	9.75	2.65	9.2	2.94	4.51	2.86	5.67	3.12	2.2	1	**52.08**
1960	2.1	5.17	6.94	3.54	1.18	4.7	16.2	6.5	8.57	2.95	0.1	1.5	**59.45**
1961	2.9	4.85	1.17	4.16	3.06	5.27	3.48	10.6	1.02	0.27	0.9	0.5	**38.15**
1962	2.2	0.52	3.1	2.36	1.12	8.22	6.31	10.1	4.37	1.13	2.1	2.5	**43.9**
1963	5.4	6.93	2.23	1.75	1.74	12.5	6.47	4.95	4.88	1.53	2.7	3.6	**54.66**
1964	7.3	6.55	1.76	4.65	4.8	4.67	6.12	5.63	10.3	5.09	3.3	4.8	**65.03**
1965	0.7	5.5	3.91	0.95	0.94	9.79	2.71	9.58	11	1.75	1.9	3.8	**52.47**
1966	4.6	5.97	0.71	2.25	10.4	7.74	11.1	3.88	5.94	1.38	0.2	1.1	**55.3**
1967	3.1	4.35	0.81	2	1.18	12.9	5.22	12.3	1.8	1.13	0.2	4.7	**49.68**
1968	0.8	3.05	1.2	0.99	2.17	12.3	6.84	16.2	2.68	5.09	1.3	1.1	**53.72**
1969	0.8	3.39	4.23	0.34	3.78	5.12	5.89	15.1	10.3	9.81	4.6	3.9	**67.26**
1970	4.2	8.85	9.98	1.77	1.84	2.65	7.6	11	3.2	3.95	0	1.6	**56.55**
1971	2	2.55	2.41	4.07	1.9	5.52	5.07	12.8	4.17	6.46	0.8	5.9	**53.69**
1972	5.8	3.48	4.43	2.98	8.26	6.75	3.15	9.76	2.6	4.46	4.2	1.4	**57.29**
1973	4.6	5.07	10.2	11.6	5.33	4.1	5.45	7.49	7.86	4.08	0.4	4.3	**70.57**
1974	0.3	1.28	3.47	1.53	4.14	5.53	9.83	11.2	8.13	0.34	1	1.7	**48.52**
1975	3.5	2.58	2.46	5.78	7	5.21	6.36	6.23	5.24	3.63	0.4	1.8	**50.15**
1976	2.3	1.05	3.41	0.63	10	4.26	5.41	6.37	8.56	1.63	2.4	4.8	**50.87**
1977	3	3.24	1.03	1.76	3.07	2.65	1.97	7.26	7.45	1.68	3.1	3.4	**39.56**
1978	4.6	4.17	2.83	2.24	9.18	2.62	6.67	2.39	4.4	1.26	0.8	1.8	**43.04**
1979	6.3	3.75	1	4.18	7.54	5.91	4.67	4.78	17.8	0.25	3.6	2	**61.76**
1980	2.6	1.06	6.83	3.91	3.02	4.59	5.29	3.97	3.03	2.69	2.3	0.2	**39.53**
1981	0.9	4.53	5.41	0.32	1.48	3.31	2.46	6.47	1.22	1.35	4.9	3.4	**35.77**
1982	3	1.67	4.26	3.6	3.55	8.06	3.81	6.93	9.32	3.37	1.9	2	**51.52**
1983	7.2	4.27	8.46	4.65	1.38	6.86	6.11	4.63	4.61	4.29	3.3	6.4	**62.19**
1984	2.1	4.67	5.77	3.14	1.46	4.76	6.01	3.78	12.3	1.53	3.3	0.1	**48.96**
1985	1.1	1.45	1.26	2.76	2.08	3.71	6.33	8.93	16.8	8.34	2.1	3.6	**58.39**
1986	4.2	4.72	5.44	0.93	2.13	2.53	3.27	9.6	1.99	1.8	2.9	4.7	**44.1**
1987	4.1	6.47	6.27	0.14	0.75	4.18	4.4	4.48	7.13	0.3	5	0.2	**43.39**
1988	6.4	6.08	2.65	3.44	1.35	3.71	4.5	8.48	16.4	2.35	4.3	1.1	**60.68**
1989	1.7	1.77	2.14	2.79	1.55	3.66	8.98	9.16	14.4	1.39	0.5	3.4	**51.45**
1990	1.8	4.07	1.59	1.34	0.18	1.59	6.53	3.81	2.6	4.54	1.2	1.9	**31.2**
1991	10	1.52	7.33	6.31	9.35	11.7	15.9	3.48	6.2	6.36	0.7	0.6	**79.63**
1992	5.8	2.64	4.09	5.33	5.97	7.04	3.32	10.8	7.33	8.34	1.9	0.7	**63.18**
1993	3.9	2.89	5.98	0.85	1.6	2.52	7.54	2.96	7.6	8.84	3.6	1.9	**50.12**
1994	6.6	0.92	2.14	1.51	3.15	14	8.26	3.29	9.79	10.2	3.5	3.9	**67.26**
1995	1.9	2.07	3.67	1.77	1.77	5.35	9.45	9.93	5.41	3.53	3.2	2.2	**50.25**
1996	1.1	1.11	6.83	2.85	0.72	11.4	4.2	7.83	8.49	11.5	1.4	3.2	**60.63**
1997	2.9	1.28	1.84	4.56	3.43	6.33	7.69	8.24	3.97	4.84	2.4	9.8	**57.27**
1998	3.5	11.1	2.64	4.71	0.96	2.95	7.29	10.1	7.65	3.01	2.4	0.4	**56.72**
1999	4.6	1.7	0.4	1.92	1.02	7.75	3.56	3.51	13	3.24	0.8	0.9	**42.44**
2000	2.8	1.17	1.79	2.6	1.15	2.43	5.69	7.38	11.6	0.23	1.6	1.4	**39.77**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2001	0.9	0.68	5.48	0.62	2.56	5.59	8.31	3.58	16	0.81	1.4	3.1	**49.14**
2002	4.5	0.82	4.38	2.41	0.47	6.24	7.8	8.14	9.31	2.58	2.7	5.4	**54.72**
2003	0.1	4.66	10.7	2.63	2.54	6.75	7.33	1.83	3.04	2.98	0.7	1.2	**44.47**
2004	1.6	4.47	1.36	2.02	1.24	17.2	8.6	9.85	16.3	1.32	2.9	2.7	**69.47**
2005	1.9	3.56	3.67	4.53	3.51	14.8	7.37	4.43	5.76	6.49	1.1	7.4	**64.44**
2006	2.30	3.91	0.68	1.22	2.01	7.25	3.97	7.08	4.55	1.81	0.39	2.90	**38.07**
2007	2.29	2.40	2.22	1.02	1.12	6.68	9.48	3.57	5.44	8.85	0.17	2.74	**45.98**
2008	2.63	5.22	3.50	2.34	0.66	8.21	8.83						**31.39**
AVG	**3.21**	**3.54**	**3.81**	**2.82**	**3.29**	**6.37**	**6.55**	**6.99**	**7.43**	**3.87**	**1.98**	**2.62**	**52.47**

Rainfall is in inches, and represents data from JIA.

Appendix J: Executive Summary of Tributary Pollution Assessment Project

Note: *This appendix contains the executive summary of the Tributary Pollution Assessment Project (TPAP) submitted to the Department by JEA and PBS&J. The six phases detailed in the methodology development and evaluation section have already been completed as of the date of this TMDL. In place of the public workshop mentioned in the section describing Phase 6, the* Tributary Pollution Assessment Manual *was presented to the Jacksonville Waterways Commission on February 1, 2007.*

The Tributary Pollution Assessment Project involves developing and evaluating a methodology for conducting tributary pollution assessments for listed water bodies in the Duval County area, as referenced in the Reasonable Assurance (RA) Plan. Duval County has approximately 100 tributary Water Body IDs (WBIDs), i.e. small to large tributaries of the St. Johns River, identified by the State. The RA Plan provides reasonable assurance that the fecal coliform levels of the 51 top-ranked WBIDs will be reduced sufficiently to restore them to their designated use for recreation. The 51 WBIDs are grouped into four priority groups in the RA Plan.

PBS&J was contracted by JEA to develop a methodology for conducting tributary pollution assessments for sources of fecal coliform contamination in the listed tributaries. This methodology will be field-verified by conducting sanitary surveys of selected tributary water body segments, and revised based on lessons learned from this process. The final product of this endeavor will be a *Tributary Pollution Assessment Manual* that can be used as a blueprint for conducting sanitary surveys.

The Tributary Pollution Assessment Project is a continuation of the effort started under the RA Plan. The RA Plan participants have been brought together to form the Tributary Assessment Team (TAT). The TAT will serve as an advisory committee to the PBS&J Project Team throughout the development of the *Tributary Pollution Assessment Manual*. The TAT is composed of representatives from:

JEA
City of Jacksonville Environmental Quality Division
City of Jacksonville Public Works Department
Duval County Health Department
Florida Department of Environmental Protection
St. Johns Riverkeeper
Water and Sewer Expansion Authority
US Army Corps of Engineers

Other representatives (from these and additional entities) may be included in the TAT activities in varying roles, as relevant.

Our approach for developing and evaluating a methodology for conducting tributary pollution assessments is divided into six major phases including:

1) Pre-planning;
2) Planning;
3) Development of Tributary Pollution Assessment Manual;
4) Evaluation of Methodology/Manual by Conducting Sanitary Surveys;
5) Summary Report; and

6) Public Workshop.
The Pre-Planning phase (Phase I) entailed four main goals:

1) to obtain and review all documents included in the RA Plan;
2) to develop categories for tributary classification and categorize the 51 priority WBIDs;
3) to overlay each WBID onto land use, infrastructure, and historical sampling maps to begin assessing probable sources and migration pathways; and
4) to develop the *Draft Work Plan*.

The Planning phase (Phase II) begins with the organization and initial meeting of the Tributary Assessment Team (TAT) with the ultimate goal of finalizing the *Work Plan*.

The Development of the *Tributary Pollution Assessment Manual* phase (Phase III) primarily involves the formulation of the assessment methodology for each tributary category described in the Pre-Planning phase, the use of a decision tree to determine which assessment methodology corresponds to each of the highest-ranked WBIDs, and the establishment of a model monitoring plan for each tributary category. This phase will be completed upon submitting the *Manual* to the TAT for review.

The next phase, Evaluation of Methodology/Manual by Conducting Sanitary Surveys (Phase IV), entails field-verification of the methodology described in the *Draft Tributary Pollution Assessment Manual* for the highest ranked water bodies for each category (or as determined to ensure adequate geographical representation of the study area) and applying the results to recommend generic corrective actions and revise the methodology, if necessary. The outcome of this phase would be the *Tributary Pollution Assessment Manual.*

The final two phases, Summary Report (Phase V) and Public Workshop (Phase VI), would entail providing a summary of the results of the tributary pollution assessments, including a discussion of lessons learned and site-specific corrective actions, to JEA and presenting the results from the *Tributary Pollution Assessment Manual* to the public. The final phase would also include a written summary of public input received at the workshop.

For additional information, please contact: Don Deis, PBS&J Project Manager, at (904) 363-8442 or drdeis@pbsj.com.

Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
2600 Blair Stone Road, Mail Station 3565
Tallahassee, Florida 32399-2400
www.dep.state.fl.us/water/