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 Terrapin Creek, WBID 2204

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Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Bureau of Watershed Management

Total Maximum Daily Load (TMDL) Program

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

Identification of Impaired Surface Waters Rule

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

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 Terrapin Creek in the North Mainstem Planning Unit of the Lower St. Johns Basin. The creek has been 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 Terrapin Creek that would restore the waterbody so that it meets the applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

Terrapin Creek, located in Duval County in northeast Florida, drains an area of approximately 1.87 square miles (mi^2). Flowing into Dunn Creek, a direct tributary of the St. Johns River (**Figures 1.1** and **1.2**), Terrapin Creek is approximately 3.32 miles long and is a second-order stream.

The Terrapin Creek watershed is located in the northeast corner of Duval County, on the north side of the St. Johns River, just east of where Interstate 295 (I-295) crosses Dunn Creek. I-295 goes through the southern part of the Terrapin Creek watershed, which encompasses a very rural part of Duval County. 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 waterbody identification (WBID) number for each watershed or stream reach. Terrapin Creek consists of one segment, WBID 2204 (**Figure 1.2**), which this TMDL addresses.

Terrapin Creek is part of the North Mainstem 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 North Mainstem Planning Unit consists of 51 WBIDs. **Figure 1.3** shows the location of these WBIDs, Terrapin Creek's location in the planning unit, and a list of the other WBIDs in the planning unit.

Figure 1.1. Location of Terrapin Creek, WBID 2204, and Major Geopolitical Features in the Lower St. Johns Basin

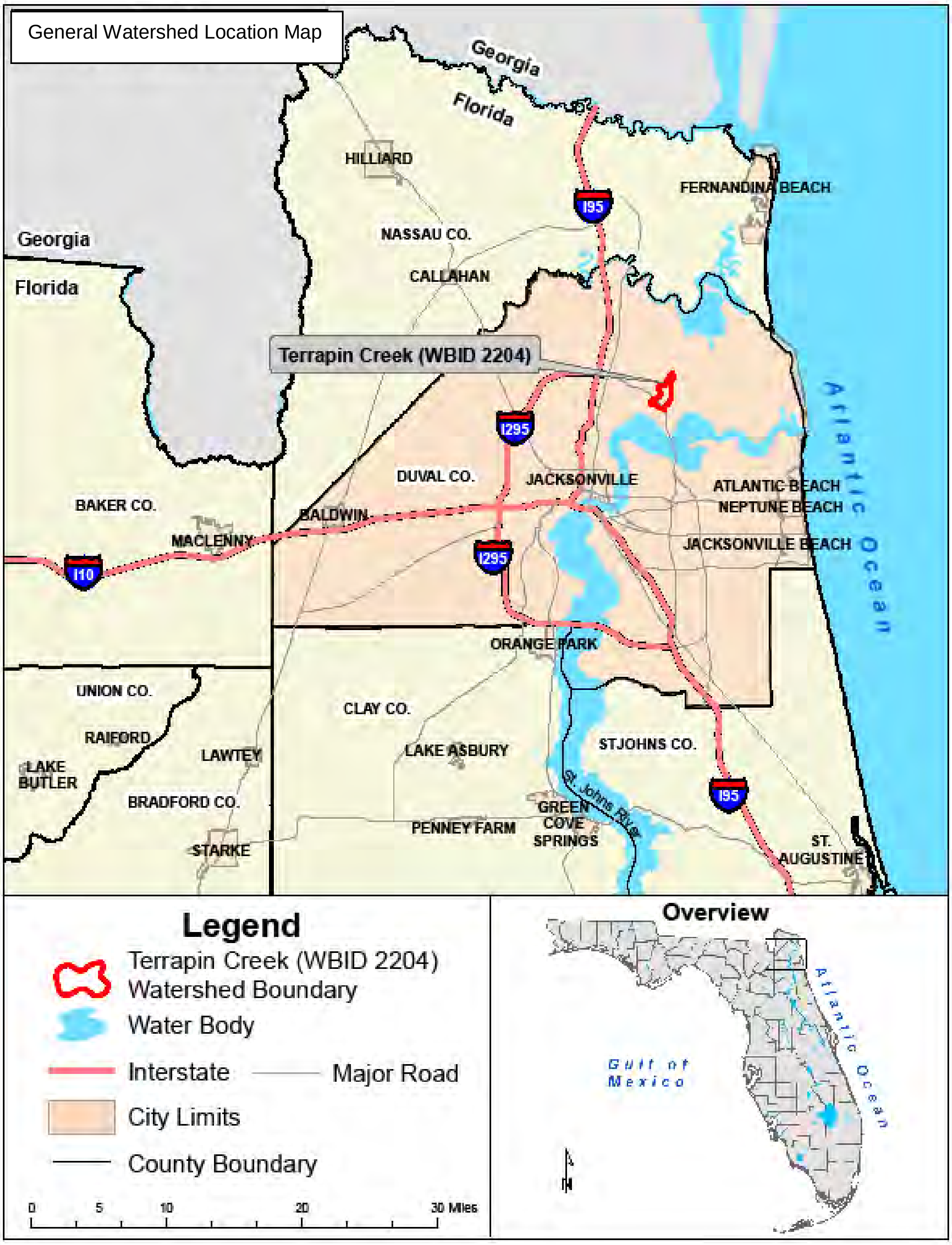


Figure 1.2. Overview of Terrapin Creek, WBID 2204

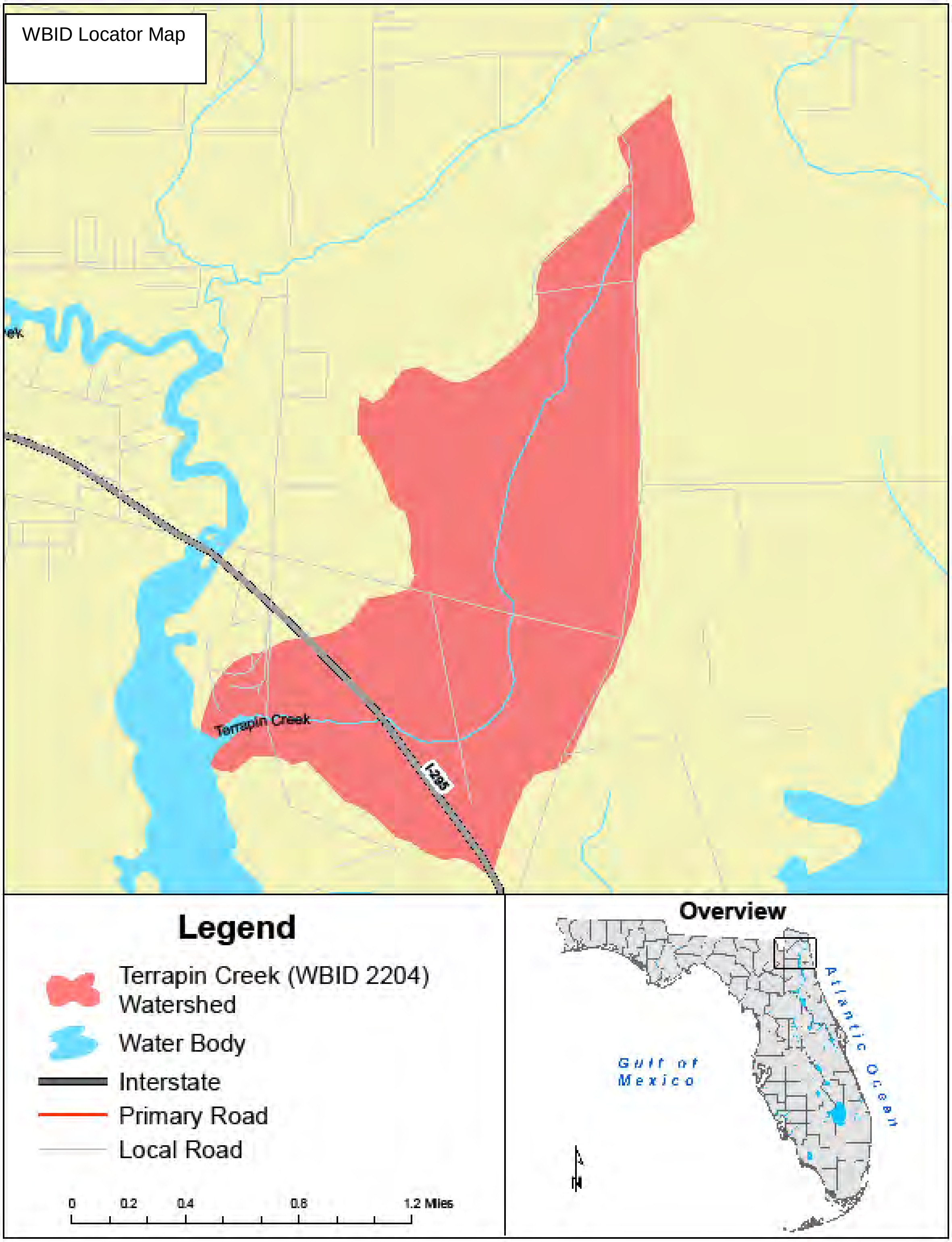
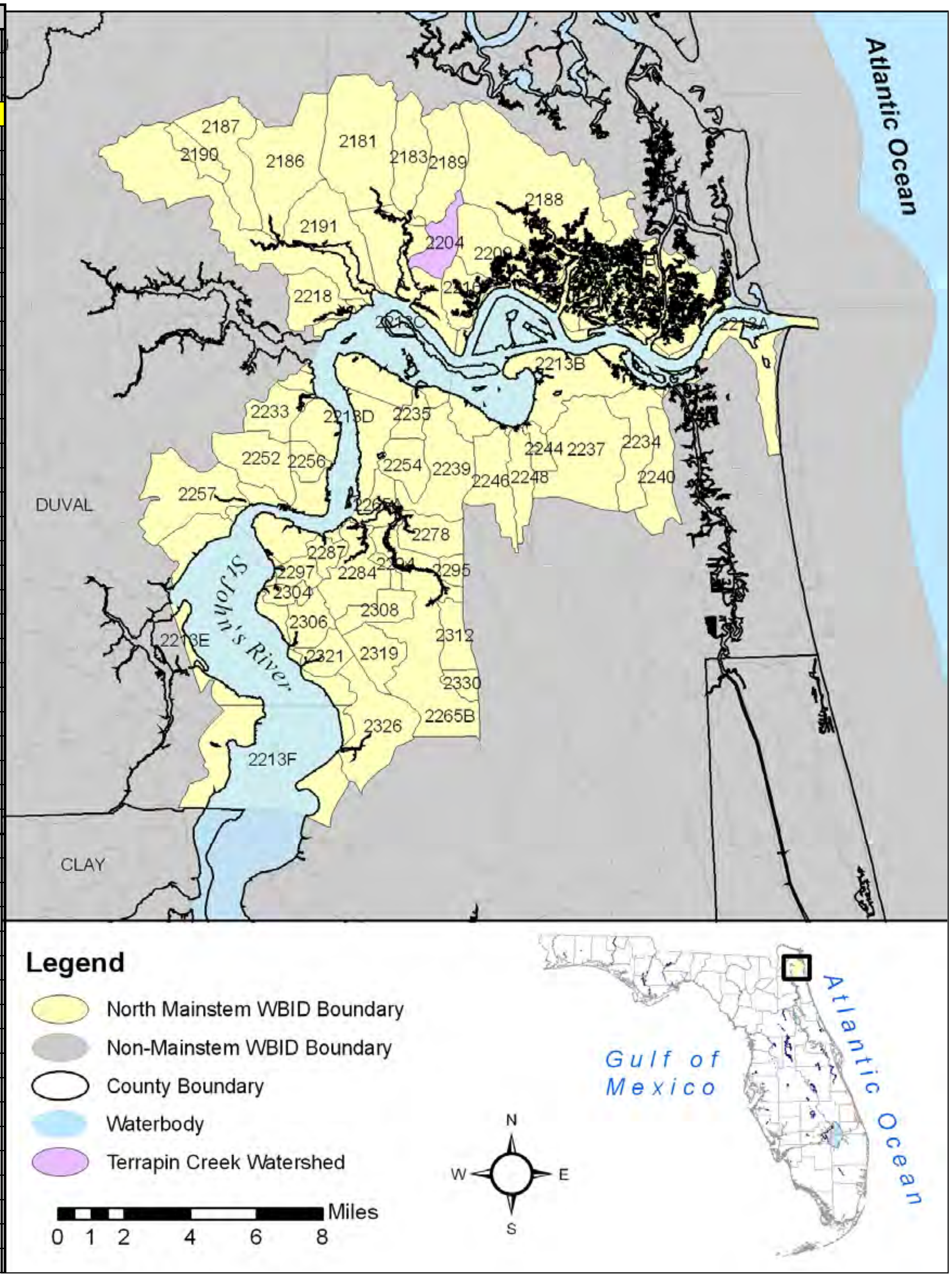


Figure 1.3. WBIDs in the North Mainstem Planning Unit

WBID	Waterbody Name
2181	Dunn Creek
2191	Broward River
2203	Trout River
2204	Terrapin Creek
2207	Blockhouse Creek
2210	West Branch
2213P	Ortega River
2220	Nine Mile Creek
2224	Ribault River
2227	Sherman Creek
2228	Moncrief Creek
2232	Sixmile Reach
2233	Long Branch
2235	New Castle Creek
2238	Little Sixmile Creek
2239	Strawberry Creek
2240	Greenfield Creek
2244	Cow Head Creek
2246	Jones Creek
2248	Gin House Creek
2249B	McGrits Creek
2249A	Ortega River
2252	Hogan Creek
2254	Red Bay Branch
2256	Deer Creek
2257	McCoy Creek
2262	Cedar River
2265B	Potsburg Creek
2266	Hopkins Creek
2270	Hogpen Creek
2278	Silversmith Creek
2280	Big Fishwier Creek
2282	Wills Branch
2284	Little Potsburg Creek
2287	Miller Creek
2297	Craig Creek
2299	Open Creek
2304	Miramar Creek
2306	New Rose Creek
2316	Williamson Creek
2321	Christopher Branch
2322	Butcher Pen Creek
2324	Fishing Creek
2326	Goobys
2351	Julington Creek
2356	Big Davis Creek
2361	Deep Bottom Creek
2365	Durbin Creek
2370	Oldfield Creek
2381	Cormorant Branch
2385	Mandarin Drain



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 Terrapin 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 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Terrapin 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 65.52 percent overall exceedance rate for fecal coliform in Terrapin Creek during the verified period. There are 29 samples, ranging from 30 to 160,000 counts per 100 milliliters (counts/100 mL), with 19 samples exceeding the criterion for fecal coliform.

Exceedances occur in all months in which samples were collected, with 100 percent exceedance rates in January, February, June, September, and October (**Table 2.1**). All months have exceedance rates greater than or equal to 50 percent, except May (20 percent) and November (not sampled). Sample size for each month is small, with all months having 5 or fewer samples, making interpretation difficult.

When aggregating data by season, winter, summer, and fall demonstrate the highest percentages of exceedances (all above 66 percent). Spring has the lowest (40 percent) (**Table 2.2**). Due to the small sample size, it is not clear whether exceedances are directly associated with rainfall events, nonpoint sources, point sources, or seasonal variation.

The yearly data indicate that exceedance rates are more or less uniform throughout the verified period (**Table 2.3**). Sample size is small, ranging from 1 to 1 samples per year, making it difficult to verify potential trends. However, from the data that are available, exceedances have remained between 50 and 75 percent, except for 1996, which had an exceedance rate of 100 percent; however, only 1 sample was collected that year.

There are four sampling sites where historical data were collected during the verified period (January 1, 1996, to June 30, 2003). Most of the samples were taken by the city of Jacksonville and the rest were gathered by the Department. **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	N	Minimum	Maximum	Median	Mean	Number of Exceedances	% Exceedances	Mean Precipitation
January	2	1,300	160,000	80,650	80,650	2	100.00	2.55
February	2	580	1,000	790	790	2	100.00	2.82
March	3	176	1,767	801	915	2	66.67	4.26
April	4	40	2,033	736	886	2	50.00	2.79
May	5	30	2,067	70	467	1	20.00	1.61
June	1	1,700	1,700	1,700	1,700	1	100.00	6.18
July	2	300	1,700	1,000	1,000	1	50.00	6.36
August	3	165	700	500	455	2	66.67	6.97
September	1	14,000	14,000	14,000	14,000	1	100.00	10.01
October	4	1,300	66,600	20,000	26,975	4	100.00	3.74
November	0	-	-	-	-	-	-	1.81
December	2	212	1,100	656	656	1	50.00	3.46

- = There are no data for November.

Coliform counts are #/100mL.

Exceedances represent values above 400 counts/100mL.

Mean precipitation is for Jacksonville International Airport (JIA) in inches.

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

Season	N	Minimum	Maximum	Median	Mean	Number of Exceedances	% Exceedances	Mean Precipitation*
Winter	7	176	160,000	1,000	23,661	6	85.71	3.21
Spring	10	30	2,067	122	758	4	40.00	3.53
Summer	6	165	14,000	600	2,894	4	66.67	7.78
Fall	6	212	66,600	8,650	18,202	5	83.33	3.00

Coliform counts are #/100mL.

Exceedances represent values above 400 counts/100mL.

Mean precipitation is for JIA in inches.

*Represents a monthly average for that season.

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

Year	N	Minimum	Maximum	Median	Mean	Number of Exceedances	% Exceedances	Mean Precipitation
1996	1	1,300	1,300	1,300	1,300	1	100.00	5.05
1997	0	-	-	-	-	-	-	4.77
1998	3	300	24,000	1,700	8,667	2	66.67	4.73
1999	4	140	16,000	1,000	4,535	3	75.00	3.54
2000	4	40	160,000	7,550	43,785	3	75.00	3.31
2001	4	30	1,000	356	436	2	50.00	4.1
2002	11	30	66,600	1,367	6,983	7	63.64	4.56
2003	2	70	580	325	325	1	50.00	3.71

- = There are no data for 1997.

Table represents years for which data exist.

Coliform counts are #/100mL.

Exceedances represent values above 400 counts/100mL.

Total precipitation is for JIA in inches.

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)**

Terrapin 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 criteria 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 are 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 is that samples shall not exceed 400 counts/100mL.

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 sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

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

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

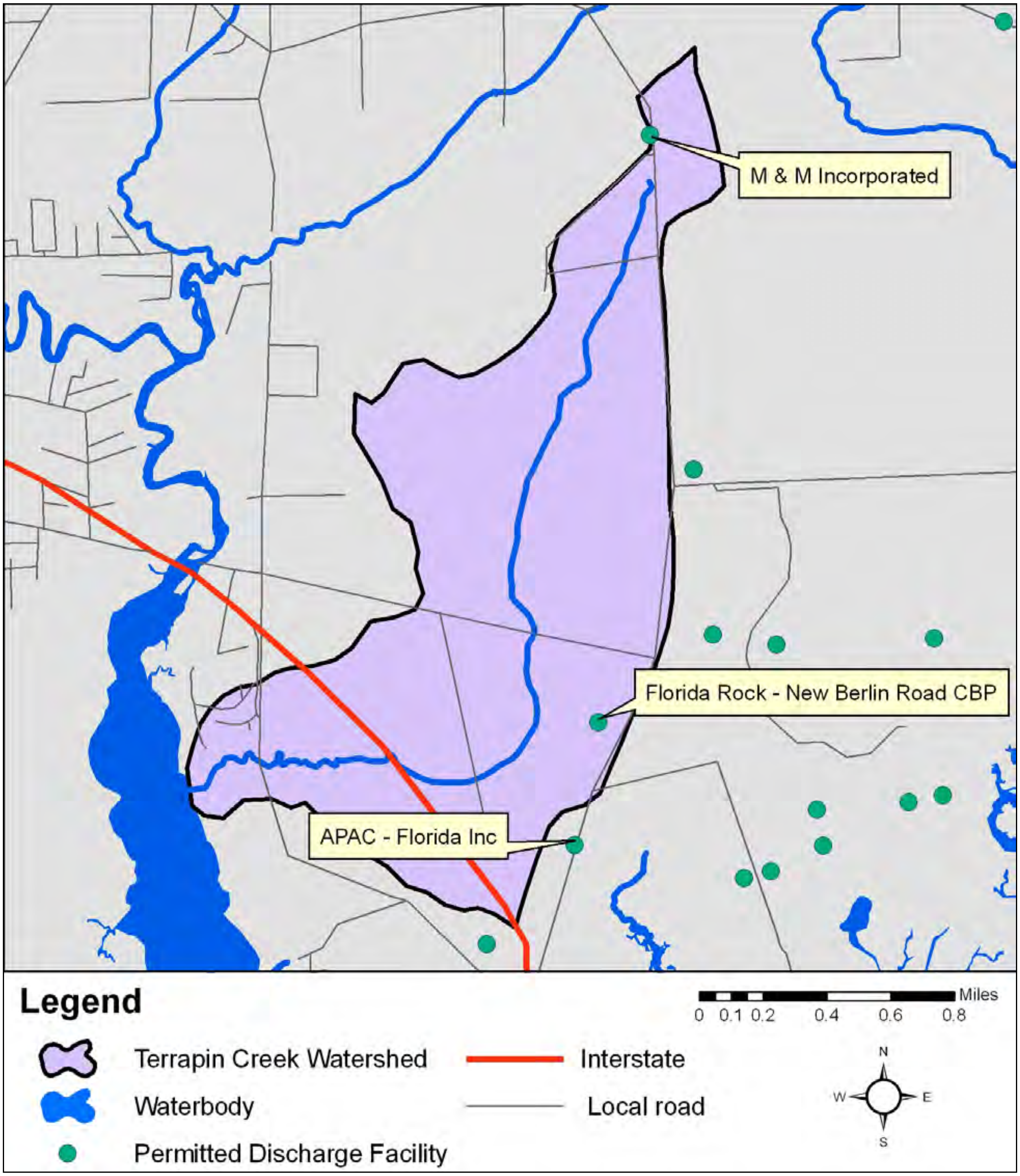
4.2 Potential Sources of Coliform in the Terrapin Creek Watershed

4.2.1 Point Sources

Two permitted facilities located in the watershed and one just outside the WBID boundary discharge into Terrapin Creek (**Figure 4.1**). Within the watershed boundary, M & M Incorporated (Permit # FLA285340), a dairy farm, closed in January 2005 when it was sold to a developer. The farm encompassed approximately 282 acres, with 83 of those acres on the north side of the Terrapin Creek watershed—including the headwaters of Terrapin Creek. Cows could have been a significant contributor to the high levels of fecal coliform found in the creek during stormwater events that resulted in runoff. Unfortunately, no monitoring stations are currently located close to the farm. **Section 4.3.1** discusses in greater detail the potential loadings from this facility.

The other facility in the watershed, Florida Rock–New Berlin Road Concrete Batch Plant (CBP) (Permit # FLG110329), provides containment of Type II waste and wet detention for Type I waste. The Type I wastewater management system consists of sediment traps along wet

Figure 4.1. Permitted Discharge Facilities in the Terrapin Creek Watershed, WBID 2204



detention or retention ponds designed to treat Type 1 wastewater by the settlement of fine particles. Type II wastewater is generated from the washout of the interior of a concrete truck mixer drum and any water that comes into contact with that wastewater. The facility has no direct discharge into Terrapin Creek or any other waterbody and is therefore unlikely to be affecting water quality.

Just outside the watershed boundary, APAC–Florida Inc. (Permit # FLR05E182), an asphalt plant, has a multisector stormwater general permit authorizing stormwater discharges into Terrapin Creek. The facility has one outfall that empties into Terrapin Creek and another that discharges into San Carlos Creek.

Neither the Florida Rock–New Berlin Road CBP nor the APAC–Florida facility is expected to be a source of fecal coliform bacteria. The permitted discharges into Terrapin Creek appear negligible in volume and should not greatly alter the creek's water quality. These facilities are not required to perform effluent monitoring under the general permit conditions, and their current coliform loadings cannot be quantified.

Municipal Separate Storm Sewer System Permittees

The city of Jacksonville and 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 Terrapin Creek watershed. FDOT and the cities of Jacksonville, Neptune Beach, and Atlantic Beach share responsibility for the permit.

Figure 4.2 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 Terrapin Creek watershed, there are 6 outfalls and 16 inlets.

4.2.2 Land Uses and Nonpoint Sources

Additional coliform loadings to Terrapin Creek are generated from nonpoint sources in the watershed. Potential nonpoint sources of coliform include loadings from surface runoff, agriculture, 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 3 codes tabulated in **Table 4.1. Figure 4.3** shows the principal Level 2 land uses in the watershed.

The Terrapin Creek watershed covers 1.87 mi^2. As **Table 4.1** shows, most of the watershed is natural (691 acres, or 58 percent), with the largest single land use being forest regeneration (15 percent). Urban land uses total 363 acres, or 30 percent of the watershed. Agricultural areas encompass 86 acres, or 5 percent of overall land use.

Figure 4.2. Stormwater Infrastructure in the Terrapin Creek Watershed, WBID 2204

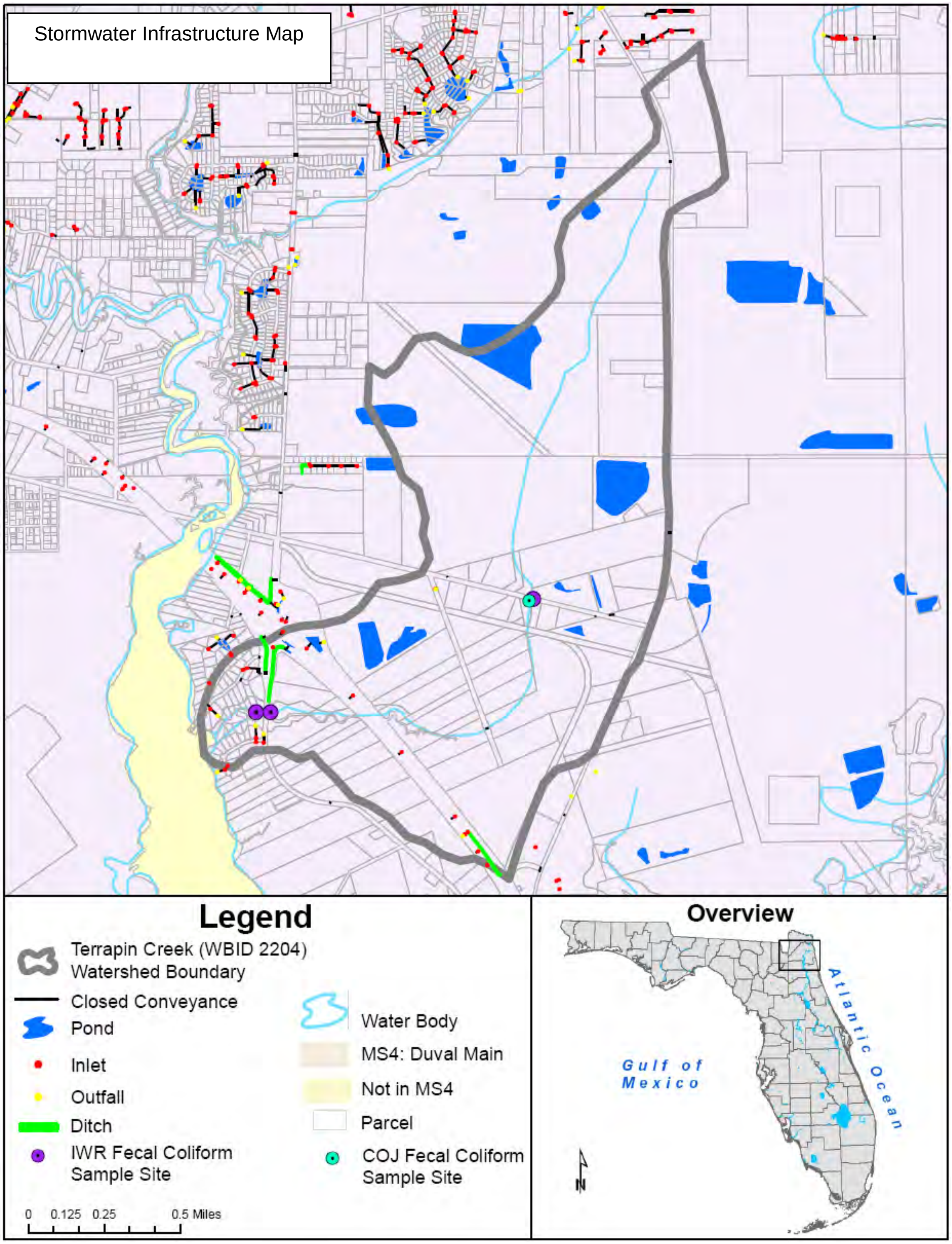
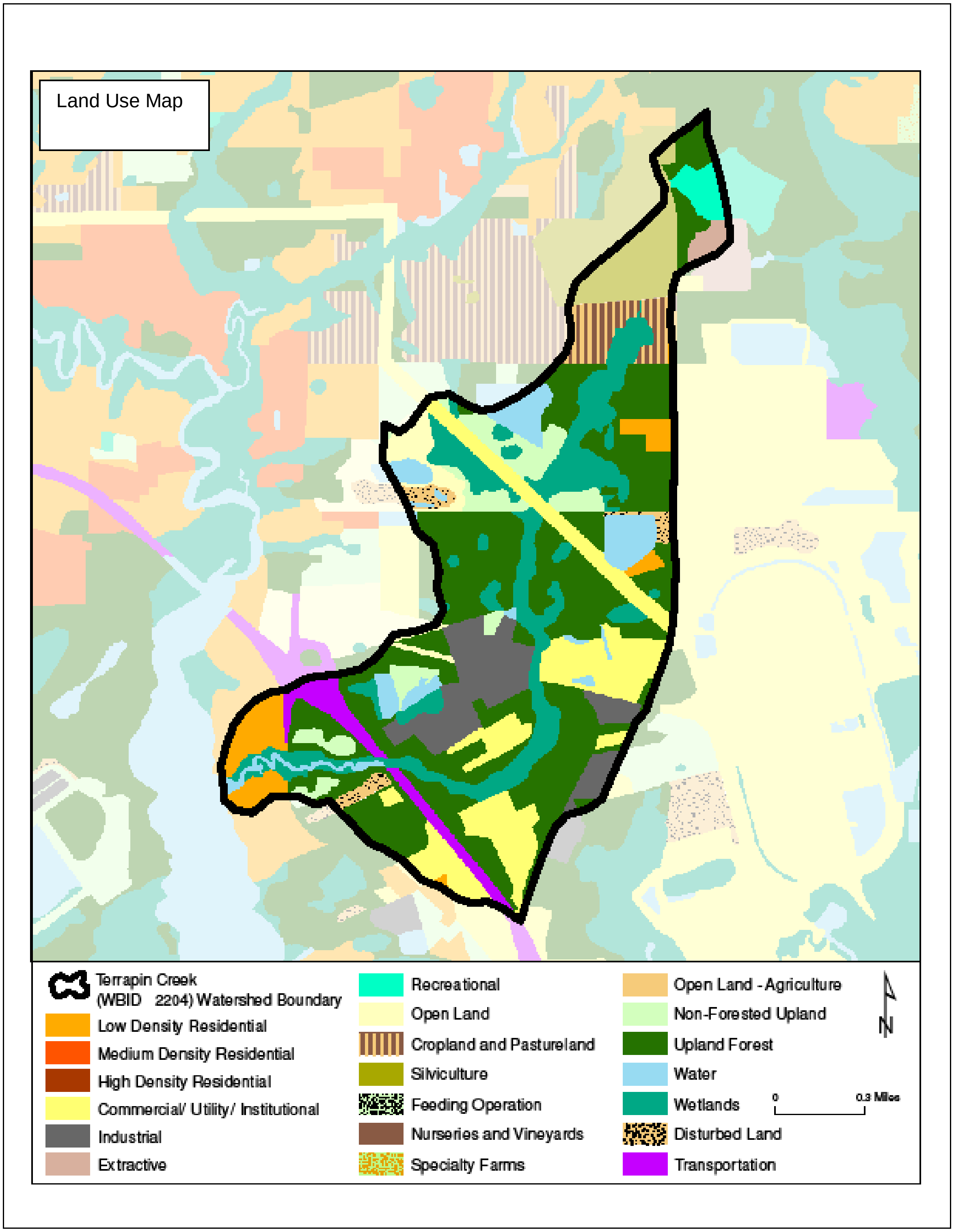


Table 4.1. Classification of Land Use Categories in the Terrapin Creek Watershed, WBID 2204

Level 3 Land Use Code	Attribute	Acres	% of Total
1100	Residential, low density–less than 2 dwelling units/acre	27.23	2.27%
1180	Rural residential	12.85	1.07%
1190	Low density under construction	9.48	0.79%
1400	Commercial and services	117.05	9.77%
1550	Other light industrial	76.05	6.35%
1560	Prestressed concrete plants (includes 1564)	10.41	0.87%
1620	Sand and gravel pits (must be active)	8.38	0.70%
1660	Holding ponds	0.82	0.07%
1890	Other recreational (stables, go-carts, skeet ranges, etc.)	15.40	1.29%
1900	Open land	24.53	2.05%
2110	Improved pastures (monoculture, planted forage crops)	35.43	2.96%
2310	Cattle-feeding operations	50.62	4.23%
3100	Herbaceous upland nonforested	38.37	3.20%
3200	Shrub and brushland	0.02	0.00%
3300	Mixed upland nonforested	22.22	1.86%
4110	Pine flatwoods	146.91	12.27%
4120	Longleaf pine-xeric oak	11.27	0.94%
4340	Upland mixed coniferous/hardwood	73.94	6.17%
4410	Coniferous pine	20.79	1.74%
4430	Forest regeneration	174.81	14.60%
5100	Streams and waterways	8.20	0.68%
5300	Reservoirs–pits, retention ponds, dams	56.40	4.71%
6210	Cypress	14.05	1.17%
6250	Hydric pine flatwoods	0.45	0.04%
6300	Wetland forested mixed	123.71	10.33%
6420	Saltwater marshes	21.23	1.77%
6440	Emergent aquatic vegetation	2.29	0.19%
6460	Mixed scrub-shrub wetland	7.75	0.65%
7410	Rural land in transition without positive indicators of intended activity	11.07	0.92%
7420	Borrow areas	6.44	0.54%
8140	Roads and highways (divided 4-lanes with medians)	32.20	2.69%
8310	Electrical power facilities	1.09	0.09%
8320	Electrical power transmission lines	36.03	3.01%
8350	Solid waste disposal	0.03	0.00%
	TOTAL:	**1,197.52**	**100.00%**

Figure 4.3. Principal Level 2 Land Uses in the Terrapin Creek Watershed, WBID 2204, in 2004



Population

According to the U.S. Census Bureau, census block population densities in the Terrapin Creek watershed in the year 2000 ranged from 0 to 3 people/acre (**Figure 4.4**), with an average of 49 people/mi^2 (0.08 people/acre). Based on this average, the estimated population in the Terrapin Creek watershed is 91. 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/mi^2. This places Duval County seventh in housing densities and population in Florida (U.S. Census Bureau Website, 2005). The estimated average housing density in Terrapin Creek is 18 houses/mi^2, based on population, which is considerably lower than that of Duval County.

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). The Florida Department of Health (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.

To focus on the Terrapin Creek watershed, the Department obtained septic tank repair permit data from JEA for its service area, which includes the Terrapin Creek watershed. The data include septic tank repair permit records issued from March 1990 to April 2004, areas serviced by a WWTF, and areas where large numbers of failing septic tanks are present. **Figure 4.5** presents this information in map form.

Based on these data, which are more watershed specific than the countywide FDOH data, there were 10 septic tank repair permits issued from 1990 to 2004. This equates to an average of 0.71 permits issued per year. If this estimate is rounded up to 1 (to allow for those septic tanks where failures may not be known or have not been repaired), with 2.78 people per household (**Table 4.2**), and using an estimate of 70 gallons/day/person (EPA, 2001), a loading of 7.37 x 10^9 colonies/day is derived. This estimation is shown in **Table 4.3.**

The data provided by JEA also include areas serviced by a WWTF and areas where large numbers of failing septic tanks are present. None of the Terrapin Creek watershed is in a septic tank phase-out area (an area with the highest priority to be sewered due to high septic tank failure rates), and there are no phase-out areas near the watershed (**Figure 4.5**). The Terrapin Creek watershed is serviced by the District II WWTF.

Figure 4.4. Population Density in the Terrapin Creek Watershed, WBID 2204, in 2000

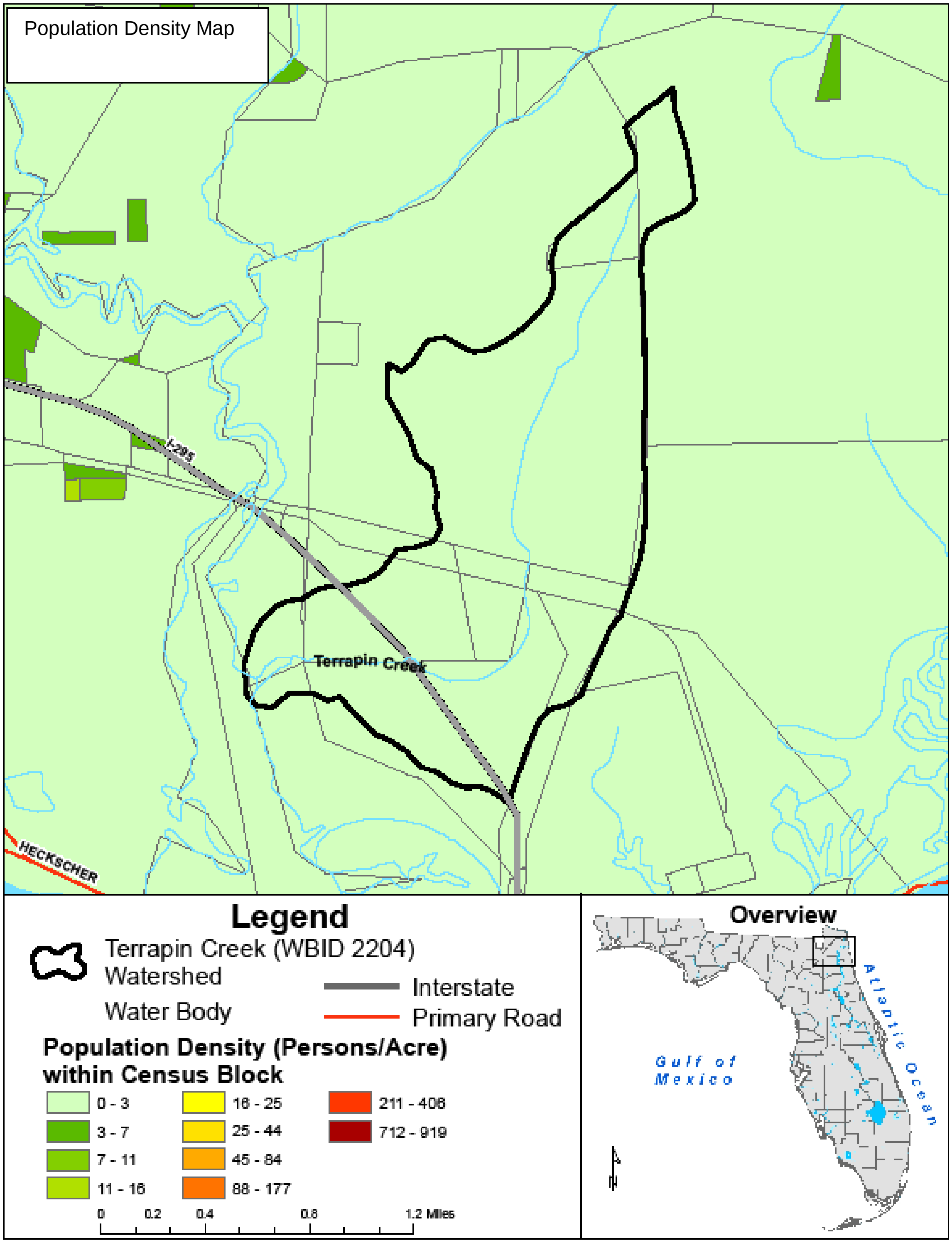


Figure 4.5. Septic Tank Repair Permits Issued for the Terrapin Creek Watershed, WBID 2204, March 1990–April 2004

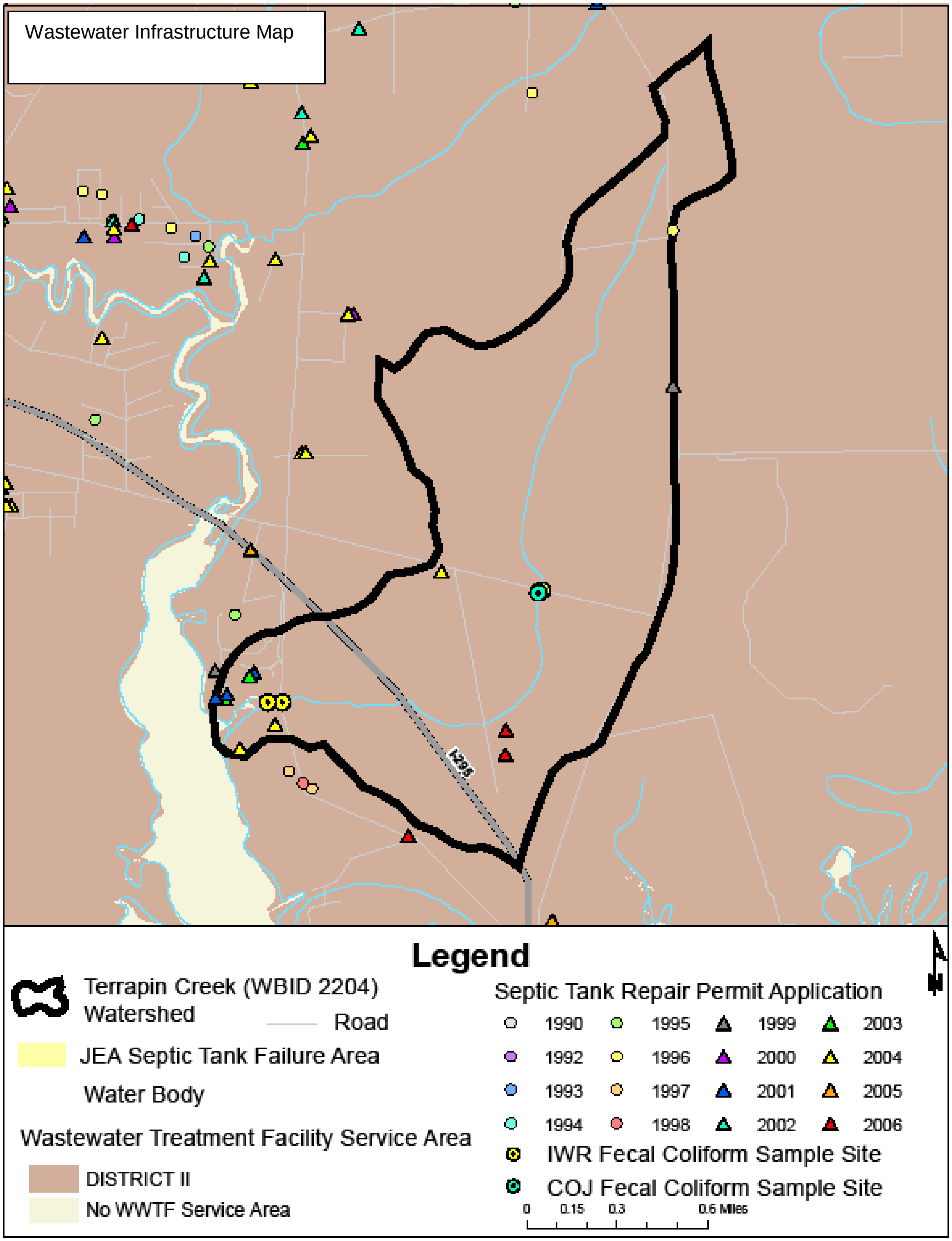


Table 4.2. Estimated Average Household Size in the Terrapin Creek Watershed, WBID 2204

Household Size	Number of Households	% of Total	Number of People
1-person household	4	12.30	4
2-person household	14	42.01	27
3-person household	5	16.11	16
4-person household	5	16.61	22
5-person household	4	12.13	20
6-person household	0	0.00	0
7-or-more-person household	0	0.85	2
TOTAL:	**33**	**100.00**	**91**
		AVERAGE HOUSEHOLD SIZE:	**2.78**

Table 4.3. Estimated Annual Fecal Coliform Loading from Failed Septic Tanks in the Terrapin Creek Watershed, WBID 2204

Estimated Population Density (persons/mi^2)	WBID Area (mi^2)	Estimated Population in Watershed	Estimated Number of Tank Failures[1]	Estimated Load from Failed Tanks[2]	Gallons/ Person/ Day[2]	Estimated Number of Persons per Household[3]	Estimated Daily Load from Failing Tanks	Estimated Annual Load from Failing Tanks
49	1.87	91	1	1.00×10^4 /mL	70	2.78	7.37×10^9	2.69×10^{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] EPA, 2001.

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

4.3 Source Summary

4.3.1 Agriculture

According to 2004 Level 3 land use data, the Terrapin Creek watershed contains agricultural areas. Cattle-feeding operations, the main agricultural activity that could affect water quality in the creek, account for approximately 83 acres of the watershed (7 percent). A cattle-feeding operation covered by the M&M Incorporated permit (see **Section 4.2.1**) closed in January 2005. However, there may be residual soil contamination that could be washed into the creek by rainfall.

According to the Florida Department of Agriculture and Consumer Services (FDACS) (2003), there are 4,200 cows in Duval County. Between dairies and cattle-feeding operations, approximately 2,202 acres of land in Duval County contain cows. Therefore, there are 1.91 cows per acre in the county. Using this ratio, there are about 159 cows in the Terrapin Creek watershed and approximately 538 cows in the dairy farm, including the portion outside the WBID boundary.

Only the number of cows in the watershed was used to calculate the potential loading from cows. Since the M & M Incorporated permit did not require any water quality monitoring and the facility did not directly discharge into a waterbody, the actual fecal coliform loading cannot be determined. The estimated loading from cows is 1.59×10^{13} organisms/day (**Table 4.4**). This number is probably high, because the dairy farm should have had a manure management policy in place to reduce potential loadings.

Table 4.4. Estimated Loading from Cows in the Terrapin Creek Watershed, WBID 2204

Type of Agriculture	Estimated Number of Cows in WBID 2204[1]	Estimated Counts/Cow/Day[2]	Estimated Counts/Day	Estimated Counts/Year
Cows	159	1×10^{11}	1.59×10^{13}	5.80×10^{15}

[1] FDACS, 2003.
[2] EPA, 2001.

4.3.2 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 4.5**). For example, using household-to-dog ratio estimates from the American Veterinary Medical Association (AVMA), the approximate loading is 9.57×10^{10} organisms/day. This is an estimate, as the actual loading from dogs is not known.

Table 4.5. Estimated Loading from Dogs in the Terrapin Creek Watershed, WBID 2204

Estimated Number of Households in WBID 2204	Estimated Dog:Household Ratio[1]	Estimated Number of Dogs in WBID 2204	Estimated Fecal Coliform (counts/dog/day[2])	Estimated Fecal Coliform (counts/day)	Estimated Fecal Coliform (counts/year)
33	0.58	19	5×10^{9}	9.57×10^{10}	3.49×10^{13}

[1] From the AVMA Website, which states the original source to be the *U.S. Pet Ownership and Demographics Sourcebook,* 2002.
[2] EPA, 2001.

4.3.3 Leaking or Overflowing Wastewater Collection Systems

As noted previously, about 78 percent of households in Duval County are connected to a wastewater facility. Assuming 33 homes in the watershed, with 2.78 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 the Terrapin Creek watershed, a daily flow of approximately 1.90×10^{4} 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 4.74×10^{10} counts/day (**Table 4.6**).

Table 4.6. Estimated Loading from Wastewater Collection Systems in the Terrapin Creek Watershed, WBID 2204

Estimated Number of Homes on Central Sewer in WBID 2204	Estimated Daily Flow (L)	Daily Leakage (L)	Raw Sewage (counts/100mL)	Estimated Fecal Coliform (counts/day)	Estimated Fecal Coliform (counts/year)
26	1.90×10^{4}	9.48×10^{2}	5×10^{6}	4.74×10^{10}	1.73×10^{13}

Table 4.7 summarizes the various estimates from potential 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 Terrapin Creek.

Table 4.7. Summary of Estimated Potential Coliform Loading from Various Sources in the Terrapin Creek Watershed, WBID 2204

Source	Fecal Coliform (counts/day)
Septic Tanks	7.37×10^{9}
Agriculture	5.80×10^{15}
Dogs	9.57×10^{10}
Collection Systems	4.74×10^{10}

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 Terrapin Creek. To determine the TMDL, the percent reduction that would be required for each of the exceedances to meet the applicable criterion 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

Four sampling stations on Terrapin Creek have historical fecal coliform observations, as follows (**Figure 5.1**):

- *Terrapin Creek at Faye Road (STORET ID: 21FLA 20030653);*
- *Terrapin Creek at Faye Road (STORET ID: 21FLJXWQDC7);*
- *Terrapin Creek at Alta Rd (STORET ID: 21FLJXWQDC5); and*
- *Terrapin Creek at Alta Road (STORET ID: 21 FLA 20030654).*

The two locations, Alta Road and Faye Road, each have two stations monitored by different entities, the city of Jacksonville and the Department. Station 21FLJXWQDC5 is located just west of where Alta Road crosses Terrapin Creek, while Station 21FLA 20030654 is slightly to the east of the crossing. The two stations at Faye Road (21FLA 20030653 and 21FLJXWQDC7) are situated where Faye Road crosses over Terrapin Creek.

The stations maintained by the Department had the fewest samples: 4 samples were collected in 2002 at the Faye Road location (21FLA 20030653) and 8 samples in 2002 and 2007 at the Alta Road location (21FLA 20030654). The city of Jacksonville maintained routine (mostly quarterly) sampling from 1995 to 2007 (excluding 1997) at Alta Road (21FLJXWQDC5) and from 2003 to 2007 at Faye Road (21FLJXWQDC7). **Table 5.1** shows data collection information for each station and **Figure 5.1** shows the locations of the sample sites. **Table 5.2** shows observed historical data analysis and **Appendix B** contains all of the historical fecal coliform observations from each site for the planning and verified periods for Terrapin Creek. **Figure 5.2** shows the observations over time.

The two Faye Road stations, which are farther upstream and closer to the dairy farm, both exhibited 100 percent exceedance rates. The two downstream stations at Alta Road had fewer exceedances (25 and 50 percent), indicating that fecal coliform concentrations appear to be higher closer to the dairy farm upstream and then dilute as they flow downstream (**Table 5.2**).

Figure 5.1. Historical Sample Sites in the Terrapin Creek Watershed, WBID 2204

Figure 5.2. Historical Fecal Coliform Observations for Terrapin Creek, WBID 2204

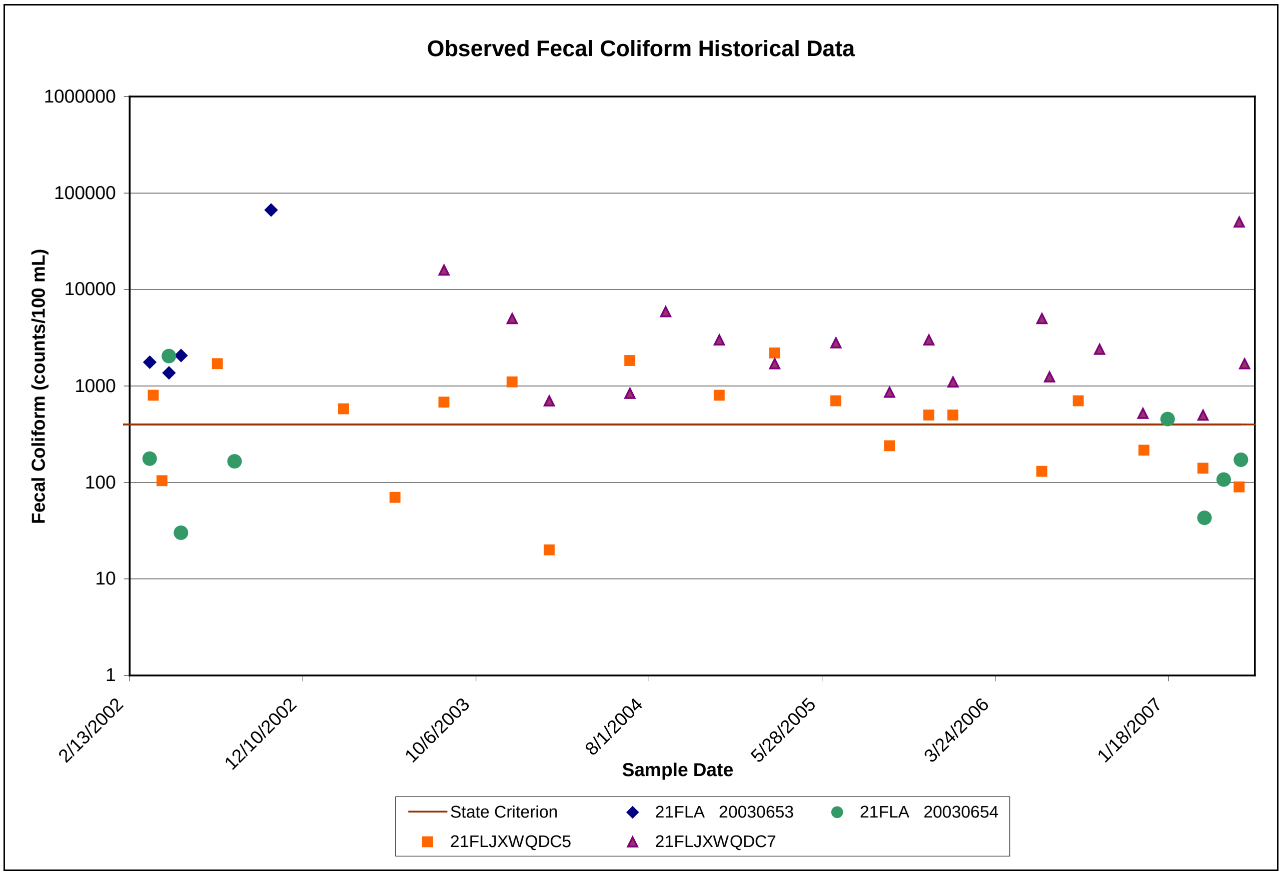


Table 5.1. Sampling Station Summary for Terrapin Creek, WBID 2204

Station	STORET ID	Monitoring Agency	Years with Data	N
Terrapin Creek at Faye Road	21FLA 20030653	Department (Northeast District)	2002	4
Terrapin Creek at Alta Road	21FLA 20030654	Department (Northeast District)	2002, 2007	8
Terrapin Creek at Alta Rd	21FLJXWQDC5	City of Jacksonville	1995–996, 1998–2007	38
Terrapin Creek at Faye Road	21FLJXWQDC7	City of Jacksonville	2003–07	18

Table 5.2. Statistical Summary of All Historical Data for Terrapin Creek, WBID 2204

Station	STORET ID	N	Minimum	Maximum	Median	Mean	Exceedances	% Exceedances
Terrapin Creek at Faye Road	21FLA 20030653	4	1,367	66,600	1,917	17,950	4	100.00
Terrapin Creek at Alta Road	21FLA 20030654	8	30	2,033	169	398	2	25.00
Terrapin Creek at Alta Rd	21FLJXWQDC5	38	20	160,000	700	6,414	19	50.00
Terrapin Creek at Faye Road	21FLJXWQDC7	18	500	50,000	2,050	5,676	18	100.00

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 71 percent. This means that in order to meet the state criterion of 400 counts/100mL, a 71 percent reduction in current loading is necessary, and is therefore the TMDL for Terrapin Creek. **Table 5.3** shows annual summaries of exceedances used to determine the TMDL by year, and **Table 5.4** shows the individual exceedances used in calculating the TMDL for Terrapin Creek.

Table 5.3. Annual Summary of Fecal Coliform Exceedances Used to Develop the TMDL for Terrapin Creek, WBID 2204

Year	N	Minimum	Maximum	Median	Mean
1995	2	1,300	7,000	4,150	356
1996	1	1,300	1,300	1,300	1,300
1997	-	-	-	-	-
1998	3	300	24,000	1,700	8,667
1999	4	140	16,000	1,000	4,535
2000	4	40	160,000	7,550	43,785
2001	4	30	1,000	356	436
2002	11	30	66,600	1,367	6,983
2003	6	70	15,900	890	3,888
2004	7	20	5,900	840	1,870
2005	8	240	3,000	1,280	1,500
2006	9	130	5,000	700	3,737
2007	9	43	50,000	172	5,912

- = There are no data for 1997.
Coliform counts are #/100mL and represent years for which exceedances exist.

Table 5.4. Calculation of Reductions for the Fecal Coliform TMDL for Terrapin Creek, WBID 2204

Sample Date	Location	Observed Value (exceedance)	Required Reduction (%)
3/20/2002	Terrapin Creek at Faye Road	1,767	77.36
4/22/2002	Terrapin Creek at Faye Road	1,367	70.74
5/13/2002	Terrapin Creek at Faye Road	2,067	80.65
10/16/2002	Terrapin Creek at Faye Road	66,600	99.40
4/22/2002	Terrapin Creek at Alta Road	2,033	80.32
1/17/2007	Terrapin Creek at Alta Road	454	11.89
1/25/1995	Terrapin Creek at Alta Rd	1,300	69.23
4/4/1995	Terrapin Creek at Alta Rd	7,000	94.29
10/21/1996	Terrapin Creek at Alta Rd	1,300	69.23
6/1/1998	Terrapin Creek at Alta Rd	1,700	76.47
10/14/1998	Terrapin Creek at Alta Rd	24,000	98.33
1/13/1999	Terrapin Creek at Alta Rd	1,300	69.23
8/23/1999	Terrapin Creek at Alta Rd	700	42.86
10/19/1999	Terrapin Creek at Alta Rd	16,000	97.50
1/26/2000	Terrapin Creek at Alta Rd	160,000	99.75
9/6/2000	Terrapin Creek at Alta Rd	14,000	97.14
12/6/2000	Terrapin Creek at Alta Rd	1,100	63.64
2/1/2001	Terrapin Creek at Alta Rd	1,000	60.00
8/28/2001	Terrapin Creek at Alta Rd	500	20.00
3/26/2002	Terrapin Creek at Alta Rd	801	50.06
7/15/2002	Terrapin Creek at Alta Rd	1,700	76.47
2/19/2003	Terrapin Creek at Alta Rd	580	31.03
8/12/2003	Terrapin Creek at Alta Rd	680	41.18
12/8/2003	Terrapin Creek at Alta Rd	1,100	63.64
6/29/2004	Terrapin Creek at Alta Rd	1,830	78.14
12/1/2004	Terrapin Creek at Alta Rd	800	50.00
3/7/2005	Terrapin Creek at Alta Rd	2,200	81.82
6/21/2005	Terrapin Creek at Alta Rd	700	42.86
11/29/2005	Terrapin Creek at Alta Rd	500	20.00
1/10/2006	Terrapin Creek at Alta Rd	500	20.00
8/15/2006	Terrapin Creek at Alta Rd	700	42.86
8/12/2003	Terrapin Creek at Faye Road	15,900	97.48
12/8/2003	Terrapin Creek at Faye Road	5,000	92.00
2/10/2004	Terrapin Creek at Faye Road	700	42.86
6/29/2004	Terrapin Creek at Faye Road	840	52.38
8/30/2004	Terrapin Creek at Faye Road	5,900	93.22
12/1/2004	Terrapin Creek at Faye Road	3,000	86.67
3/7/2005	Terrapin Creek at Faye Road	1,700	76.47
6/21/2005	Terrapin Creek at Faye Road	2,800	85.71
9/22/2005	Terrapin Creek at Faye Road	860	53.49
11/29/2005	Terrapin Creek at Faye Road	3,000	86.67
1/10/2006	Terrapin Creek at Faye Road	1,100	63.64

Sample Date	Location	Observed Value (exceedance)	Required Reduction (%)
6/13/2006	Terrapin Creek at Faye Road	5,000	92.00
6/26/2006	Terrapin Creek at Faye Road	1,245	67.87
9/21/2006	Terrapin Creek at Faye Road	2,400	83.33
12/5/2006	Terrapin Creek at Faye Road	520	23.08
3/19/2007	Terrapin Creek at Faye Road	500	20.00
5/21/2007	Terrapin Creek at Faye Road	50,000	99.20
5/30/2007	Terrapin Creek at Faye Road	1,700	76.47
	MEDIAN:	**1,367**	**70.74**

5.1.3 Critical Conditions/Seasonality

Exceedances in Terrapin Creek cannot be associated with flows, as there are no flow data available within the watershed. Therefore, the effects of flow under various conditions cannot be determined or considered as a critical condition.

Appendix B provides historical fecal coliform observations in Terrapin Creek. Coliform data are presented by month, season, and year to determine whether certain patterns are evident in the dataset (see **Tables 2.1**, **2.2**, and **2.3**).

A nonparametric test (Kruskal-Wallis) was applied to the fecal coliform dataset to determine whether there were significant differences among months or seasons. The analysis indicated that there were no significant differences between fecal coliform observations versus season (**Appendix C**) and versus month (**Appendix D**) at an alpha (α) level of 0.05. It is very difficult to evaluate possible patterns among months due to the small sample sizes; the range in monthly observations for fecal coliform varies from 0 to 5 in a given month (**Table 2.1**). January, February, June, September, and October all had exceedance rates of 100 percent, while May had the lowest exceedance rate among months, at 20 percent. Grouping observations by season increased sample sizes for statistical comparison, as seen in **Table 2.2**, but sample size is still relatively small (between 6 and 10 samples). Winter and fall demonstrated the highest percentage of exceedances (over 80 percent) and spring exhibited the lowest (40 percent). **Appendix E** presents comparisons by station and season.

A factor that could contribute to these monthly or seasonal differences is the pattern of rainfall. Records for JIA (**Appendix F** 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), and the cumulative total for the day of sampling and 29 days prior (30D) were all paired with the respective coliform observation based on date. A Spearman correlation matrix was generated that summarized the simple correlation coefficients between the various rainfall and coliform values (**Appendix G**). The simple correlations (r values in the Spearman correlation table) between both fecal coliform and the various rainfall totals were all 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 all of the various precipitation intervals were not significant (see **Appendix H**). A table of historical monthly average rainfall (**Appendix I**) indicates that monthly rainfall totals increase in June, peak in September, and by October return to the levels observed in February and March. **Appendix J** includes a graph of annual rainfall from 1955 to 2008 versus the long-term average (52.47 inches) over this period. The years 1996 to 1998 had above-average rainfall, while 1999 to 2001 were below average, and 2002 was again above average. Data exceedances occur almost all of the time, making it difficult to correlate them to rainfall patterns.

Table 2.3 indicates that exceedances do not appear to follow the same pattern as rainfall. The highest percentage of exceedances was seen in 1996 (100 percent; only 1 sample), 1999 (75 percent), and 2000 (75 percent). In 1996, there was above-average rainfall, while 1999 and 2000 were below average. The lowest percentage of exceedances was observed in 2001 (50 percent) and 2003 (50 percent), both below-average rainfall years. A trend with rainfall cannot be established, and again this is probably attributable to small sample size, between 1 and 11 samples per year.

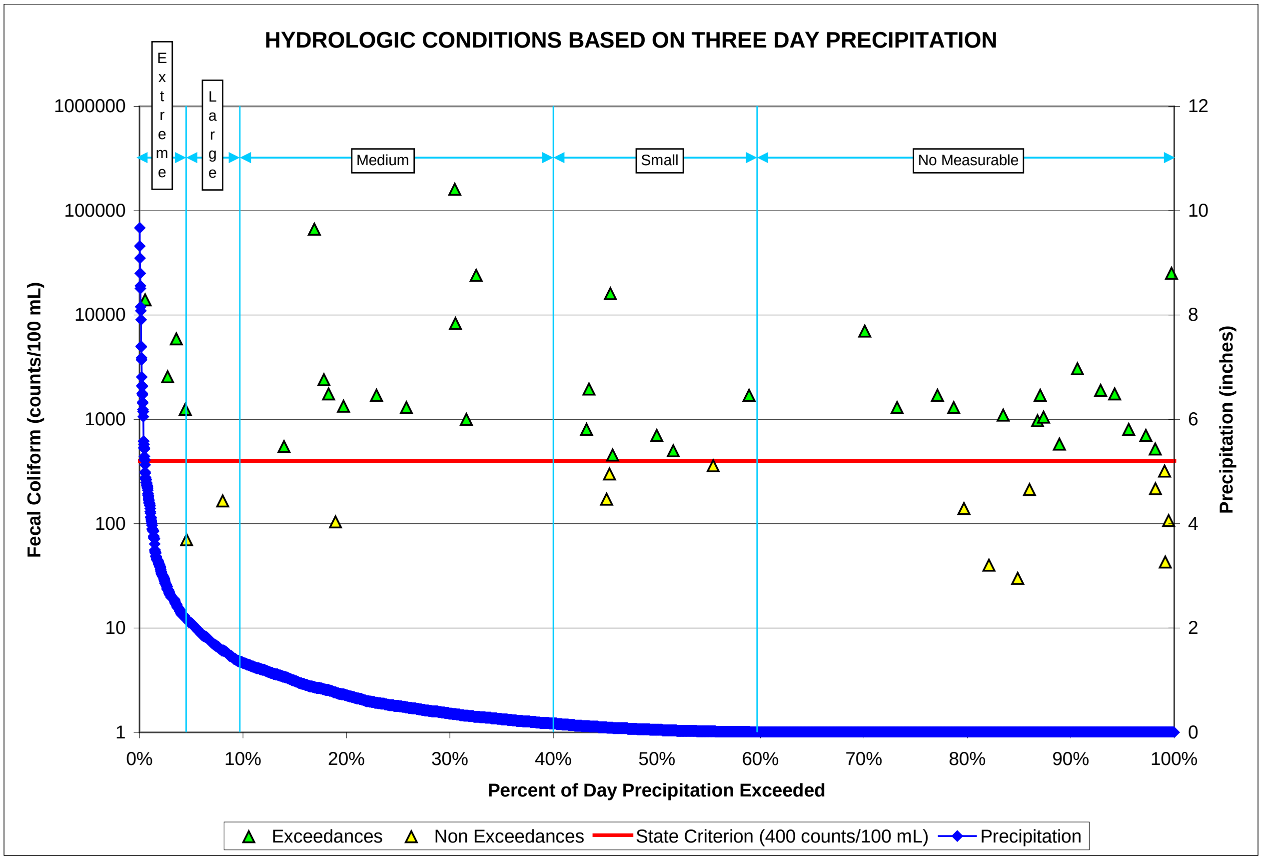
As no flow data were available, hydrologic conditions were analyzed using rainfall. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from JIA from January 1, 1990, to July 31, 2007. The chart was divided in the same manner as if flow were being 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 (**Figure 5.3**).

Fecal coliform exceedances occurred over all hydrologic conditions for which data exist, except for large precipitation events, but only 1 sample was collected following a rainfall event of this magnitude. The lowest percentage of exceedances, other than 0 percent seen after the single large precipitation event, occurred during periods of no measurable precipitation (66.67 percent). The highest percentage (91.67 percent) occurred after medium precipitation events. Only 5 samples were collected within 3 days of an extreme precipitation event, and 1 within 3 days of a large precipitation event. It is difficult to draw conclusions with so few samples representing extreme and large precipitation events; however, if these 2 events are excluded due to small sample size, exceedances appear to decrease as precipitation amounts decrease, indicating that nonpoint sources are probably a major contributing factor. A pattern could become clearer if more samples were collected, especially following extreme and large rainfall events. **Table 5.5** summarizes data and hydrologic conditions. **Figure 5.3** shows the same data visually.

Table 5.5. Summary of Fecal Coliform Data by Hydrologic Condition

Precipitation Event	Event Range (inches)	Total Samples	Number of Exceedances	% Exceedances	Number of Nonexceedances	% Nonexceedances
Extreme	>2.1"	5	4	80.00	1	20.00
Large	1.33" - 2.1"	1	0	0.00	1	100.00
Medium	0.18" - 1.33"	12	11	91.67	1	8.33
Small	0.01" - 0.18"	10	7	70.00	3	30.00
None/ No Measurable	<0.01"	24	16	66.67	8	33.33

Figure 5.3. Fecal Coliform Data by Hydrologic Condition Based on Rainfall



Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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

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

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

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

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 Terrapin 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**).

Table 6.1. TMDL Components for Terrapin Creek, WBID 2204

WBID	Parameter	TMDL (colonies/100mL)	WLA Wastewater (colonies/day)	WLA NPDES Stormwater	LA (% Reduction)	MOS
2204	Fecal Coliform	400	N/A	71%	71%	Implicit

N/A – Not applicable

6.2 Load Allocation

The LA for nonpoint sources is a 71 percent reduction of instream fecal coliform concentrations. 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

There is currently only one permitted NPDES discharge into Terrapin Creek; however, the permit is for a facility (Florida Rock–New Berlin Road CBP, Permit # FLG110329) that has no direct discharge into Terrapin Creek and no monitoring requirement for fecal coliform. Any future discharge permits issued in the Terrapin Creek watershed will be required to meet the state Class III criterion for fecal coliform as well as the TMDL value, and therefore will not be allowed to 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.

6.3.2 NPDES Stormwater Discharges

The WLA for the city of Jacksonville and FDOT's MS4 permit is to address anthropogenic sources in the watershed to result in a 71 percent reduction of instream fecal coliform concentrations. 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 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, 2001), an implicit MOS was used 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 the Trout River, 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 K**. 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.

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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 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. These 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 Terrapin Creek, WBID 2204

Waterbody	WBID	Sample Date	Station	Location	Value (#/100mL)	Remark Code
Terrapin Creek	2204	1/25/1995	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,300	
Terrapin Creek	2204	4/4/1995	21FLJXWQDC5	Terrapin Creek at Alta Rd	7,000	
Terrapin Creek	2204	10/21/1996	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,300	
Terrapin Creek	2204	6/1/1998	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,700	
Terrapin Creek	2204	7/22/1998	21FLJXWQDC5	Terrapin Creek at Alta Rd	300	
Terrapin Creek	2204	10/14/1998	21FLJXWQDC5	Terrapin Creek at Alta Rd	24,000	
Terrapin Creek	2204	1/13/1999	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,300	
Terrapin Creek	2204	5/3/1999	21FLJXWQDC5	Terrapin Creek at Alta Rd	140	
Terrapin Creek	2204	8/23/1999	21FLJXWQDC5	Terrapin Creek at Alta Rd	700	
Terrapin Creek	2204	10/19/1999	21FLJXWQDC5	Terrapin Creek at Alta Rd	16,000	
Terrapin Creek	2204	1/26/2000	21FLJXWQDC5	Terrapin Creek at Alta Rd	160,000	L
Terrapin Creek	2204	4/18/2000	21FLJXWQDC5	Terrapin Creek at Alta Rd	40	
Terrapin Creek	2204	9/6/2000	21FLJXWQDC5	Terrapin Creek at Alta Rd	14,000	
Terrapin Creek	2204	12/6/2000	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,100	
Terrapin Creek	2204	2/1/2001	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,000	
Terrapin Creek	2204	5/23/2001	21FLJXWQDC5	Terrapin Creek at Alta Rd	30	
Terrapin Creek	2204	8/28/2001	21FLJXWQDC5	Terrapin Creek at Alta Rd	500	
Terrapin Creek	2204	12/17/2001	21FLJXWQDC5	Terrapin Creek at Alta Rd	212	
Terrapin Creek	2204	3/20/2002	21FLA 20030654	Terrapin Creek at Alta Road	176	
Terrapin Creek	2204	3/20/2002	21FLA 20030653	Terrapin Creek at Faye Road	1767	
Terrapin Creek	2204	3/26/2002	21FLJXWQDC5	Terrapin Creek at Alta Rd	801	
Terrapin Creek	2204	4/10/2002	21FLJXWQDC5	Terrapin Creek at Alta Rd	104	
Terrapin Creek	2204	4/22/2002	21FLA 20030654	Terrapin Creek at Alta Road	2,033	
Terrapin Creek	2204	4/22/2002	21FLA 20030653	Terrapin Creek at Faye Road	1,367	
Terrapin Creek	2204	5/13/2002	21FLA 20030654	Terrapin Creek at Alta Road	30	
Terrapin Creek	2204	5/13/2002	21FLA 20030653	Terrapin Creek at Faye Road	2,067	
Terrapin Creek	2204	7/15/2002	21FLJXWQDC5	Terrapin Creek at Alta Rd	1,700	
Terrapin Creek	2204	8/14/2002	21FLA 20030654	Terrapin Creek at Alta Road	165	
Terrapin Creek	2204	10/16/2002	21FLA 20030653	Terrapin Creek at Faye Road	66,600	B
Terrapin Creek	2204	2/19/2003	DC5	Terrapin Creek at Alta Rd	580	
Terrapin Creek	2204	5/19/2003	DC5	Terrapin Creek at Alta Rd	70	
Terrapin Creek	2204	8/12/2003	DC5	Terrapin Creek at Alta Rd	680	
Terrapin Creek	2204	8/12/2003	DC7	Terrapin Creek at Faye Road	15,900	
Terrapin Creek	2204	12/8/2003	DC5	Terrapin Creek at Alta Rd	1,100	
Terrapin Creek	2204	12/8/2003	DC7	Terrapin Creek at Faye Road	5,000	
Terrapin Creek	2204	2/10/2004	DC5	Terrapin Creek at Alta Rd	20	
Terrapin Creek	2204	2/10/2004	DC7	Terrapin Creek at Faye Road	700	
Terrapin Creek	2204	6/29/2004	DC5	Terrapin Creek at Alta Rd	1,830	
Terrapin Creek	2204	6/29/2004	DC7	Terrapin Creek at Faye Road	840	

Waterbody	WBID	Sample Date	Station	Location	Value (#/100mL)	Remark Code
Terrapin Creek	2204	8/30/2004	DC7	Terrapin Creek at Faye Road	5,900	
Terrapin Creek	2204	12/1/2004	DC5	Terrapin Creek at Alta Rd	800	
Terrapin Creek	2204	12/1/2004	DC7	Terrapin Creek at Faye Road	3,000	
Terrapin Creek	2204	3/7/2005	DC5	Terrapin Creek at Alta Rd	2,200	
Terrapin Creek	2204	3/7/2005	DC7	Terrapin Creek at Faye Road	1,700	
Terrapin Creek	2204	6/21/2005	DC5	Terrapin Creek at Alta Rd	700	
Terrapin Creek	2204	6/21/2005	DC7	Terrapin Creek at Faye Road	2,800	
Terrapin Creek	2204	9/22/2005	DC5	Terrapin Creek at Alta Rd	240	
Terrapin Creek	2204	9/22/2005	DC7	Terrapin Creek at Faye Road	860	
Terrapin Creek	2204	11/29/2005	DC5	Terrapin Creek at Alta Rd	500	
Terrapin Creek	2204	11/29/2005	DC7	Terrapin Creek at Faye Road	3,000	
Terrapin Creek	2204	1/10/2006	DC5	Terrapin Creek at Alta Rd	500	
Terrapin Creek	2204	1/10/2006	DC7	Terrapin Creek at Faye Road	1,100	
Terrapin Creek	2204	6/13/2006	DC5	Terrapin Creek at Alta Rd	130	
Terrapin Creek	2204	6/13/2006	DC7	Terrapin Creek at Faye Road	5,000	
Terrapin Creek	2204	6/26/2006	DC7	Terrapin Creek at Faye Road	1,245	
Terrapin Creek	2204	8/15/2006	DC5	Terrapin Creek at Alta Rd	700	
Terrapin Creek	2204	9/21/2006	DC7	Terrapin Creek at Faye Road	2,400	
Terrapin Creek	2204	12/5/2006	DC7	Terrapin Creek at Faye Road	520	
Terrapin Creek	2204	12/7/2006	DC5	Terrapin Creek at Alta Rd	216	
Terrapin Creek	2204	1/17/2007	21FLA 20030654	Terrapin Creek at Alta Road	454	A
Terrapin Creek	2204	3/19/2007	DC5	Terrapin Creek at Alta Rd	140	
Terrapin Creek	2204	3/19/2007	DC7	Terrapin Creek at Faye Road	500	
Terrapin Creek	2204	3/22/2007	21FLA 20030654	Terrapin Creek at Alta Road	43	A
Terrapin Creek	2204	4/24/2007	21FLA 20030654	Terrapin Creek at Alta Road	107	B
Terrapin Creek	2204	5/21/2007	DC5	Terrapin Creek at Alta Rd	90	
Terrapin Creek	2204	5/21/2007	DC7	Terrapin Creek at Faye Road	50,000	
Terrapin Creek	2204	5/24/2007	21FLA 20030654	Terrapin Creek at Alta Road	172	A
Terrapin Creek	2204	5/30/2007	DC7	Terrapin Creek at Faye Road	1,700	

*Deleted blank result entries and dups.

COJ data from PBS&J.

Shaded cells are values that exceed the state criterion of 400 counts/100mL.

Remark Code:

A – Average value.

B – Results based on colony counts outside the acceptable range.

L – Off-scale high. Actual value not known, but known to be greater than value shown.

Appendix C: Kruskal–Wallis Analysis of Fecal Coliform Observations versus Season in Terrapin Creek, WBID 2204

Categorical values encountered during processing are:
SEASON$ (4 levels)
fall, spring, summer, winter

Kruskal-Wallis One-Way Analysis of Variance for 68 cases
Dependent variable is FECALS
Grouping variable is SEASON$

Group	Count	Rank Sum
fall	14	598.000
spring	23	708.500
summer	13	479.000
winter	18	560.500

Kruskal-Wallis Test Statistic = 3.926

Probability is 0.270 assuming Chi-square distribution with 3 df

Appendix D: Kruskal–Wallis Analysis of Fecal Coliform Observations versus Month in Terrapin Creek, WBID 2204

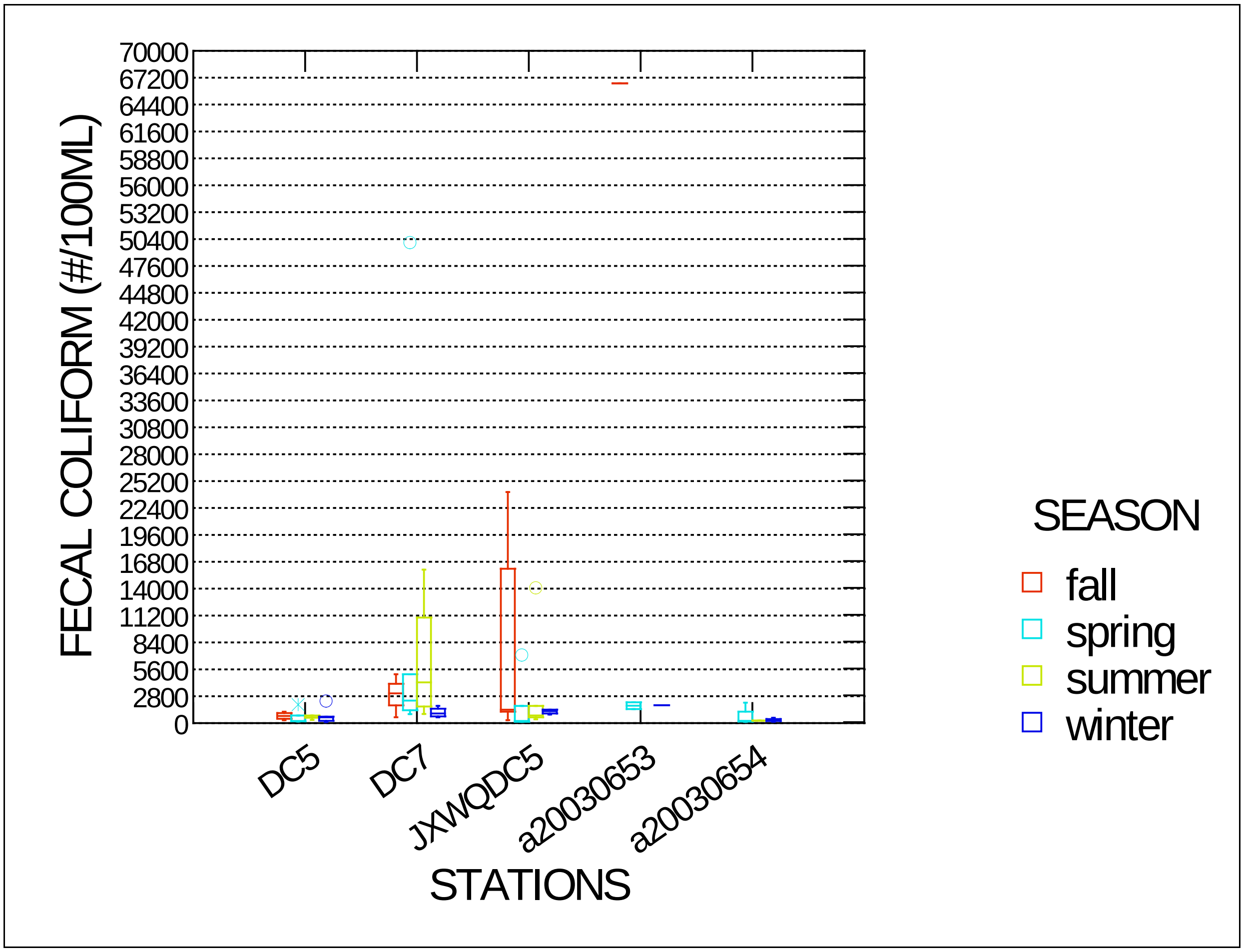
Categorical values encountered during processing are:
MONTH (12 levels)
1, 2, 3, 4, 5, 6, 7,
8, 9, 10, 11, 12

Kruskal-Wallis One-Way Analysis of Variance for 68 cases
Dependent variable is FECALS
Grouping variable is MONTH

Group	Count	Rank Sum
1	6	232.500
2	4	92.500
3	8	235.500
4	6	177.000
5	9	208.000
6	8	323.500
7	2	65.500
8	7	244.500
9	4	169.000
10	4	238.000
11	2	79.000
12	8	281.000

Kruskal-Wallis Test Statistic = 13.390
Probability is 0.269 assuming Chi-square distribution with 11 df

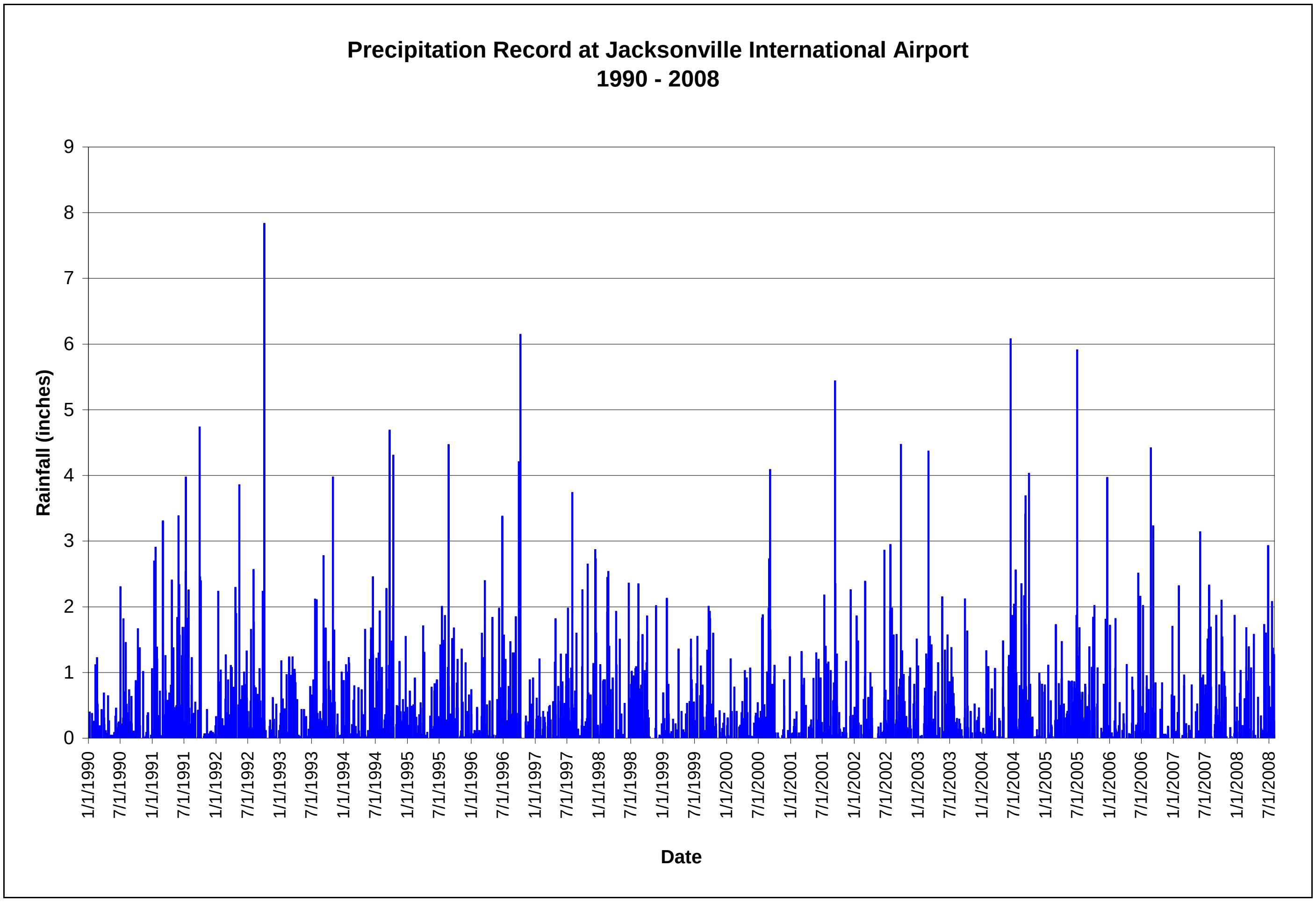
Appendix E: Chart of Fecal Coliform Observations by Season and Station in Terrapin Creek, WBID 2204



Of 68 cases, 1 was excluded by making graph range less than data range.

Station	STORET ID
Terrapin Creek at Faye Road	21FLA 20030653
Terrapin Creek at Alta Road	21FLA 20030654
Terrapin Creek at Alta Rd	21FLJXWQDC5
Terrapin Creek at Faye Road	21FLJXWQDC7

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

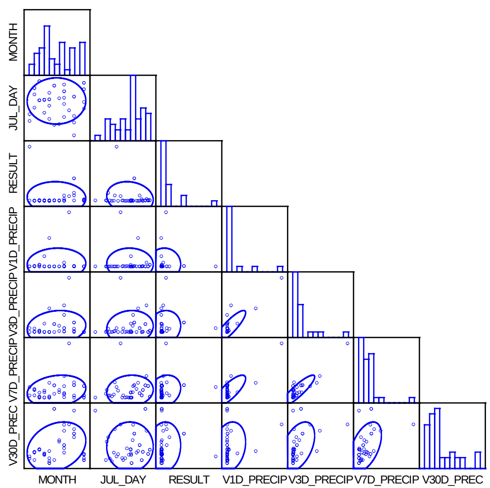


Appendix G: Spearman Correlation Matrix Analysis for Precipitation and Fecal Coliform in Terrapin Creek, WBID 2204

Spearman correlation matrix

	MONTH	JUL_DAY	RESULT	V1D_PRECIP	V3D_PRECIP
MONTH	1.000				
JUL_DAY	0.033	1.000			
RESULT	0.267	0.087	1.000		
V1D_PRECIP	-0.202	0.268	0.035	1.000	
V3D_PRECIP	0.043	0.230	0.263	0.583	1.000
V7D_PRECIP	0.162	0.298	0.225	0.329	0.667
V30D_PREC	0.223	0.137	0.259	0.246	0.670

	V7D_PRECIP	V30D_PREC
V7D_PRECIP	1.000	
V30D_PREC	0.512	1.000



Number of observations: 43

Appendix H: Analysis of Fecal Coliform Observations and Precipitation in Terrapin Creek, WBID 2204

FECAL COLIFORM DATA VERSUS DAY OF SAMPLING PRECIPITATION

Dep Var: FECALS N: 68 Multiple R: 0.006 Squared multiple R: 0.000

Adjusted squared multiple R: 0.000 Standard error of estimate: 21821.442

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	6225.226	2747.613	0.000	.	2.266	0.027
V1D_PREC	-187.748	3859.035	-0.006	1.000	-0.049	0.961

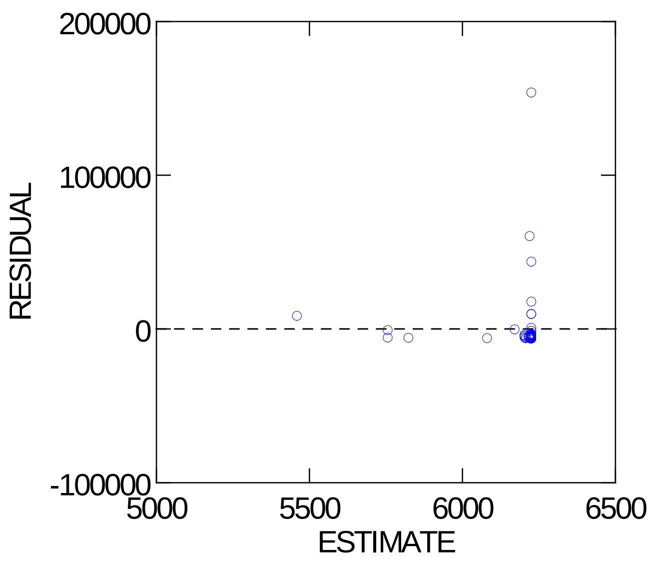
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	1127090.170	1	1127090.170	0.002	0.961
Residual	3.14276E+10	66	4.76175E+08		

*** WARNING ***
Case 11 is an outlier (Studentized Residual = 14.528)
Case 13 has large leverage (Leverage = 0.488)
Case 53 has large leverage (Leverage = 0.181)
Case 54 has large leverage (Leverage = 0.181)

Durbin-Watson D Statistic 1.989
First Order Autocorrelation 0.005

Plot of residuals against predicted values



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

Dep Var: FECALS N: 68 Multiple R: 0.042 Squared multiple R: 0.002

Adjusted squared multiple R: 0.000 Standard error of estimate: 21802.502

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5732.777	2961.418	0.000	.	1.936	0.057
V3D_PREC	1029.865	3009.699	0.042	1.000	0.342	0.733

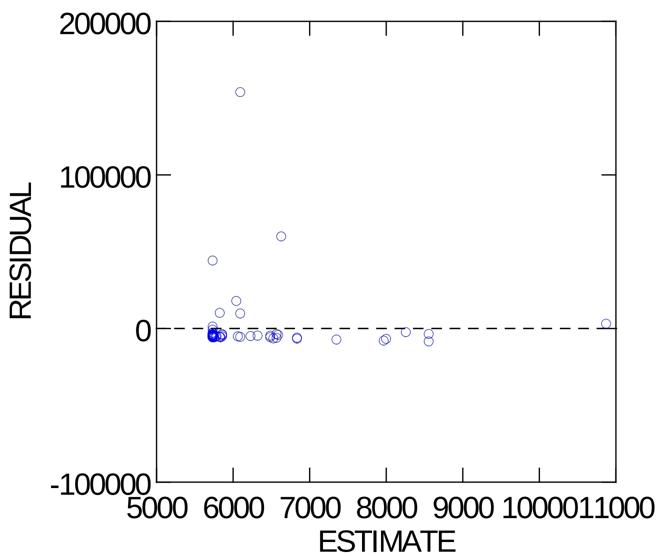
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	5.56579E+07	1	5.56579E+07	0.117	0.733
Residual	3.13730E+10	66	4.75349E+08		

*** WARNING ***
Case 11 is an outlier (Studentized Residual = 14.604)
Case 13 has large leverage (Leverage = 0.409)

Durbin-Watson D Statistic 1.976
First Order Autocorrelation 0.011

Plot of residuals against predicted values



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

Dep Var: FECALS N: 68 Multiple R: 0.160 Squared multiple R: 0.026

Adjusted squared multiple R: 0.011 Standard error of estimate: 21540.542

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3644.551	3248.958	0.000	.	1.122	0.266
V7D_PRE	2931.383	2225.476	0.160	1.000	1.317	0.192

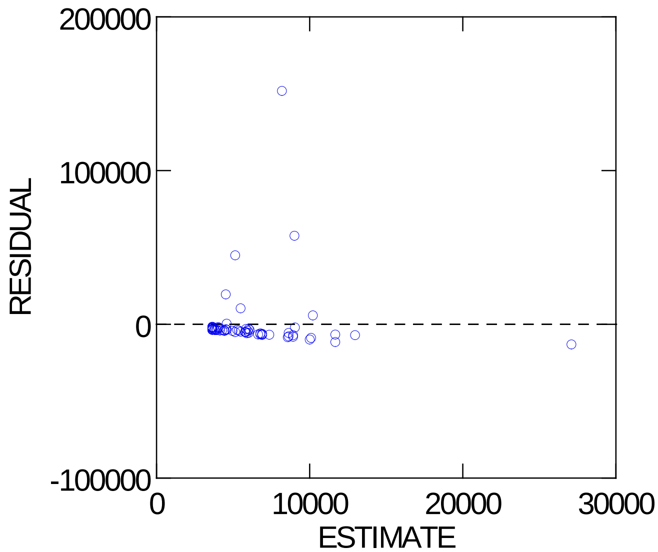
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	8.05031E+08	1	8.05031E+08	1.735	0.192
Residual	3.06237E+10	66	4.63995E+08		

*** WARNING ***
Case 11 is an outlier (Studentized Residual = 14.656)
Case 13 has large leverage (Leverage = 0.558)

Durbin-Watson D Statistic 2.025
First Order Autocorrelation -0.013

Plot of residuals against predicted values



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

Dep Var: FECALS N: 68 Multiple R: 0.079 Squared multiple R: 0.006

Adjusted squared multiple R: 0.000 Standard error of estimate: 21753.827

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	8071.356	3940.833	0.000	.	2.048	0.045
MONTH_PR	-440.987	685.954	-0.079	1.000	-0.643	0.523

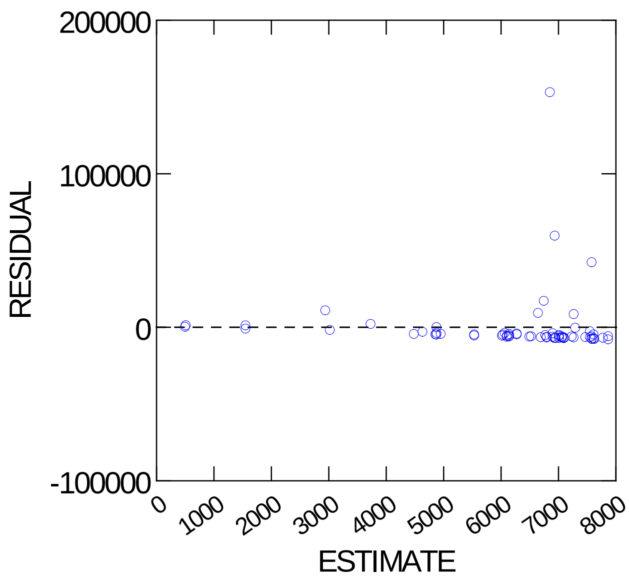
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	1.95583E+08	1	1.95583E+08	0.413	0.523
Residual	3.12331E+10	66	4.73229E+08		

*** WARNING ***
Case 11 is an outlier (Studentized Residual = 14.502)
Case 38 has large leverage (Leverage = 0.180)
Case 39 has large leverage (Leverage = 0.180)

Durbin-Watson D Statistic 1.993
First Order Autocorrelation 0.003

Plot of residuals against predicted values



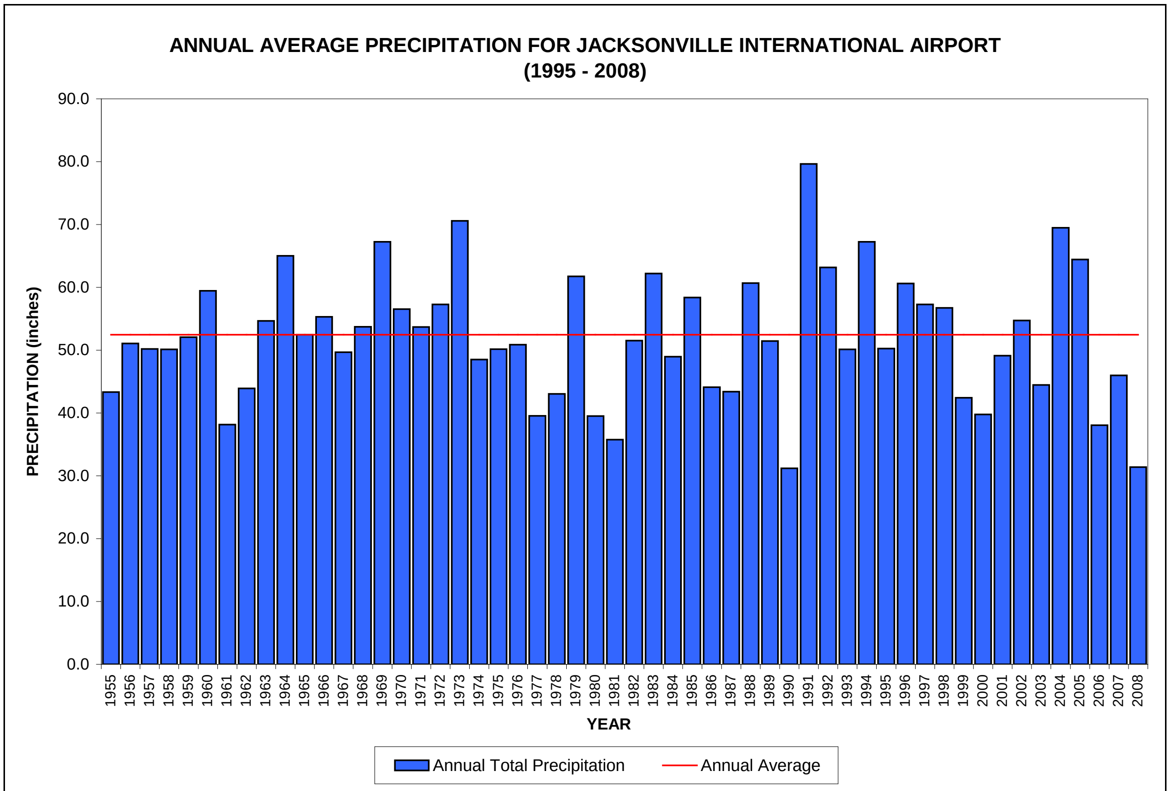
Appendix I: Monthly and Annual Precipitation from JIA, 1955–2008

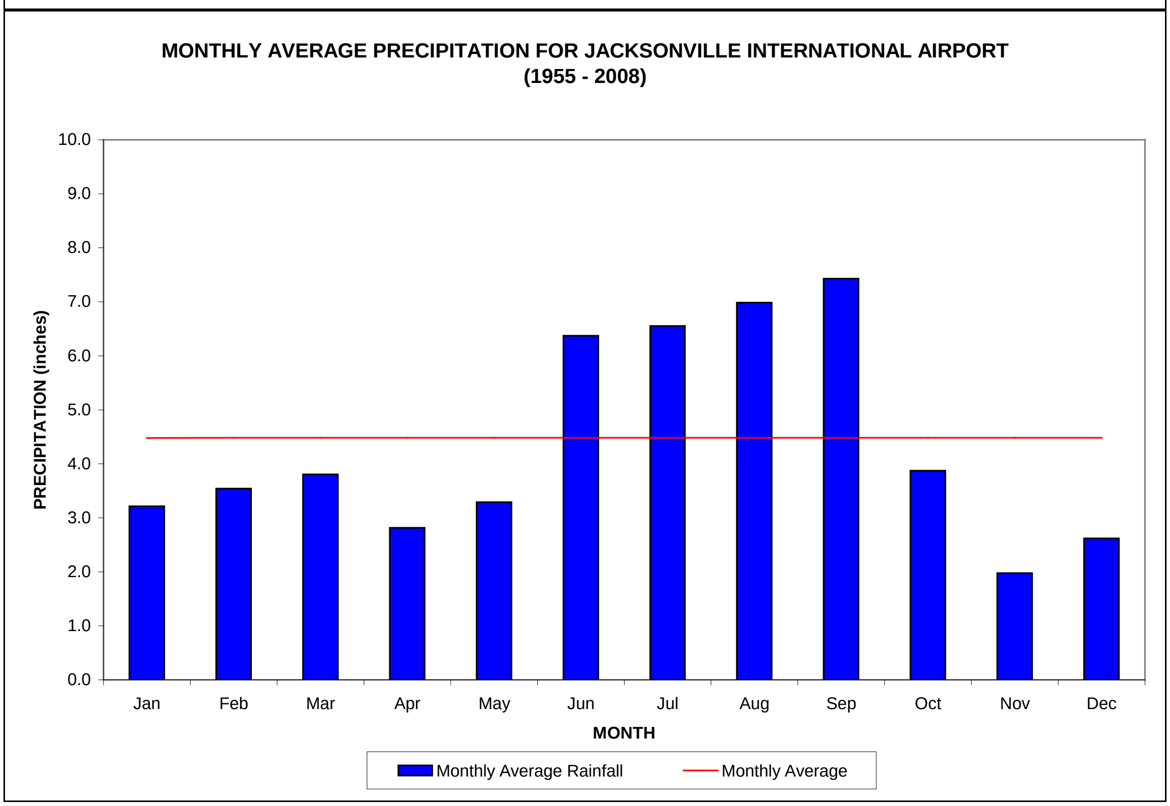
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1955	3.1	2.46	1.66	1.5	4.51	2.7	5.53	3.85	10.6	5.36	1.9	0.2	**43.33**
1956	2.9	2.94	0.81	2.33	3.98	7.87	8.25	5.24	2.89	13.4	0.4	0	**51.08**
1957	0.3	1.69	3.87	1.61	5.25	7.1	12.3	3.3	8.33	3.5	1.6	1.3	**50.18**
1958	3.4	3.74	3.38	8.24	3.79	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**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
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**
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: Annual and Monthly Average Precipitation at JIA





Appendix K: 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.

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