FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHWEST DISTRICT • PENSACOLA BAY BASIN

FINAL TMDL Report

Fecal Coliform TMDL for Yellow River (WBID 30)

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Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

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

Florida STORET Program

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

2012 Integrated Report

http://www.dep.state.fl.us/water/docs/2012_integrated_report.pdf

Criteria for Surface Water Quality Classifications

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

Water Quality Status Report : Pensacola Bay

http://www.dep.state.fl.us/water/basin411/pensacola/status.htm

Water Quality Assessment Report: Pensacola Bay

http://www.dep.state.fl.us/water/basin411/pensacola/assessment.htm

U.S. Environmental Protection Agency

Region 4: TMDLs 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 bacteria for the Yellow River, located in the Pensacola Bay Basin. This waterbody was verified as impaired for fecal coliform and therefore was included on the Verified List of impaired waters for the Pensacola Bay Basin that was adopted by Secretarial Order in May 2006. The TMDL establishes the allowable fecal coliform loading to the Yellow River that would restore the waterbody so that it meets its applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Pensacola Bay Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Yellow River is WBID 30.

The entire Yellow River is 118 miles (190 kilometers) long and runs through Alabama and Florida. It empties into Blackwater Bay, an arm of Pensacola Bay. The river is located in the upper central portion of Okaloosa County, in northwest Florida, and northwest of the city of Crestview (**Figure 1.1**). It flows from north to south and joins with the Shoal River. Interstate 10 passes through the southern portion of the WBID (**Figure 1.2**). Additional information about the hydrology and geology of this area is available in the Water Quality Status Report for the Pensacola Bay Basin (Department 2004).

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.

A TMDL report is followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform that caused the verified impairment of a waterbody. These activities depend heavily on the active participation of local governments, businesses, citizens, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions of fecal coliform and achieve the established TMDLs for impaired waterbodies.

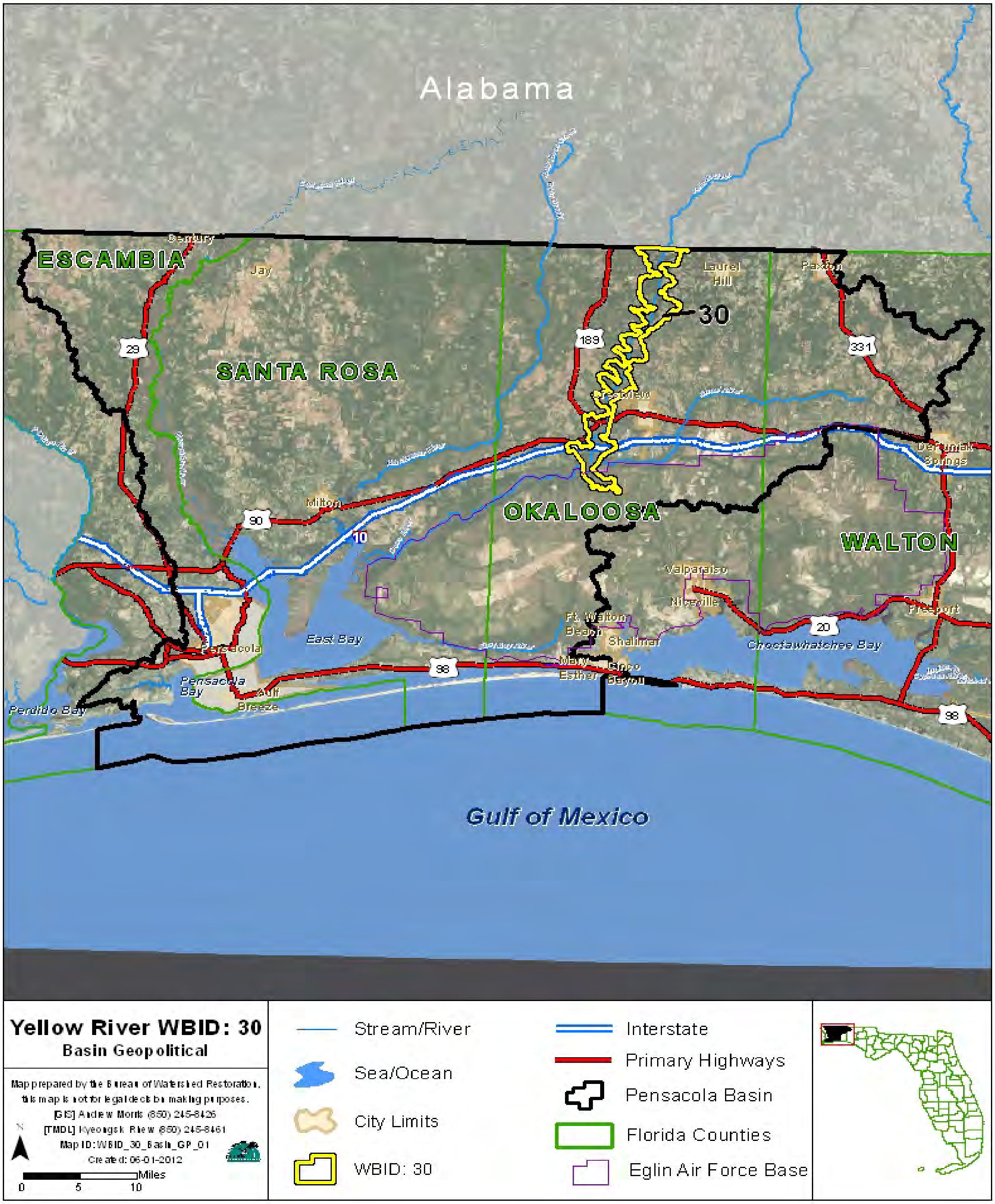


Figure 1.1. Location of the Yellow River (WBID 30) Watershed in the Pensacola Bay Basin and Major Geopolitical and Hydrologic Features in the Area

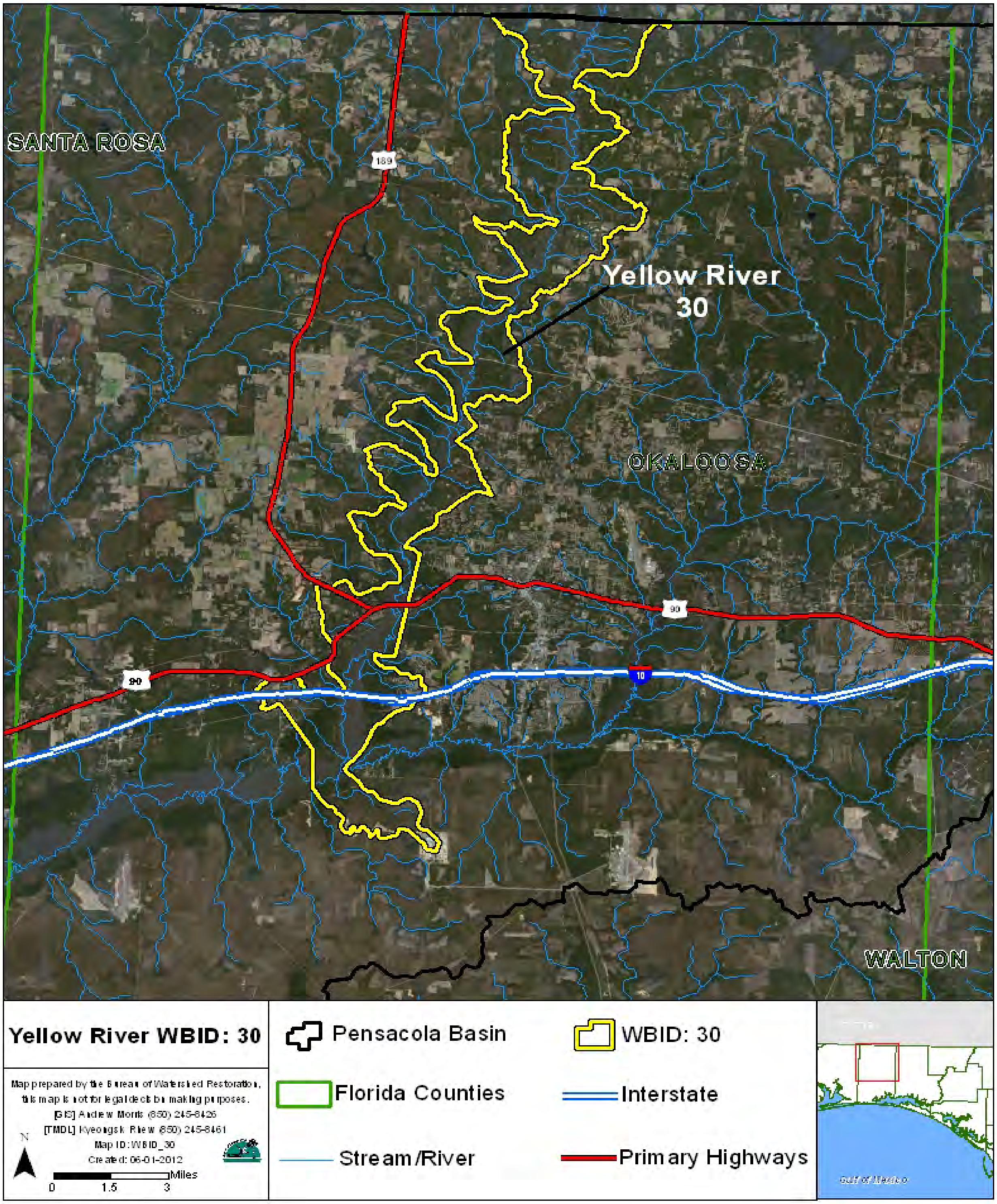


Figure 1.2. Detailed View of the Yellow River (WBID 30) Watershed and Major Geopolitical and Hydrologic Features in the Area

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

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

Florida's 1998 303(d) list included 43 waterbodies in the Pensacola Bay Basin. However the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Yellow River and has verified that this waterbody segment is impaired for fecal coliform bacteria. The Yellow River was initially assessed during the Cycle 1 verified period (January 1, 1998, through June 30, 2005). Because a fecal coliform TMDL was not developed following the Cycle 1 listing, the WBID was reassessed during the Cycle 2 verified period (January 1, 2003, through June 30, 2010). The initial verified impairment was based on the observation that 23 out of 148 fecal coliform samples collected during the Cycle 1 verified period exceeded the assessment threshold of 400 counts per 100 milliliters (counts/100mL) (see **Section 3.2** for details). The verified impairment was reaffirmed during the Cycle 2 verified period when 20 out of 106 fecal coliform samples collected exceeded the assessment threshold.

Table 2.1 summarizes the fecal coliform monitoring results for the Cycle 1 and Cycle 2 verified periods for the Yellow River. To ensure that the fecal coliform TMDL was developed based on current conditions in the river and that recent trends in water quality were adequately captured, monitoring data gathered during the Cycle 2 verified period and more recent data were used in TMDL development. **Table 2.2** summarizes the fecal coliform monitoring results for the Cycle 2 verified period.

Table 2.1. Summary of Fecal Coliform Monitoring Data for the Yellow River During the Cycle 1 Verified Period (January 1, 1998–June 30, 2005) and the Cycle 2 Verified Period (January 1, 2003–June 30, 2010)

This is a three-column table. Column 1 lists the parameter, Column 2 lists the corresponding Cycle 1 results, and Column 3 lists the corresponding Cycle 2 results.

Parameter	Cycle 1 Fecal Coliform	Cycle 2 Fecal Coliform
Total number of samples	148	106
IWR-required number of exceedances for the Verified List	21	16
Number of observed exceedances	23	20
Number of observed nonexceedances	125	86
FINAL ASSESSMENT	**Impaired**	**Impaired**

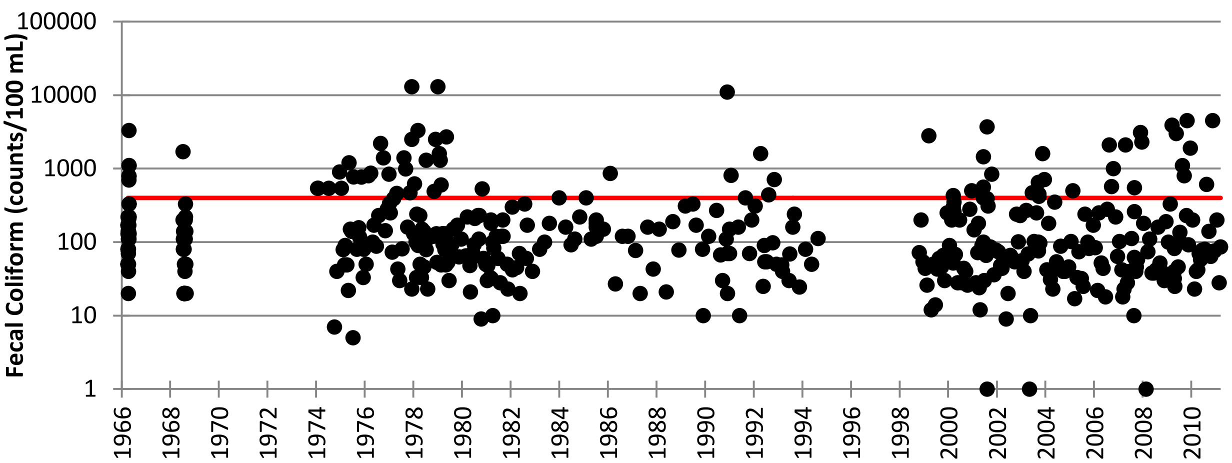
Table 2.2. Summary of Fecal Coliform Monitoring Data for the Yellow River During the Cycle 2 Verified Period (January 1, 2003–June 30, 2010)

This is a two-column table. Column 1 lists the parameter, and Column 2 lists the corresponding Cycle 2 results

Parameter	Fecal Coliform
Total number of samples	106
Number of observed exceedances	20
Number of observed nonexceedances	86
Number of seasons during which samples were collected	4
Highest observation (counts/100mL)	4,500
Lowest observation (counts/100mL)	1
Median observation (counts/100mL)	80
Mean observation (counts/100mL)	371

2.3 Period of Record Trend

Historical fecal coliform data collection began in 1966 and continued until 2011 in the Yellow River. Fecal coliform concentrations ranged from 1 to 13,000 counts/100mL and averaged 379 counts/100mL. Plotting the entire period of record (historical) fecal coliform data by time for the river (Prob> F = 0.8916) revealed no significant increasing or decreasing trend (**Figure 2.1**).



Note: The red line indicates the target concentration (400 counts/100mL).

Figure 2.1. Fecal Coliform Concentration Trends in the Yellow River for the Entire Period of Record (1966–2011)

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion 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)**

The Yellow River is a Class III waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The criterion applicable to this TMDL is the Class III criterion for fecal coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform bacteria concentration. The water quality criterion for the protection of Class III waters, as established by Rule 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. 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 counts/100mL in any sampling event for fecal coliform. The 10% exceedance allowed by the water quality criterion for fecal coliform bacteria was not used directly in estimating the target load, but was included in the TMDL margin of safety (as described in subsequent chapters).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of pollutants in the impaired waterbody and the amount of pollutant loadings contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernible, 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 Fecal Coliform within the Yellow River WBID Boundary

4.2.1 Point Sources

Wastewater Point Sources

There are no NPDES-permitted facilities located or that discharge within the Yellow River WBID boundary.

Municipal Separate Storm Sewer System Permittees

Three Phase II NPDES municipal separate storm sewer system (MS4) permits cover the Yellow River watershed. Okaloosa County is the permittee for Permit FLR04E073. The Florida Department of Transportation (FDOT) District 3 is the permittee for Permit FLR04E023. Eglin Air Force Base is the permittee for Permit FLR04E007, which includes the southern portion of the WBID.

4.2.2 Land Uses and Nonpoint Sources

Accurately quantifying the fecal coliform loadings from nonpoint sources requires identifying nonpoint source categories, locating the sources, determining the intensity and frequency at which these sources create high fecal coliform loadings, and specifying the relative contributions from these sources. Depending on the land use distribution in a given watershed, frequently cited nonpoint sources in urban areas include failed septic tanks, leaking sewer lines, and pet feces. For a watershed dominated by agricultural land uses, fecal coliform loadings can come from the runoff from areas with animal feeding operations or direct animal access to receiving waters.

In addition to the sources associated with anthropogenic activities, birds and other wildlife can also act as fecal coliform contributors to receiving waters. While detailed source information is not always available for accurately quantifying the fecal coliform loadings from different sources, land use information can provide some hints on the potential sources of observed fecal coliform impairment.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the Northwest Florida Water Management District's (NWFWMD) 2009–10 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Yellow River WBID boundary were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low-, medium-, and high-density residential) and tabulated in **Table 4.1**. **Figure 4.1** shows the spatial distribution of the principal land uses within the WBID boundary.

As shown in **Table 4.1**, the total WBID area is about 29,874 acres. The dominant land use category is upland forest, which accounts for about 45% of the total watershed area. Urban lands—including urban and built-up; low-, medium-, and high-density residential; and transportation, communication, and utilities—make up about 6%. Agricultural land use accounts for 3%. Low-impact land uses—including rangeland, upland forest, water, wetland, and barren land—occupy 91% of the watershed.

Urban Development

Given that the important land use categories contributing to nonpoint source pollution are urban land areas—urban and built-up (commercial and services), and medium- density residential—possible sources for fecal coliform loadings can include failed septic tanks, sewer line leakage, and pet feces. A preliminary quantification of the fecal coliform loadings from these sources was conducted to demonstrate the relative contributions. **Appendix B** provides detailed load estimates and describes the methods used for the quantification. It should be noted that the information included in **Appendix B** was only used to demonstrate the possible relative contributions from different sources. These loading estimates were not used in establishing the final TMDL.

Wildlife and Sediments

Wildlife and sediments could also contribute to fecal coliform exceedances in each watershed. Wildlife such as rabbits, birds, and raccoons have direct access to the waterbody and can deposit their feces directly into the water. Wildlife also deposits coliform bacteria with their feces onto land surfaces, where they can be transported during storm events to nearby streams. Studies have shown that fecal coliform bacteria can survive and reproduce in streambed sediments and can be resuspended in surface water when conditions are right (Jamieson *et al.* 2005; Solo-Gabriele *et al.* 2002).

Current source identification methodologies cannot quantify the exact amount of fecal coliform loading from wildlife and/or sediment sources.

Table 4.1. Classification of Land Use Categories within the Yellow River WBID Boundary

This is a four-column table. Column 1 lists the Level 1 land use code, Column 2 lists the land use, Column 3 lists the acreage, and Column 4 lists the percent acreage.

- = Empty cell/no data

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and built-up	253	0.8%
-	Low-density residential	767	2.6%
-	Medium-density residential	419	1.4%
-	High-density residential	-	-
2000	Agriculture	875	2.9%
3000	Rangeland	2,231	7.5%
4000	Upland forest	13,420	44.9%
5000	Water	688	2.3%
6000	Wetland	10,882	36.4%
7000	Barren land	15	0.1%
8000	Transportation, communication, and utilities	324	1.1%
-	**TOTAL**	**29,874**	**100.0%**

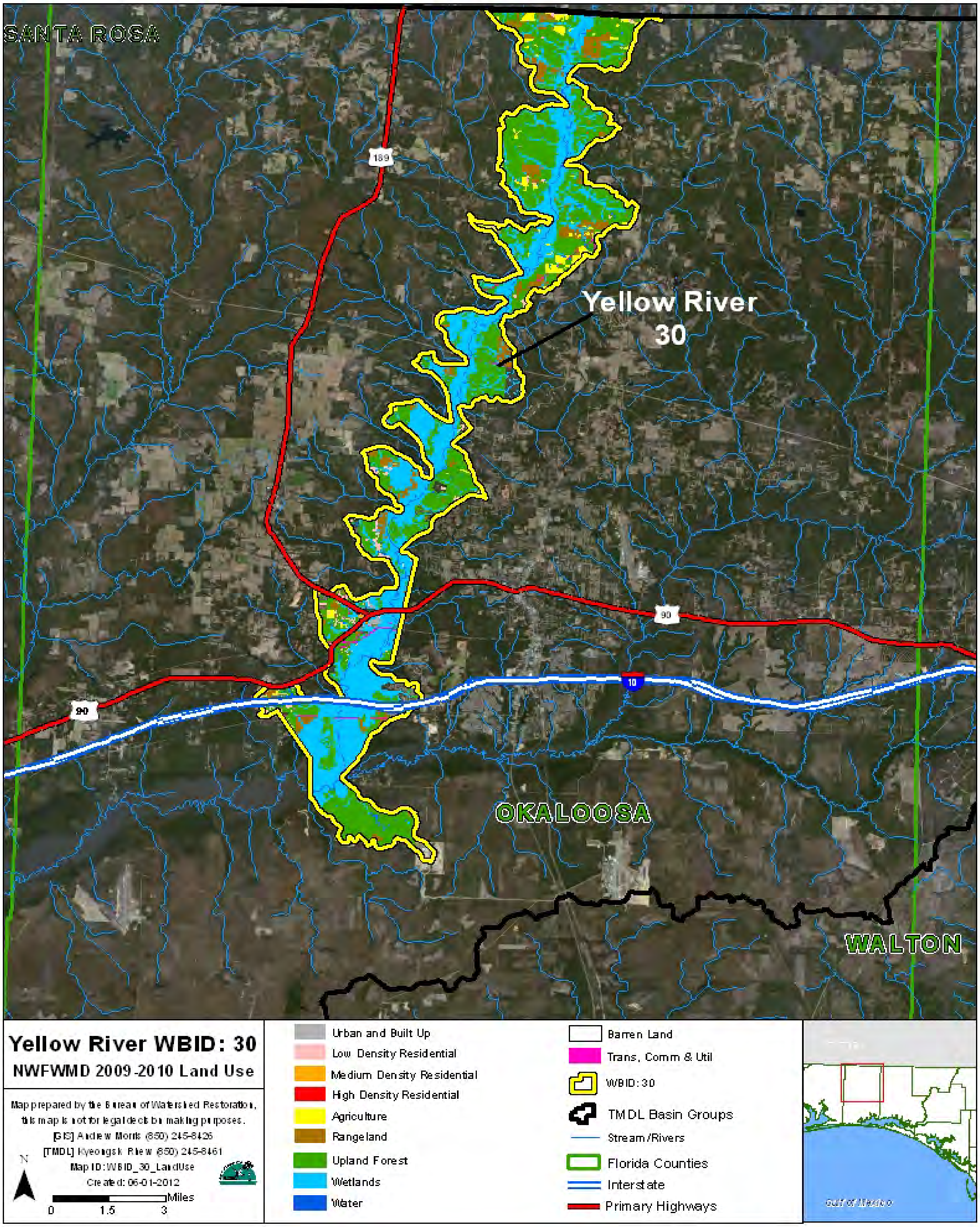


Figure 4.1. Principal Land Uses within the Yellow River WBID Boundary in 2009–10

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The fecal coliform TMDL was developed using the Hazen method, which is a percent reduction approach. Using this method, the percent reduction needed to meet the applicable criterion is calculated based on the 90^{th} percentile of all measured concentrations collected during the Cycle 2 verified period (January 1, 2003, through June 30, 2010) and data gathered since that time. Because bacteriological counts in water are not normally distributed, a nonparametric method is more appropriate for the analysis of fecal coliform data (Hunter 2002). The Hazen method, which uses a nonparametric formula, was used to determine the 90^{th} percentile value. The percent reduction of fecal coliform needed to meet the applicable criterion was calculated as described in **Section 5.1.3**.

5.1.1 Data Used in the Determination of the TMDL

All data used for this TMDL report were provided by the Department. The data were included in Run_44 of the Department's IWR database. **Figure 5.1** shows the locations of the water quality sites where fecal coliform data were collected. This analysis used fecal coliform data collected during the Cycle 2 verified period and a more recent year (January 1, 2003, through June 30, 2011) to represent better the current conditions. During this period, a total of 116 fecal coliform samples were collected from 18 water quality stations in the Yellow River.

Figure 5.2 shows the observed fecal coliform concentrations. These ranged from 1 to 4,500 counts/100mL and averaged 389 counts/100mL during the period of observation. Plotting fecal coliform data by time for the Yellow River during the period of observation revealed no significant increasing or decreasing trend (Prob> F = 0.0549).

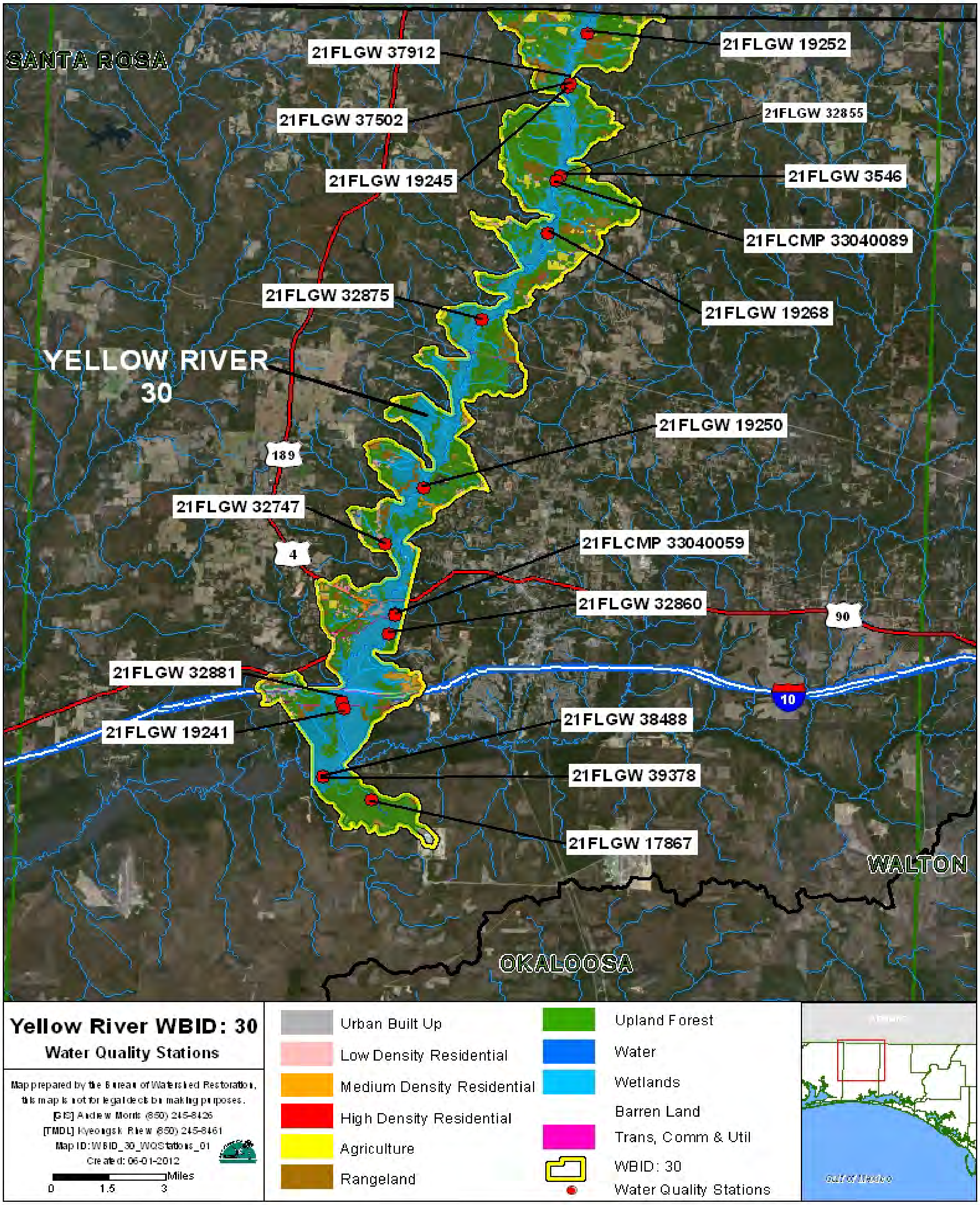
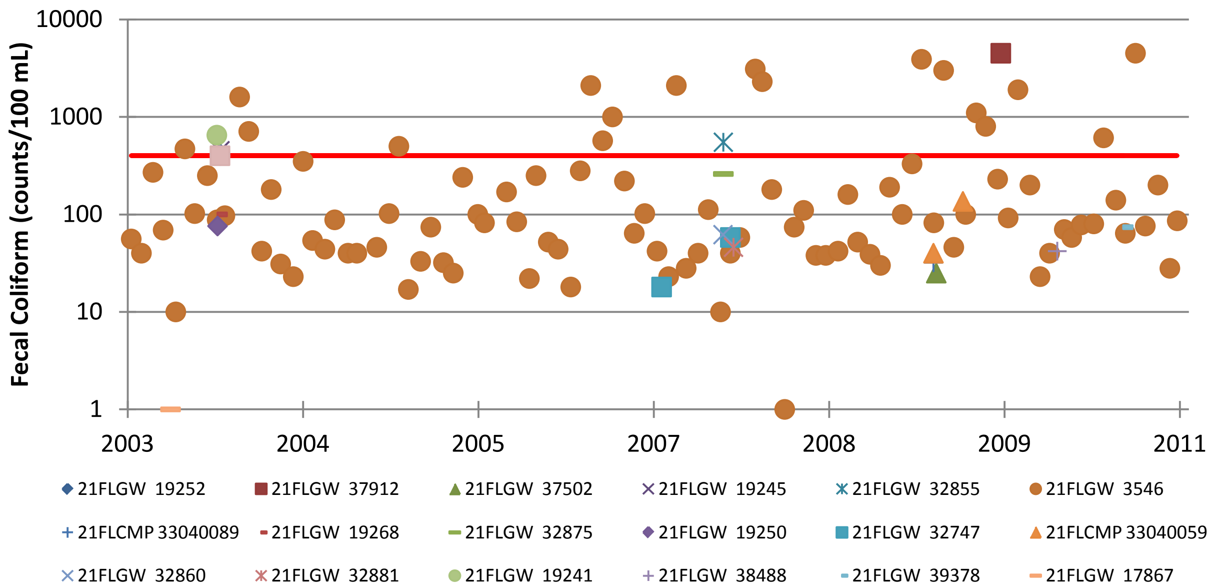


Figure 5.1. Location of Water Quality Stations in the Yellow River



Note: The red line indicates the target concentration (400 counts/100mL).

Figure 5.2. Trends in Fecal Coliform Concentrations in the Yellow River During the Period of Observation (January 1, 2003–June 30, 2011)

Temporal Patterns

Monthly and Seasonal Trends

Seasonally, a peak in fecal coliform concentrations and exceedance rates is commonly observed during the third quarter (summer, July–September), when conditions are rainy and warm, and lower concentrations and exceedance rates are observed in the first quarter (winter, January–March), when conditions are drier and colder. However such a relationship was not found in the Yellow River. The exceedance rates and mean fecal coliform concentrations were highest in the fourth quarter (**Table 5.1b** and **Figure 5.3b**).

Using rainfall data collected at Crestview Bob Sikes Airport (Climate Information for Management and Operational Decisions [CLIMOD] website 2008), it was possible to compare average quarterly total rainfall with long-term (2003–11) average monthly and quarterly fecal coliform exceedance rates at all stations (**Figures 5.3a** and **5.3b**). Rainfall differences among months were relatively small, but the months from July to August were wetter than the other months. Seasonal differences in rainfall were also small, and the third quarter was wettest.

The highest quarterly exceedance rate (33%) was observed in the fourth quarter, and the highest quarterly average fecal coliform concentration (883 counts/100mL) was also observed during the same quarter. The lowest exceedance rate (7%) was observed during the first quarter. Episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2003–11). Except for January and July, fecal coliform exceedances were observed in the Yellow River in the other months. The highest monthly average fecal coliform concentration (1,590 counts/100mL) was observed in November. **Tables 5.1a** and **5.1b** summarize the monthly and seasonal fecal coliform average and percent exceedances, respectively, for data collected from January 2003 to June 2011 for this WBID.

The influence of rainfall on monthly and quarterly exceedances in the Yellow River is inconclusive, as during the period of observation, monthly exceedance rates do not appear to be correlated with monthly rainfall.

Table 5.1a. Summary Statistics of Fecal Coliform Data for All Stations in the Yellow River by Month During the Period of Observation (January 1, 2003–June 30, 2011)

This is an eight-column table. Column 1 lists the month, Column 2 lists the number of samples, Column 3 lists the minimum coliform count/100mL, Column 4 lists the maximum count, Column 5 lists the median count, Column 6 lists the mean count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	9	42	200	102	118	0	0%
February	9	1	500	40	130	1	11%
March	10	17	3,900	57	471	1	10%
April	12	23	2,100	47	223	1	8%
May	9	1	3,000	44	400	1	11%
June	8	18	470	43	97	1	13%
July	9	25	280	100	102	0	0%
August	11	10	2,100	250	494	4	36%
September	15	40	800	100	242	5	33%
October	10	39	4,500	78	618	2	20%
November	6	30	4,500	910	1,590	3	50%
December	8	46	2,300	180	682	3	38%

Table 5.1b. Summary Statistics of Fecal Coliform Data for All Stations in the Yellow River by Season During the Period of Observation (January 1, 2003–June 30, 2011)

This is an eight-column table. Column 1 lists the season, Column 2 lists the number of samples, Column 3 lists the minimum coliform count/100mL, Column 4 lists the maximum count, Column 5 lists the median count, Column 6 lists the mean count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	28	1	3,900	79	248	2	7%
Quarter 2	29	1	3,000	44	243	3	10%
Quarter 3	35	10	2,100	102	285	9	26%
Quarter 4	24	30	4,500	134	883	8	33%

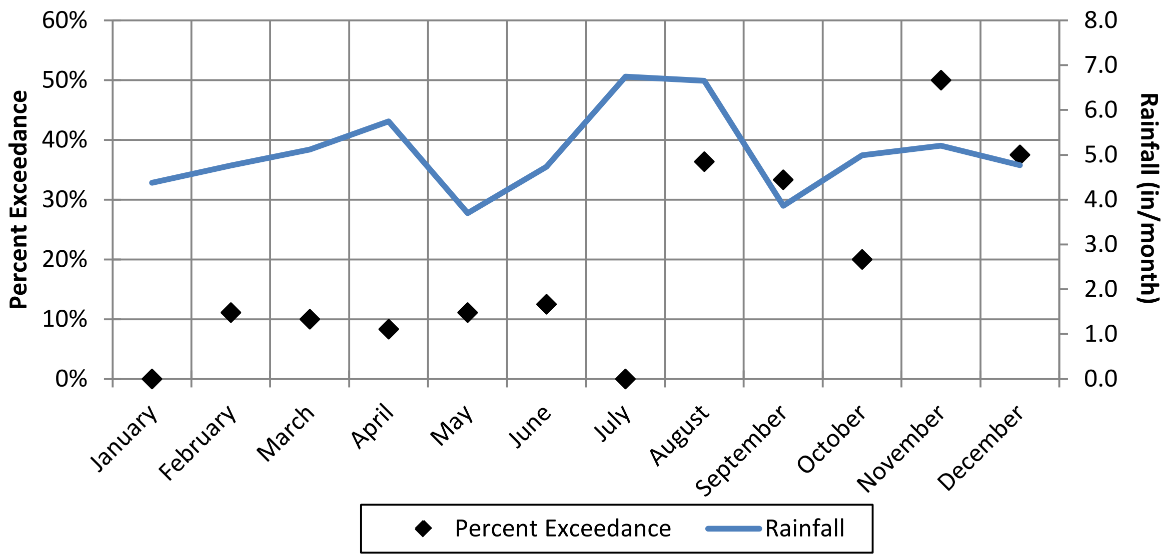


Figure 5.3a. Fecal Coliform Exceedances and Rainfall at All Stations in the Yellow River by Month During the Period of Observation (January 1, 2003–June 30, 2011)

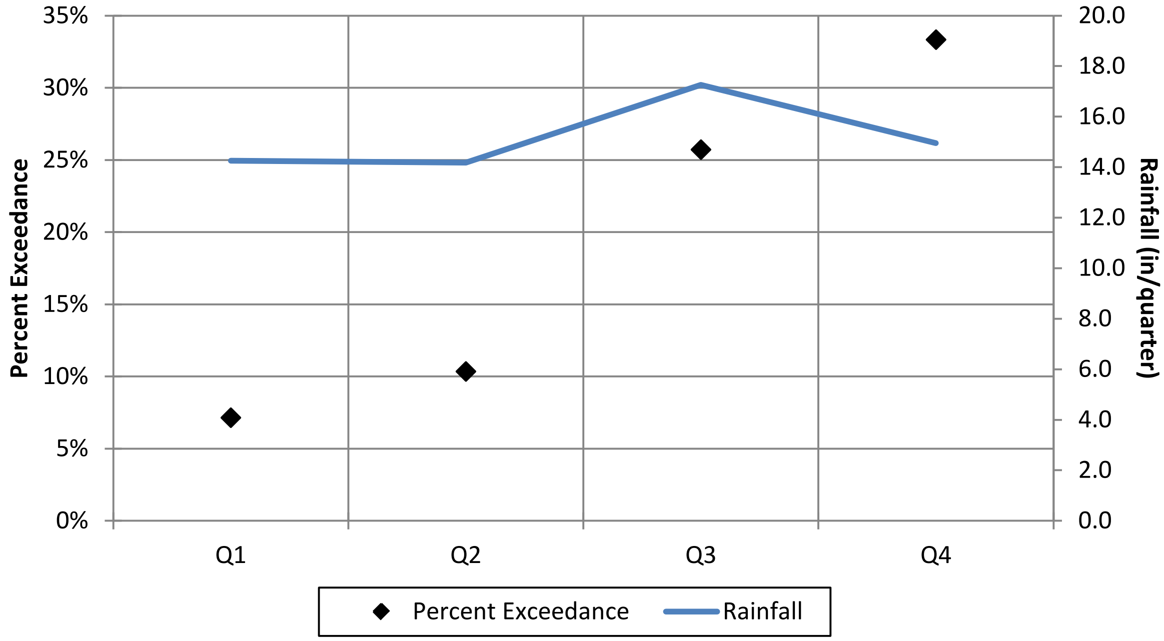


Figure 5.3b. Fecal Coliform Exceedances and Rainfall at All Stations in the Yellow River by Season During the Period of Observation (January 1, 2003–June 30, 2011)

Spatial Patterns

Fecal coliform data for the WBID from the Cycle 2 verified period and a more recent year (January 1, 2003, through June 30, 2011) were analyzed to detect spatial trends in the data (**Table 5.2** and **Figure 5.4**). Stations are displayed from upstream to downstream (from left to right) (**Figure 5.4**).

Fecal coliform concentrations that exceeded the state criterion were observed in 6 of the 18 sampling stations within the Yellow River (**Table 5.2** and **Figure 5.4**). Station 21FLGW 3546, located in the upstream portion of the waterbody, comprised 84% of the samples collected from 2003 to 2011, and 17 of 97 samples were exceedances. Only 19 samples out of 116 were collected from the 17 other water quality stations, i.e., 1 or 2 samples from each station. Thus it is hard to reach any conclusions about spatial patterns in the waterbody.

Table 5.2. Station Summary Statistics of Fecal Coliform Data for the Yellow River During the Period of Observation (January 1, 2003–June 30, 2011)

This is a nine-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the minimum count/100mL, Column 5 lists the maximum count, Column 6 lists the median count, Column 7 lists the mean count, Column 8 lists the number of exceedances, and Column 9 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLGW 19252	2003	1	420	420	420	420	1	100%
21FLGW 37912	2009	1	4,500	4,500	4,500	4,500	1	100%
21FLGW 37502	2009	1	25	25	25	25	0	0%
21FLGW 19245	2003	1	450	450	450	450	1	100%
21FLGW 32855	2007	1	550	550	550	550	1	100%
21FLGW 3546	2003–11	97	1	4,500	82	388	17	18%
21FLCMP 33040089	2009	1	32	32	32	32	0	0%
21FLGW 19268	2003	1	100	100	100	100	0	0%
21FLGW 32875	2007	1	260	260	260	260	0	0%
21FLGW 19250	2003	1	76	76	76	76	0	0%
21FLGW 32747	2007	2	18	58	38	38	0	0%
21FLCMP 33040059	2009	2	40	136	88	88	0	0%
21FLGW 32860	2007	1	62	62	62	62	0	0%
21FLGW 32881	2007	1	46	46	46	46	0	0%
21FLGW 19241	2003	1	650	650	650	650	1	100%
21FLGW 38488	2010	1	42	42	42	42	0	0%
21FLGW 39378	2010	1	74	74	74	74	0	0%
21FLGW 17867	2003	1	1	1	1	1	0	0%

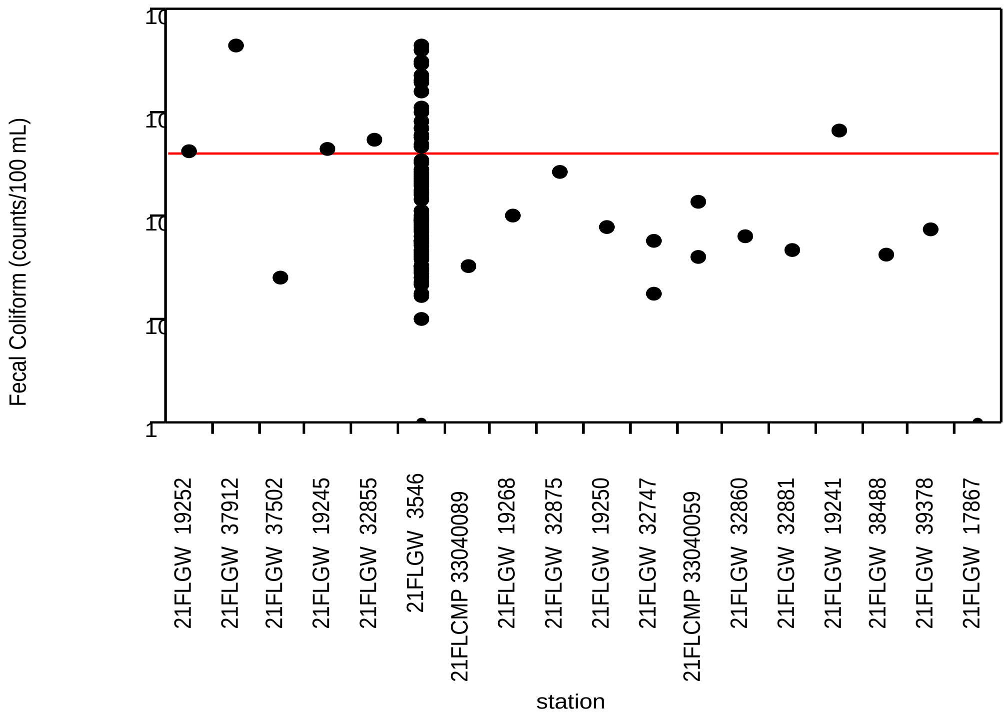


Figure 5.4. Spatial Fecal Coliform Concentration Trends in the Yellow River (WBID 30) by Station During the Period of Observation (January 1, 2003–June 30, 2011)

5.1.2 Critical Condition

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

Hydrologic conditions were analyzed using rainfall in the Yellow River. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from Crestview Bob Sikes Airport. The chart was divided in the same manner as if flow were being analyzed, where extreme precipitation events represent the upper percentiles (0–5th percentile), followed by large precipitation events (5th–10th percentile), medium precipitation events (10th–40th percentile), small precipitation events (40th–60th percentile), and no recordable precipitation events (60th–100th percentile). Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis (**Table 5.3** and **Figure 5.5**).

Data show that fecal coliform exceedances occurred over all hydrologic conditions except for small precipitation events. The highest percentage of exceedances (75%) occurred after extreme precipitation events. The exceedance rates, in general, increased from conditions when rainfall was not measurable to extreme precipitation conditions, indicating that nonpoint sources are probably a major contributing factor. The exceedance rate for a “no measurable precipitation” event is not insignificant, reaching 6%. These exceedances at baseflow can be attributed to ground water contributions from failed septic tanks and/or wildlife. **Table 5.3** and **Figure 5.5** show fecal coliform data by hydrologic condition.

Table 5.3. Summary of Fecal Coliform Data by Hydrologic Condition for the Yellow River During the Period of Observation (January 1, 2003–June 30, 2011)

This is a seven-column table. Column 1 lists the type of precipitation event, Column 2 lists the event range (in inches), Colum 3 lists the total number of samples, Column 4 lists the number of exceedances, Column 5 lists the percent exceedances, Column 6 lists the number of nonexceedances, and Column 7 lists the percent nonexceedances.

Precipitation Event	Event Range (inches)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	> 2.36"	4	3	75%	1	25%
Large	1.55" - 2.36"	6	4	67%	2	33%
Medium	0.20" - 1.55"	34	12	35%	22	65%
Small	0.01" - 0.20"	20	0	0%	20	100%
None/ Not Measurable	< 0.01"	52	3	6%	49	94%

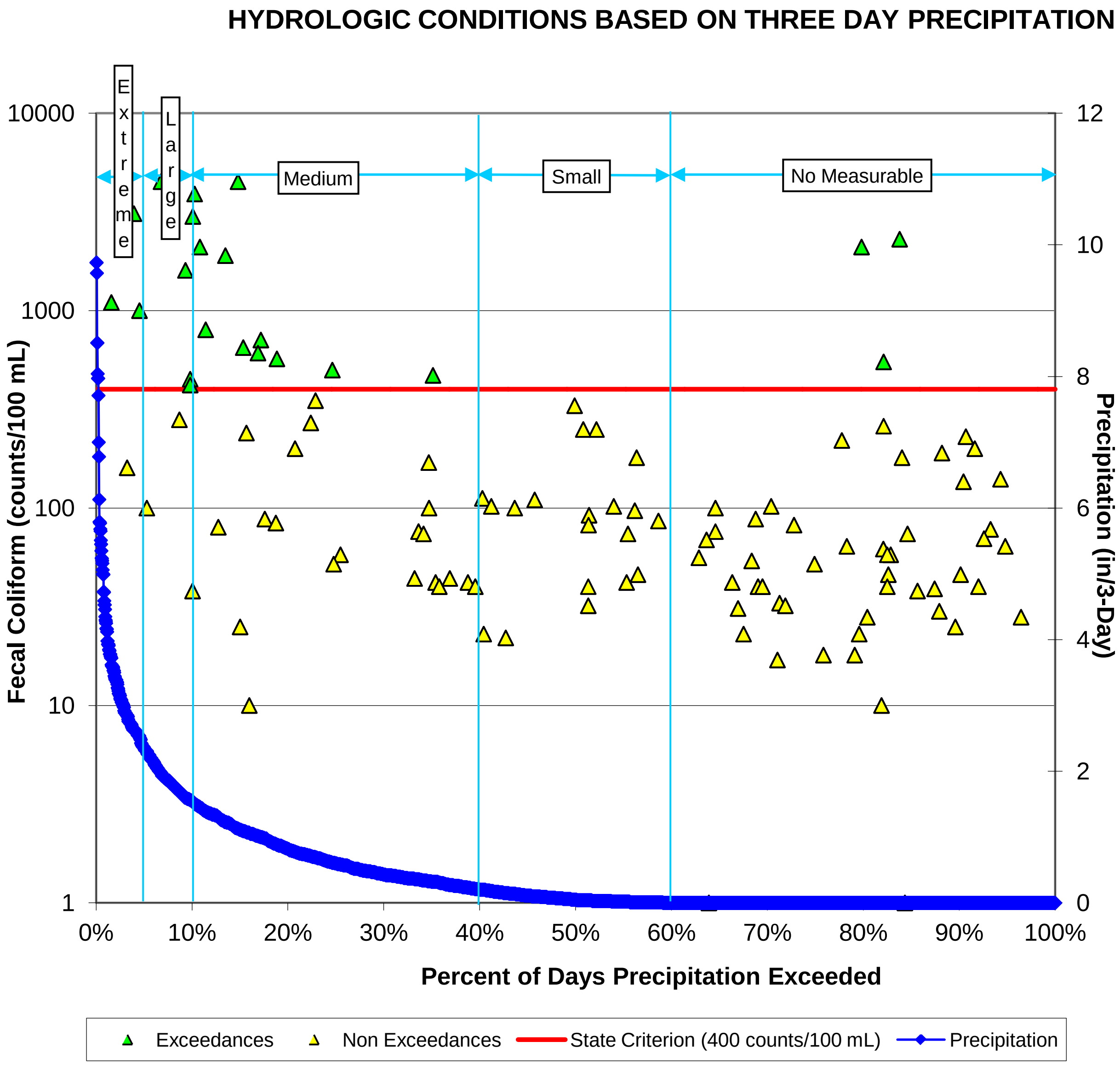


Figure 5.5. Fecal Coliform Data by Hydrologic Condition for the Yellow River During the Period of Observation (January 1, 2003—June 30, 2011)

5.1.3 TMDL Development Process

A simple reduction calculation was performed to determine the reduction in fecal coliform concentration necessary to achieve the concentration target (400 counts/100mL). The percent reduction needed to reduce the pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

$$\textbf{Needed \% reduction} = \frac{\textbf{Existing 90th percentile concentration} - \textbf{Allowable concentration}}{\textbf{Existing 90th percentile concentration}} \times \textbf{100\%} \qquad \textbf{Formula 1}$$

Using the Hazen method for estimating percentiles, as described in Hunter (2002), the existing condition concentration was defined as the 90th percentile of all the fecal coliform data collected during the Cycle 2 verified period (January 1, 2003, to June 30, 2010) and a more recent year (July 1, 2010, to March 31, 2011). This will result in a target condition that is consistent with the state bacteriological water quality assessment threshold for Class III waters.

In applying this method, all of the available data are ranked (ordered) from the lowest to the highest (**Table 5.4**), and **Formula 2** is used to determine the percentile value of each data point:

$$\textbf{Percentile} = \frac{\textbf{Rank - 0.5}}{\textbf{Total Number of Samples Collected}} \qquad \textbf{Formula 2}$$

If none of the ranked values is shown to be the 90th percentile value, then the 90th percentile number (used to represent the existing condition concentration) is calculated by interpolating between the two data points adjacent (above and below) to the desired 90th percentile rank using **Formula 3** as described below;

$$\textbf{90}^{th} \textbf{ Percentile Concentration} = C_{lower} + (P90^{th} * R) \qquad \textbf{Formula 3}$$

Where:

C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90th percentile;

P_{90th} is the percentile difference between the 90th percentile and the percentile number immediately lower than the 90th percentile; and

R is a ratio defined as R = (fecal coliform concentration $_{upper}$ – fecal coliform concentration $_{lower)}$ / (percentile $_{upper}$ – percentile $_{lower}$).

Table 5.4 presents the individual fecal coliform data, the ranks, the percentiles for each individual data, the existing 90th percentile concentration (1,000 counts/100mL), the allowable concentration (400 counts/100mL), and the percent reduction needed to meet the applicable water quality criterion for fecal coliform. The needed reduction was calculated as 60%.

$$\textbf{Needed \% reduction} = \frac{\textbf{1000} - \textbf{400}}{\textbf{1000}} \times \textbf{100\%}$$

Table 5.4. Calculation of Fecal Coliform Reductions for the Yellow River TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sample collection date, Column 3 lists the fecal coliform existing concentration (counts/100mL), Column 4 lists the concentration rank, and Column 5 lists the concentration percentile.

Note: The row with boldface type and yellow highlighting indicates the 90th percentile.
- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 17867	5/6/2003	1	1	0%
21FLGW 3546	2/20/2008	1	2	1%
21FLGW 3546	5/21/2003	10	3	2%
21FLGW 3546	8/21/2007	10	4	3%
21FLGW 3546	3/14/2005	17	5	4%
21FLGW 32747	3/6/2007	18	6	5%
21FLGW 3546	6/20/2006	18	7	6%
21FLGW 3546	2/22/2006	22	8	6%
21FLGW 3546	4/20/2004	23	9	7%
21FLGW 3546	3/26/2007	23	10	8%
21FLGW 3546	2/17/2010	23	11	9%
21FLGW 3546	7/20/2005	25	12	10%
21FLGW 37502	4/27/2009	25	13	11%
21FLGW 3546	5/15/2007	28	14	12%
21FLGW 3546	2/22/2011	28	15	13%
21FLGW 3546	11/19/2008	30	16	13%
21FLGW 3546	3/15/2004	31	17	14%
21FLCMP 33040089	4/19/2009	32	18	15%
21FLGW 3546	6/22/2005	32	19	16%
21FLGW 3546	4/18/2005	33	20	17%
21FLGW 3546	5/19/2008	38	21	18%
21FLGW 3546	6/16/2008	38	22	19%
21FLGW 3546	10/20/2008	39	23	19%
21FLCMP 33040059	4/19/2009	40	24	20%
21FLGW 3546	2/12/2003	40	25	21%
21FLGW 3546	9/23/2004	40	26	22%
21FLGW 3546	10/18/2004	40	27	23%
21FLGW 3546	6/18/2007	40	28	24%
21FLGW 3546	9/18/2007	40	29	25%
21FLGW 3546	3/16/2010	40	30	25%
21FLGW 3546	1/21/2004	42	31	26%
21FLGW 3546	2/21/2007	42	32	27%
21FLGW 3546	7/21/2008	42	33	28%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 38488	4/7/2010	42	34	29%
21FLGW 3546	7/19/2004	44	35	30%
21FLGW 3546	5/15/2006	44	36	31%
21FLGW 32881	9/27/2007	46	37	31%
21FLGW 3546	12/14/2004	46	38	32%
21FLGW 3546	6/16/2009	46	39	33%
21FLGW 3546	4/17/2006	52	40	34%
21FLGW 3546	9/15/2008	52	41	35%
21FLGW 3546	6/14/2004	54	42	36%
21FLGW 3546	1/14/2003	56	43	37%
21FLGW 32747	9/18/2007	58	44	38%
21FLGW 3546	10/15/2007	58	45	38%
21FLGW 3546	5/18/2010	58	46	39%
21FLGW 32860	8/28/2007	62	47	40%
21FLGW 3546	12/18/2006	64	48	41%
21FLGW 3546	10/18/2010	64	49	42%
21FLGW 3546	4/15/2003	69	50	43%
21FLGW 3546	4/27/2010	70	51	44%
21FLGW 3546	5/17/2005	74	52	44%
21FLGW 3546	3/18/2008	74	53	45%
21FLGW 39378	10/12/2010	74	54	46%
21FLGW 19250	9/17/2003	76	55	47%
21FLGW 3546	12/14/2010	76	56	48%
21FLGW 3546	6/14/2010	78	57	49%
21FLGW 3546	7/20/2010	80	58	50%
21FLGW 3546	10/17/2005	82	59	50%
21FLGW 3546	4/20/2009	82	60	51%
21FLGW 3546	1/17/2006	84	61	52%
21FLGW 3546	3/15/2011	86	62	53%
21FLGW 3546	9/16/2003	88	63	54%
21FLGW 3546	8/16/2004	88	64	55%
21FLGW 3546	11/18/2009	92	65	56%
21FLGW 3546	10/8/2003	97	66	56%
21FLGW 19268	9/17/2003	100	67	57%
21FLGW 3546	9/28/2005	100	68	58%
21FLGW 3546	1/20/2009	100	69	59%
21FLGW 3546	7/20/2009	100	70	60%
21FLGW 3546	7/14/2003	102	71	61%
21FLGW 3546	1/18/2005	102	72	62%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 3546	1/17/2007	102	73	63%
21FLGW 3546	4/14/2008	110	74	63%
21FLGW 3546	7/17/2007	112	75	64%
21FLCMP 33040059	7/12/2009	136	76	65%
21FLGW 3546	9/21/2010	140	77	66%
21FLGW 3546	8/18/2008	160	78	67%
21FLGW 3546	12/19/2005	170	79	68%
21FLGW 3546	2/17/2004	180	80	69%
21FLGW 3546	1/14/2008	180	81	69%
21FLGW 3546	12/15/2008	190	82	70%
21FLGW 3546	1/19/2010	200	83	71%
21FLGW 3546	1/19/2011	200	84	72%
21FLGW 3546	11/20/2006	220	85	73%
21FLGW 3546	10/19/2009	230	86	74%
21FLGW 3546	8/16/2005	240	87	75%
21FLGW 3546	8/19/2003	250	88	75%
21FLGW 3546	3/13/2006	250	89	76%
21FLGW 32875	8/29/2007	260	90	77%
21FLGW 3546	3/17/2003	270	91	78%
21FLGW 3546	7/17/2006	280	92	79%
21FLGW 3546	2/17/2009	330	93	80%
21FLGW 3546	5/18/2004	350	94	81%
21FLGW 19252	9/24/2003	420	95	81%
21FLGW 19245	9/24/2003	450	96	82%
21FLGW 3546	6/16/2003	470	97	83%
21FLGW 3546	2/15/2005	500	98	84%
21FLGW 32855	8/29/2007	550	99	85%
21FLGW 3546	9/19/2006	570	100	86%
21FLGW 3546	8/17/2010	610	101	87%
21FLGW 19241	9/15/2003	650	102	88%
21FLGW 3546	12/15/2003	710	103	88%
21FLGW 3546	9/15/2009	800	104	89%
21FLGW 3546	**10/17/2006**	**1,000**	**105**	**90%**
21FLGW 3546	8/19/2009	1,100	106	91%
21FLGW 3546	11/19/2003	1,600	107	92%
21FLGW 3546	12/16/2009	1,900	108	93%
21FLGW 3546	8/16/2006	2,100	109	94%
21FLGW 3546	4/17/2007	2,100	110	94%
21FLGW 3546	12/18/2007	2,300	111	95%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 3546	5/18/2009	3,000	112	96%
21FLGW 3546	11/28/2007	3,100	113	97%
21FLGW 3546	3/16/2009	3,900	114	98%
21FLGW 3546	11/16/2010	4,500	115	99%
21FLGW 37912	10/28/2009	4,500	116	100%
-	**-**	**-**	**Existing condition concentration-90th percentile (counts/100mL)**	**1,000**
-	**-**	**-**	**Allowable concentration (counts/100mL)**	**400**
-	**-**	**-**	**Final % reduction**	**60%**

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:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) 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 (2) 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 the Yellow River is expressed in terms of counts/100mL and percent reduction, and represents the maximum daily fecal coliform load the stream can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform in the Yellow River

This is a six-column table. Column 1 lists the parameter, Column 2 lists the TMDL (counts/100mL), Column 3 lists the WLA for wastewater (counts/100mL), Column 4 lists the WLA for NPDES stormwater (percent reduction), Column 5 lists the LA (percent reduction), and Column 6 lists the MOS.

N/A – Not applicable

Parameter	TMDL (counts/100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
Fecal coliform	400	N/A	60%	60%	Implicit

6.2 Load Allocation

A fecal coliform reduction of 60% is needed from nonpoint sources in the Yellow River watershed. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

There are currently no NPDES-permitted wastewater facilities within the Yellow River WBID boundary. The state already requires all NPDES point source dischargers to meet bacteria criteria at the end of the pipe. It is the Department's current practice not to allow mixing zones for bacteria. Any point sources that may discharge in the WBID in the future will also be required to meet end-of-pipe standards for coliform bacteria.

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with an MS4 permit is a 60% reduction in current fecal coliform loadings for the Yellow River. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

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 subtracting contributions from natural sources and sediments when the percent reduction was calculated. This makes the estimation of human contribution more stringent and therefore adds to the MOS.

Chapter 7: TMDL IMPLEMENTATION

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines that a BMAP is needed to support the implementation of this TMDL, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- *Water quality goals (based directly on the TMDL);*
- *Refined source identification;*
- *Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDL;*
- *Timetables for implementation;*
- *Implementation funding mechanisms;*
- *An evaluation of future increases in pollutant loading due to population growth;*
- *Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and*
- *Stakeholder statements of commitment (typically a local government resolution).*

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information in managing water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

7.2 Other TMDL Implementation Tools

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its designated uses. This is because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old-fashioned detective work that is best done by those in the area.

A multitude of assessment tools is available to assist local governments and interested stakeholders in this detective work. The tools range from the simple (such as Walk the WBIDs and GIS mapping) to the complex (such as bacteria source tracking). Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize fecal coliform sources of pollution. Based on work in the Lower St Johns River Tributaries and Hillsborough Basins, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work.

In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

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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 Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit (ERP) regulations.

Rule 62-40, F.A.C., also requires the state's 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. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began 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 the 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 implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and FDOT throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's Stormwater/ERP Programs is that the NPDES Program covers both new and existing discharges, while the state's program focus on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, 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: Estimates of Fecal Coliform Loadings from Potential Sources

The Department has provided these estimations for informational purposes only and did not use them to calculate the TMDL. They are intended to give the public a general idea of the relative importance of each source in the waterbody. The estimates were based on the best information available to the Department when the calculation was made. The numbers provided do not represent actual loadings from the sources.

Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff within the Yellow River WBID boundary. Studies report that up to 95% of the fecal coliform found in urban stormwater can have nonhuman origins (Alderiso *et al.* 1996; Trial *et al.* 1993).

The most important nonhuman fecal coliform contributors appear to be dogs and cats. In a highly urbanized Baltimore catchment, Lim and Olivieri (1982) found that dog feces were the single greatest source of fecal coliform and fecal strep bacteria. Trial *et al.* (1993) also reported that cats and dogs were the primary source of fecal coliform in urban subwatersheds. Using bacteria source tracking techniques, it was found in Stevenson Creek in Clearwater, Florida, that the amount of fecal coliform bacteria contributed by dogs was as important as that from septic tanks (Watson 2002).

According to the American Pet Products Manufacturers Association (APPMA), about 4 out of 10 U.S. households include at least 1 dog. A single gram of dog feces contains about 2.2 million fecal coliform bacteria (Weiskel *et al.* 1996). Unfortunately, statistics show that about 40% of American dog owners do not pick up their dogs' feces. The number of dogs within the Yellow River WBID boundary is not known. Therefore, the statistics produced by APPMA were used in this analysis to estimate the possible fecal coliform loads contributed by dogs.

Using information from the Florida Department of Revenue's (DOR) 2009 Cadastral tax parcel and ownership coverage contained in the Department's GIS library, residential parcels were identified using DOR's residential land use codes. The final number of households within the WBID boundary was calculated by adding the number of residential units on the parcels for all improved residential land use codes. There are about 877 households within the WBID boundary (**Table B.1**). **Table B.2** shows the waste production rate for a dog (450 grams/animal/day) and the fecal coliform counts per gram of dog waste (2,200,000 counts/gram).

Table B.1 also shows the estimated number of dogs within the WBID boundary, assuming that 40% of the households in these areas have 1 dog; the total waste produced (grams/day) by dogs and left on the land surface in residential areas in the WBID, assuming that 40% of dog owners do not pick up their dogs' feces; and the total load of fecal coliform produced by dogs (counts/day) within the WBID.

It should be noted that this load only represents the fecal coliform load created in the WBID and is not intended to be used to represent a part of the existing load that reaches the receiving waterbody. The fecal coliform load that eventually reaches the receiving waterbody could be significantly less than this value due to attenuation in overland transport.

Table B.1. Estimated Number of Households and Dogs, Waste Produced (grams/day) by Dogs Left on the Land Surface, and Total Load of Fecal Coliform (counts/day) Produced by Dogs within the Yellow River WBID Boundary

This is a four-column table. Column 1 lists the number of households, Column 2 lists the number of dogs, Column 3 lists the waste produced left on land, and Column 4 lists the fecal coliform loading.

Number of Households	Number of Dogs	Waste Produced Left on Land Surface (grams/day)	Loading (counts/day)
877	351	63,144	1.39×10^{11}

Table B.2. Dog Population Density, Wasteload, and Fecal Coliform Density Based on the Literature (Weiskel *et al.* 1996)

This is a four-column table. Column 1 lists the animal type (dog), Column 2 lists the population density, Column 3 lists the wasteload, and Column 4 lists the fecal coliform density.

* Number from APPMA

Type	Population Density (animals/household)	Wasteload (grams/animal-day)	Fecal Coliform Density (counts/gram)
Dog	0.4*	450	2,200,000

Septic Tanks

Septic tanks are another potentially important source of coliform pollution in urban watersheds. When properly installed, most of the coliform from septic tanks should be removed within 50 meters of the drainage field (Minnesota Pollution Control Agency 1999). However, the physical properties of an aquifer, such as thickness, sediment type (sand, silt, and clay), and location play a large part in determining whether contaminants from the land surface will reach the ground water (U.S. Geological Survey [USGS] 2010). The risk of contamination is greater for unconfined (water table) aquifers than for confined aquifers because they usually are nearer to land surface and lack an overlying confining layer to impede the movement of contaminants (USGS 2010).

Sediment type (sand, silt, and clay) also determines the risk of contamination in a particular watershed. According to the USGS (2010), "Porosity, which is the proportion of a volume of rock or soil that consists of open spaces, tells us how much water rock or soil can retain. Permeability is a measure of how easily water can travel through porous soil or bedrock. Soil and loose sediments, such as sand and gravel, are porous and permeable. They can hold a lot of water, and it flows easily through them. Although clay and shale are porous and can hold a lot of water, the pores in these fine-grained materials are so small that water flows very slowly through them. Clay has a low permeability."

Also, the risk of contamination is increased for areas with a relatively high ground water table. The drain field can be flooded during the rainy season, resulting in ponding, and coliform bacteria can pollute the surface water through stormwater runoff. Additionally, in these circumstances, a high water table can result in coliform bacteria pollution reaching the receiving waters through baseflow.

Septic tanks may also cause coliform pollution when they are built too close to irrigation wells. Any well that is installed in the surficial aquifer system will cause a drawdown. If the septic tank system is built too close to the well (e.g., less than 75 feet), the septic tank discharge will be within the cone of influence of the well. As a result, septic tank effluent may enter the well, and once the polluted water is used to irrigate lawns, coliform bacteria may reach the land surface and wash into surface waters through stormwater runoff.

A rough estimate of fecal coliform loads from failed septic tanks within the Yellow River WBID boundary can be made using **Equation B.1**:

$$L = 37.85 * N * Q * C * F \qquad \textbf{Equation B.1}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the number of households using septic tanks in the WBID;
Q is the discharge rate for each septic tank (gallons/day);
C is the fecal coliform concentration for the septic tank discharge (counts/100mL);
F is the septic tank failure rate; and
37.85 is a conversion factor (100mL/gallon).

Based on the Florida Department of Health's (FDOH) 2012 onsite sewage GIS coverage contained in the Department's GIS library, about 399 households were identified as being on active septic tanks in the Yellow River watershed (**Figure B.1** and **Table B.3**). The discharge rate from each septic tank (*Q*) was calculated by multiplying the average household size by the per capita wastewater production rate per day. Based on the information published by the Census Bureau, the average household size for Okaloosa County is about 2.44 people/household (U.S. Census Bureau website 2006–10). The same population densities were assumed within the WBID boundary. A commonly cited value for per capita wastewater production rate is 70 gallons/day/person (EPA 2001). The commonly cited concentration (*C*) for septic tank discharge is 1×10^6 counts/100mL for fecal coliform (EPA 2001).

No measured septic tank failure rate data were available for the WBID when this TMDL was developed. Therefore, the failure rate was derived from the number of septic tanks in Okaloosa County based on FDOH's septic tank inventory and the number of septic tank repair permits issued in Okaloosa County, as published by FDOH (FDOH website 2010). The cumulative number of septic tanks in Okaloosa County on an annual basis was calculated by subtracting the number of issued septic tank installation permits for each year from the current number of septic tanks in the county based on FDOH's 2009–10 inventory, assuming that none of the installed septic tanks will be removed after being installed (**Table B.4**). The reported number of septic tank repair permits was also obtained from the FDOH website.

Based on **Table B.4**, the average annual septic tank failure discovery rate is about 0.86% for Okaloosa County. Assuming that failed septic tanks are not discovered for about 5 years, the estimated annual septic tank failure rate is about 5 times the discovery rate, or 4.30%. Based on **Equation B.1**, the estimated fecal coliform loading from failed septic tanks within the Yellow River WBID boundary is about 1.1×10^{11} counts/day (**Table B.3**).

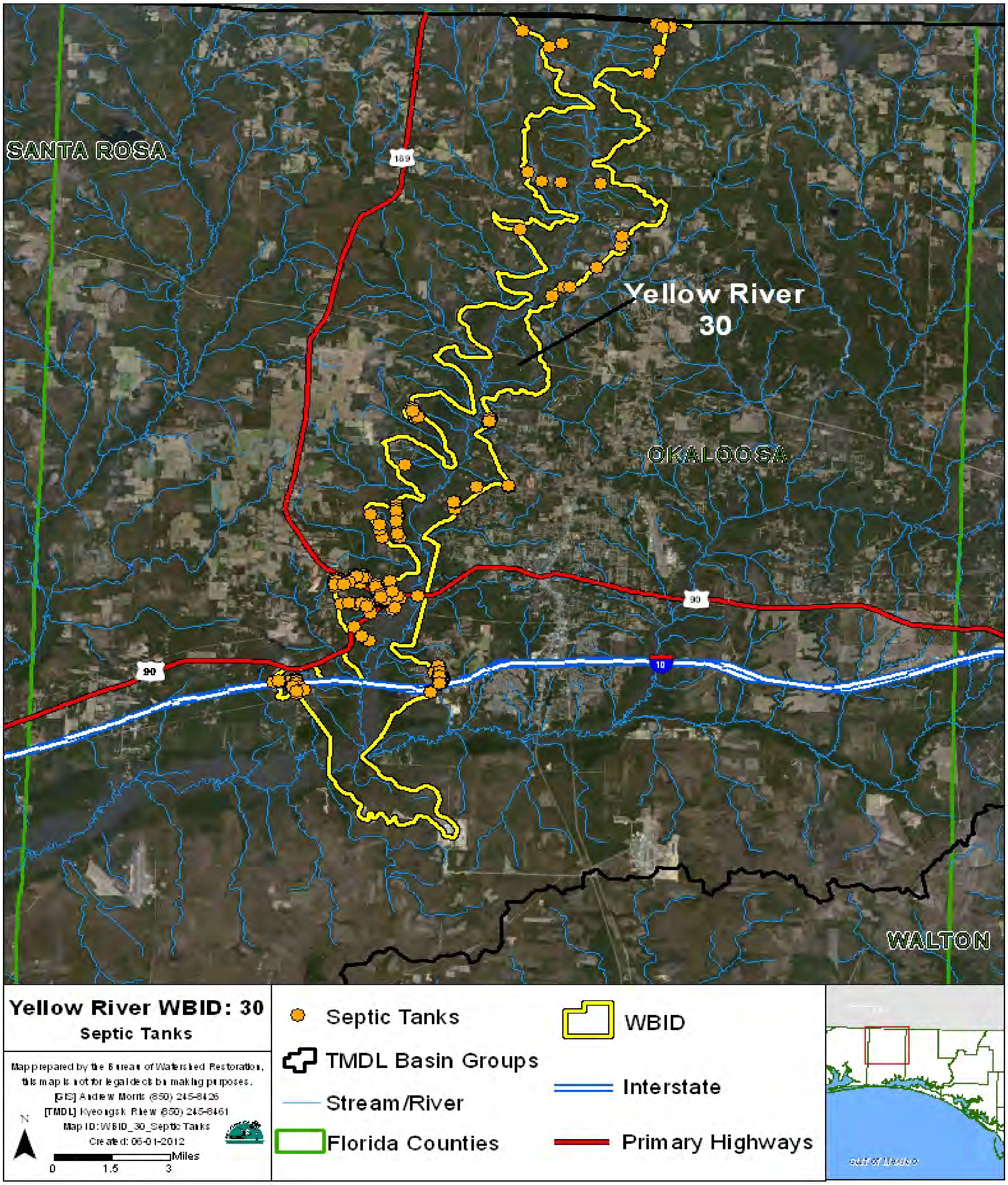

Figure B.1. Distribution of Onsite Sewage Disposal Systems (Septic Tanks) in the Residential Land Use Areas within the Yellow River WBID Boundary

Table B.3. Estimated Number of Households Using Septic Tanks and Estimated Septic Tank Loading within the Yellow River WBID Boundary

This is a two-column table. Column 1 lists the number of households with a septic tank, and Column 2 lists the septic tank loading.

Number of Households Using Septic Tanks	Septic Tanks (counts/day)
399	1.1×10^{11}

Table B.4. Estimated Number of Septic Tanks and Septic Tank Failure Rates for Okaloosa County, 2003–10

This is a 10-column table. Column 1 lists the parameter, Columns 2 through 9 list the estimate for each year from 2003 to 2010, respectively, and Column 10 lists the average.

[1] The failure rate is 5 times the failure discovery rate.

Year	2003	2004	2005	2006	2007	2008	2009	2010	Average
Number of new septic tank installations	726	704	895	715	321	243	199	352	519
Cumulative total number of septic tanks	29,008	29,712	30,607	31,322	31,643	31,886	32,085	32,437	31,088
Number of septic tank repair permits issued	279	282	261	274	298	264	292	183	267
Failure discovery rate (%)	0.96%	0.95%	0.85%	0.87%	0.94%	0.83%	0.91%	0.56%	0.86%
Failure rate (%)[1]	4.81%	4.75%	4.26%	4.37%	4.71%	4.14%	4.55%	2.82%	4.30%

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) can also be a potential source of fecal bacteria pollution. Human sewage can be introduced into surface waters even when storm and sanitary sewers are separated. Leaks and overflows are common in many older sanitary sewers where capacity is exceeded, high rates of infiltration and inflow occur (i.e., outside water gets into pipes, reducing capacity), frequent blockages occur, or sewers are simply falling apart due to poor joints or pipe materials. Power failures at pumping stations are also a common cause of SSOs. The greatest risk of an SSO occurs during storm events; however, few comprehensive data are available to quantify SSO frequency and bacteria loads in most watersheds. Therefore, in this report, the possible fecal coliform load contributed by sewer line leakage was estimated based on an empirical leakage rate of 0.5% of the total raw sewage (Culver *et al.* 2002) created within the WBID by the households connected to the sewer system.

Fecal coliform loading from sewer line leakage can be calculated based on the number of people in the watershed, typical per household generation rates, and typical fecal coliform concentrations in domestic sewage, assuming a leakage rate of 0.5% (Culver *et al.* 2002). Based on this assumption, a rough estimate of fecal coliform loads from leaks and SSOs within the Yellow River WBID boundary can be made using **Equation B.2:**

$$L = 37.85 * N * Q * C * F \qquad \textbf{Equation B.2}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the number of households using sanitary sewer in the WBID;
Q is the discharge rate for each household (gallons/day);
C is the fecal coliform concentration for domestic wastewater (counts/100mL);
F is the sewer line leakage rate; and
37.85 is a conversion factor (100mL/gallon).

The number of households *(N)* tied to sewer lines is 478 (total households minus households using septic tanks) in the Yellow River watershed. The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size for Okaloosa County (2.44) (U.S. Census Bureau website 2006–10) by the per capita wastewater production rate per day (70 gallons/day/person). The commonly cited concentration (*C*) for domestic wastewater is 1x106 counts/100mL for fecal coliform (EPA 2001). The contribution of fecal coliform through sewer line leakage was assumed to be 0.5% of the total sewage loading created from the population not on septic tanks (Culver *et al.* 2002). Based on **Equation B.2**, the estimated fecal coliform loading from sewer line leakage in the WBID is about 1.55×10^{10} counts/day (**Table B.5**).

Wildlife

Wildlife such as deer, raccoons, muskrats, beavers, and birds are another possible source of fecal coliform bacteria within the Yellow River WBID boundary. However, as these represent natural inputs, no reductions are assigned to these sources by this TMDL.

Table B.5. Estimated Number of Households Served by Sanitary Sewers and Estimated Fecal Coliform Loading from Sewer Line Leakage within the Yellow River WBID Boundary

This is a two-column table. Column 1 lists the number of households served by sanitary sewers, and Column 2 lists the sanitary sewer loading.

Number of Households Served by Sanitary Sewers	Sanitary Sewer (counts/day)
478	1.55×10^{10}

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