Final

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

NORTHEAST DISTRICT • SUWANNEE RIVER BASIN

Nutrient and Dissolved Oxygen TMDL for the Suwannee River, Santa Fe River, Manatee Springs (3422R), Fanning Springs (3422S), Branford Spring (3422J), Ruth Spring (3422L), Troy Spring (3422T), Royal Spring (3422U), and Falmouth Spring (3422Z)

John F. Hallas
Wayne Magley, PhD

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For additional information on the watershed management approach and impaired waters in the Suwannee River Basin, contact

Terry Hansen
Florida Department of Environmental Protection
Bureau of Watershed Management
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
Email: Terry.Hansen@dep.state.fl.us
Phone: (850) 245-8561; SunCom: 5561
Fax: (850) 245-8434

Access to all data used in the development of this report can be obtained by contacting
Wayne Magley
Florida Department of Environmental Protection
Bureau of Watershed Management
Watershed Assessment Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
Email: Wayne.Magley@dep.state.fl.us
Phone: (850) 245-8463, SunCom: 5463
Fax: (850) 245-8356

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This document presents Total Maximum Daily Loads (TMDLs) for Nitrate (NO_3) for the Middle Suwannee River, Lower Suwannee River and the Santa Fe River, in the Suwannee River Basin (SRB). The river was verified as impaired by nutrients based on elevated chlorophyll *a* and photographic evidence in the freshwater and marine portions of the river. It was included on Florida's Verified List of impaired waters for the SRB that was adopted by Secretarial Order on June 3, 2008. The purpose of this TMDL is to establish the allowable amount of pollutants to Suwannee River and the Santa Fe River that would restore these waterbodies such that they meet their applicable water quality criteria for nutrients. This report will be used as the basis for discussions during the development of the Basin Management Action Plan (BMAP). While the BMAP is under development, the Department recognizes the activities of the Suwannee River Partnership, which include the implementation of best management practices, significant public outreach, and advancing needed research with respect to nutrient controls, as the necessary implementation steps for this TMDL until such time as the BMAP discussions generate other actions that would provide further water quality improvements

1.2 Identification of the Waterbody

1.2.1 Suwannee River Basin

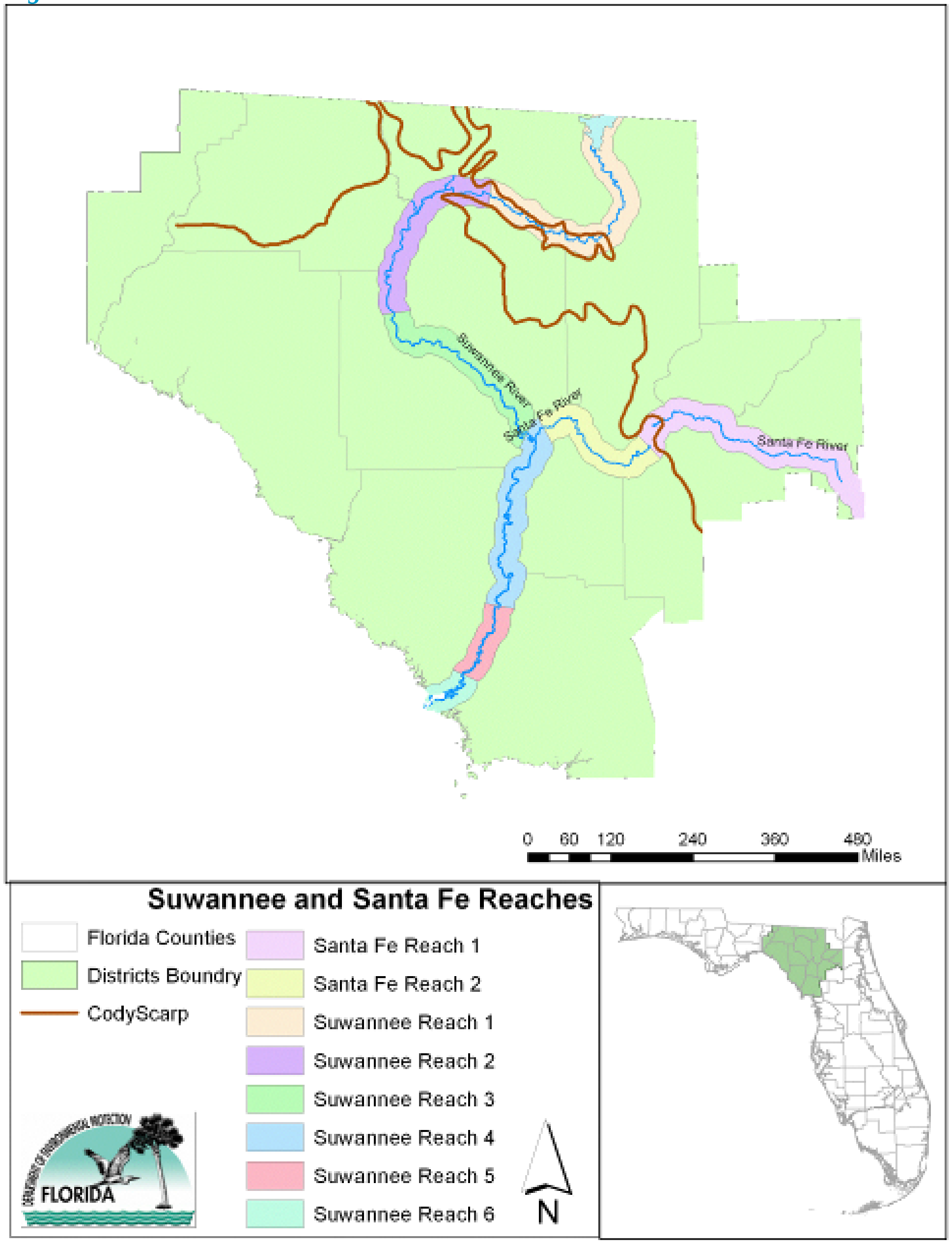
The Suwannee Basin drains approximately 10,000 square miles of south Georgia and north Florida, discharging an annual average flow of approximately 10,000 cubic feet per second (cfs)(Figures 1.1-1.4) (FDEP 2001). The Suwannee River is the second largest river in the state in terms of flow. Within the Suwannee Basin, the Alapaha, Withlacoochee, and Upper Suwannee watersheds lie almost entirely in Georgia. These are dominated by surface water runoff, as are the Florida portions of the basin in the Northern Highlands region. After crossing the Cody Scarp, ground water discharges from springs and diffuse seepage strongly influences the Suwannee River and makes up the baseflow of the river. Most of the streams in the Upper Suwannee and Santa Fe watersheds are highly colored (blackwater). Blackwater streams typically have low dissolved oxygen (DO) concentrations and acidic, highly colored water and these streams are less biologically productive than some of the downstream stretches of the river. In the lower third of the basin, surface waterbodies are relatively absent because recharge flows directly to the aquifer through karst features. Along the coast, there are extensive tidal salt marshes, with hardwood swamps lying at slightly higher elevations just inland. Although the coastline has no barrier islands, much of this stretch is estuarine in nature, due to the low-energy wave action, shallow water, and fresh water inflows. Seagrass beds are healthy and abundant, except at the mouths of the river where seagrasses are sparse or absent due to the dark color of the river discharges that limit light in the area (FDEP 2001).

The SRB contains two major physiographic regions, the Northern Highlands and the Gulf Coastal Lowlands. Separating the two is the Cody Scarp, a steep face that constitutes the most prominent topographic feature in the state. Much of the lowlands make up a karst plain where sinkholes form and natural limestone springs occur. Although the highlands contain some springs, most of the basin's more than 250 springs are in the lowlands. Springs are especially abundant along the Suwannee River where the river has cut into the upper portion of the limestone bedrock. Characteristics of the marshes and swamps are typically found along the Gulf Coast.

The Suwannee River, as is cuts through North Florida, goes through changes, as does its water chemistry. These changes are reflected by its' six ecological region or reaches (Figure 1.1).

Reach 1. Upper River Blackwater
Reach 2. Cody Scarp Transitional
Reach 3. Middle River Calcareous
Reach 4. Lower River Calcareous
Reach 5. Tidal Riverine
Reach 6. Estuarine

Figure 1.1 Suwannee Santa Fe Reaches



The upper Suwannee River (Reaches 1 and 2) is an acidic, blackwater stream, with waters of low mineral content (low hardness) and high color. As the river progresses downstream (Reaches 3, 4, and 5), it receives increasing amounts of water from the Floridian aquifer, which changes river water quality to a clear, slightly colored, alkaline stream (Hornsby et al., 2000).

These natural chemical gradients influence the ecology of the river in many ways. In terms of overall biological production, the upper river tends to be more oligotrophic, while the lower river is more productive.

For assessment purposes, the Department has divided the SRB into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The main stem of the SRB is divided into fifteen segments. WBIDs are combined into larger units called Planning Units. Figures 1.2-1.4 illustrate the Middle Suwannee, Lower Suwannee and Santa Fe Planning Units and Tables 1.1-1.3 list the WBIDs in each of the Planning Units.

Figure 1.2 Middle Suwannee Planning Unit and major cities in study area

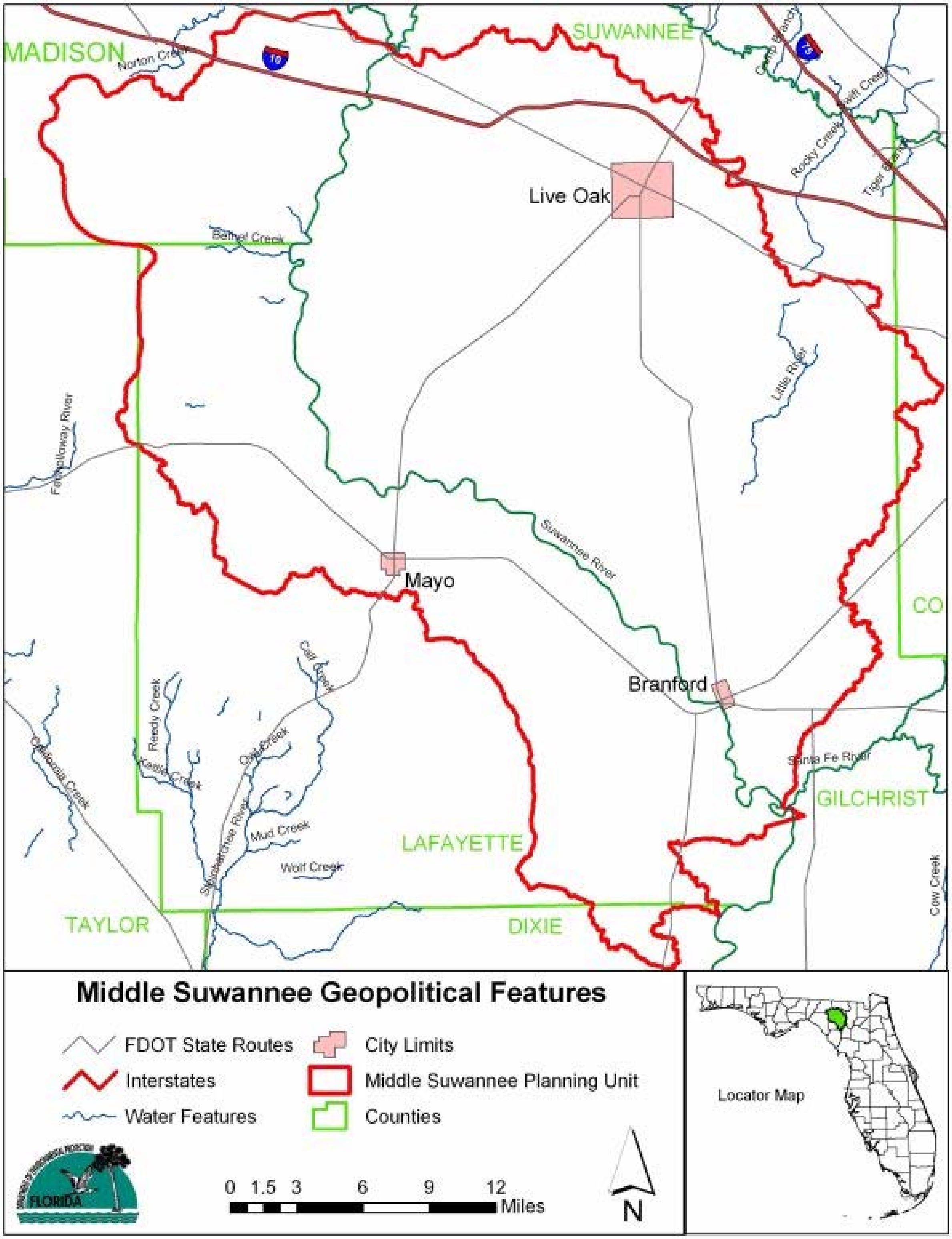


Table 1.1 WBIDs in the Middle Suwannee Planning Unit

WBID	Name
3422B	Suwannee River (Lower)
3422C	Townsend Pond Near May
3422J	Branford Spring
3422L	Ruth Spring
3422P	Mearson Spring
3422Q	Ellaville Spring
3422T	Troy Spring
3422U	Royal Spring
3422V	Convict Spring
3422W	Running Spring
3422X	Telford Spring
3422Y	Charles Spring
3422Z	Falmouth Spring
3438	Temnile Hollow
3438A	Peacock Lake
3438B	White Lake
3439	Unnamed Drain
3469	Springhead Creek
3471	Unnamed Ditch
3472	Bethel Creek
3476	William Waterhole Dr
3480	Bethel Creek
3483	Peacock Slough
3485	Unnamed Branch
3495	Fourmile Creek
3496	Little River
3496A	Low Lake
3496B	Unnamed Slough
3496Z	Little River Springs
3497	Unnamed Drain
3498	Crab Creek
3501	Unnamed Drain
3502	Unnamed Branch
3507	Unnamed Drain
3508	Unnamed Branch
3509	Unnamed Drain
3515	Unnamed Slough
3521	Unnamed Drain
3523	Thomas Spring
3525	Allen Mill Pond
3528	Lafayette Blue Spring Drain
3528Z	Lafayette Blue Springs
3529	Irving Slough
3543	Unnamed Slough
3561	Morgan Lagoon
3568	Owens Spring
3591	Picket Lake Outlet
3591A	Picket Lake
3597	Unnamed Slough
3608	Unnamed Ditch
3618	Unnamed Slough
3624	Unnamed Slough
3636	Unnamed Slough
3643	Unnamed Ditch

Figure 1.3 Lower Suwannee Planning Unit and major cities in study area.

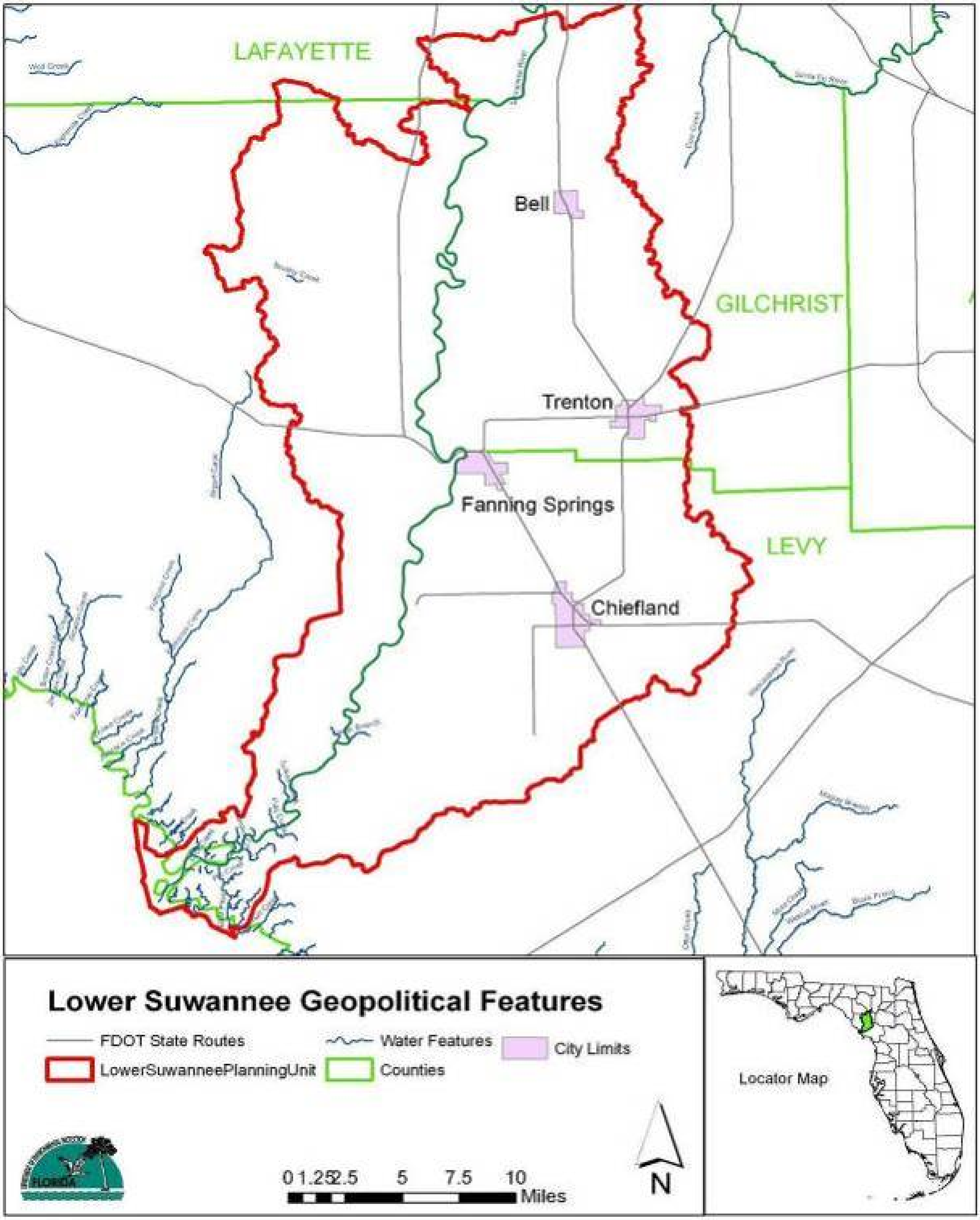


Table 1.2 WBIDs in Lower Suwannee Planning Unit

WBID	Name
3422	Suwannee River (Lower)
3422A	Suwannee River (Lower)
3422D	Lower Suwannee Estuary
3422K	Guaranto Spring
3422M	Turtle Spring
3422N	Hart Springs
3422R	Manatee Springs
3422S	Fanning Springs
3652	Sevenmile Lake Outlet
3652A	Sevenmile Lake
3662	Cow Pond Outlet
3662A	Cow Pond
3668	Beason Prairie Drain
3668A	Govenor Hill Lake
3673	Rock Bluff Spring
3679	Unnamed Slough
3684	Old Town Hammock Drain
3687	Unnamed Drain
3693	Unnamed Slough
3704	Unnamed Drain
3707	Unnamed Drain
3708	Unnamed Drain
3709	Unnamed Drain
3710	Unnamed Slough
3713	Drummond Pond Outlet
3715	Yellow Jacket Slough
3716	Unnamed Drain
3717	Unnamed Drain
3722	Week Creek
3726	Sandfly Creek
3732	Gopher River
3733	Direct Runoff To Gulf

1.2.2 Santa Fe River Basin

The Santa Fe River is a tributary to the Suwannee River (Figure 1.4). This river system drains about 1,400 square miles of north Florida, discharging an annual average flow of more than 1,600 cfs. The Santa Fe River flows west from its headwaters in the Santa Fe Lakes area, in the easternmost portion of the watershed, joining the Suwannee River near Branford. Its two major tributaries, New River and Olustee Creek, have their headwaters in southern Baker County. A third tributary, the Ichetucknee River is a clear, spring-fed stream and a very popular recreational site. The Upper Santa Fe watershed, in the Northern Highlands, is dominated by surface water runoff. At the Cody Scarp, the river goes underground and reemerges supplemented by ground water flow. As the Santa Fe flows across the Gulf Coastal Lowlands, it gains significant flow from numerous springs, including the Ichetucknee River. Because ground water dominates its flow, the Lower Santa Fe is for the most part a spring-fed river. The eastern two-thirds of the Santa Fe watershed has surface drainage features, including lakes, streams, and wetlands. The western third lacks surface drainage, except for the Santa Fe and Ichetucknee Rivers and Cow Creek. The upper watershed is characterized by nearly level pine flatwoods with gently rolling hills. Tributary streams are fairly well incised into the landscape, which occasionally opens into broad, forested floodplains. In the middle portion of the watershed, moderate to gently rolling hills with areas of prominent karstic features, such as sink depressions and captured streams, create surface relief. The lower watershed is primarily a broad, slightly undulating karst plain, with interspersed wetlands (FDEP 2001).

Figure 1.4 Santa Fe Planning Unit and major cities in study area.

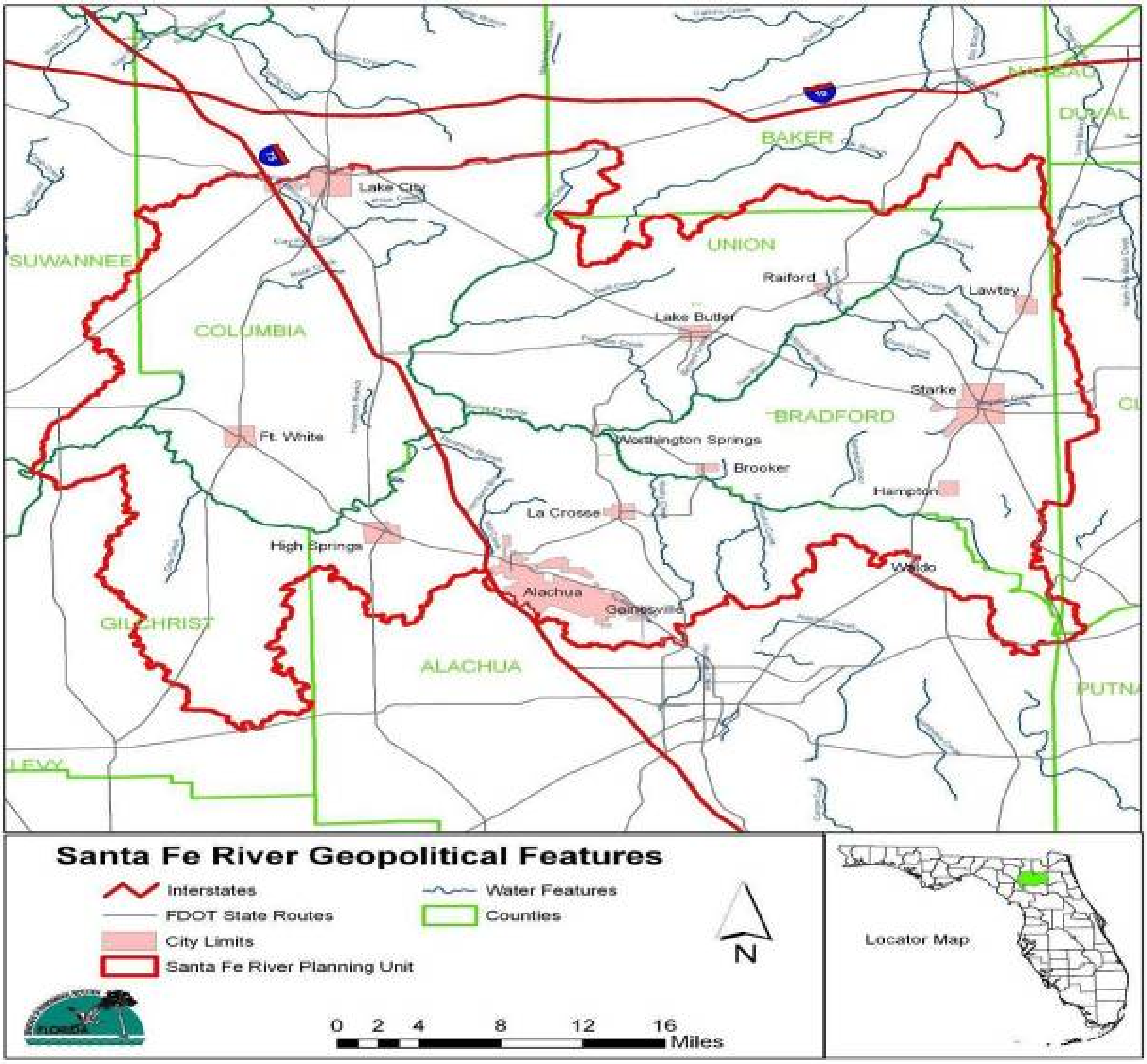


Table 1.3 WBIDs in the Santa Fe Planning Unit

WBID	Name
3504	Olustee Creek
3504A	Olustee Creek
3506	New River
3506A	New River
3506B	New River
3513	Unnamed Slough
3516	Alligator Lake Outlet
3516A	Alligator Lake
3517	Price Creek
3519	Ichetucknee River
3519C	Coffee Springs
3519Q	Mill Pond Spring
3519R	Grassy Hole Spring
3519S	Mission Spring
3519T	Devil'S Eye Spring
3519X	Blue Hole Spring
3519Y	Cedar Head Spring
3519Z	Ichetucknee Head Sprin
3520	Cannon Creek
3522	Unnamed Slough
3524	Turkey Creek
3527	Unnamed Slough
3530	Swift Creek
3531	Rose Creek
3531A	Rose Creek Sink
3532	Grannybay Drain
3535	Unnamed Branch
3537	Unnamed Creek
3539	Unnamed Slough
3540	Unnamed Drain
3541	Center Bay Drain
3542	Unnamed Branch
3545	Unnamed Slough
3546	Richard Creek
3547	Unnamed Branch
3548	Unnamed Drain

WBID	Name
3549	Alligator Creek
3552	Piney Bay Drain
3553	Unnamed Drain
3555	Unnamed Drain
3557	Unnamed Slough
3558	Unnamed Branch
3559	Unnamed Branch
3562	Unnamed Slough
3563	Unnamed Branch
3566	Lake Butler
3566A	Lake Butler Outlet
3567	Wateroak Creek
3570	Unnamed Slough
3571	Cedar Hammock Drain
3576	Unnamed Branch
3578	Fivemile Creek
3579	Gum Creek
3583	Mckinney Branch
3584	Unnamed Drain
3585	Unnamed Branch
3586	Fern Pond Drain
3587	Browns Still Run
3589	Unnamed Branch
3590	Cypress Run
3593	Lake Crosby Outlet
3593A	Lake Crosby
3595	Unnamed Slough
3596	Unnamed Branch
3598	Sampson River
3598B	Lake Rowell
3598C	Alligator Creek
3598D	Lake Sampson
3600	Hammock Branch
3601	Unnamed Creek
3602	Unnamed Branch
3604	Unnamed Branch
3605	Santa Fe River

WBID	Name
3605A	Santa Fe River
3605B	Santa Fe River
3605C	Santa Fe River
3605D	Santa Fe River
3605E	Santa Fe River
3605F	Altho Drainage
3605G	Santa Fe Lake
3605H	Lake Altho
3605P	Siphon Creek Rise (Gil
3605Q	Ala 112971
3605R	Santa Fe Rise
3605S	Devils Ear
3605T	Columbia Springs
3605U	Col 61981 (Spring)
3605W	Poe Spring
3605X	Blue Spring Gilchrist
3605Y	Ginnie Spring
3605Z	Trail Springs
3606	Mined Area
3609	Unnamed Branch
3611	Unnamed Branch
3612	Unnamed Creek
3613	Unnamed Branch
3614	Unnamed Slough
3615	Unnamed Slough
3616	Unnamed Ditch
3617	Unnamed Branch
3619	Unnamed Slough
3620	Unnamed Branch
3621	Unnamed Creek
3622	Prevatt Creek
3623	Unnamed Drain
3625	Unnamed Creek
3626	Pareners Branch
3627	Unnamed Branch
3629	Unnamed Slough
3630	Double Run Creek

WBID	Name
3632	Braggs Branch
3633	Hampton Ditch
3634	Unnamed Branch
3635A	Hampton Lake
3635B	Hampton Lake Outlet
3637	Unnamed Branch
3638	Unnamed Slough
3639	Theressa Slough
3641	Rocky Creek
3642	Townsend Branch
3644	Mill Creek Sink
3646	Unnamed Slough
3647	Unnamed Branch
3648	Rhuda Branch
3649	Cow Creek
3649A	Waters Lake
3651	Unnamed Branch
3653	Hornsby Spring Run
3653Z	Hornsby Spring
3654	Monteocha Creek
3655	Trout Pond Outlet
3655A	Trout Pond
3656	Unnamed Drain
3657	Unnamed Branch
3658	Unnamed Creek
3660	Unnamed Slough
3663	Little Monteocha Creek
3664	Unnamed Branch
3665	Unnamed Drain
3666	Unnamed Branch
3667	Unnamed Drain
3669	Unnamed Branch
3670	Burnetts Lake Drain
3671	Turkey Creek
3678	Hague Branch
3681	Turkey Creek
3682	Blue Creek

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, Section 403.067, Florida Statutes [F.S.])

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, and 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 nutrients that caused the verified impairment of Suwannee River and Santa Fe River. These activities will depend heavily on the active participation of the SJRWMD, local governments, 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 Clean Water Act requires states to submit to the EPA a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant source in each of these impaired waters on a schedule. The Department has developed these lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin is also required by the FWRA (Subsection 403.067[4)] Florida Statutes [F.S.]), and the list is amended annually to include updates for each basin statewide.

Florida's 1998 303(d) list included 571 waterbodies in the Suwannee River Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists of impairments were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001, and amended in 2006 and again in 2007. The list of waters for which impairments have been verified using the methodology in the IWR is referred to as the Verified List.

Table 2.1 is the list of all waterbodies on the Cycle 2 verified list. This TMDL's focus will be on nutrients and dissolved oxygen (DO) impairments. As required by the FWRA, the Verified List of impaired waters for the SRB and SFRB was adopted by Secretarial Order on June 3, 2008. Figures 2.1-2.3 show all the WBIDs located in the Middle Suwannee, Lower Suwannee, and Santa Fe Planning Units, respectively.

Table 2.1 Cycle 2 Verified List for Suwannee River Basin

Planning Unit	WBID	Water Segment Name	Waterbody Type	Water Class	1998 303(d) Parameter of Concern	Parameters Assessed Using the IWR	Priority for TMDL Development
Lower Suwannee	3422	Suwannee River (Lower)	Stream	3F		Nutrients (Hist Chlorophyll)	High
Lower Suwannee	3422D	Lower Suwannee Estuary	Estuary	3M		Fecal Coliform (Shellfish)	Low
Lower Suwannee	3422D	Lower Suwannee Estuary	Estuary	3M		Mercury (in fish tissue)	High
Lower Suwannee	3422R	Manatee Springs	Stream	3F		Nutrients (Algal Mats)	Medium
Lower Suwannee	3422R	Manatee Springs	Stream	3F		Iron	Medium
Lower Suwannee	3422S	Fanning Springs	Stream	3F		Nutrients (Algal Mats)	Medium
Lower Suwannee	3422D	Lower Suwannee Estuary	Estuary	3M		Chlorophyll	High
Lower Suwannee	3717	Unnamed Drain	Estuary	3M		Mercury (in fish tissue)	High
Lower Suwannee	3733	Direct Runoff To Gulf	Stream	2		Fecal Coliform	Low
Lower Suwannee	3733	Direct Runoff To Gulf	Stream	2		Fecal Coliform (3)	Low

Planning Unit	WBID	Water Segment Name	Waterbody Type	Water Class	1998 303(d) Parameter of Concern	Parameters Assessed Using the IWR	Priority for TMDL Development
Middle Suwannee	3422B	Suwannee River (Lower)	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422J	Branford Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3422J	Branford Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422L	Ruth Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3422P	Mearson Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422Q	Ellaville Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422T	Troy Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3422T	Troy Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422U	Royal Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3422U	Royal Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422V	Convict Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422W	Running Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422X	Telford Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422Y	Charles Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3422Z	Falmouth Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3422Z	Falmouth Spring	Stream	3F		Mercury (in fish tissue)	High
Middle Suwannee	3496A	Low Lake	Lake	3F		Dissolved Oxygen	Medium
Middle Suwannee	3480	Bethel Creek	Stream	3F		Fecal Coliform	Low
Middle Suwannee	3483	Peacock Slough	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3528Z	Lafayette Blue Springs	Stream	3F		Nutrients (Algal Mats)	Medium
Middle Suwannee	3528Z	Lafayette Blue Springs	Stream	3F		Mercury (in fish tissue)	High
Santa Fe River	3506	New River	Stream	3F	Coliforms	Fecal Coliform	Low
Santa Fe River	3520	Cannon Creek	Stream	3F		Fecal Coliform	Medium
Santa Fe River	3530	Swift Creek	Stream	3F		Turbidity	Medium
Santa Fe River	3626	Pareners Branch	Stream	3F		Fecal Coliform	Medium
Santa Fe River	3641	Rocky Creek	Stream	3F	BOD 5Day	BOD	Low
Santa Fe River	3644	Mill Creek Sink	Stream	3F		Dissolved Oxygen	Medium

Planning Unit	WBID	Water Segment Name	Waterbody Type	Water Class	1998 303(d) Parameter of Concern	Parameters Assessed Using the IWR	Priority for TMDL Development
Santa Fe River	3644	Mill Creek Sink	Stream	3F		Fecal Coliform	Low
Santa Fe River	3649	Cow Creek	Stream	3F		Fecal Coliform	Medium
Santa Fe River	3681	Turkey Creek	Stream	3F		Fecal Coliform	Medium
Santa Fe River	3682	Blue Creek	Stream	3F		Fecal Coliform	Low
Santa Fe River	3504A	Olustee Creek	Stream	3F		Dissolved Oxygen	Medium
Santa Fe River	3504A	Olustee Creek	Stream	3F		Fecal Coliform	Low
Santa Fe River	3506A	New River	Stream	3F		Dissolved Oxygen	Medium
Santa Fe River	3506A	New River	Stream	3F		Fecal Coliform	Low
Santa Fe River	3516A	Alligator Lake	Lake	3F		Dissolved Oxygen	Medium
Santa Fe River	3516A	Alligator Lake	Lake	3F	Nutrients	Nutrients (TSI)	Low
Santa Fe River	3519S	Mission Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Santa Fe River	3519T	Devil'S Eye Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Santa Fe River	3519X	Blue Hole Spring	Stream	3F		Nutrients (Algal Mats)	Medium
Santa Fe River	3531A	Rose Creek Sink	Stream	3F		Nutrients (Chlorophyll)	Medium
Santa Fe River	3531A	Rose Creek Sink	Stream	3F		Dissolved Oxygen	Medium
Santa Fe River	3593A	Lake Crosby	Lake	3F		Mercury (in fish tissue)	High
Santa Fe River	3598C	Alligator Creek	Stream	3F		Fecal Coliform	Low
Santa Fe River	3598D	Lake Sampson	Lake	3F		Mercury (in fish tissue)	High
Santa Fe River	3605A	Santa Fe River	Stream	3F		Nutrients (Algal Mats)	High
Santa Fe River	3605C	Santa Fe River	Stream	3F		Nutrients (Algal Mats)	High
Santa Fe River	3635A	Hampton Lake	Lake	3F		Mercury (in fish tissue)	High
Santa Fe River	3605A	Santa Fe River	Stream	3F	Dissolved Oxygen	Dissolved Oxygen	High
Santa Fe River	3605C	Santa Fe River	Stream	3F	Dissolved Oxygen	Dissolved Oxygen	High
Santa Fe River	3605F	Altho Drainage	Stream	3F	Dissolved Oxygen	Dissolved Oxygen	High

Figure 2.1 Middle Suwannee WBIDs

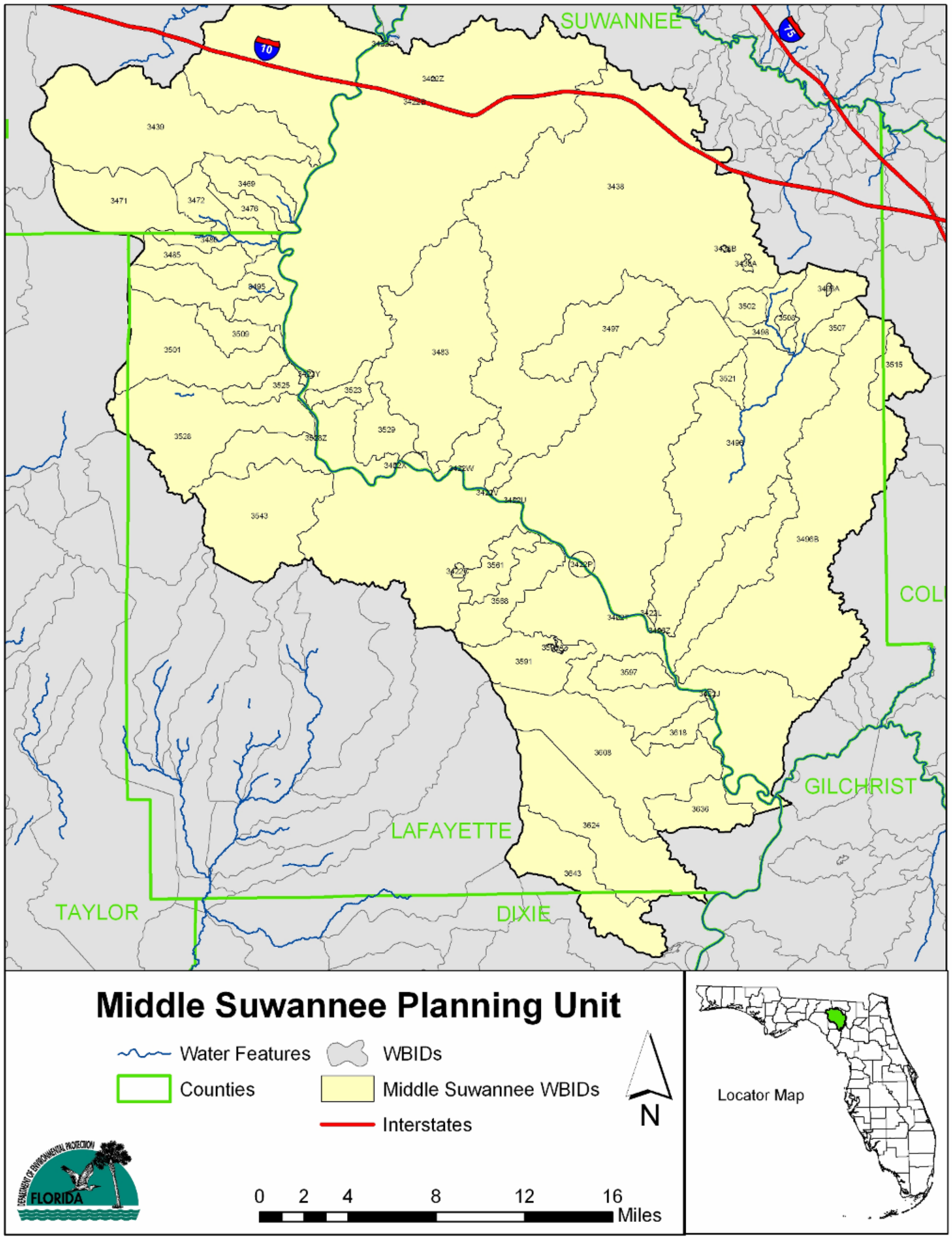


Figure 2.2 Lower Suwannee WBIDs

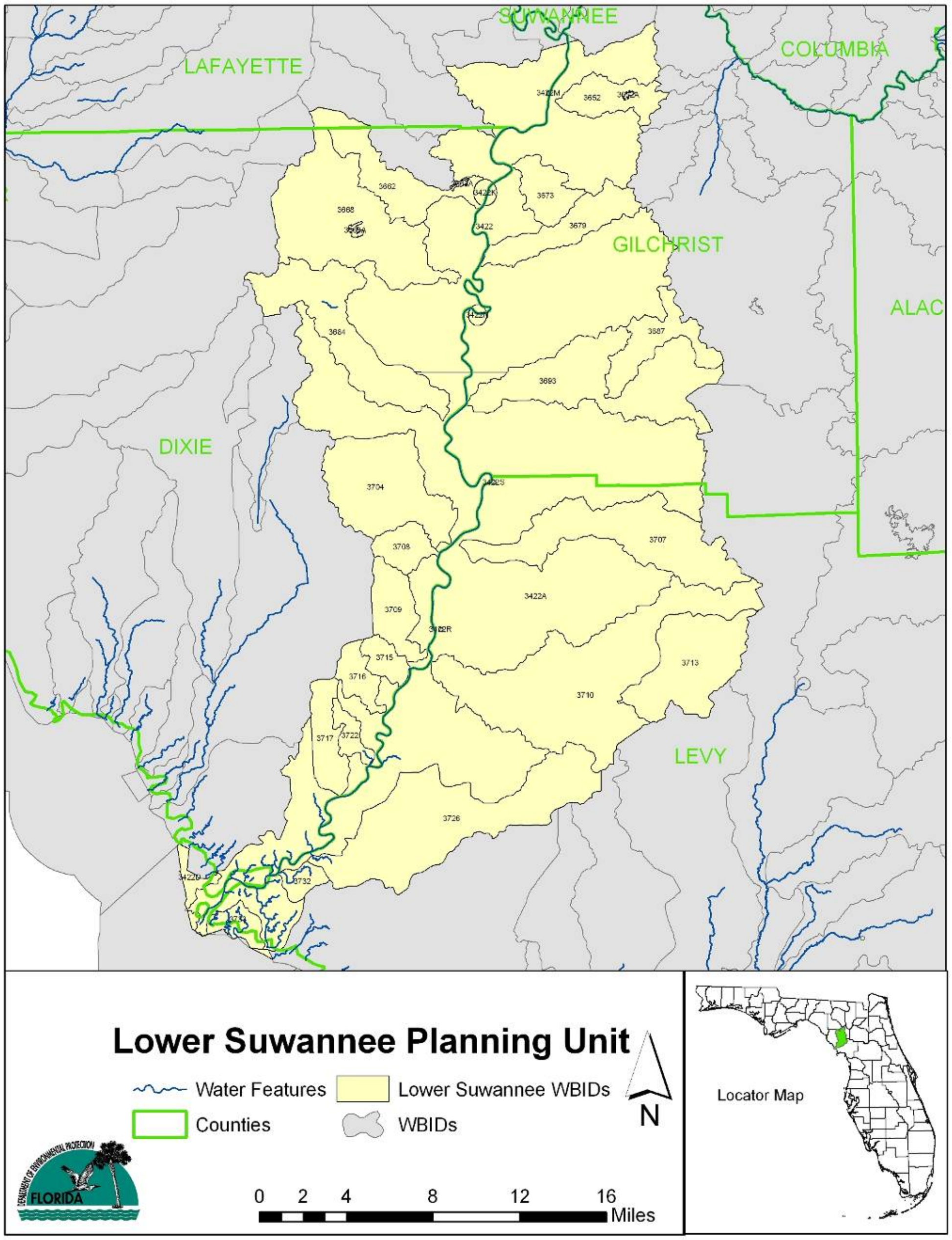
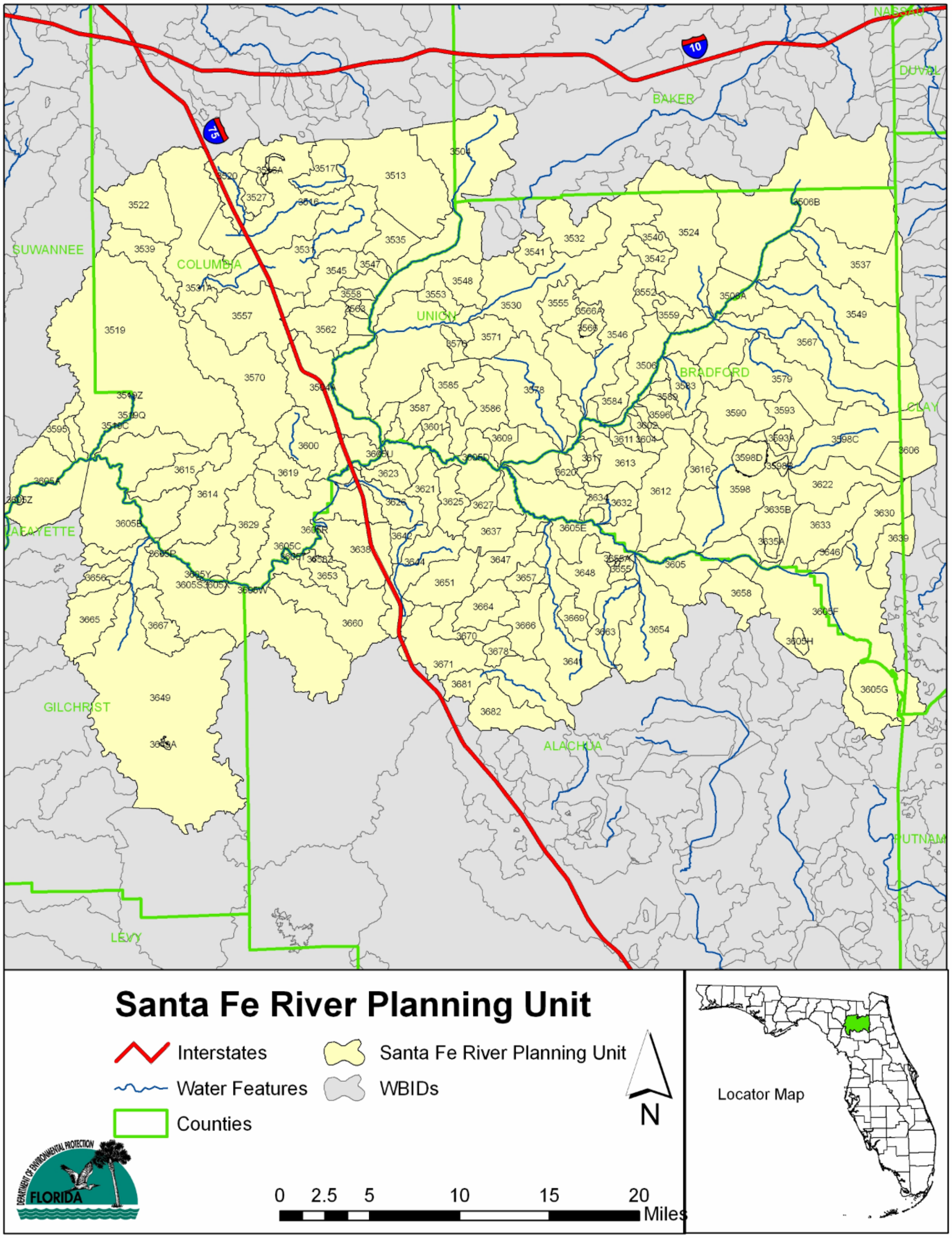


Figure 2.3 Santa Fe WBIDs



2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the main stems of the Suwannee and Santa Fe Rivers and verified that portions of the Suwannee and Santa Fe Rivers are impaired for dissolved oxygen (DO) and nutrients, based on data in the Department's IWR database.

2.2.1 Nutrients

In this report nitrate is NO_3 as nitrogen (NO_3N) and for the purposes of this report, unless otherwise stated, the sum of NO_3 and nitrite (NO_2) is used to represent NO_3 due to minimal contributions of NO_2. Chapter 5 discusses the nitrate (NO_3) nutrient impairment and the setting of the target concentration of NO_3.

Total Phosphorus (TP) rose in the SRB until it peaked in 1983 and has been generally declining since then (Figure 2.4). The figure below was calculated by taking annual average phosphorus concentrations from all data collected within the main stems of the rivers for each planning unit and then calculating a three year rolling average to correct for annual climactic differences, such as rainfall. A significant decreasing trend (α=0.01) is observed when comparing the TP concentrations in the early 1980s to its present condition (Hornsby 2007). This trend was observed in all parts of the basin and does not track with records for mining activities. While mining activity has been present in the upper Suwannee since the 1960s, it does not appear to account for the trend below because the same trend is also observed in the Santa Fe River, which does have mining activity. The trend does track with fertilizer application (Figure 2.5 and Appendix C). The lag time between the two peaks can reasonably be explained by the time it takes for phosphorus to move through the soils and into the surrounding ground water and surface waters.

The Department performed a regression analysis to determine if there was a correlation between phosphorus concentrations and flow. The maximum correlation coefficient found in all the regression for each planning unit was 0.42, leading us to conclude that flow was not a dominant factor effecting concentrations.

Additionally, the Department could not find any climactic conditions that would generate this type of trend. A change point analysis was also conducted in the same manner as the nitrate in Chapter 5. This analysis is used to determine if there is a relationship between phosphorus concentrations and algal biomass or density. No relationship was observed for TP. In 2003, Quinlan found that the nitrogen was most widely the limiting nutrient in the estuary and that TP was rarely the limiting nutrient. For the purposes of this TMDL the Department could not link the impairments with either phosphorus load or concentration and, therefore, will be targeting NO_3 to achieve standards. Monitoring and evaluation for total phosphorus should continue as this TMDL is implemented.

Figure 2.4 Total Phosphorus-Three Year Rolling Average by Planning Unit

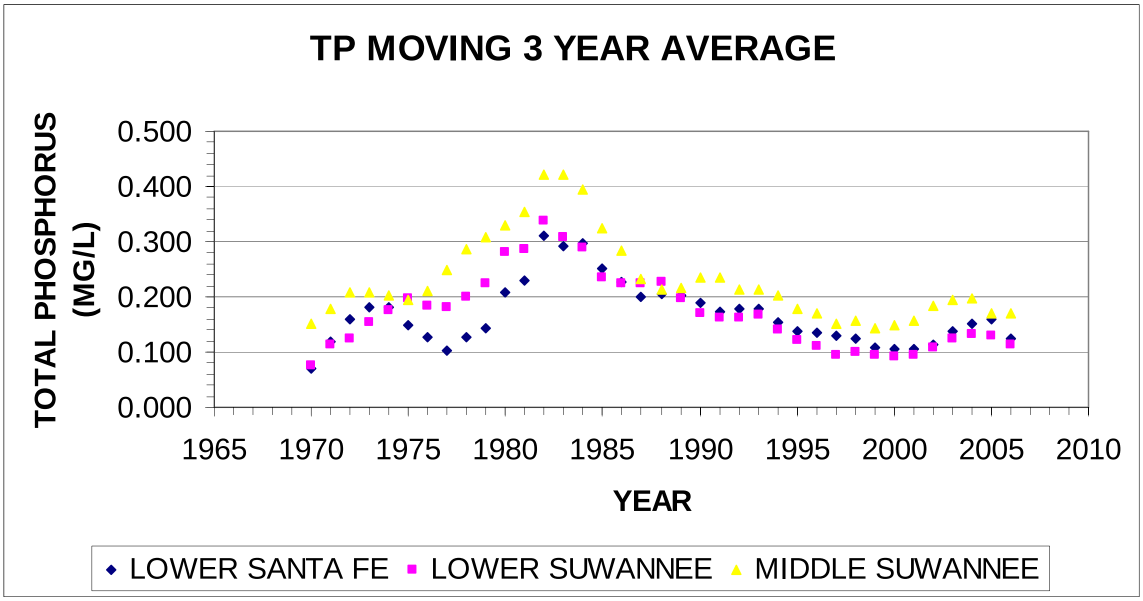
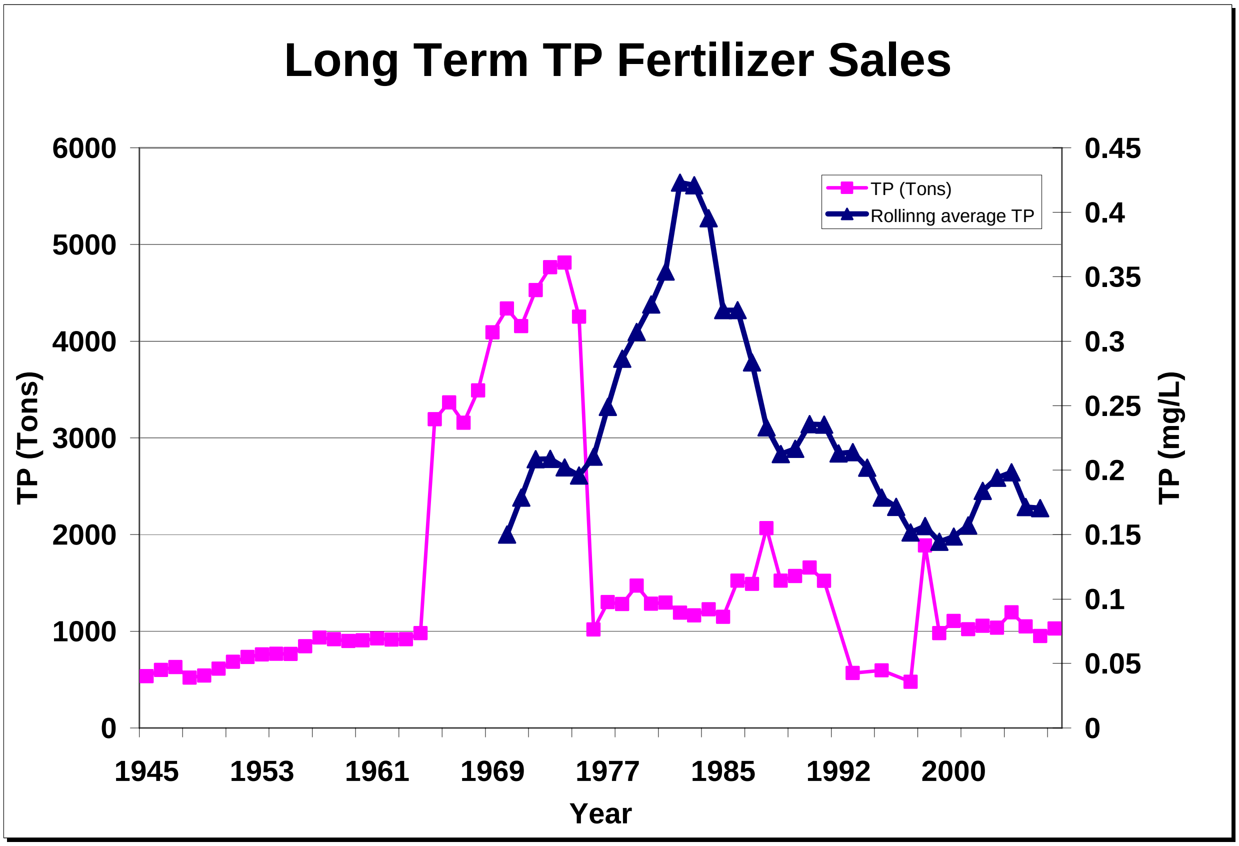


Figure 2.5 Rolling Average TP concentrations for the Middle Suwannee River and TP fertilizer sales for Suwannee and Lafayette counties



2.2.2 Dissolved Oxygen

Tables 2.2 through 2.4 summarize the DO data for the verification period, which for Group 1 waters was June 1, 2000, through June 30, 2007, by month, season, and year, respectively. There is a 35 % overall exceedance rate for DO in Suwannee and Santa Rivers during the verified period. During the verified period, samples ranged from 0.9 to 11.93 milligrams per liter (mg/L).

When aggregating data by season, the lowest percentage of exceedances occurred in the winter and the highest in spring/summer. Possible relationships between DO and other water quality parameters will be further assessed using the complete historical dataset in Chapter 5.

Table 2.2 Summary of DO Data by Month for the Verified Period (June 1, 2000 – June 30, 2007)

WBID	Month	Number of Observations	DO Min	DO Max	DO Mean	DO Median	Number of Exceedances	Exceedance Rate
3605A	1	8	5.4	7.4	6.08	5.9	0	0.00%
	2	8	5.5	7.1	6.18	6.0	0	0.00%
	3	11	3	7	5.92	6.1	2	18.18%
	4	8	2.6	7	5.60	6.2	2	25.00%
	5	8	4.3	8.2	6.19	6.35	2	25.00%
	6	9	4.5	6.9	5.99	6.2	1	11.11%
	7	12	4	8.86	6.72	6.8	2	16.67%
	8	7	4.7	6.2	5.50	5.7	2	28.57%
	9	16	4.3	6.74	5.60	5.7	1	6.25%
	10	7	1.8	5.69	4.87	5.3	1	14.29%
	11	7	3.6	6.22	5.63	5.9	1	14.29%
	12	12	5	8.41	6.63	6.6	0	0.00%
3605C	1	39	3.14	9.6	5.99	5.8	10	25.64%
	2	45	3.9	10.19	5.86	5.3	16	35.56%
	3	48	3.3	11.93	5.45	5.1	20	41.67%
	4	48	2.5	9.9	4.67	4.7	33	68.75%
	5	45	1.8	7.7	5.00	5.05	18	40.00%
	6	49	2.4	9.3	5.10	4.7	27	55.10%
	7	38	2.4	9.9	5.08	4.95	19	50.00%
	8	43	1.2	5.99	3.87	4.2	35	81.40%
	9	87	1.02	6.11	3.47	3.7	84	96.55%
	10	41	0.9	9.1	3.36	3.7	39	95.12%
	11	41	2.04	6.2	4.04	4.5	31	75.61%
	12	41	1.1	8.5	5.04	5.1	19	46.34%

Table 2.3 Summary of DO Data by Season for the Verified Period (June 1, 2000 – June 30, 2007)

WBID	Month	Number of Observations	DO Min	DO Max	DO Mean	DO Median	Number of Exceedances	Exceedance Rate
3605A	WINTER	27	3	7.4	6.04	6.1	2	7.41%
	SPRING	25	2.6	8.2	5.93	6.2	5	20.00%
	SUMMER	35	4	8.86	5.97	5.8	5	14.29%
	FALL	26	1.8	8.41	5.89	6	2	7.69%

WBID	Month	Number of Observations	DO Min	DO Max	DO Mean	DO Median	Number of Exceedances	Exceedance Rate
3605C	WINTER	132	3.14	11.93	5.75	5.3	46	34.85%
	SPRING	142	1.8	9.9	4.92	4.8	78	54.93%
	SUMMER	168	1.02	9.9	3.94	4	138	82.14%
	FALL	123	0.9	9.1	4.15	4.1	89	72.36%

Table 2.4 Summary of DO Data by Year for the Verified Period (June 1, 2000 – June 30, 2007)

WBID	Month	Number of Observations	DO Min	DO Max	DO Mean	DO Median	Number of Exceedances	Exceedance Rate
3605A	1999	14	5.3	6.5	6.04	6.15	0	0.00%
	2000	18	5.1	8.2	6.46	6.5	0	0.00%
	2001	15	5	8.1	6.05	5.9	0	0.00%
	2002	17	5.3	8.86	6.59	6.2	0	0.00%
	2003	16	2.6	7.8	5.01	5.15	8	50.00%
	2004	12	1.8	6.6	5.43	6.05	2	16.67%
	2005	15	3.8	8.41	5.81	5.8	4	26.67%
	2006	6	5.9	6.5	6.18	6.2	0	0.00%
3605C	1999	63	1.5	6.7	4.28	4.7	40	63.49%
	2000	62	1.2	7.7	4.49	4.5	33	53.23%
	2001	71	1.02	11.93	4.94	4.6	37	52.11%
	2002	66	0.9	9.9	4.96	4.7	40	60.61%
	2003	113	1.8	9.1	4.28	4.3	84	74.34%
	2004	82	1.6	9.6	4.70	4.7	53	64.63%
	2005	71	2.57	7.6	4.54	4.49	49	69.01%
	2006	37	3.1	9.6	5.76	5	15	40.54%

2.2.3 Sampling Sites

Figures 2.6-2.8 show the locations of the data collection sampling sites.

Figure 2.6 Middle Suwannee Aerial and Sampling Station Locations

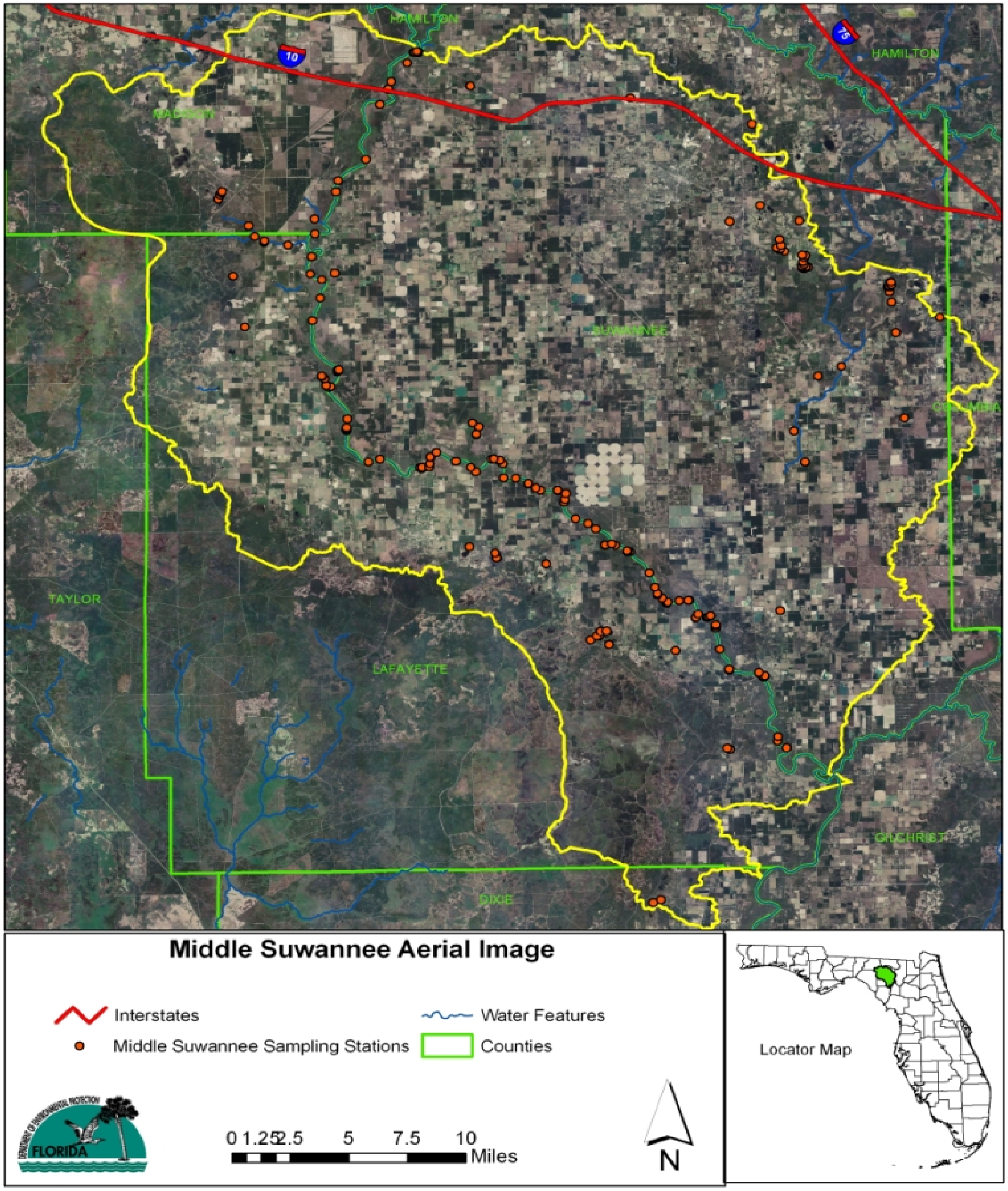


Figure 2.7 Lower Suwannee Aerial and Sampling Station Locations

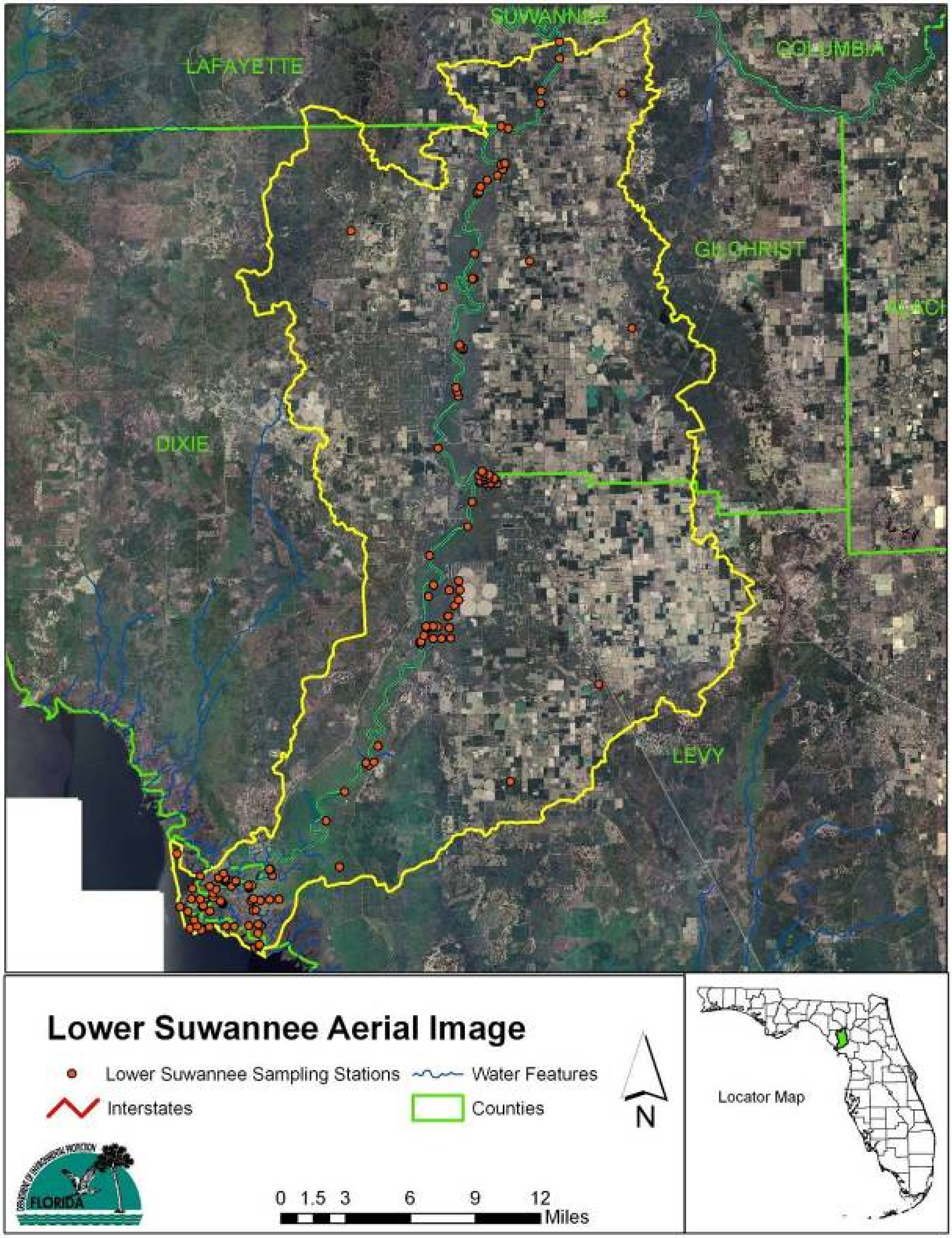
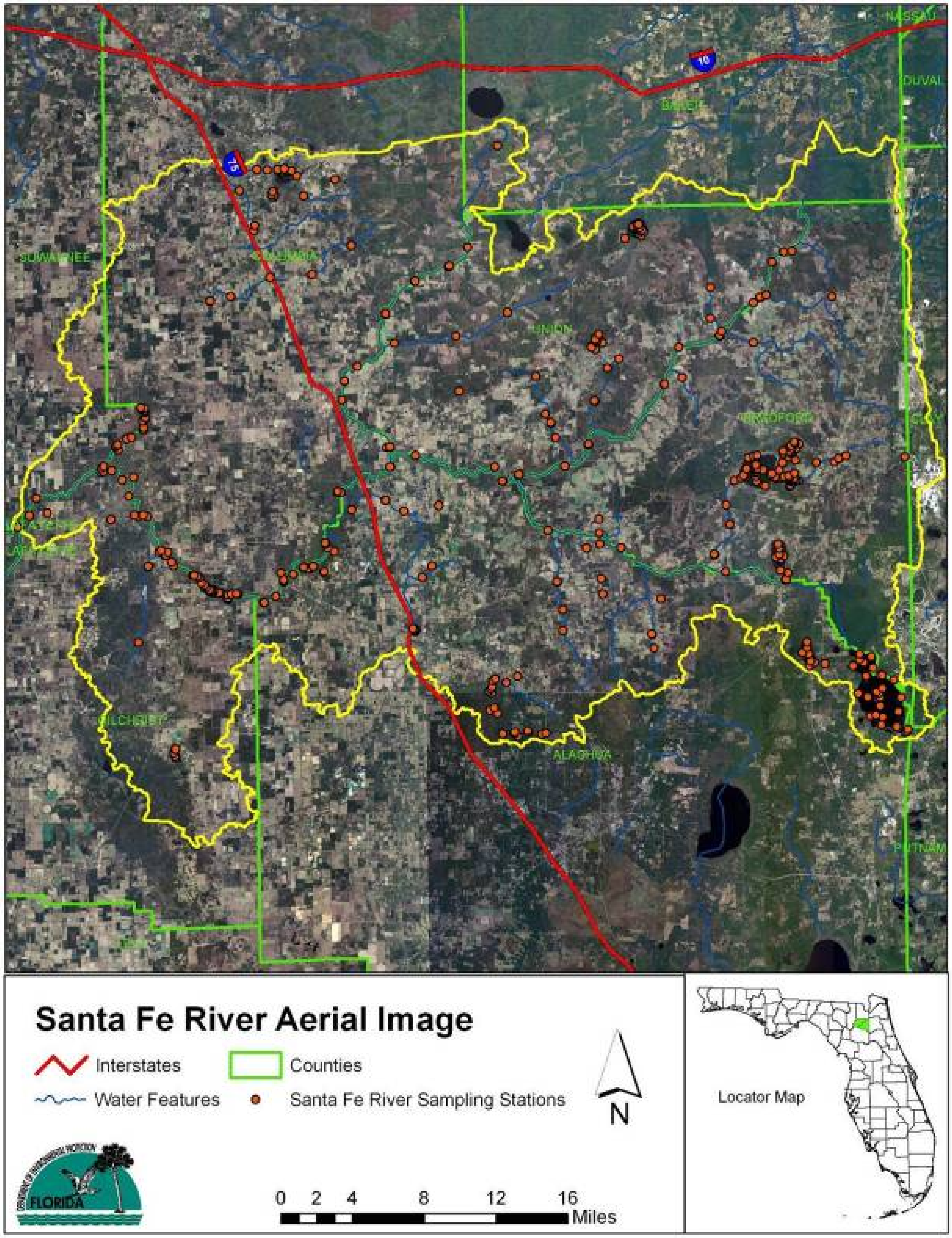


Figure 2.8 Santa Fe Aerial and Sampling Station Locations



The Suwannee River Water Quality Report 2000 documents the effect of nitrate on the Suwannee River. The reports states there are "significant positive relationships between nitrate and total periphyton biomass and algal density, meaning that higher nitrate levels appear to result in increased algal abundance." In the years prior to the report there were flow events that led to extensive growth of filamentous algae in the Suwannee and Santa Fe Rivers. Figure 2.9 provides photographic documentation of the blooms (Hornsby et al, 2000). Excessive algal growth is also documented by the photographic evidence shown in Figure 2.10.

Figure 2.9 Photographic evidence 2000

Photograph of filamentous algae at Branford Spring on the Suwannee River

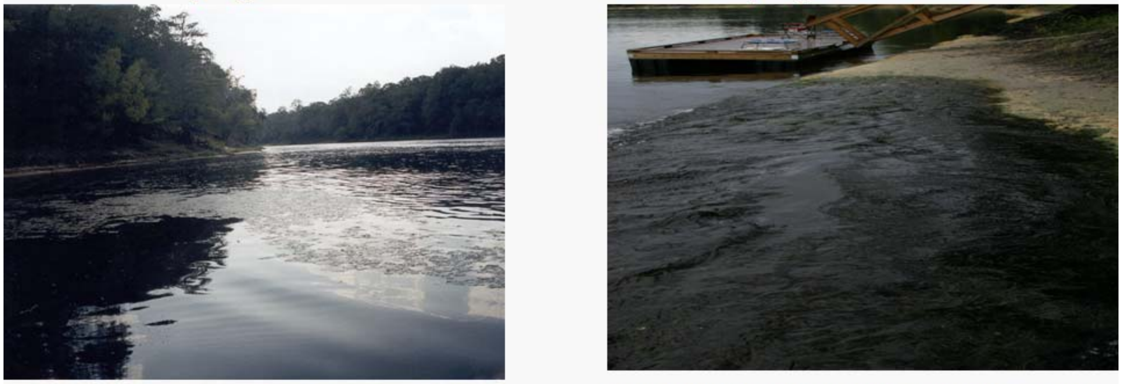
Macroalgal mats on the lower Santa Fe River WY2000

Macroalgal bloom in Suwannee estuary winter 2000

Figure 2.10 Additional Photographic Evidence.

Little River Spring 1998, Suwannee River

Little River Spring 2001, Suwannee River



Middle Suwannee River *Branford, 2000*

LAF718972 Spring Suwannee River, 2006

Chapter 3: DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS

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)

Both the Suwannee River and Santa Fe River are Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the impairment addressed by this TMDL are for nutrients and dissolved oxygen.

3.2 Interpretation of Dissolved Oxygen Criterion and Narrative Nutrient

The following is the relevant sections Rule 62-302 F.A.C for fresh and marine waters.

Dissolved Oxygen Criterion
62-302.530 Table: Surface Water Quality Criteria
Criteria for Surface Water Quality Classifications

		Class III: Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife	
Parameter	Units	Predominantly Fresh Waters	Predominantly Marine Waters
(30) Dissolved Oxygen	Milligrams/L	Shall not be less than 5.0. Normal daily and seasonal fluctuations above these levels shall be maintained.	Shall not average less than 5.0 in a 24-hour period and shall never be less than 4.0. Normal daily and seasonal fluctuations above these levels shall be maintained.

The nutrient criterion in Rule 62-302, F.A.C., is expressed as a narrative:
Nutrients:

In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna [Note: For Class III waters in the Everglades Protection Area, this criterion has been numerically interpreted for phosphorus in Section 62-302.540, F.A.C.].

Florida's nutrient criterion is narrative only—i.e., nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels above which an imbalance in flora or fauna is expected to occur. A threshold commonly used for assessing the nutrient impairment in streams is the annual average chl a concentration of 20 µg/L, which is defined in the Impaired Waters Rule (IWR, 62-303 F.A.C). In addition, the IWR also allows the use of other information indicating imbalance in flora or fauna due to nutrient enrichment, including, but not limited to, algal blooms, excessive macrophyte growth, decrease in the distribution (either in density or areal coverage) of seagrasses or other submerged aquatic vegetation, changes in algal species richness, and excessive diel oxygen swings.

3.3 Outstanding Florida Waters Classification (OFW)

Section 403.061(27), Florida Statutes, grants DEP the power to: Establish rules which provide for a special category of waterbodies within the state, to be referred to as “Outstanding Florida Waters,” which shall be worthy of special protection because of their natural attributes. Most OFWs are areas managed by the state or federal government as parks, wildlife refuges, preserves, marine sanctuaries, estuarine research reserves, certain waters within state or national forests, scenic and wild rivers, or aquatic preserves. The Suwannee River and Santa Fe Rivers are both designated “Special Waters” because of their exceptional ecological and recreational significance.

The Suwannee River was designated an OFW in 1979. That year (pre-OFW) the annual NO_3-N load was 3,548,981 kg N yr^{-1} and in 2005(post-OFW) the annual NO_3-N load was 6,197,855 kg N yr^{-1} (Hornsby, 2007). The Santa Fe River was designated an OFW in 1984.

3.4 Watershed Management Basin Rotation Cycle 1

The Watershed Management Program is responsible for fostering better stewardship of Florida’s ground and surface water resources. Working with other state agencies, water management districts, local governments, citizens, and the private sector, the bureau coordinates the collection, data management, and interpretation of monitoring information to assess the health of our water resources; develops watershed-based aquatic resource goals and pollutant loading limits for individual waterbodies; and develops and implements management action plans to preserve or restore waterbodies. These activities are undertaken using the rotating basin approach that assures that the watershed plans for each of the state’s watersheds are evaluated and updated every five years.

In the first cycle rotation the Santa Fe River was verified for impairments of Nutrients (WBID 3605A) due to algal mats and historical chlorophyll and dissolved oxygen (WBID3605B) linked to nutrients.

3.5 Suwannee River Partnership and Reasonable Assurance Documentation

During the first Suwannee Basin assessment under the Watershed Management Program in 2002, portions of the Suwannee and Santa Fe Rivers impairments were identified for dissolved oxygen and nutrients. The listing process included an option to not place waters on the adopted verified list if Reasonable Assurance (RA) could be demonstrated by responsible entities that a management plan was in place that would restore water quality to achieve its designated use and a TMDL was not necessary.

The Suwannee River Partnership, a coalition of state, federal and regional agencies, local governments and private industry representatives that had been formed in 1999 to reduce nitrate levels in the surface and ground water of the Middle Suwannee watershed submitted a RA document to the Department in 2002.

On June 11, 2003, in the EPA’s decision document, the EPA while recognizing “that the efforts of the partnership have realized great success in gaining commitments in the Middle Suwannee that should result in water quality improvements once executed” did not accept the Partnership’s RA documentation. The EPA sited that “similar commitments have not been initiated in the Upper Suwannee and Santa Fe watersheds. Attaining water quality standards in the Suwannee basin, including the estuary, will require that control strategies be in place in the Upper Suwannee and Santa Fe watersheds as well as the Middle Suwannee.” Since then, the Partnership expanded its work to include the Santa Fe River Basin and the entire Suwannee River Water Management District area.

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 the pollutant of concern in the target 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 NPDES Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" is 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** on **Expression and Allocation of the TMDL).** However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES 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 Point Sources in the Suwannee River Basin

Table 4.1 and Figures 4.1-4.4 identify the facilities authorized as permitted discharges in the Suwannee River Basin. As the seven NPDES point sources are either outside the watersheds of interest (they do not discharge into the impaired waters covered by this TMDL) or do not have a direct effect on the nutrient levels in the Middle or Lower Suwannee River or Santa Fe River Basins, no WLAs are assigned.

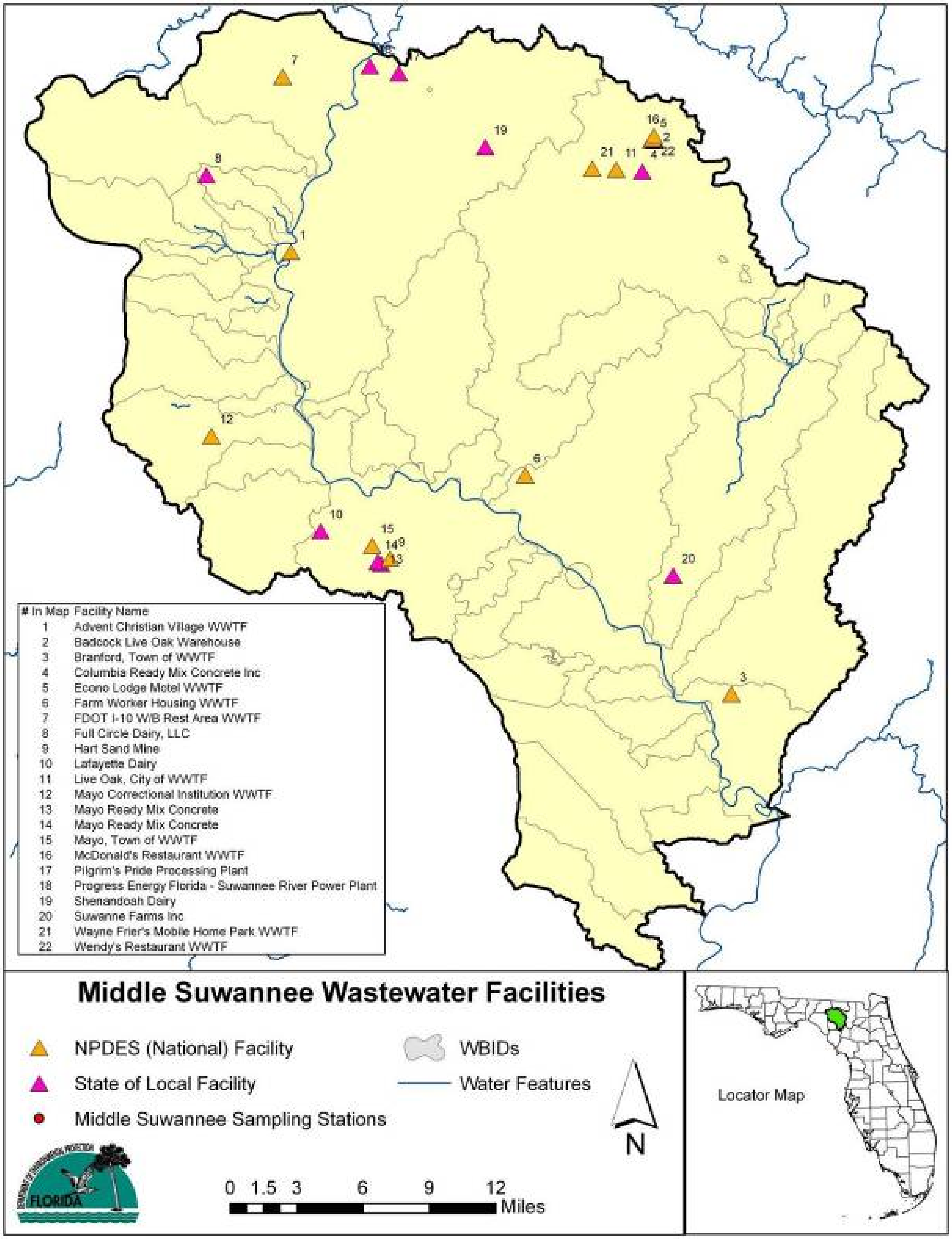
Table 4.1 Permitted facilities identified in the drainage basin discharge to Suwannee River Basin

FACILITY ID	FACILITY NAME	Facility Type	DESIGN Capacity (MGD)	COUNTY
FL0000051	EI Dupont De Nemours Trailridge Mine	IW	30.0	Bradford
FL0000183	Progress Energy FL - Suwannee River Power Plant	IW	342.0	Suwannee
FL0001465	Pilgrim's Pride Processing Plant	IW	1.5	Suwannee
FL0028126	Starke, City of WWTF	DW	1.65	Bradford
FL0038300	Mead Westvaco Corp	IW	0.0482	Columbia
FL0043567	Cochran Forest Products	IW	0.05	Columbia
FL0189120	High Springs Commercial Park WWTF	DW	0.03	Alachua
FLA011323	IFAS - Dairy Research	CFO	0.151	Alachua

FACILITY ID	FACILITY NAME	Facility Type	DESIGN Capacity (MGD)	COUNTY
	Unit			
FLA116173	Dairy Production Systems - Branford Farm	CFO	0.175	Gilchrist
FLA116190	Piedmont Dairy	CFO	0.045	Gilchrist
FLA116521	Alliance Dairies	CFO	0.37	Levy
FLA161977	Oak Grove Dairy, Inc	CFO	0.11	Dixie
FLA184047	Lafayette Dairy	CFO		Lafayette
FLA184993	Hill Top Dairy	CFO		Gilchrist
FLA282821	North Florida Holsteins	CFO		Gilchrist
FLA285331	Bell Farm (FKA Aurora 1)	CFO		Gilchrist
FLA362778	Shenandoah Dairy	CFO		Suwannee
FLA371912	Full Circle Dairy, LLC	CFO		Madison
FLA470031	Suwannee Farms Inc	CFO		Suwannee
FLG110015	A Materials Group Inc - Plant #11	CBP		Columbia
FLG110073	Florida Rock Industries Inc - High Springs CBP	CBP		Alachua
FLG110190	Florida Rock Industries - Starke CBP	CBP		Bradford
FLG110278	Bell Concrete Products	CBP		Gilchrist
FLG110304	Columbia Ready Mix Concrete Inc	CBP		Columbia
FLG110369	A Materials Group Inc - Plant #12	CBP		Levy
FLG110370	Bell Concrete	CBP		Levy
FLG110374	Columbia Ready Mix Concrete Inc	CBP		Suwannee
FLG110450	Mayo Ready Mix Concrete	CBP		Lafayette
FLG110558	Mayo Ready Mix Concrete	CBP		Lafayette
FLG911679	Badcock Live Oak Warehouse	PET		Suwannee
FLS000062	Lake City, City of - WWTF	WWTP ISW		Columbia
FLS000062	Lake City, City of - WWTF	WWTP ISW		Columbia

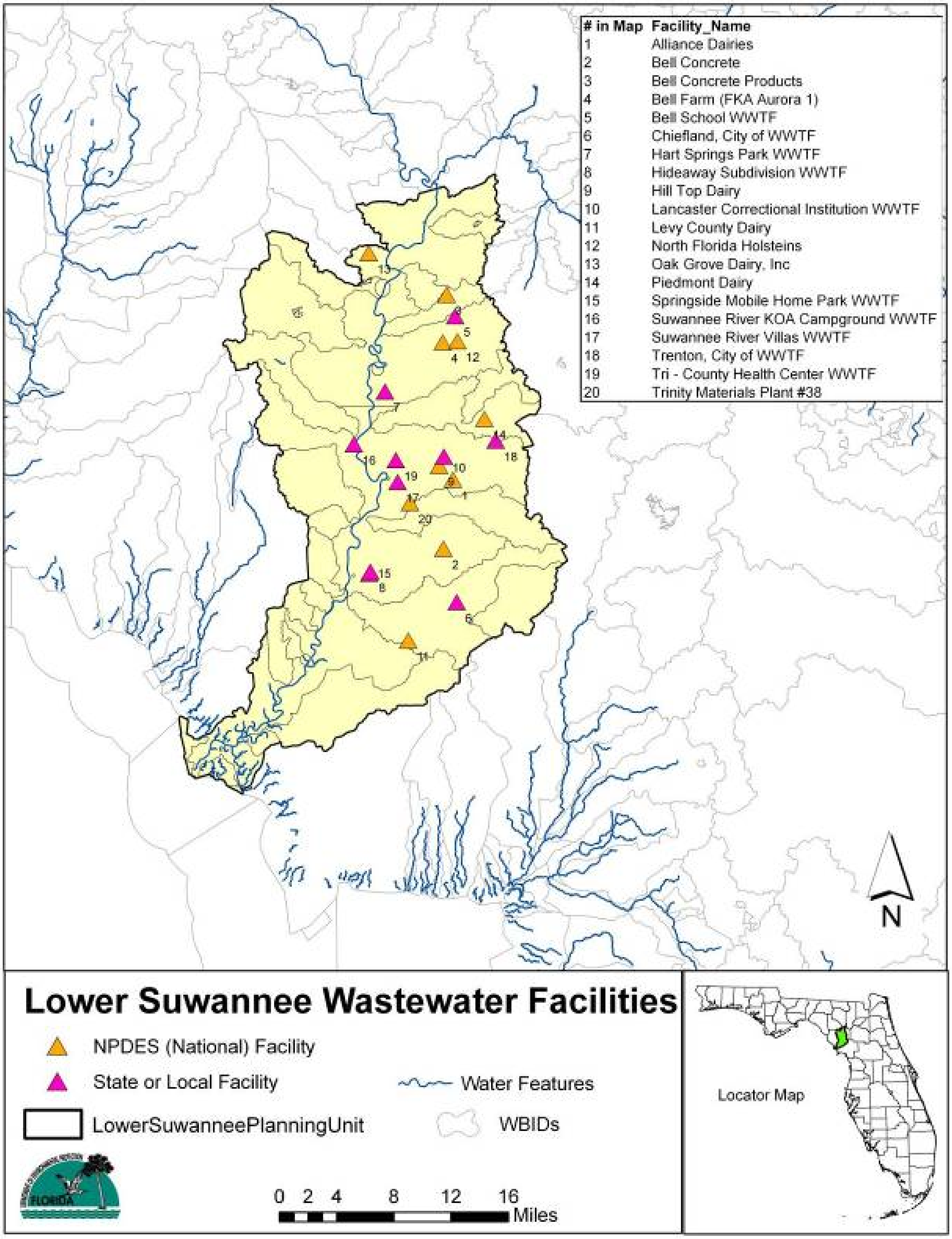
IW Industrial Wastewater
DW Domestic
CFO Concentrated Animal Feeding Operation
CBP Concrete Batch
PET Petroleum Cleanup GP (long term)
WWTP ISW Individual Stormwater

Figure 4.1 Wastewater Facilities in the Middle Suwannee River Basin.



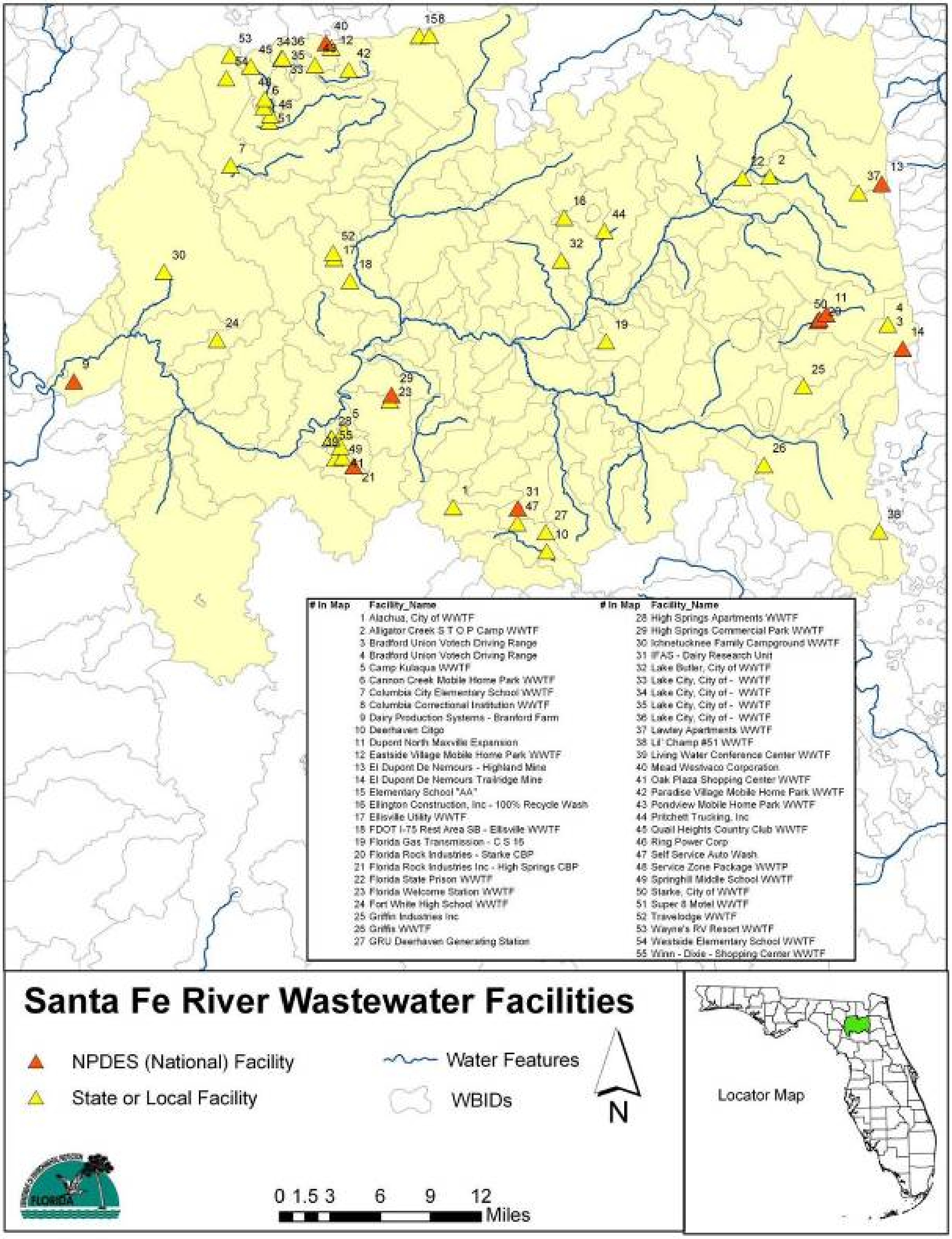
# In Map	Facility Name
1	Advent Christian Village WWTF
2	Badcock Live Oak Warehouse
3	Branford, Town of WWTF
4	Columbia Ready Mix Concrete Inc
5	Econo Lodge Motel WWTF
6	Farm Worker Housing WWTF
7	FDOT I-10 W/B Rest Area WWTF
8	Full Circle Dairy, LLC
9	Hart Sand Mine
10	Lafayette Dairy
11	Live Oak, City of WWTF
12	Mayo Correctional Institution WWTF
13	Mayo Ready Mix Concrete
14	Mayo Ready Mix Concrete
15	Mayo, Town of WWTF
16	McDonald's Restaurant WWTF
17	Pilgrim's Pride Processing Plant
18	Progress Energy Florida - Suwannee River Power Plant
19	Shenandoah Dairy
20	Suwanne Farms Inc
21	Wayne Frier's Mobile Home Park WWTF
22	Wendy's Restaurant WWTF

Figure 4.2 Wastewater Facilities in the Lower Suwannee River Basin.



# in Map	Facility_Name
1	Alliance Dairies
2	Bell Concrete
3	Bell Concrete Products
4	Bell Farm (FKA Aurora 1)
5	Bell School WWTF
6	Chiefland, City of WWTF
7	Hart Springs Park WWTF
8	Hideaway Subdivision WWTF
9	Hill Top Dairy
10	Lancaster Correctional Institution WWTF
11	Levy County Dairy
12	North Florida Holsteins
13	Oak Grove Dairy, Inc
14	Piedmont Dairy
15	Springside Mobile Home Park WWTF
16	Suwannee River KOA Campground WWTF
17	Suwannee River Villas WWTF
18	Trenton, City of WWTF
19	Tri - County Health Center WWTF
20	Trinity Materials Plant #38

Figure 4.3 Wastewater Facilities in the Santa Fe River Basin.



# In Map	Facility_Name
1	Alachua, City of WWTF
2	Alligator Creek S T O P Camp WWTF
3	Bradford Union Votech Driving Range
4	Bradford Union Votech Driving Range
5	Camp Kulaqua WWTF
6	Cannon Creek Mobile Home Park WWTF
7	Columbia City Elementary School WWTF
8	Columbia Correctional Institution WWTF
9	Dairy Production Systems - Branford Farm
10	Deerhaven Citgo
11	Dupont North Maxville Expansion
12	Eastside Village Mobile Home Park WWTF
13	El Dupont De Nemours - Highland Mine
14	El Dupont De Nemours Trailridge Mine
15	Elementary School "AA"
16	Ellington Construction, Inc - 100% Recycle Wash
17	Ellisville Utility WWTF
18	FDOT I-75 Rest Area SB - Ellisville WWTF
19	Florida Gas Transmission - C S 16
20	Florida Rock Industries - Starke CBP
21	Florida Rock Industries Inc - High Springs CBP
22	Florida State Prison WWTF
23	Florida Welcome Station WWTF
24	Fort White High School WWTF
25	Griffin Industries Inc
26	Griffis WWTF
27	GRU Deerhaven Generating Station
28	High Springs Apartments WWTF
29	High Springs Commercial Park WWTF
30	Ichnetucknee Family Campground WWTF
31	IFAS - Dairy Research Unit
32	Lake Butler, City of WWTF
33	Lake City, City of - WWTF
34	Lake City, City of - WWTF
35	Lake City, City of - WWTF
36	Lake City, City of - WWTF
37	Lawtey Apartments WWTF
38	Lil' Champ #51 WWTF
39	Living Water Conference Center WWTF
40	Mead Westvaco Corporation
41	Oak Plaza Shopping Center WWTF
42	Paradise Village Mobile Home Park WWTF
43	Pondview Mobile Home Park WWTF
44	Pritchett Trucking, Inc
45	Quail Heights Country Club WWTF
46	Ring Power Corp
47	Self Service Auto Wash
48	Service Zone Package WWTP
49	Springhill Middle School WWTF
50	Starke, City of WWTF
51	Super 8 Motel WWTF
52	Travelodge WWTF
53	Wayne's RV Resort WWTF
54	Westside Elementary School WWTF
55	Winn - Dixie - Shopping Center WWTF

4.2.1 Municipal Separate Storm Sewer System Permittees

A municipal separate storm sewer system (MS4) is a publicly-owned conveyance or system of conveyances (i.e., ditches, curbs, catch basins, underground pipes, etc.) that is designed or used for collecting or conveying stormwater and that discharges to surface waters of the State. Table 4.2 show the Phase II MS4 permits in the Santa Fe River Basin. The Department welcomes input from the MS4 permittees regarding the extent of their discharges in the WBIDs of concern. There are no MS4 Permittees in the Middle and Lower Suwannee River Planning Units.

Table 4.2 MS4 Permittees

County	Permitee	Permit Number	Phase
Alachua	University of Florida	FLR04E067	Phase II
Alachua	FDOT District 2 (Gainesville UA)	FLR04E018	Phase II
Alachua	Alachua County	FLR04E005	Phase II
Alachua	City of Gainesville	FLR04E006	Phase II

4.3 Nonpoint Sources

Potential nonpoint sources of total nitrogen in the watershed were calculated in Figures 4.4-4.6 using the equations in Hornsby 1997 and data from 2007. Estimates of total nitrogen for humans, poultry, beef, and dairy are based on the percentage of total nitrogen in raw waste and population size.

Figure 4.4 Total Nitrogen inputs in the Middle Suwannee

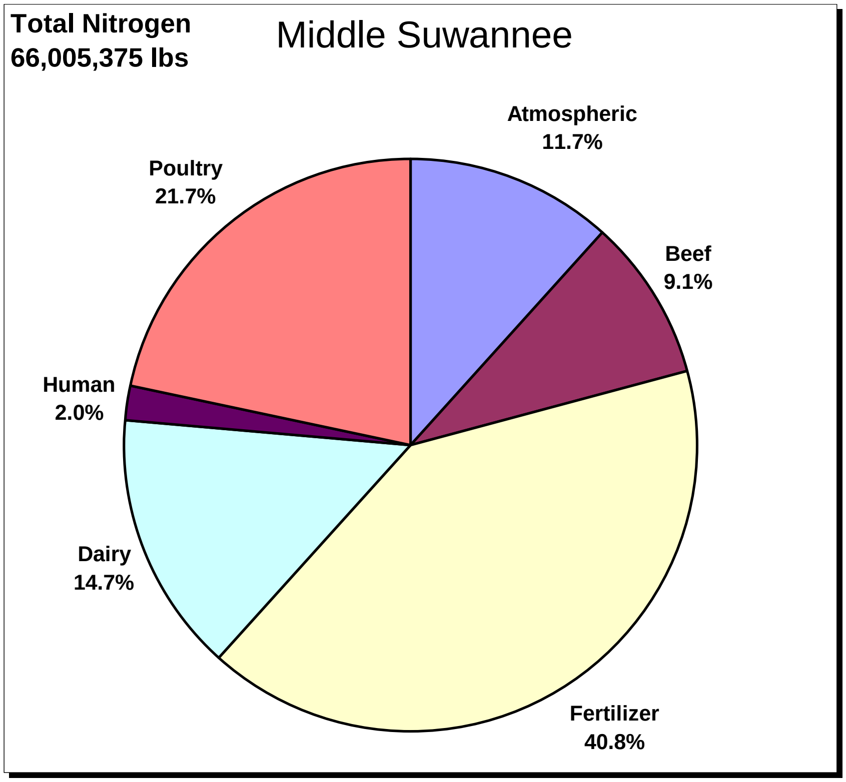


Figure 4.5 Total Nitrogen inputs in the Lower Suwannee

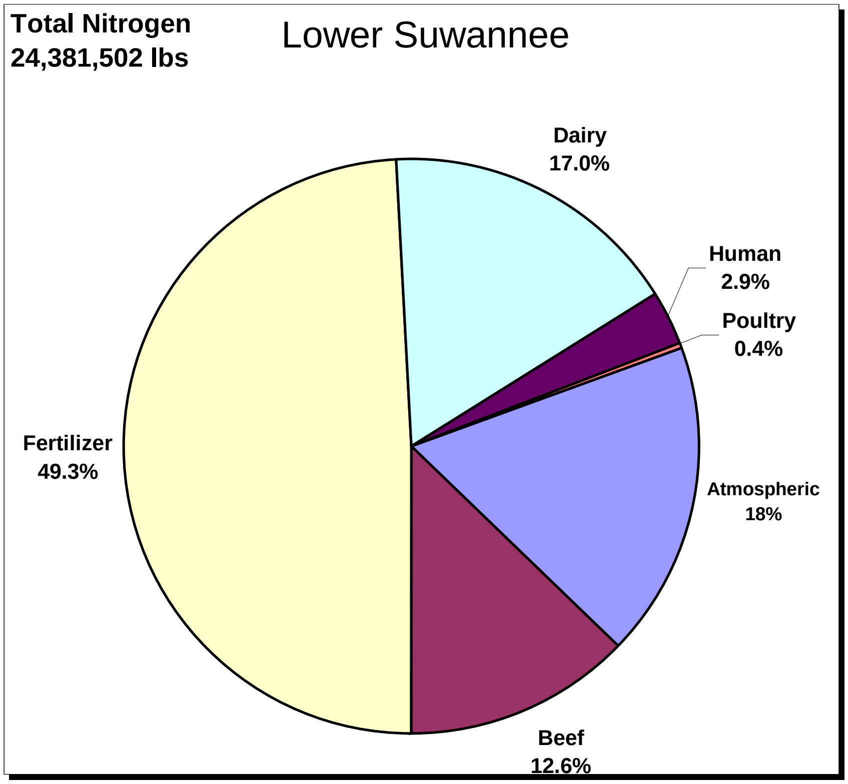
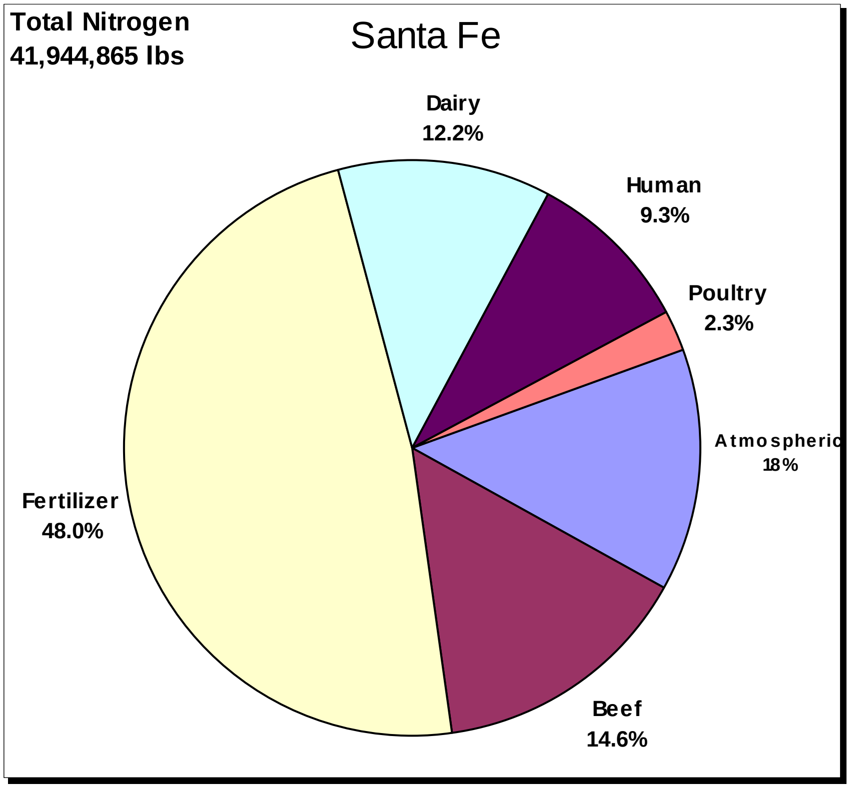


Figure 4.6 Total Nitrogen inputs in the Santa Fe



4.3.1 Onsite Sewage Treatment and Disposal Systems

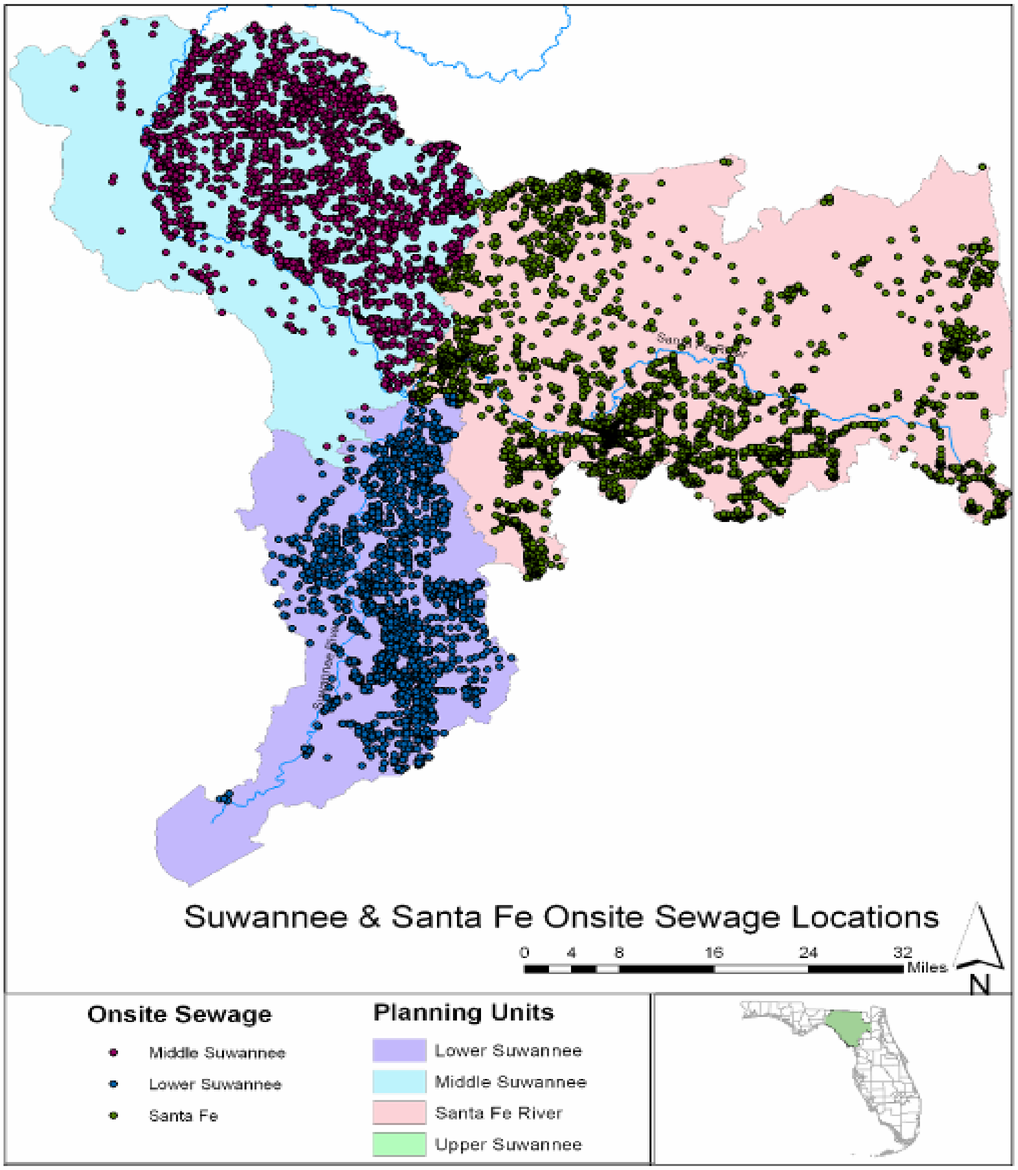
In 1993 a report on onsite sewage treatment and disposal systems (OSTDS) found that over two-thirds of septic systems in the ten year floodplain of the Suwannee River were not functioning properly, installed incorrectly or in need of repair (HRS 1993). Figure 4.4 and Table 4.3 depict the number and location of OSTDS in the SRB. The Department at this time has only an estimated number of OSTDS in the SRB (DOH, 2007).

Table 4.3 Estimated Number of Onsite Sewage Treatment Systems

Planning Unit	Number of Sites*
Middle Suwannee	4,894
Lower Suwannee	4,630
Santa Fe	11,684

*Number of onsite sewage treatment and disposal system sites is estimated from Department of Health information and does not constitute the actual number of onsite sewage treatment systems in the area.

Figure 4.7 Onsite Sewage in the Suwannee River Basin



4.3.2 Human Population

Table 4.4 and Figures 4.5-4.7 depict the populations in the individual planning units and their population densities (people per acre).

Table 4.4 Population and number of household in SRB

Middle Suwannee	**Total households**	**1-person household**	**2-person household**	**3-person household**	**4-person household**	**5-person household**	**6-person household**	**7-or-more person household**
Total	12503	3035	4567	2045	1670	745	265	176
Fraction of Total	1.00	0.23	0.41	0.18	0.14	0.05	0.00	0.00
% of Total	100	22.73	40.91	18.18	13.64	4.55	0.00	0.00
# of People	31532	3035	9135	6136	6679	3723	1592	1232
Average Household Size	2.52							

Lower Suwannee	**Total households**	**1-person household**	**2-person household**	**3-person household**	**4-person household**	**5-person household**	**6-person household**	**7-or-more person household**
Total	9053	2200	3590	1411	1091	491	163	106
Fraction of Total	1.00	0.24	0.40	0.16	0.12	0.05	0.02	0.01
% of Total	100	24.30	39.65	15.58	12.05	5.43	1.80	1.18
# of People	22158	2200	7180	4232	4364	2456	980	745
Average Household Size	2.45							

Santa Fe	**Total households**	**1-person household**	**2-person household**	**3-person household**	**4-person household**	**5-person household**	**6-person household**	**7-or-more person household**
Total	33348	7558	11979	5918	4759	2005	714	416
Fraction of Total	1.00	0.23	0.36	0.18	0.14	0.06	0.02	0.01
% of Total	100	22.66	35.92	17.75	14.27	6.01	2.14	1.25
# of People	85523	7558	23958	17755	19034	10023	4281	2914
Average Household Size	2.56							

Figure 4.8 Middle Suwannee Basin Population Density

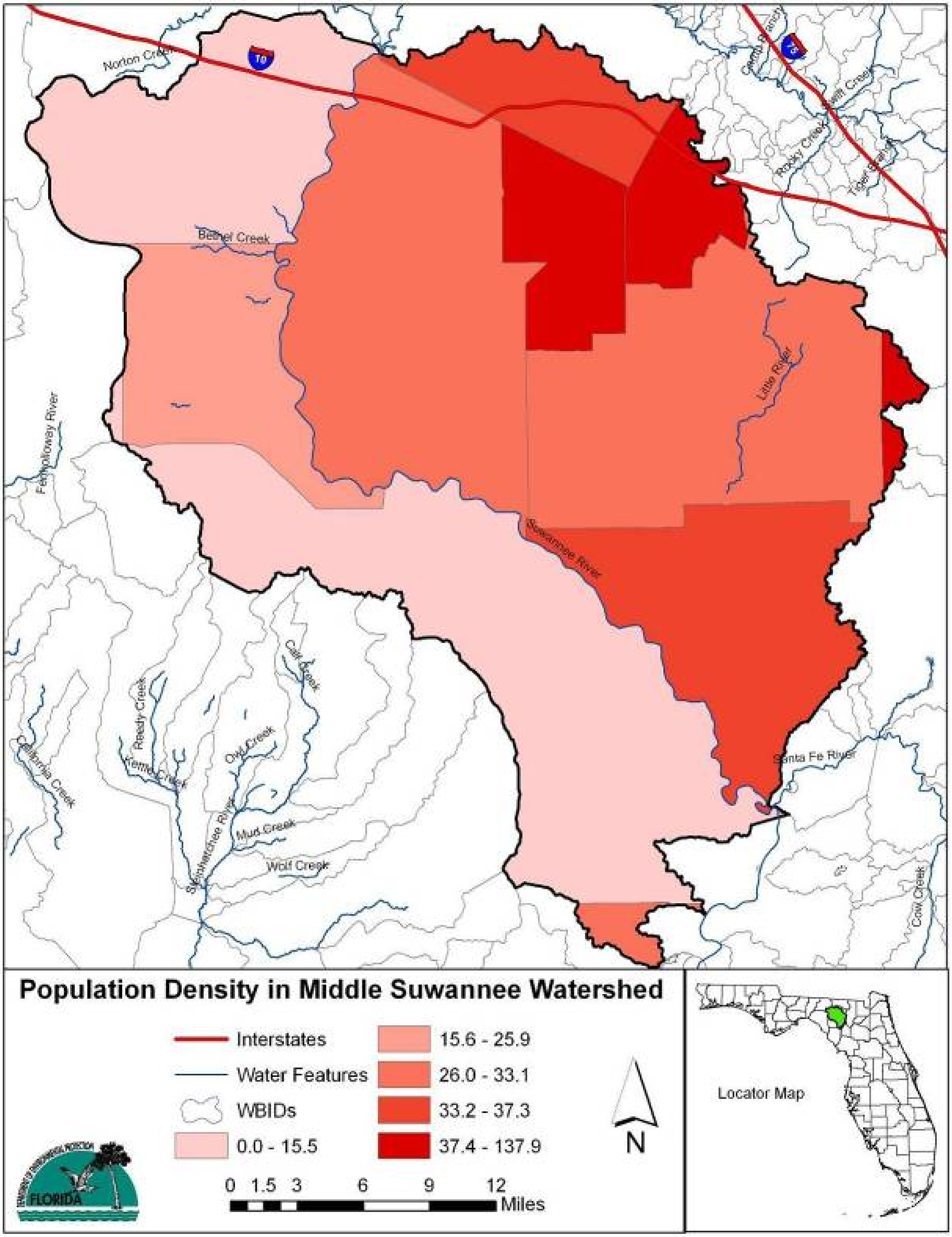


Figure 4.9 Lower Suwannee Basin Population Density

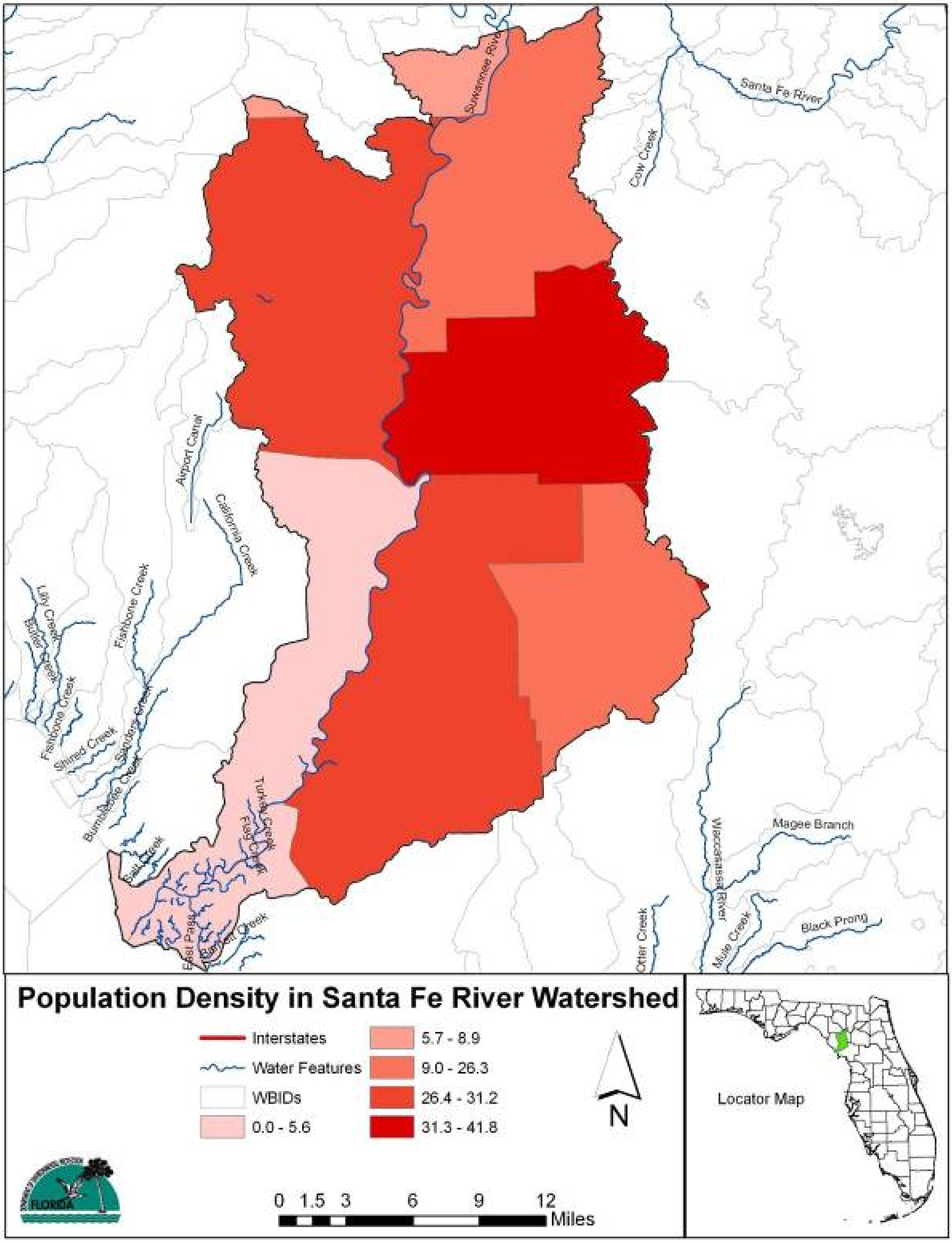
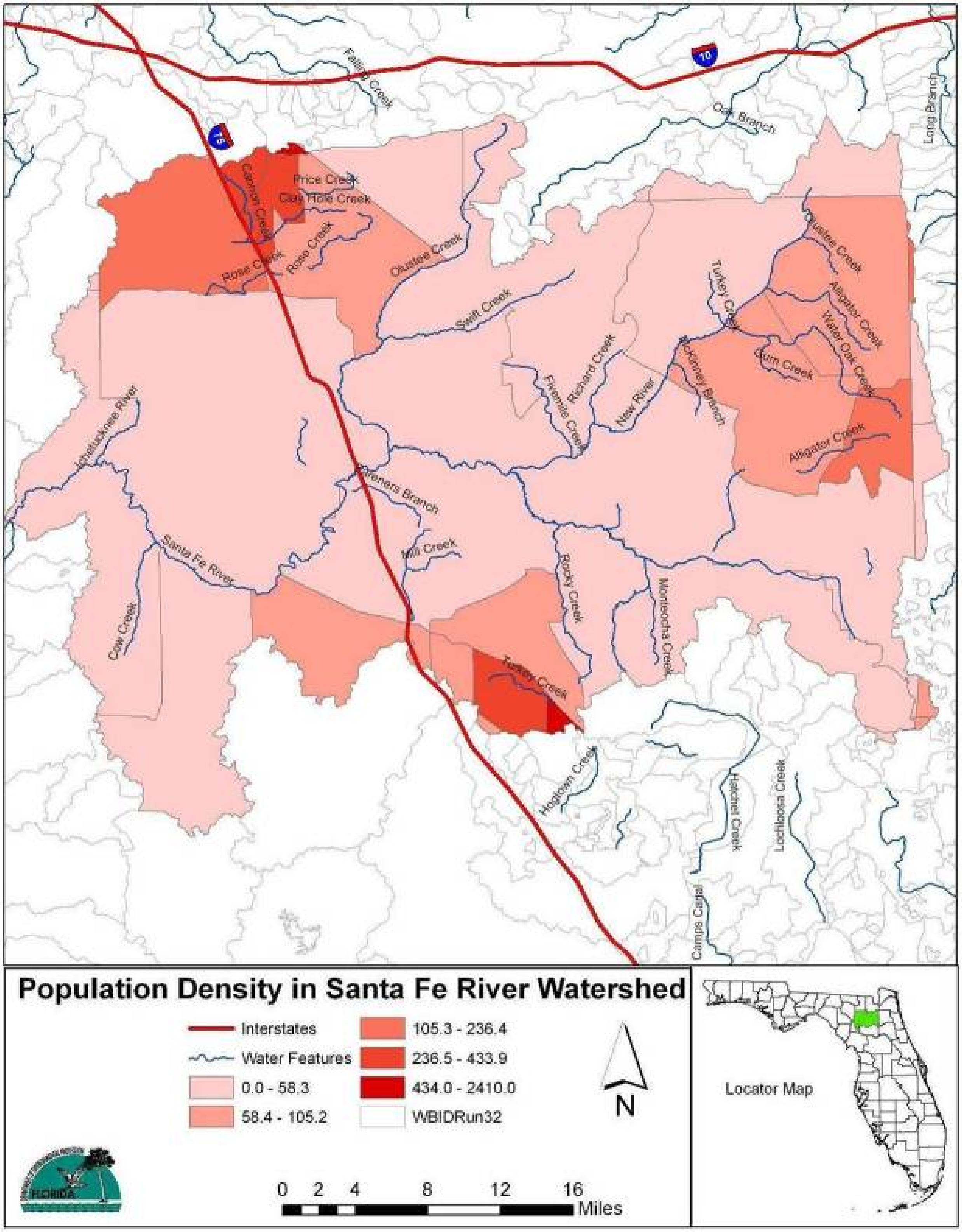


Figure 4.10 Santa Fe Basin Population Density.



4.3.3 Animal Operations

Table 4.5 shows the estimated population sizes of animal operations in the SRB. Table 4.6 provides the estimates of the annual contribution of total nitrogen by human and animal operations (USDA 2007). Using the annual contribution numbers, an estimated equivalent human population of approximately 3,800,000 in the SRB was calculated based on the amount of nitrogen contributed annually.

Table 4.5 Animal Operations 2007 Estimates by planning unit

Planning Unit	Population
	Human (Census 2007)
Middle	66,749
Lower	70,905
Santa Fe	354,268
	Beef Cattle
Middle	30,000
Lower	31,000
Santa Fe	47,500
	Milk Cows and calf
Middle	21,000
Lower	18,000
Santa Fe	4,200
	Poultry
Middle	49,965,391
Lower	79,006
Santa Fe	6,465,663

Table 4.6 Total Nitrogen contribution estimates.

	Population Total	Annual TN contribution (Tons)	Conversion*	Mean wt
Human	491,922	2,424	0.2 lbs. N/1000 lbs. / day	135 lbs.
Milk Cows	58,900	6,772	0.45 lbs. N/1000 lbs. / day	1400 lbs.
Beef Cattle	116,500	5,783	0.34 lbs. N/1000 lbs. / day	800 lbs.
Poultry	56,510,060	4,050	1.10 lbs. N/1000 lbs. / day **	2 lbs.
Estimated Equivalent Human population	3,861,899			

* *ASTM Standard Conversion*

** *Calculated for 6 flocks for 6 weeks or chicken on ground 252 days/year; weight averaged over life*

4.3.4 Agriculture

In 2004 Agriculture amounted to the second largest land use and was approximately 24% of all land use. Table 4.7 show the estimated areas of agriculture uses in the SRB from 2004 land use data.

Agriculture Land Use	Middle Suwannee		Lower Suwannee		Santa Fe	
	Acres	Percent	Acres	Percent	Acres	Percent
Improved Pastures	52,234	32	41,126	43	88,583	49
Hay Fields	40,127	25	17,882	19	6,965	4
Field Crops	21,627	13	16,711	17	36,985	20
Woodland Pastures	15,413	10	7,687	8	17,161	9
Unimproved Pastures	14188	9	5296	6	20166	11
Row Crops	7964	5	3610	4	6215	3

4.3.5 Land Uses

Table 4.7 shows the changes in land use and the different percentages of use from 1988 to 2004. Differences in acres and total acre can be attributed to different methods of measurement and quantification of land use. In 2004 the largest percentage of land use was upland forests, approximately 30% of which was silviculture, followed by agriculture. Figures 4.4-4.12 show the current land use, population density and the changes over time.

Table 4.7 Acreages and percent acreages of different land use categories for the SRB.

	Middle Suwannee					
	1988		1995		2004	
	Acres	Percent	Acres	Percent	Acres	Percent
Urban and Built Up	7,078	1.1	46,041	7.5	39,305	6.4
Agriculture	207,477	33.6	178,715	29.0	162,035	26.3
Rangeland	162048	26.3	5,969	1.0	17,338	2.8
Upland Forest	179,827	29.2	318,181	51.6	309,527	50.2
Water	5,170	0.8	5,335	0.9	4,485	0.7
Wetland	51,766	8.4	57,618	9.3	77,070	12.5
Barren Land	2,745	0.4	87	0.0	1,768	0.3
Transportation, Communication & Utilities	684	0.1	4,849	0.8	5,268	0.9
Total	616,795		616,795		616,795	
	Lower Suwannee					
	1988		1995		2004	
	Acres	Percent	Acres	Percent	Acres	Percent
Urban and Built up	2,561	0.7	46,171	11.8	32,789	8.3
Agriculture	121,908	31	103175	26.3	96,146	24.4
Rangeland	56,239	14	4,989	1.3	10,226	2.6
Upland Forest	130,088	33	161,004	41.0	172,734	43.8
Water	8,322	2	7,056	1.8	7,948	2.0
Wetland	68,088	17	68,490	17.4	72,266	18.3
Barren Land	4,753	1	48	0.0	894	0.2
Transportation, Communication & Utilities	457	0.1	1,574	0.4	1,688	0.4
Total	392,416		392,506		394,692	
	Santa Fe					
	1988		1995		2004	
	Acres	Percent	Acres	Percent	Acres	Percent
Urban and Built up	20,434	2.3	80,157	8.8	102,838	12
Agriculture	182,780	20.2	198,045	21.7	182,758	21
Rangeland	192,834	21.3	12,505	1.4	26,507	3
Upland Forest	364,852	40.3	458,294	50.1	399,180	45
Water	14,283	1.6	15,652	1.7	14,002	2
Wetland	123,716	13.7	140,363	15.3	149,684	17
Barren Land	3,643	0.4	441	0.05	2,064	0.2
Transportation, Communication & Utilities	1,766	0.2	9,155	1.0	8,757	1.0
Total	904,308		914,611		885,791	

Figure 4.11 Principal land uses in the drainage basin of the Middle Suwannee River.

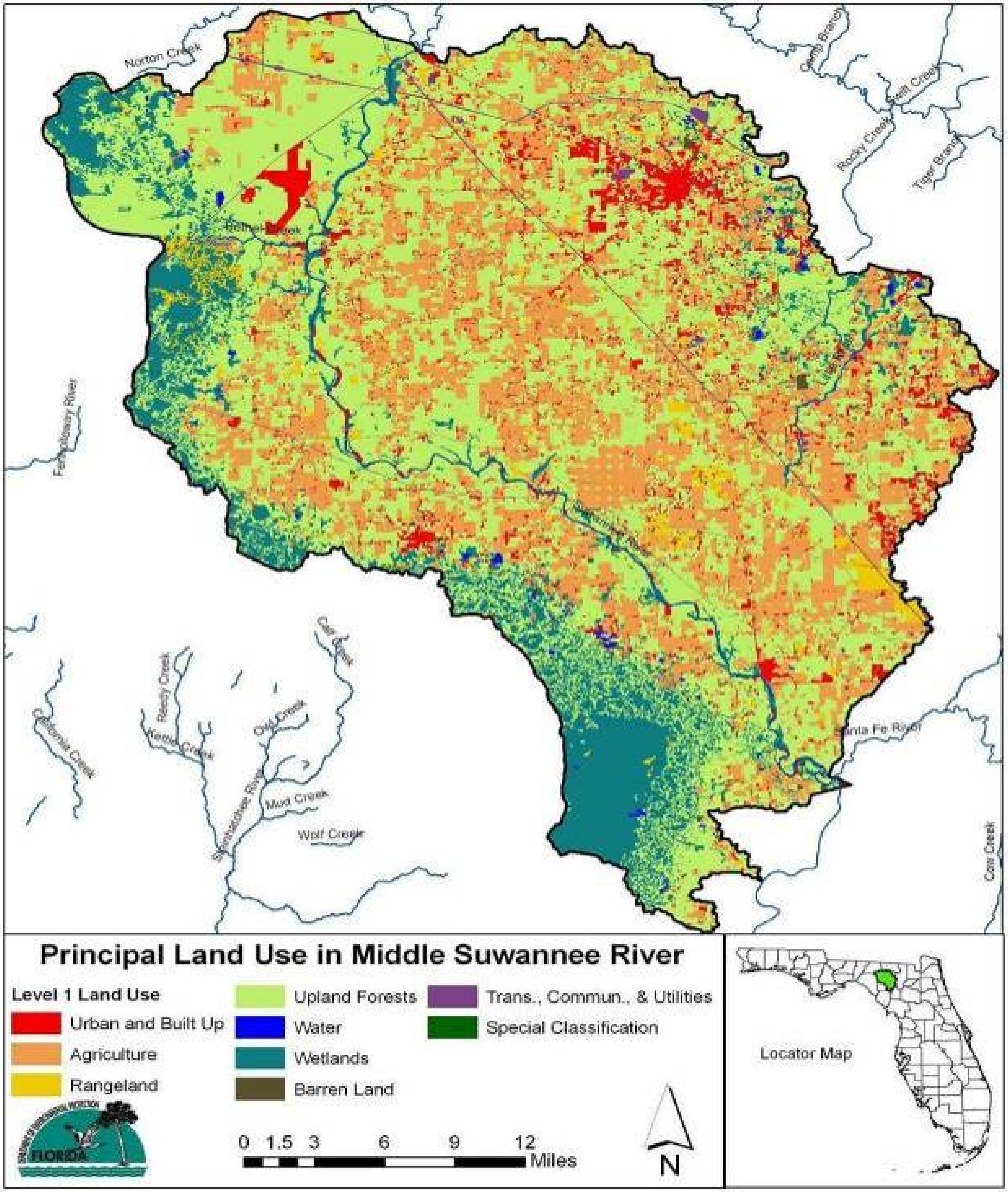


Figure 4.12 Principal land uses in the drainage basin of the Middle Suwannee River.

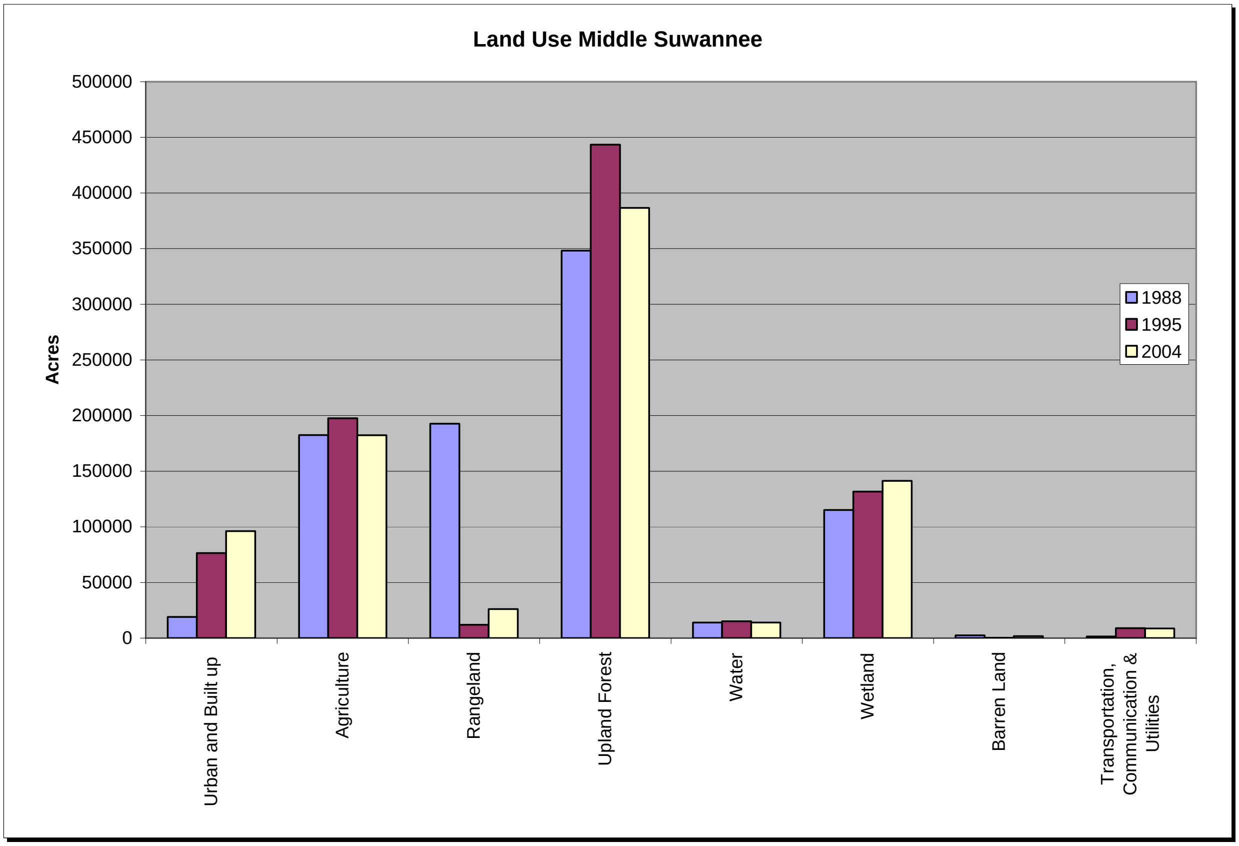


Figure 4.13 Principal land uses in the drainage basin of the Lower Suwannee River.

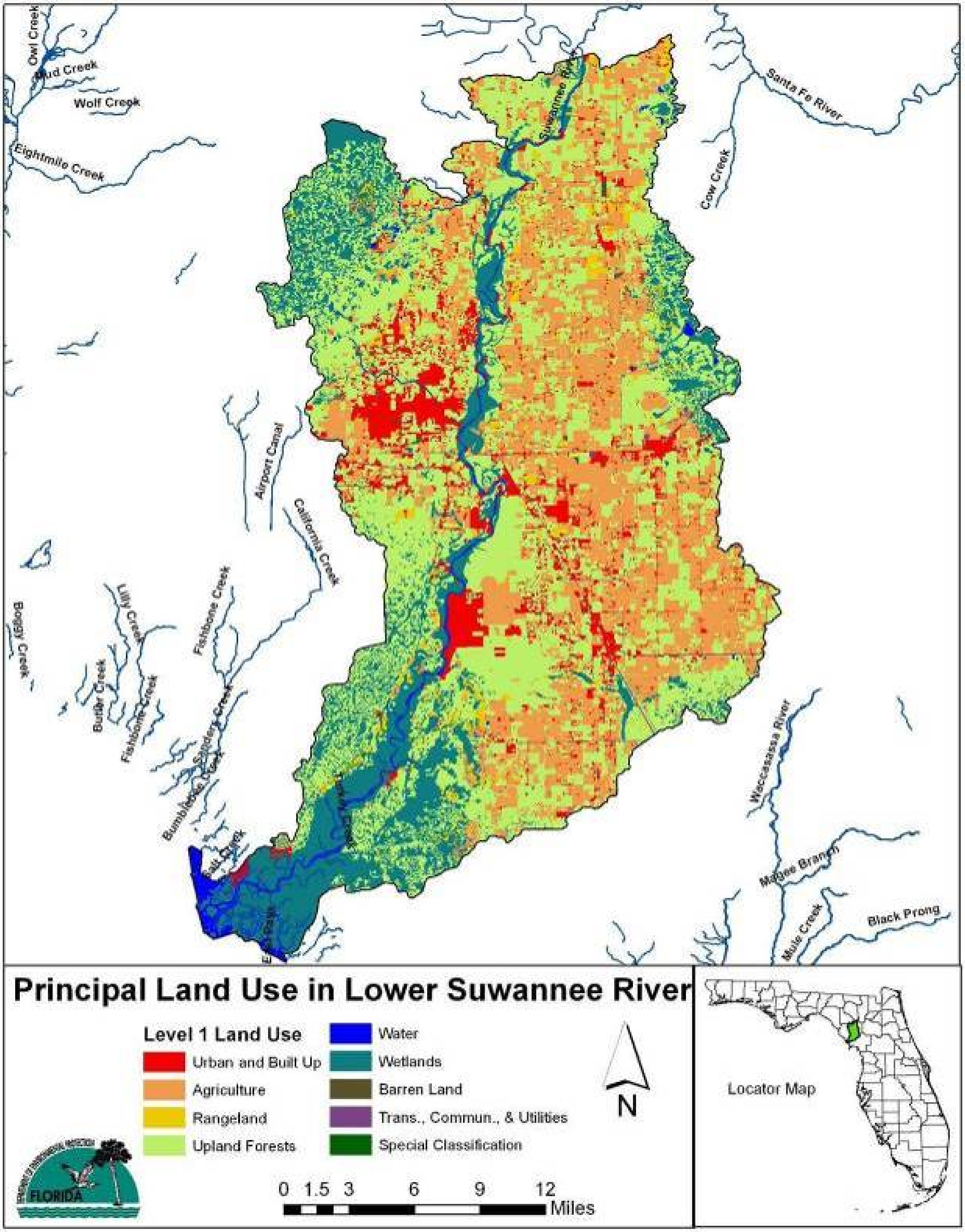


Figure 4.14 Principal land uses in the drainage basin of the Lower Suwannee River.

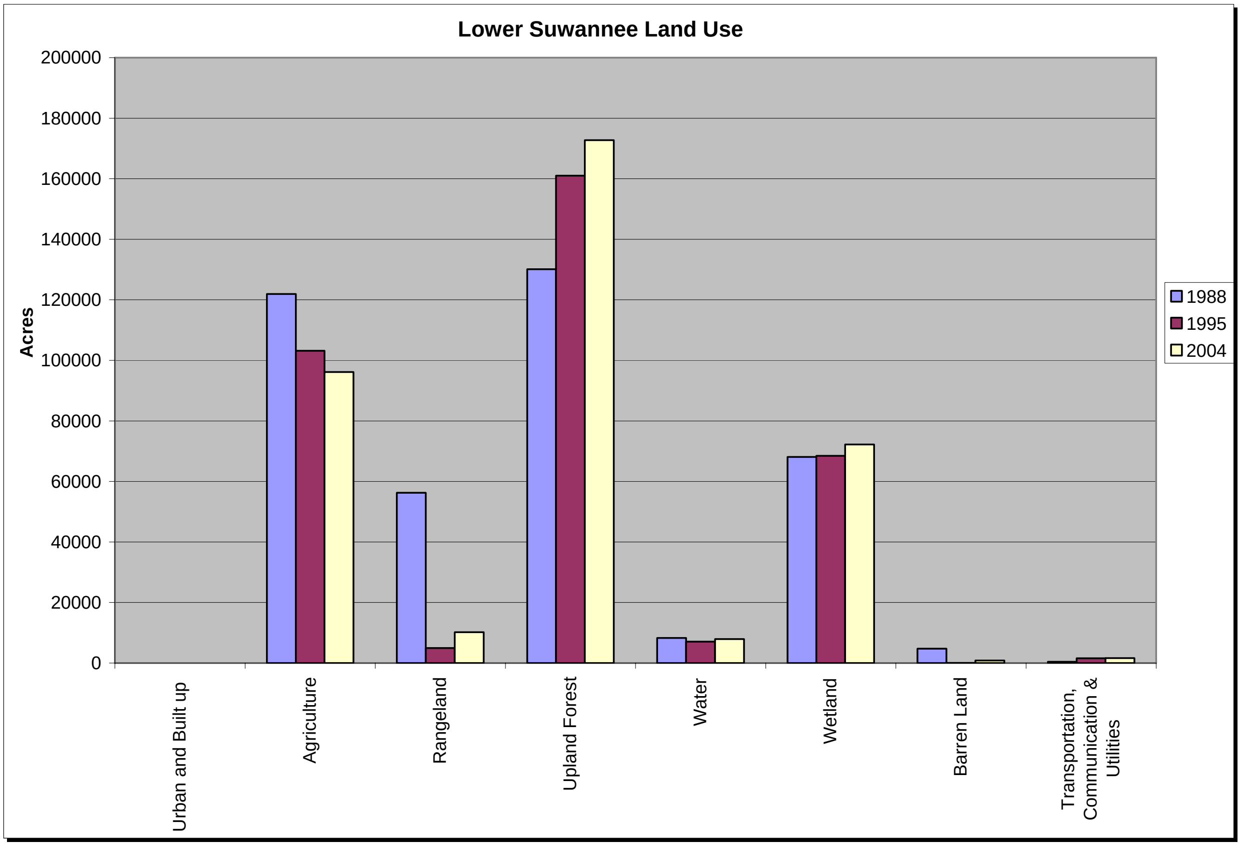


Figure 4.15 Principal land uses in the drainage basin of the Santa Fe River.

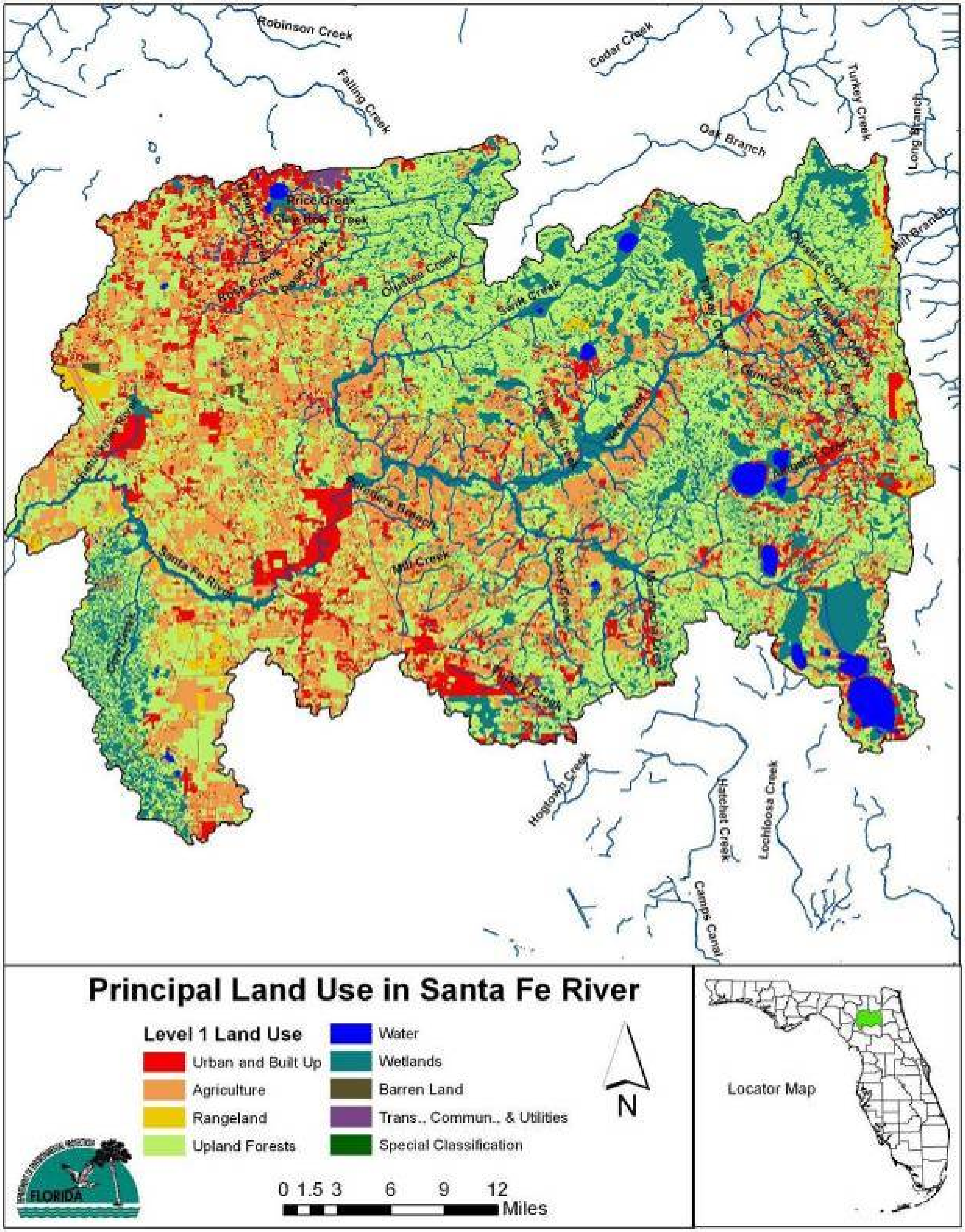
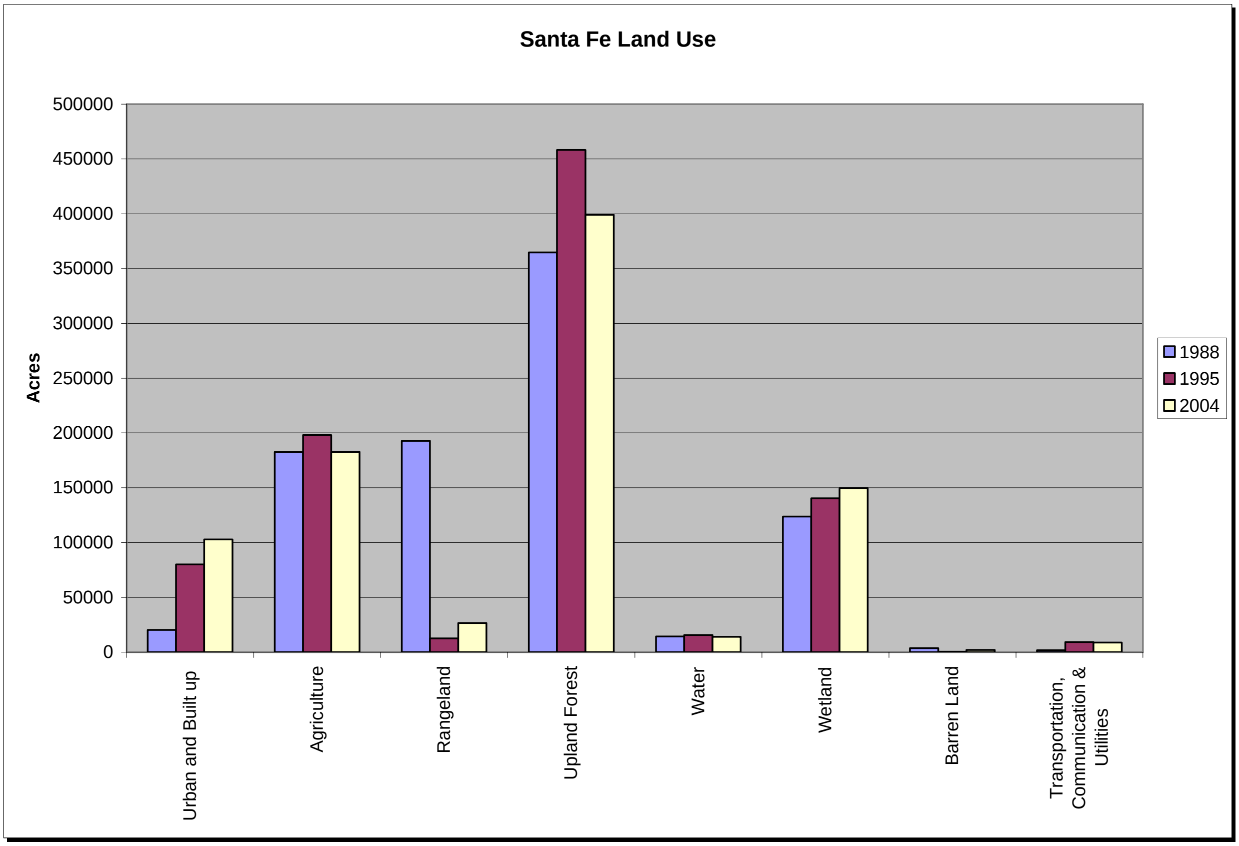


Figure 4.16 Principal land uses in the drainage basin of the Santa Fe River



Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

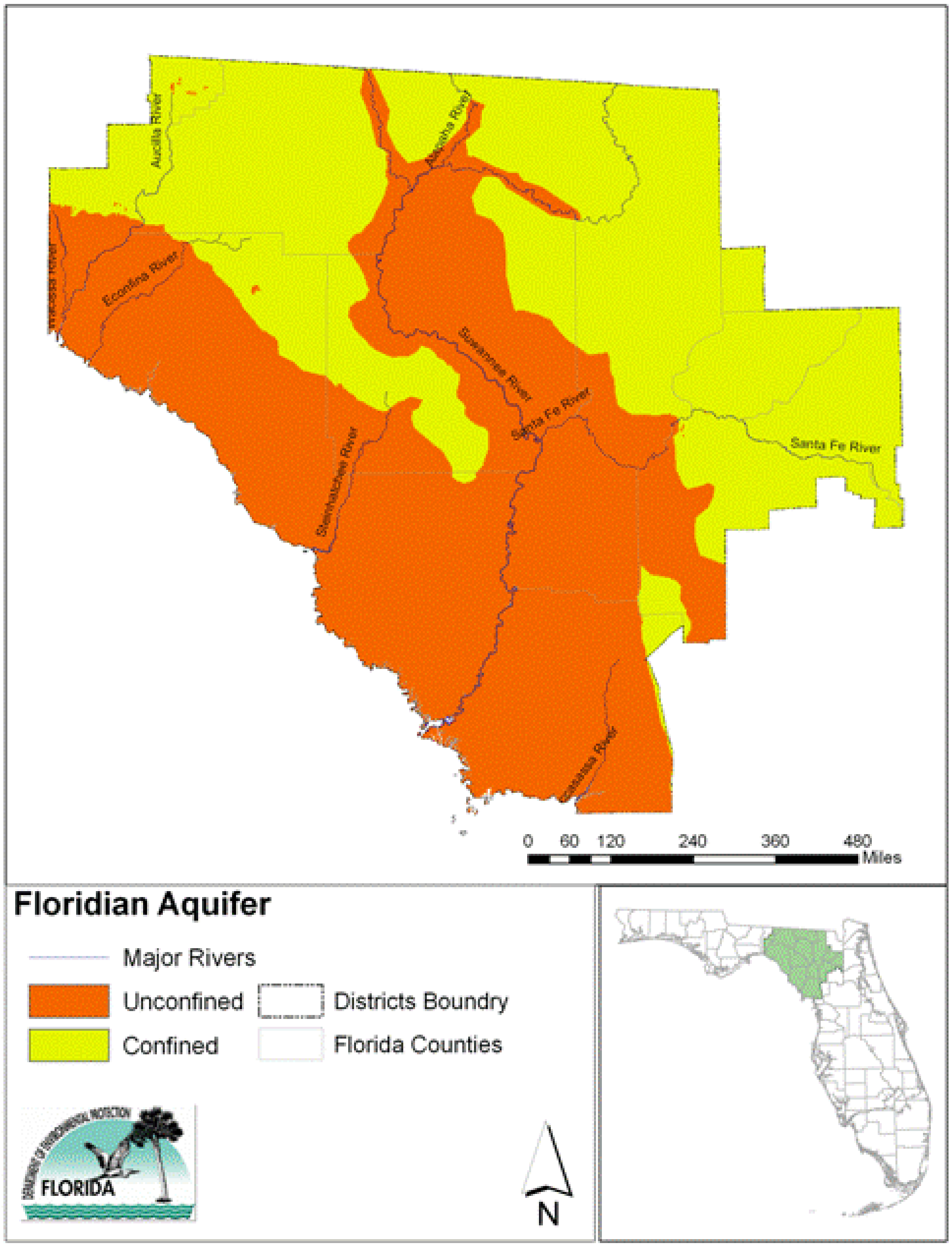
Often the Department will use a hydraulic and water quality model to simulate loading and the effect of the loading within a given waterbody. However, there are other appropriate methods to develop a TMDL that are just as credible as a modeling approach. Such an alternative approach was used to estimate existing conditions and calculate a TMDL.

5.1 Hydrology

A study by the USGS in cooperation with the SRWMD in 1999 found that the porous karst topography of the region has facilitated increased nitrate concentrations in the ground water inflow to the river stemming from increases in anthropogenic activities. “Agricultural activities (cropland farming, animal farming operations (beef and dairy cattle, poultry, and swine), along with atmospheric deposition, have contributed large quantities of nitrogen to ground water in the Suwannee River Basin in northern Florida” (Katz et al, 1999).

In the SRB, the Floridian aquifer is both confined and unconfined (Figure 5.1). A layer of clay and then limestone over the confined portion of the aquifer decrease the contribution of rainwater and runoff to the aquifer. In contrast, the unconfined is capable of being recharged directly by rainfall and runoff allowing water soluble contaminants, such as nitrate, to enter the aquifer rapidly.

Figure 5.1 Floridian Aquifer



5.2 Water Quality Over Time

The pre-OFW and post-OFW data were analyzed in a report prepared for the Department in 1999 by Janicki Environmental. The analyses suggested that there has been a statistically significant increase in NO_3 concentrations and loadings since the OFW designation of the Suwannee River in 1979.

On the Suwannee River, the area where the largest increase in nitrate concentration occurs is a 38 mile segment of the Middle Suwannee River Basin from Dowling Park to Branford. In the Santa Fe River the largest increase is from US 441 to State Road 47 (Hornsby 2007). The monitoring site at Branford has a data record for nitrates from 1954 to 2007 (Figure 5.2) and shows an increasing trend in nitrate. The Santa Fe River's lower three WBIDs (3605A, 3605B, 3605C) were combined to show the historic trends in NO_3 (Figure 5.3).

Figure 5.2 Historic Nitrate Data for the Suwannee River at Branford, FL

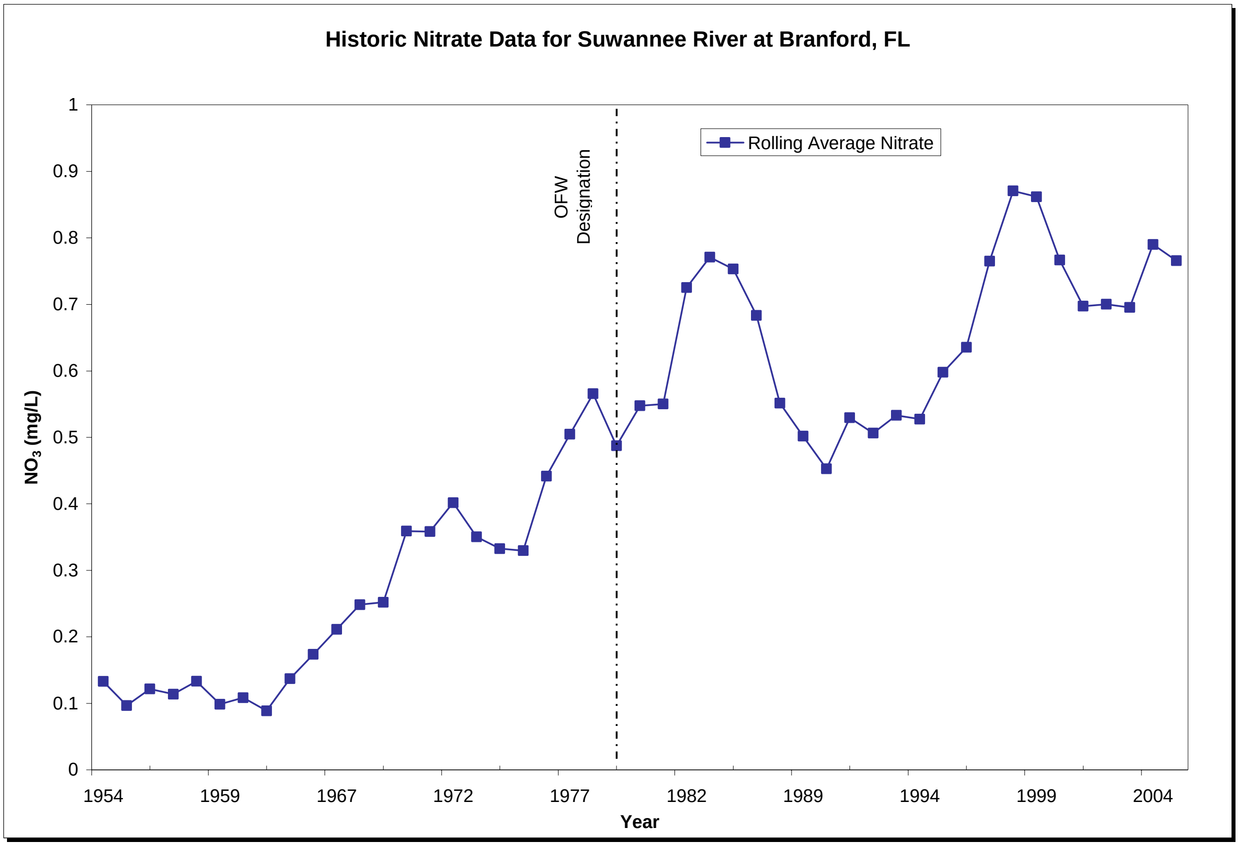
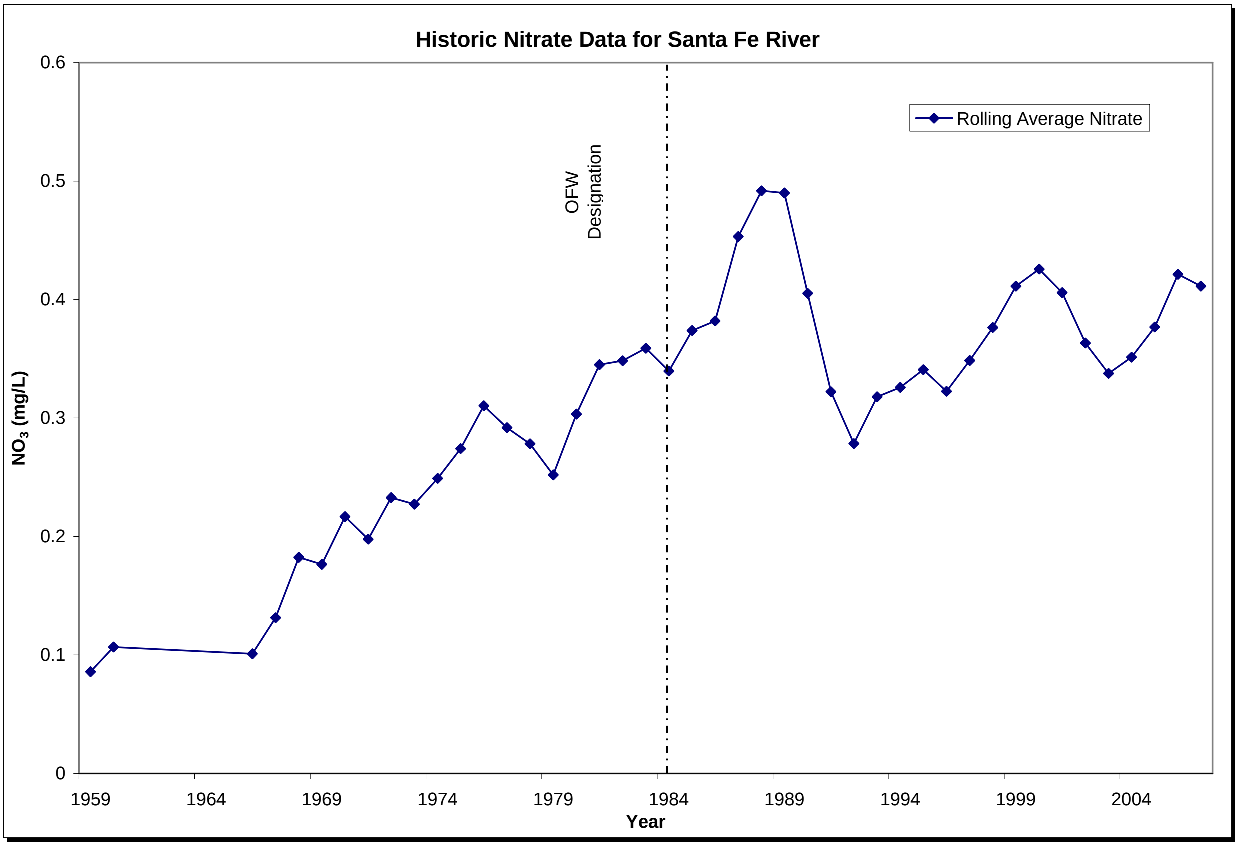


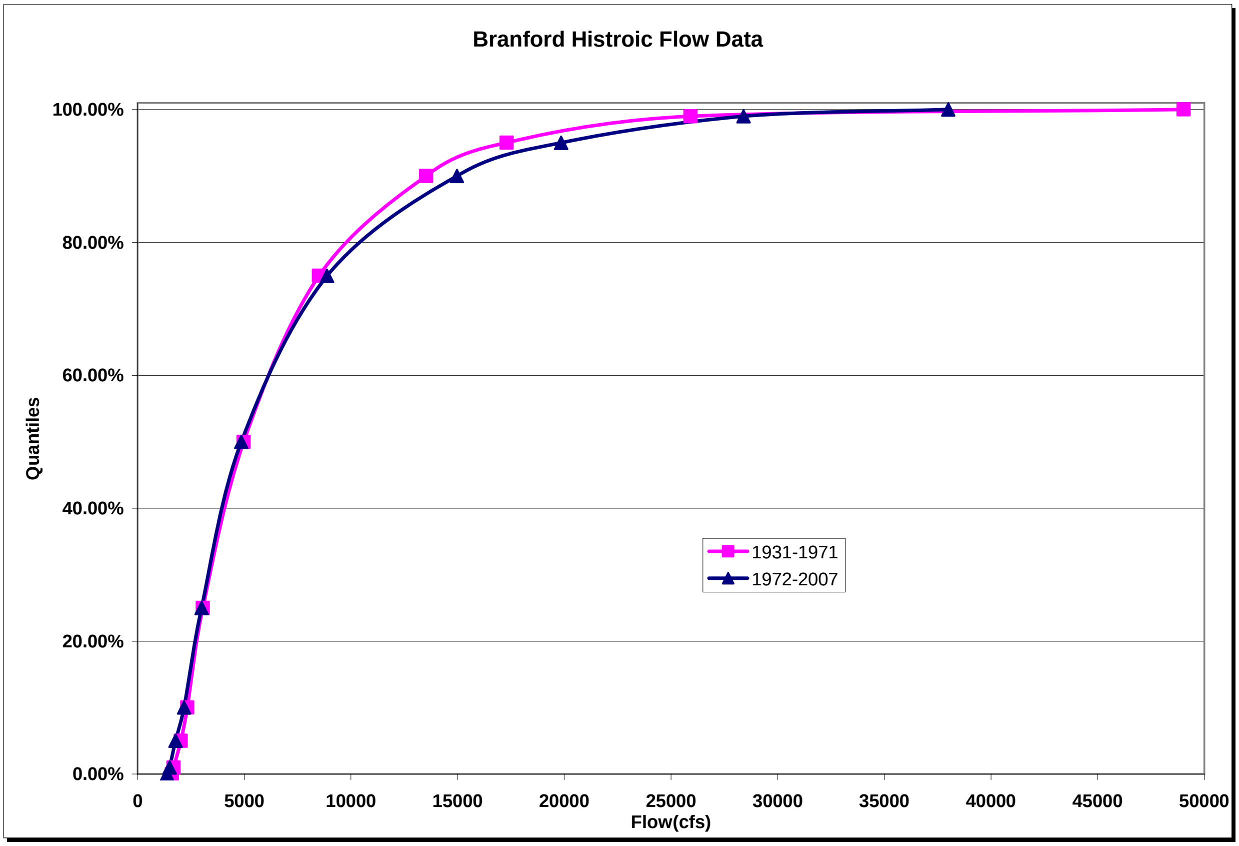
Figure 5.3 Historic Nitrate Data for the Santa Fe River



5.3 Flows over time

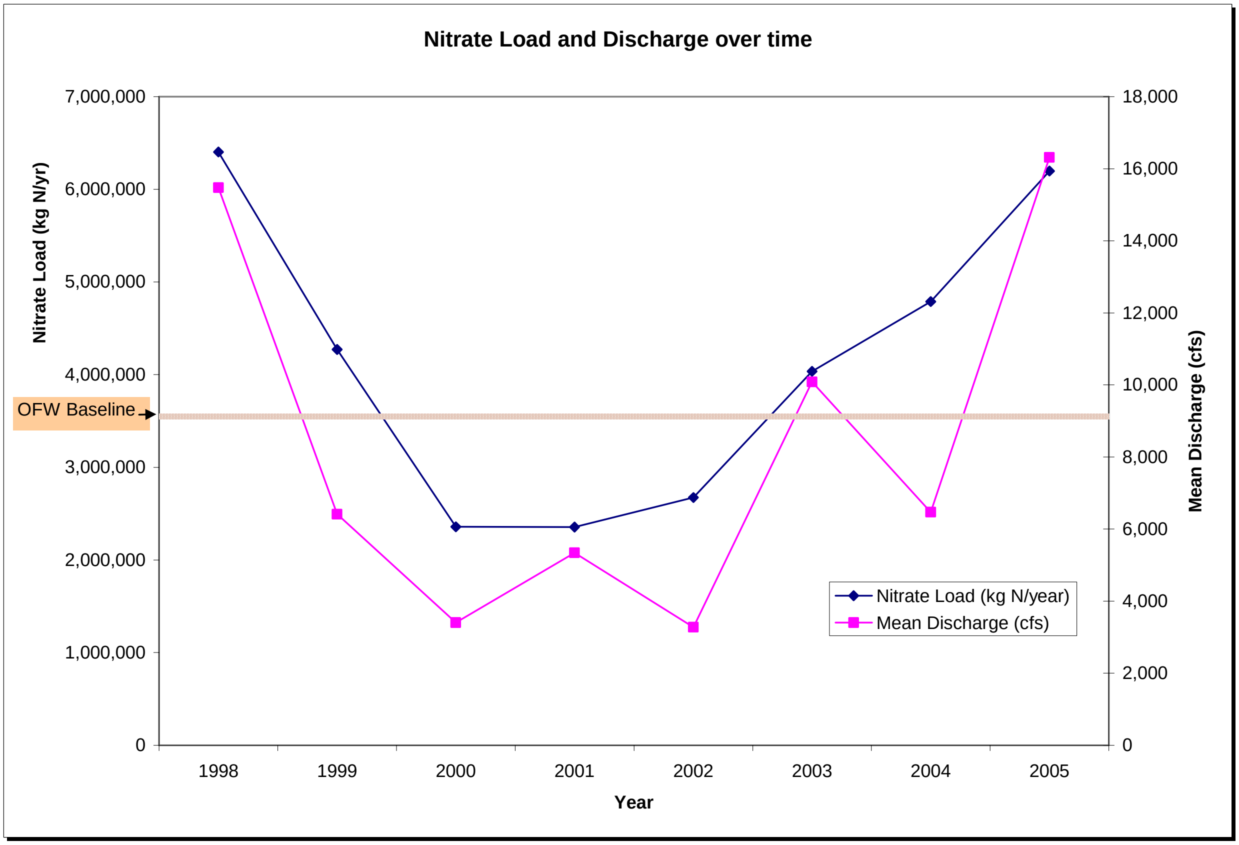
The USGS has flow record at the Branford site from 1931 to 2007. Figure 5.4 shows that the flow has not changed significantly when comparing the cumulative frequency profile for first forty years of the record to the present 36 year record (Figure 5.3)

Figure 5.4 Historic Flow Data Branford FL



Flows have not changed significantly, but loads of nitrate in the OFW baseline (3,548,981 kg N yr^{-1} in 1979) climbed significantly, to as high as 6,197,655 kg N yr^{-1} in 2005 (Figure 5.3). This indicates that the increasing trend of nitrate in the SRB has cumulated in an approximately 75% increase in loading to the Gulf of Mexico (Hornsby, 2007)

Figure 5.5 Nitrates Loads from the Suwannee River to the Gulf of Mexico from 1998-2005 (Hornsby 2007)



5.4 Biological Effects

In 2003, Quinlan found that nutrient loads into the Suwannee River estuary were followed by increased patterns in annual mean algal biomass. “During higher freshwater discharge the nutrient-rich plume extended seaward and phytoplankton biomass increased because of increased nutrient availability.” This same study also found that the most widely limiting nutrient was nitrogen.

5.5 Nitrate (NO_3) Target

The target nitrate concentration for the Suwannee and Santa Fe River Basins was established based on several lines of evidence, including 1) laboratory nutrient amendment bioassays, 2) comparing metabolic rates, specifically, ecological efficiency, of aquatic communities, 3) examining the ecological condition of algae and nutrients in Florida Springs Report, and 4) examining the relationship between periphyton biomass and cell density and the nitrate concentration in SRB and SFRB.

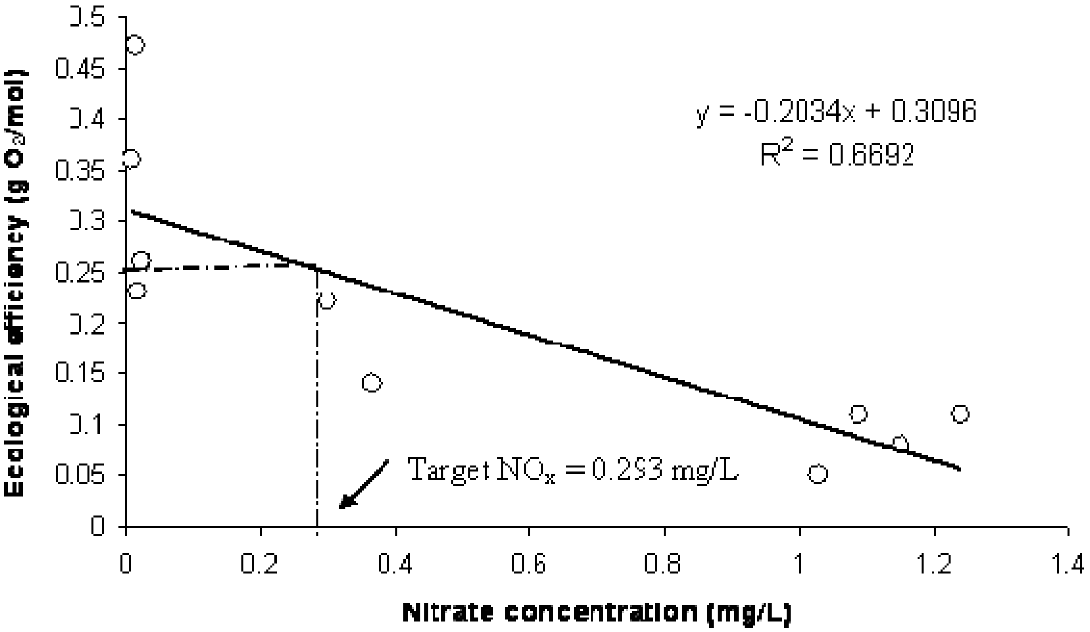
5.5.1 Laboratory nutrient amendment bioassays

The nutrient amendment bioassay work was conducted by Cowell and Dawes (2004), who examined the required nitrate concentration in the Rainbow River, Marion County, Florida to achieve a reduction of biomass of *Lyngbya wollei*. *L. wollei* is a nuisance blue-green benthic algal species that dominates the Rainbow River due to elevated nitrate concentrations. Using *Lyngbya* cultures incubated in a series of nitrate amendments, Cowell and Dawes (2004) found that, at the end of the nutrient amendment experiments, both the biomasses and growth rates were low in treatment groups, with nitrate concentration at or below 300 µg/L, while the growth rates and biomass were significantly higher in treatments with nitrate concentrations at or higher than 600 µg/L. In addition, the experiment also showed that the biomass and growth rate in 300 and 70 µg/L treatment groups were similar, suggesting that further reduction of nitrate concentration below the 300 µg/L level probably would not achieve dramatic further reduction of *L. wollei*. A nitrate concentration of 300 µg/L should be appropriate in controlling *L. wollei*.

5.5.2 Relationship between ecological efficiency and nitrate concentration

Wetland Solutions, Inc (WSI, 2005) studied the effects of nutrient concentrations on the community metabolic rates in the Wekiva River (WR), Rock Springs Run (RSR), Alexander Springs Creek (ASC) and Juniper Creek (JC). The gross community primary production, community respiration, net primary production, and ecological efficiency were measured and examined. The community metabolic parameter shown to have a significant functional relationship with nutrient concentrations was ecological efficiency, which is defined as the quotient between the rate of gross primary productivity (GPP) and the incident photosynthetically active radiation (PAR) during a specified time interval. It is an ecosystem-level property that estimates the overall efficiency of an aquatic ecosystem to utilize incident solar radiation. Figure 5.6 shows the correlation between the ecological efficiency and nitrate concentration.

Figure 5.6 Correlation between ecological efficiency and nitrate concentration in WR, RSR, ASC, and JC.

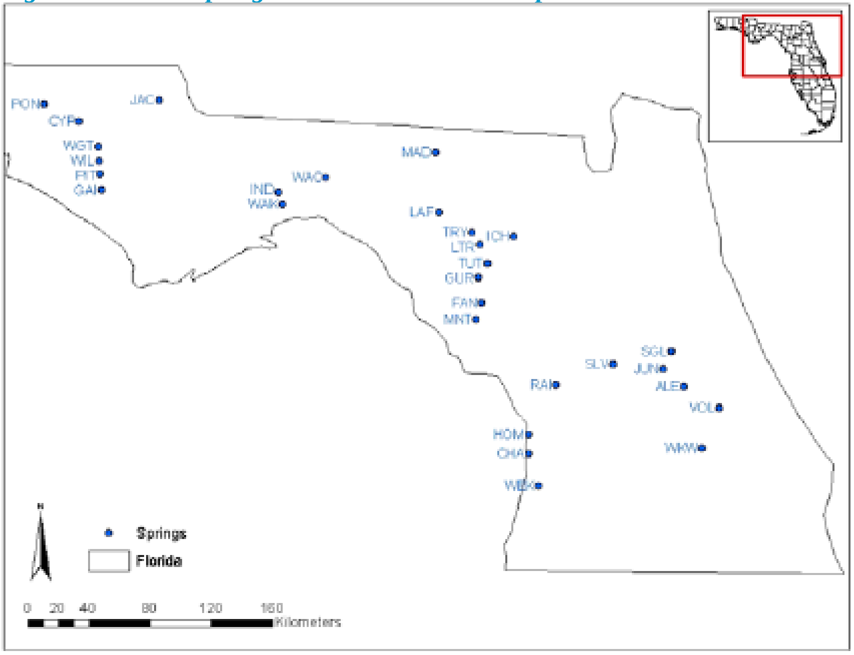


The target ecological efficiency defined using this method is 0.25 g O_2/mol. Using the ecological efficiency – nitrate concentration equation defined in Figure 5.6, the target nitrate concentration is 0.293 mg/L.

5.5.3 Examining the ecological condition of algae and nutrients in Florida Springs Report

The saturating concentration i.e. the nutrient concentration at which growth was predicted to be elevated by 90% above which no effects of nutrient reduction would be expected, for two taxa of common macroalgae that occurred in extensive growth were study in a report for the Department in 2007. Surveys of Florida springs indicated that almost all springs had macroscopic algae growing in them, an average of 50% of the spring bottoms were covered by macroalgae, and the thickness of macroalgal mats was commonly 0.5 m and as thick as 2 m in one spring boil. *Lyngbya wollei* and *Vaucheria* spp. were the two most common taxa of macroalgae that occurred in areas with extensive growths in the studied springs, however 23 different macroalgal taxa were observed in the spring survey. The study involved both field and laboratory components. In the field experiments excessive growth and cover of *Vaucheria* was found at sites with nitrate-nitrite concentrations at or above 0.454 mg/L. In the laboratory experiments, the taxa *L. wollei* and *Vaucheria* spp. were found to have saturating nitrate concentrations of 0.230 (mg/L) and 0.261 (mg/L) respectively (Stevenson et al, 2007). The study included 28 springs through out Florida, including 8 springs in the SRB. The springs were Madison Blue, Lafayette Blue, Troy, Little River, Turtle, Guranato, Fanning, and Manatee Springs (Figure 5.7).

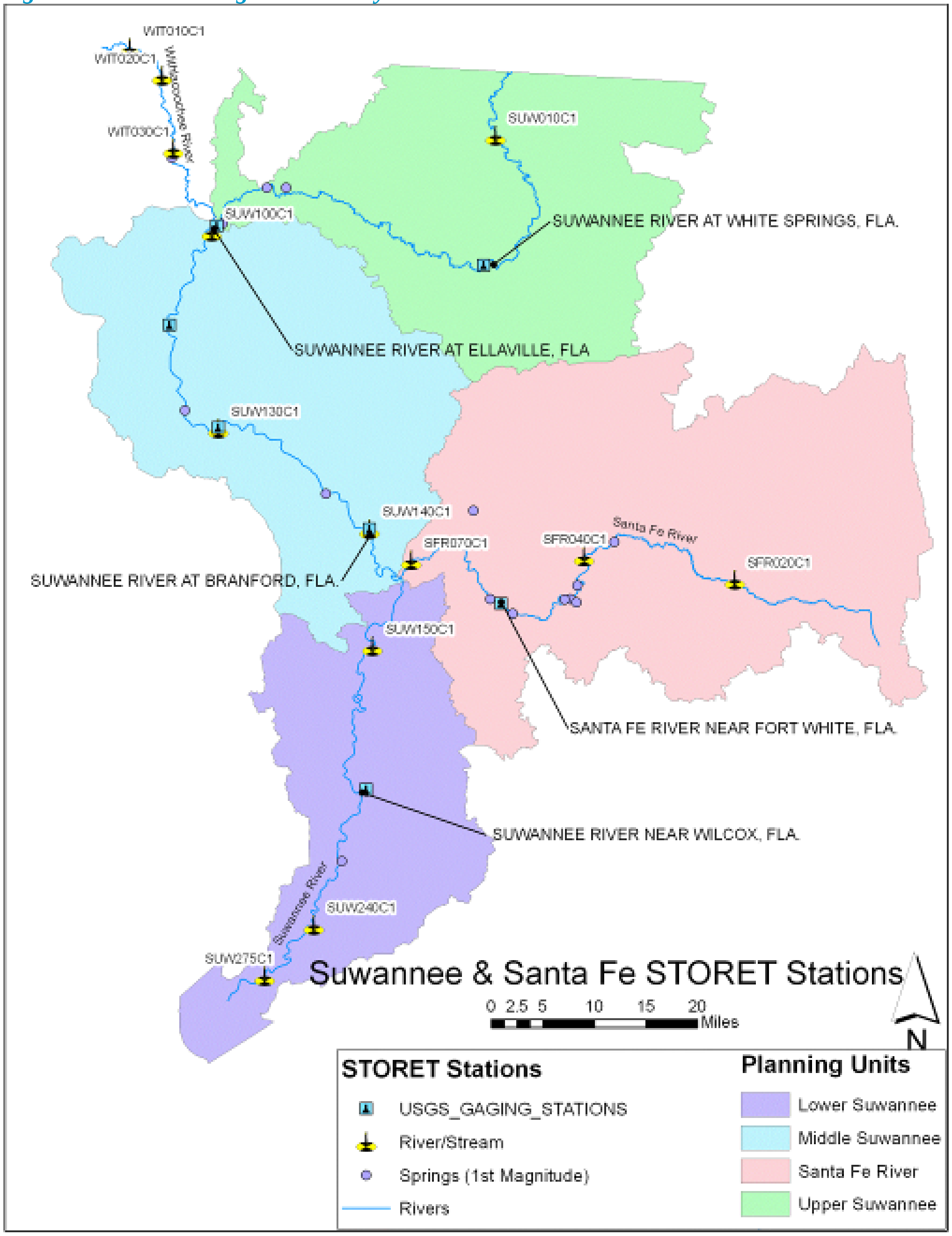
Figure 5.7 Springs included in the 2007 report



5.5.4 Relationship between periphyton biomass and cell density and nitrate concentration

The nitrate target suggested by the Rainbow River study was corroborated by the findings of Hornsby et al. (2000), who evaluated periphyton and water quality data collected from the Suwannee River and two tributaries, including the Withlacoochee River and Santa Fe River. Much of the length of the Suwannee River was heavily influenced by spring inflow. Hornsby et al 2000 showed positive correlations for both periphyton biomass versus nitrate concentration and cell density versus nitrate concentration. The functional relationships of periphyton biomass (represented as ash free dry mass, or AFDM) versus nitrate concentration and cell density versus nitrate concentration are shown in long-term average biomass, cell densities, and nitrate concentrations measured at 13 stations across the Suwannee River system (including the Withlacoochee River and Santa Fe River) (Figure 5.8).

Figure 5.8 Change Point Study Sites



To further define the nitrate concentration that may significantly impact the periphyton biomass and cell density per unit increase of nitrate concentration, the Department contracted with Dr. Xufeng Niu of the Department of Statistics, Florida State University, to conduct a change-point analysis for a dataset of 13 long-term periphyton monitoring sites over the 1990 to 2007 period provided by the SRWMD. The applied method fits a step function through observed data by examining the probability of each data point as the change-point. A nitrate concentration change point was identified (at a 5% significant level) if the change of cell density or periphyton biomass caused by the nitrate concentration was 3.5 times higher (the T-test critical value) than the standard error of the change of cell density or periphyton biomass The identified step-function (the change-point model) was also compared to linear regression and non-linear regression models for its goodness-of-fit and the extent of over-fitting based on the Bayesian Information Criterion (BIC). For both periphyton cell density and periphyton biomass, change-point step functions were shown to be the best model among the models tested. This supports the use of the change-point model identified in the T test. Details of the change-point analyses are provided in Appendix B. For both methods based on these analyses the major changes in mean abundance and mean biomass happened at mean a NO_x around 0.441 (Figures 5.9 and 5.10).

Figure 5.9 Relationship between mean nitrate concentration and mean periphyton biomass from 12 sampling sites on the Suwannee, Santa Fe, and Withlacoochee Rivers

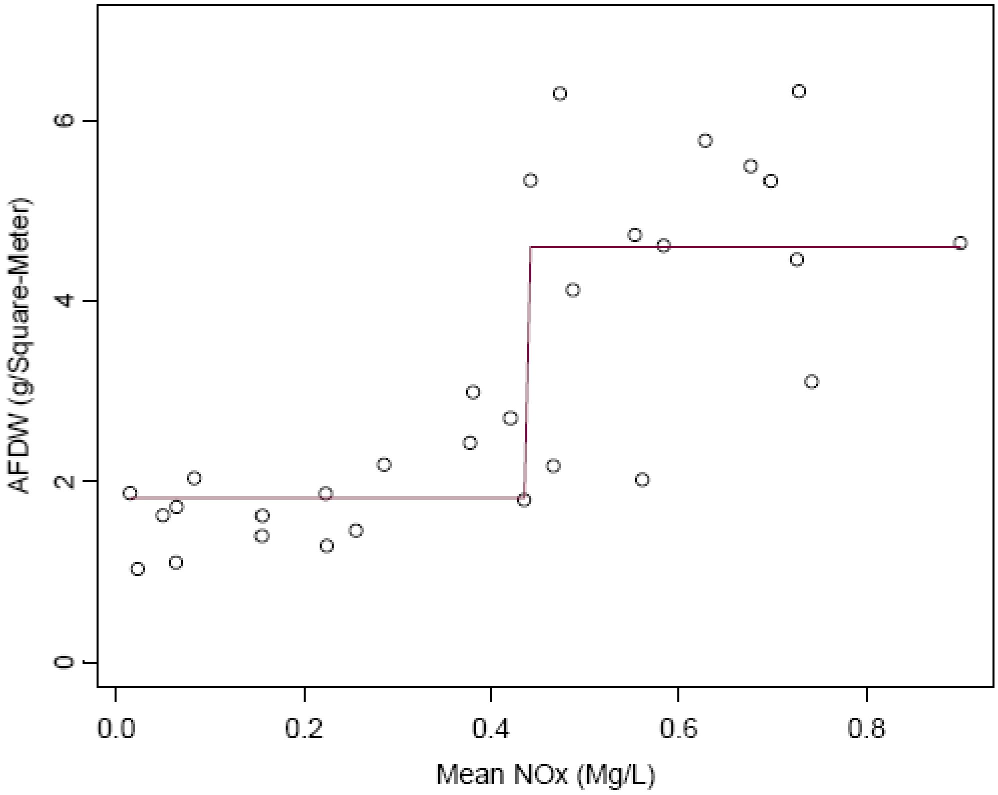
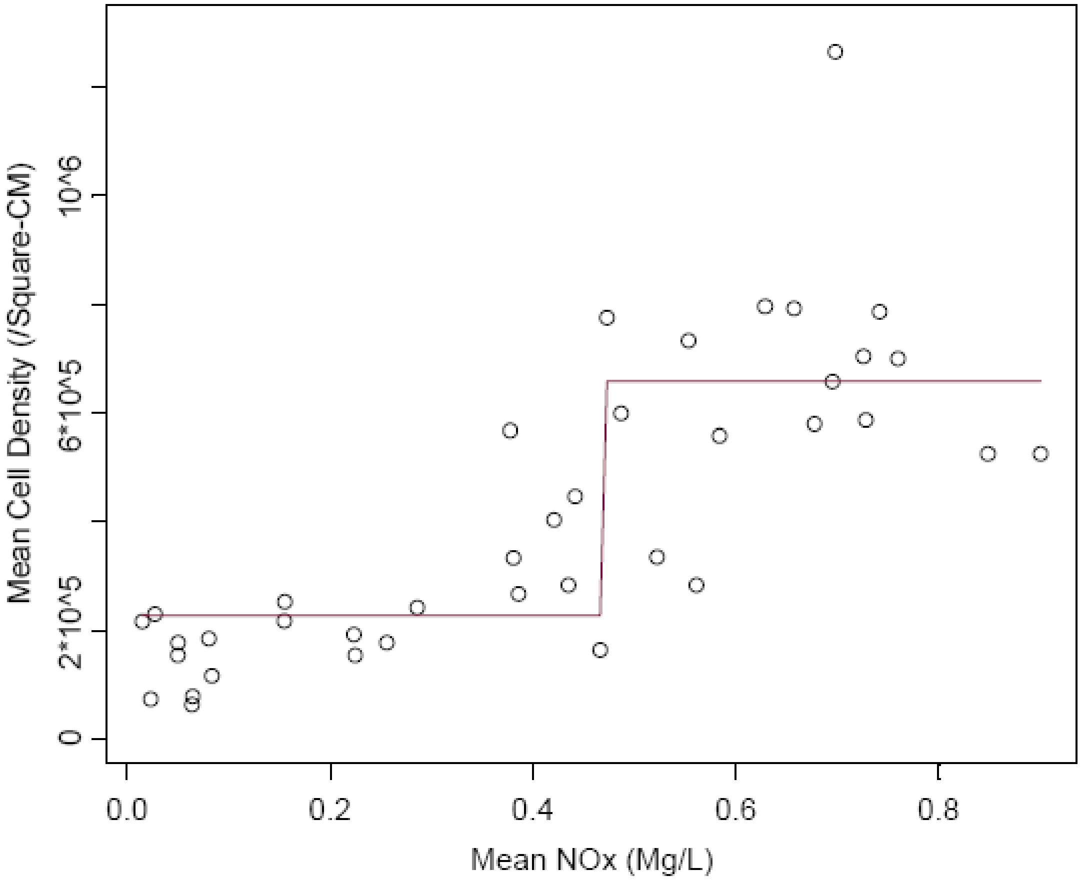


Figure 5.10 Relationship between mean nitrate concentration and mean periphyton cell density from 12 sampling sites on the Suwannee, Santa Fe, and Withlacoochee Rivers



When explaining the functional relationship between cell density and nitrate concentration, the change-point step function identified two cell density levels (Table 2 in Appendix B). One level is about 218,732 cells/cm^2 (P = 0.00), and the other is about 218,732 + 427,894 = 646,626 cells/cm^2 (P = 0.0001). In this study, the 218,732 cells/cm^2 was considered as the baseline condition under which no significant nitrate impact was detected. The nitrate concentration that significantly changed the cell density level from 218,732 cells/cm^2 to 646,626 cells/cm^2 was identified by the change-point step function as 0.441 mg/L (Table 1 in Appendix B), indicating that, to prevent the periphyton cell density from switching to the higher level, the nitrate concentration should not exceed 0.441 mg/L. In addition, based on Table 1 and Figure 1 of Appendix B, the cell density switch occurred when the nitrate concentration reached 0.441 mg/L.

The functional relationship between periphyton biomass and nitrate concentration, the change-point step function identified two biomass levels (Table 4 in Appendix B). One level is about 1.82 g/m^2 (P= 0.00), and the other level is about 1.82+2.97 = 4.79 g/m^2 (P = 0.00). In this study, the 1.82 g/m^2 was considered as the baseline condition under which no significant nitrate impact was detected. The nitrate concentration that significantly changed the biomass level from 1.81 g/m^2 to 4.79 g/m^2 was identified by the change-point step function as 0.441 mg/L (Table 3 in Appendix B), indicating that, to prevent the periphyton biomass from switching to the higher level, the nitrate concentration should not exceed 0.441 mg/L. In addition, based on Table 3 and Figure 4 of Appendix B, the highest observed nitrate concentration that allowed the biomass baseline condition was 0.441 mg/L.

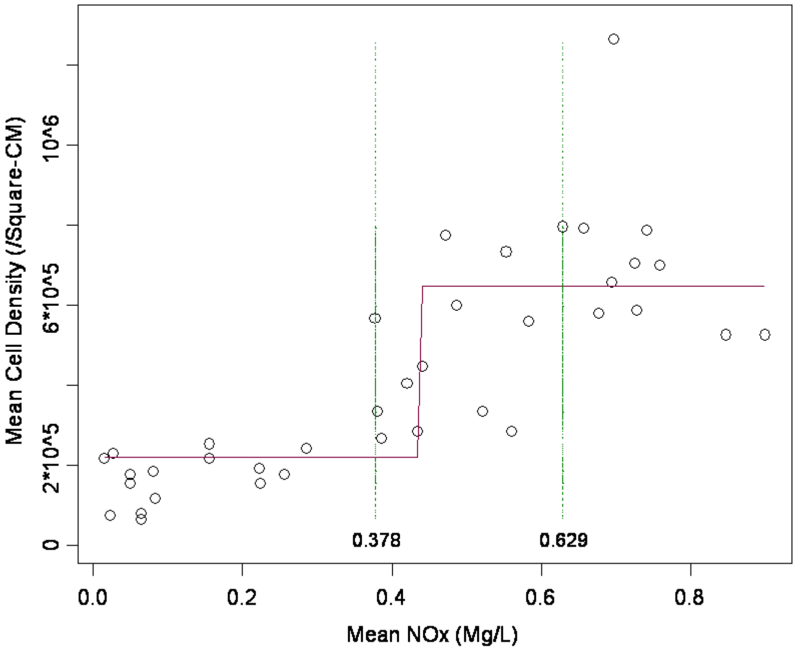
In the Wekiva River Main Stem and Rock Springs Run TMDL, which was adopted by rule June 8, 2008 Chapter 62-304, Florida Administrative Code (F.A.C.) included a change point analysis of the Suwannee periphyton data set fort the 1990 to 1998 period as one of the line of evidence in target setting

5.5.5 Target Setting.

Based on the above lines of evidence, nitrate was primary factor causing elevated growth at levels above 0.230 to 0.263 mg/L. Nuisance accumulations of *Vaucheria* occurred at nitrate-nitrite concentrations at or above 0.454 mg/L. Nitrate concentrations lower than 0.441 mg/L should be appropriate to maintain periphyton cell density and biomass at baseline conditions, respectively. An appropriate target (neither under- nor over-protective) should include a margin of safety to address uncertainty, as well as to sustain environmental conditions below the imbalance point.

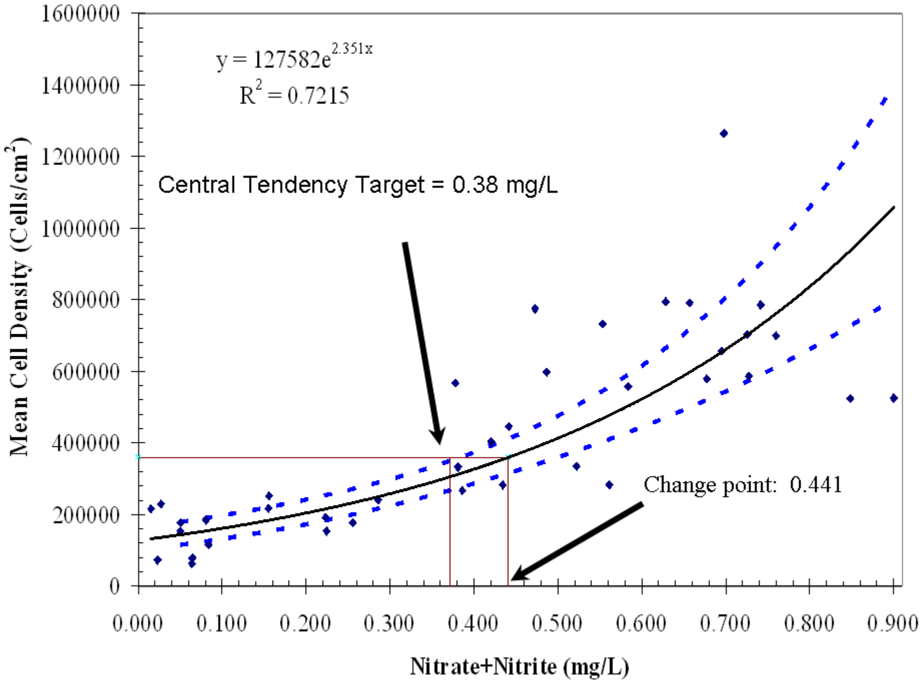
In the change point analysis for mean cell density the mean NO_3 was 0.441 mg/L with the test statistic of 7.68 and confidence level over 95%. The 95% confidence interval for the change point was between 0.378 mg/L and 0.629 mg/L of NO_3 (Figure 5.11), the lower bound being 0.378 mg/L NO_3. It is important to note that the change point analysis provides a concentration of nitrate for which change occurs. The TMDL target must be established at a level that prevents such a change. Given that we are 95% confident that change occurs between 0.378 mg/L and 0.629 mg/L of NO_3, the department must establish the TMDL threshold below that interval as a preventative measure.

Figure 5.11 Change Point Analyses the 95% confidence interval



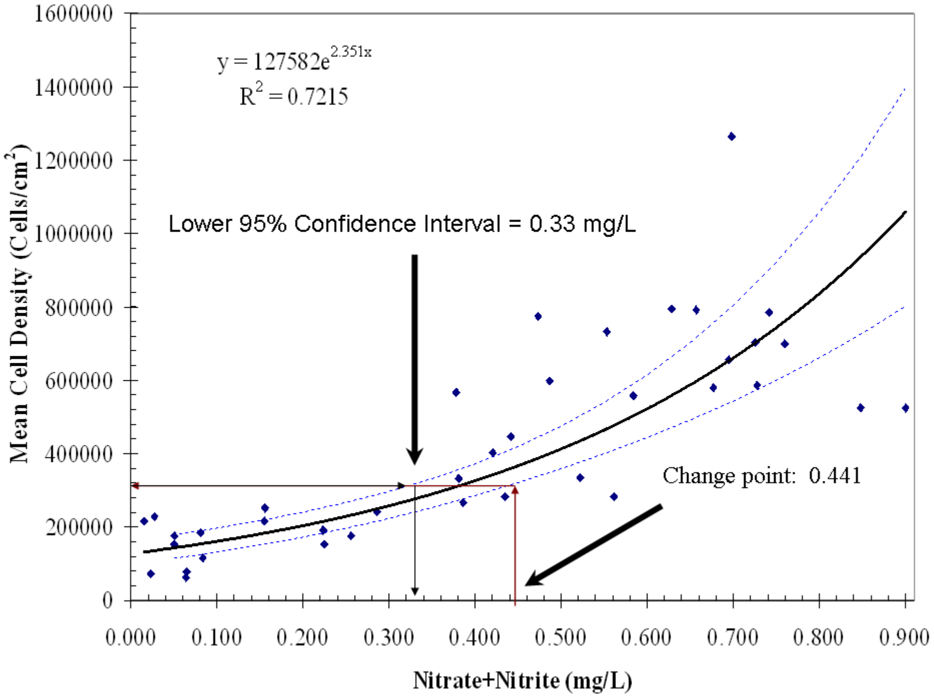
While the change point analysis provided a definitive conclusion that the change in periphyton was related to nitrate, the second part is finding the relationship of nitrate concentration to periphyton. The best relationship between nitrate and periphyton cell density is an exponential relationship, as shown in Figure 5.12. This relationship can be used to define a nitrate target that prevents change. The first approach to finding a target was using the change point of 0.441 mg/L to identify an equivalent cell density concentration relative to the central tendency (an exponential curve R^2=0.72) of the relationship. Once identified, the nitrate concentration prior to the change point can be identified by finding the equivalent Upper 95% Confidence Interval, i.e., a NO_3 value of 0.38 mg/L.

Figure 5.12 Central Tendency and Upper 95% Confidence interval approach



In the next approach the same change point of 0.441 was used to find the lower 95% Confidence Interval of cell density, which helped establish a margin of safety. The relationship between nitrate and cell density has confidence intervals, between which we are 95% confident that the relationship holds. By taking the lower cell density at the change point of 0.441 mg/L, we have targeted a more conservative condition in the waterbody. Once identified, we again used that cell density to identify a nitrate number prior to the change points by finding the equivalent upper 95% Confidence Interval (Figure 5.13), i.e., a NO_3 value of 0.33 mg/L.

Figure 5.13 Upper and Lower 95% Confidence Interval approach.



Considering that the lower confidence interval value of the change point analysis was 0.378 mg/L and the two approaches above found values of 0.38 mg/L and 0.33 mg/L, respectively, an average of the two techniques was used to set the target of 0.35 mg/L.

In conclusion, based on the information currently available, the Department believes that a monthly average nitrate concentration of 0.35 mg/L should be sufficiently protective of the aquatic flora or fauna in the Suwannee and Santa Fe River Basins. A monthly average is considered to be the appropriate time frame as the Suwannee periphyton data set was based on a 28 day deployment and a the response of algae to nutrients is on the order of days to weeks. An elevated pollutant concentration in the system alone does not necessarily constitute impairment as long as there is no negative response from the local aquatic flora or fauna. Based on information provided above, 0.35 mg/L nitrate is the target concentration that will not cause an imbalance in the aquatic flora or fauna in the Suwannee and Santa Fe River Basins. The reductions in NO3 will reduce any pollutant impacts associated on DO. Excessive growth of algae may result in large diurnal fluctuations in DO due to photosynthesis during the day (oxygen production) and respiration during the night (oxygen consumption). The subsequent decomposition of algal biomass also consumes large quantities of DO.

5.6 Effects of independent variables on Nitrate.

Algal growth is related to a number of factors including light, water temperature, available nutrients, and flow. Certain variables may also be highly correlated with each other (positively or negatively). A Spearman correlation matrix was used to assess the correlation between nitrate, algal cell density, algal biomass, and other water quality parameters collected in conjunction with periphyton. Nitrate was found to have the highest correlation to both cell density and biomass with correlations of 0.797 and 0.699 respectively (Table 5.1).

Table 5.1 Spearman Correlation on Cell Density and Biomass

Parameter	Cell Density	P value	Biomass	P value
NO3NO2	0.797	0	0.699	0
ALKALINITY	0.67	0	0.49	0.002
SECCHI	0.591	0	0.382	0.018
FLOW	0.575	0	0.511	0.001
CONDUCTIVITY	0.542	0	0.355	0.029
PH	0.468	0.003	0.346	0.033
DO	0.242	0.143	0.236	0.154
SALINITY	0.131	0.459	0.063	0.723
TN	-0.021	0.9	0.131	0.432
TURBIDITY	-0.104	0.533	-0.065	0.697
NH4	-0.15	0.377	0.114	0.501
TEMPERATURE	-0.174	0.295	-0.18	0.28
TP	-0.211	0.204	-0.098	0.557
TSS	-0.215	0.253	-0.095	0.616
TKN	-0.41	0.011	-0.229	0.168
COLOR	-0.518	0.001	-0.305	0.062
TOC	-0.531	0.001	-0.395	0.014

Multiple linear regressions were performed to understand the functional relationships between the dependent (cell density or algal biomass) and key independent water quality variables. Again nitrate's correlations were the highest when including multiple parameters (Table 5.2).

Table 5.2 Multiple Regression on Cell Density and Biomass

	Cell Density		Biomass	
Variables	Squared multiple R	P value	Squared multiple R	P value
Flow	0.3311	0	0.261	0.001
Color	0.268	0.001	0.093	0.062
Temperature	0.03	0.295	0.014	0.478
NO_3NO_2	0.621	0	0.475	0
Color + Temperature	0.292	0.002	0.096	0.172
Flow + Color	0.513	0	0.311	0.001
NO_3NO_2 + Color	0.622	0	0.528	0
Flow + Temperature	0.513	0	0.283	0.003
NO_3NO_2 + Temperature	0.626	0	0.508	0
NO_3NO_2 + Flow	0.64	0	0.492	0
Flow + Color + Temperature	0.554	0	0.32	0.004
Color + Temperature + NO_3NO_2	0.627	0	0.57	0

Flow + Color + Temperature + NO_3NO_2	0.641	0	0.574	0

Selection of variables to include in a regression analysis may result in misleading conclusions if the interactions between variables (both dependent and independent) are not considered. The General Linear Model can be used to calculate the partial correlations of two variables (*a* and *b*) controlling for the effects of a third (*c*). **Table 5.3** illustrates the correlations after applying the General Linear Model by controlling for the effects of flow, color, and water temperature. Correlation of Nitrate concentration to cell density and biomass independent of flow, color and water temperature was the highest, 0.428 and 0.611 respectively.

Table 5.3 Partial correlation on Cell density and biomass

Parameter	Cell Density	P Value	Biomass	P Value
NO_3NO_2	0.428	0.006	0.611	0
ALKALINITY	0.397	0.35	0.388	0.025
CONDUCTIVITY	0.269	0.242	0.229	0.245
TN	0.147	0.314	0.257	0.111
NH_4	0.015	0.928	0.259	0.121
PH	-0.108	0.386	0.038	0.9
TURBIDITY	-0.323	0.046	-0.207	0.207
TP	-0.389	0.011	-0.168	0.371

5.7 Setting the Monthly Average Concentration for Nitrate

As part of the TMDL process, the Department provides a percent reduction goal in the allocation in order to assist with implementation. Note that the percent reduction can be calculated in many ways and that achievement of the TMDL target (a monthly average of 0.35 mg/L nitrate) may require a different percent reduction depending on when and where the measurements are taken. Achievement of the target equates to achievement of the TMDL. However, in order to calculate the percent reductions required for each planning unit for this TMDL, the monthly value for nitrate was averaged over 1999-2006 and the maximum monthly average was used the as the target for percent reduction (Tables 5.1-5.3).

Table 5.4 $NO_3 + NO_2$ Concentrations (mg/L) in the Main Stem WBIDs over the 1999 - 2006 period, Middle Suwannee River

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1999	0.758	0.313	0.624	0.685	0.735	0.761	0.685	0.656	0.666	0.833	0.671	0.817
2000	0.854	0.773	0.560	0.205	0.623	0.415	0.471	0.419	0.365	0.514	0.884	0.828
2001	0.370	0.426	0.407	0.213	0.596	0.546	0.319	0.289	0.687	0.796	0.841	0.843
2002	0.807	0.716	0.143	0.399	0.609	0.563	0.395	0.503	0.589	0.660	0.509	0.424
2003	0.204	0.620	0.054	0.138	0.538	0.586	0.339	0.355	0.369	0.986	0.528	0.920
2004	0.859	0.209	0.270	0.816	0.837	0.800	0.496	0.553	0.051	0.006	0.496	0.384
2005	0.404	0.581	0.119	0.022	0.350	0.447	0.190	0.190	0.719	0.944	1.021	0.720
2006	0.114	0.079	0.283	0.946	0.881	0.825	0.772	0.659	2.275	0.548	0.821	0.797
Monthly Average	0.546	0.465	0.308	0.428	0.646	0.618	0.458	0.453	0.715	0.661	0.721	0.716
Monthly Reduction	36%	25%	0%	18%	46%	43%	24%	23%	51%	47%	51%	51%
Maximum of monthly averages			0.721									
Maximum Percent Reduction				51%								

Table 5.5 $NO_3 + NO_2$ Concentrations (mg/L) in the Main Stem WBIDs over the 1999 - 2006 period, Lower Suwannee River

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1999	0.943	0.513	0.662	0.960	0.790	0.505	0.360	0.663	0.666	1.000	0.744	0.905
2000	0.951	0.881	0.868	0.415	0.492	0.209	0.504	0.766	0.630	0.658	1.048	0.811
2001	0.510	0.584	0.781	0.244	0.651	0.396	0.463	0.516	0.791	0.690	0.913	0.645
2002	0.796	0.633	0.274	0.395	0.679	0.351	0.388	0.390	0.580	0.526	0.709	0.536
2003	0.269	0.740	0.066	0.136	0.641	0.689	0.565	0.423	0.501	0.850	0.709	1.077
2004	1.080	0.513	0.269	0.805	0.965	0.672	0.643	0.664	0.282	0.128	0.439	0.568
2005	0.456	0.776	0.509	0.106	0.390	0.600	0.771	0.390	0.872	1.233	1.286	0.910
2006	0.893	0.493	0.558	1.005	0.992	0.596	1.222	0.644	0.897	0.856	0.855	0.859
Monthly Average	0.737	0.642	0.498	0.508	0.700	0.502	0.614	0.557	0.652	0.743	0.838	0.789
Monthly Reduction	53%	45%	30%	31%	50%	30%	43%	37%	46%	53%	58%	56%
Maximum of monthly averages			0.838									
Maximum Percent Reduction				58%								

Table 5.6 $NO_3 + NO_2$ Concentrations (mg/L) in the Main Stem WBIDs over the 1999 - 2006 period, Lower Santa Fe River

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1999	0.802	0.570	0.642	0.450	0.370	0.563	0.594	0.483	0.398	0.495	0.553	0.598
2000	0.557	0.498	0.548	0.472	0.473	0.485	0.480	0.397	0.476	0.397	0.542	0.545
2001	0.170	0.472	0.516	0.465	0.335	0.356	0.396	0.338	0.451	0.418	0.473	0.479
2002	0.479	0.440	0.387	0.295	0.409	0.369	0.402	0.431	0.471	0.443	0.395	0.387
2003	0.158	0.377	0.111	0.183	0.477	0.557	0.279	0.276	0.283	0.525	0.570	0.579
2004	0.589	0.550	0.364	0.536	0.437	0.494	0.416	0.454	0.351	0.024	0.456	0.532
2005	0.498	0.633	0.473	0.109	0.378	0.665	0.261	0.392	0.606	0.726	0.655	0.683
2006	0.246	0.402	0.471	0.699	0.639	0.549	0.497	0.529	0.540	0.586	0.563	0.478
Monthly Average	0.437	0.493	0.439	0.401	0.440	0.505	0.416	0.412	0.447	0.452	0.526	0.535
Monthly Reduction	20%	29%	20%	13%	20%	31%	16%	15%	22%	23%	33%	35%
Maximum of monthly averages			0.535									
Maximum Percent Reduction				35%								

Please note that many springs are also being addressed in this TMDL report and that the nitrate target should also be achieved in each of those WBIDs as well. The amount of nitrate data collected in each spring vent is not adequate to calculate a monthly average. However, for information purposes, the table below provides the median nitrate concentrations and the percent difference between that number and 0.35 mg/L (Table 5.4).

Table 5.7 Median NO_3 in Springs within the SRB

WBID	Name	Median NO_3 (mg/L) during the Verified Period (1999-2006)	Reduction form Target (0.35 mg/L)
3422J	BRANFORD SPRING	0.895	61%
3422L	RUTH SPRING	4.55	92%
3422R	MANATEE SPRINGS	1.7	79%
3422S	FANNING SPRINGS	4.6	92%
3422T	TROY SPRING	1.865	81%
3422U	ROYAL SPRING	1.35	74%
3422Z	FALMOUTH SPRING	0.91	62%

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:

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

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

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

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 the loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of BMPs.

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. TMDLs for the Suwannee and Santa Fe River Basins are expressed in terms of concentration of NO_3 (mg/L), and percent reduction of nitrate and represent the maximum long-term nitrate concentration the SRB can assimilate and maintain a balanced aquatic flora or fauna **(Table 6.1**).

Table 6.1 TMDL components for Suwannee River and Santa Fe River Basins WBIDs, shown as related by Planning Units

Planning Unit	Parameter	TMDL	$WLA_{NPDES\ wastewater}$	$WLA_{NPDES\ Stormwater}$	LA*	MOS
Middle Suwannee (WBIDs 3422J, 3422L, 3422T, 3422U, 3422Z)	Nitrate, monthly average	0.35 mg/L	N/A	N/A	51%**	Implicit
Lower Suwannee (WBIDs 3422, 3422R, 3422S)	Nitrate, monthly average	0.35 mg/L	N/A	N/A	58%**	Implicit
Lower Santa Fe (WBIDs 3605A, 3605B, 3605C)	Nitrate, Monthly average	0.35 mg/L	N/A	35%**	35%**	Implicit

*See section 5.6, Tables 5.1-5.3 for description of percent reduction calculation. If the overall TMDL (0.35 mg/L) is the basis for the percent reduction and the percent reduction may be different based on variations in time and space. Achievement of the TMDL constitutes achievement of the percent reduction.
**Springs located in with in the different Planning Units will have varying percent reduction Load Allocations. However, data do not exist at this time to calculate a monthly average (see Figure 5.10)

The percent load reductions listed on **Table 6.1** were established to achieve the monthly average nitrate concentration of 0.35 mg/L. While these percent reductions are the expression of the TMDL that will be implemented, EPA[1] recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard. Daily maximum concentration target for nitrate was established using the following equation[2], which assumes that the nitrate data distributions are lognormal in Suwannee and Santa Fe River Basins:

$$MDL = LTA * \exp(Z_p\sigma_y - 0.5\sigma_y^2)$$

$$\sigma_y = \mathrm{sqrt}(\ln(CV^2 + 1))$$

Where

LTA = long-term average (0.35 mg/L)
Z_p = pth percentage point of the standard normal distribution, at 95% (Z_p =1.645)
σ = standard deviation
CV = coefficient of variance

For the daily maximum nitrate concentration, it was assumed that the average monthly target concentration should be the same as the average daily concentration. Also, assuming the target data set will have the same CV as the existing measured data set and allowing 10% exceedance, the daily maximum nitrate concentrations for Middle Suwannee, Lower Suwannee and Lower Santa Fe Rivers are 1.19, 0.76, and 0.77 mg/L, respectively. The nitrate daily maximum target was chosen as the final daily maximum nitrate target for the Suwannee and Santa Fe River Basins (Table 6.2)**.** The means, STDEVs, and CVs of nitrate concentrations of different water segments are listed in Table 6.2.

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[1] November 2006 U. S. Environmental Protection Agency (USEPA 2006) Memorandum “Establishing TMDL “Daily” Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No.05-5015 (D.C. Cir. 2006) and Implications for NPDES permits.”
[2] EPA, “Options for Expressing Daily Load in TMDL (The Option),” June, 2007.

Table 6.2 Daily maximum for target nitrate concentration (mg/L)

Statistics	Middle Suwannee	Lower Suwannee	Lower Santa Fe
Mean	0.64	0.65	0.48
STDEV	1.055	0.4	0.3
CV	1.64	0.62	0.63
Daily Maximum to achieve long term average (0.35 mg/L)	1.19	0.76	0.77

It should be emphasized that these daily maximum targets were developed for illustrative purposes. Implementation of the TMDL will be based on the monthly average concentration targets.

6.2 Load Allocation

Because no target loads were explicitly calculated in this TMDL report due to the lack of flow data at the outlet of each stream segment, TMDLs are represented as the percent reduction required to achieve the nitrate target. The percent reduction assigned to all the nonpoint sources areas (LA) are the same as those defined for the TMDL percent reduction. To achieve the annual average nitrate target of 0.35 mg/L in the Suwannee and Santa Fe River basins, the nitrate loads from the nonpoint source related to Middle Suwannee, Lower Suwannee and Santa Fe rivers need to be reduced by 51%, 58% and 35%, respectively. The target long-term average is 0.35 mg/L and the percent reduction represent an estimate of the maximum amount of reduction required to meet the target. It may be possible to the target before achieving the percent reductions.

6.3 Wasteload Allocation

6.3.1 National Pollutant Discharge Elimination System Stormwater Discharges

Because no information was available to the Department at the time this analysis was conducted regarding the boundaries and locations of all the NPDES stormwater dischargers, the exact stormwater nitrate loading from MS4 areas were not explicitly estimated. Within the Santa Fe River drainage basin, Alachua County has a Phase II MS4 permit (FLR04E005), the Florida Department of Transportation (FDOT) District 2 holds a Phase II (FLR04E018), the City of Gainesville holds a Phase II (FLR04E006) and the University of Florida holds a Phase II(FLR04E067. The wasteload allocations for each of the MS4s are the same percent nitrate reduction required for the LA assigned to the nonpoint sources in the river segments that belong to each county and municipality.

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 is not responsible for reducing other nonpoint source loads within its jurisdiction.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, February 2001), an implicit MOS was used in the development of this TMDL. The MOS was addressed in several aspects of the analyses. For example, the nitrate target was established based on the most conservative concentration from the four lines of evidence (Section 5.5). Requiring that the 0.35 mg/L target be met every month should result in the nitrate concentration to be even lower than the target concentration during the summer algal growth season based on seasonal analysis on the nitrate concentration, and therefore adds to the margin of safety. In addition, when estimating the required percent reduction to achieve the water quality target, the highest long-term monthly averages of measured nitrate concentrations, instead of average long-term monthly averages, were chosen to represent the existing condition. This will make estimating the required percent load reduction more conservative and therefore add to the margin of safety.

6.5 Recommendations for Further Studies

As described in Chapter 1, the watershed approach is implemented using a cyclical management process that rotates through the state over a 5-year cycle. Following completion of the TMDL phase, subsequent phases involve the development of a basin management action plan and implementation. There are a number of studies that are recommended to improve our understanding of this complex system and ensure that implementation activities are resulting in water quality improvements. Continued work to delineate springsheds and source identification within those springsheds is important. Ongoing development, implementation, and assessment of BMPs will also be critical to the long-term success in improving water quality. In five years when the next assessment cycle of the Suwannee River Basin occurs water quality information collected as part of the monitoring program will be essential.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, referred to as the BMAP. This document will be developed over the next two years in cooperation with local stakeholders, who will attempt to reach consensus on detailed allocations and on how load reductions will be accomplished. The BMAP will include, among other things:

- Appropriate load reduction allocations among the affected parties,
- 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,
- Confirmed and potential funding mechanisms,
- Any applicable signed agreement(s),
- Local ordinances defining actions to be taken or prohibited,
- Any applicable local water quality standards, permits, or load limitation agreements,
- Milestones for implementation and water quality improvement, and
- Implementation tracking, water quality monitoring, and follow-up measures.

An assessment of progress toward the BMAP milestones will be conducted every five years, and revisions to the plan will be made as appropriate, in cooperation with basin stakeholders.

The Department recognizes that this TMDL value still represents a monumental challenge to the local community that will take significant time, coordination, and resources to address. The Department is committed to working with the Suwannee River Water Management District and local stakeholders to address these challenges. A unique advantage in these basins is the existence of the Suwannee River Partnership, a proven organization that has proactively addressed water quality issues over the past 10 years with advances in pollution reduction, scientific understanding, and community awareness. The Department maintains that this Partnership is on the right path and should continue moving in that direction after the establishment of this TMDL. The Partnership will play a significant role the Basin Management Action Plan process.

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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 SWIM plan, other watershed plan, or rule. When applicable, stormwater PLRGs may be 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 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 municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 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/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 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 re-opener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B Change Point Analysis of the Suwannee River Algal Data

Change Point Analysis of Suwannee River Algal Data Based on an Updated Data Set.

Xu-Feng Niu

Department of Statistics
Florida State University
Tallahassee, FL 32306-4330

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I. Background

Per the request of the Wekiva Parkway and Protection Act (WPPA) passed by the Florida Legislature in 2004 (Chapter 369, Part III, FS), the Florida Department Environmental Protection is developing a nitrate Total Maximum Daily Load (TMDL) for the Wekiva River and Rock Springs Run in the central Florida area. Establishing a nitrate target for the Wekiva River and Rock Springs Run is a critical part of the TMDL development. To define this target, a functional relationship between the periphyton abundance and nitrate concentration needs to be characterized. Ideally, the functional relationship would be built upon data collected from the Wekiva River and Rock Springs Run. Unfortunately, because of the limit amount of time available to this project, not enough data were available to establish the relationship in these two waterbodies. Therefore, this study uses nitrate and periphyton data collected from a monitoring network on the Suwannee River, which was established for the Surface Water Improvement and Management (SWIM) program by the Suwannee River Water Management District (Hornsby, et al. 2000). Much of the length of the Suwannee River is heavily influenced by spring inflow, and the algal communities appear to be generally similar in composition to those in the Wekvia River and Rock Springs Run. Therefore, results from the Suwannee River are considered applicable to the Wekiva River and Rock Springs Run (Mattson et al., 2006).

Nitrate and periphyton data were collected from 13 stations across the Suwannee River and two tributaries (Withlacoochee River and Santa Fe River). **Figure 1** (Niu and Gao, 2007) shows locations of these water quality stations. Periphyton abundance was measured as both the cell density (cells/cm^2) and biomass density (ash free dry mass – AFDM/cm^2). Niu and Gao (2007) performed a change point analysis of the Suwannee River algal data collected during the period of 1990-1998 for the purpose of identifying a threshold for nitrate concentration, in which mean periphyton cell density and mean periphyton biomass were treated as response variables and mean nitrate concentration (NOx) was treated as the predictor. The main findings of Niu and Gao (2007) are: 1) for the change point analysis of mean abundance vs mean NOx, one change point was detected at NOx=0.401 that is corresponding to the data at the site SUW100. The change point is significant at the confidence level 95%; 2) for the change point analysis of mean biomass vs mean NOx, one change point was detected at NOx=0.420 that is corresponding to the data at the site SUW130. The change point is significant at the confidence level 95%.

Recently, the Suwannee River Water Management District (SRWMD) provides an updated data set for the 13 stations along the Suwannee River and its two major tributaries (Withlacoochee and Santa Fe). The updated data set covered the period from 1990 through 2007. In this report, change point analysis of the Suwannee River algal data will be performed based on the updated data set. For self-completeness, the statistical methods used in Niu and Gao (2007) will be restated in this report.

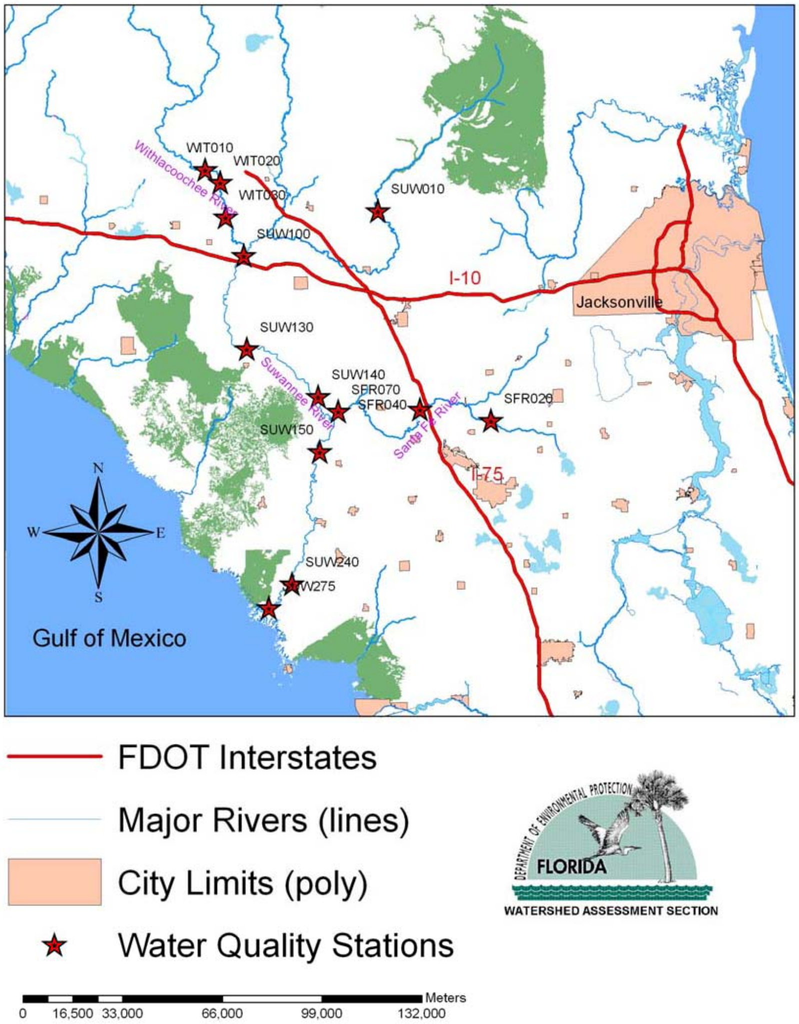


Figure 1. Locations of water quality stations from which measured nitrate and periphyton abundance were used for this analysis.

II. The Detection Procedure

Niu et al. (2000) introduced an iterative procedure for detecting and modeling level-shift change points. Niu and Miller (2007) reported the change point analysis and a model comparison procedure for the Stream Condition Index (SCI) and Biological Condition Gradient (BCG) data. The change-point detection procedure in Niu et al. (2000) is similar to that suggested by Chang (1982) and further developed by Chang et al. (1988) for detecting outliers and level shifts in time series analysis. Statistical details of this procedure can also be found in Pankratz (1991, Chapter 8).

For simplicity, let us consider a response variable Y, after an appropriate transformation. Suppose that observations $\{(X_i, Y_i),\ i = 1, 2, \cdots, n\}$ are available where n is the sample size and X is an independent variable. Moreover, we assume that the observations are arranged in the following manner:

- The values $\{X_i,\quad i = 1, 2, \cdots, n\}$ are distinct. If several Y_i's are corresponding to a single X value, the mean or median of the Y_i's is taken to be the response value for the X value.
- $\{(X_i, Y_i),\ i = 1, 2, \cdots, n\}$ are sorted according to the values of X from least to greatest.

If there exits an integer r $(1 < r < n)$ that split the observations into two groups, $\{Y_1, \cdots, Y_r)$ and $\{Y_{r+1}, \cdots, Y_n)$, such that mean value μ_1 of the first group is different from mean value μ_2 of the second group, we define r as a change-point in the response variable. The procedure introduced in this report will detect whether such a change point exists or not. In other words, this procedure only detects a possible **level shift** of the response variable but not variance changes. If a level shift of the response variable is detected at r $(1 < r < n)$, the corresponding value X_{r+1} is call a change point, i.e., the response variable Y_{r+1} changes into a new level at X_{r+1}.

The detection procedure proceeds as the follows. For each integer $l > 1$, define the step variable $S_i(l) = 0$ for $i < l$ and $S_i(l) = 1$ for $i \geq l$.

Step 1. Fit the linear regression model:

$$Y_i = \beta_0(l) + \beta_1(l) S_i(l) + \varepsilon_i(l), \qquad i = 1, 2, \cdots, n, \tag{1}$$

where for a fixed l, the $\varepsilon_i(l)$'s are assumed to be independent and identically distributed normal random variables with mean zero and variance $\sigma^2(l)$.

Step 2. Calculate the values $\{L(l) = \hat{\beta}_1(l)/se(\hat{\beta}_1(l)),\ l = 2, 3, \cdots, (n-1)\}$ where $se(\hat{\beta}_1(l))$ is the estimated standard error of $\hat{\beta}_1(l)$.

Step 3. Let $L(l_1) = \max\{L(2), L(3), \cdots, L(n-1)\}$ and compare $L(l_1)$ with the critical value C=3.0 (or C=3.5). The critical value C=3.0 (or C=3.5) corresponds roughly to $\alpha = 0.10$ (or $\alpha = 0.05$), or the 10% (or the 5%) significance level, based on the simulation results of Chang et al. (1988). If $L(l_1)$ is significant, we conclude that the response Y has a change point at X_{l_1} with a level-shift $\hat{\beta}_1(l)$.

Step 4. Let $Y_i^* = Y_i - \beta_1(l_1)S_i(l_1)$. Repeat Steps 1-3 on the new response variable Y_i^* for detecting a possible second change point. Continue the process until no further change point can be identified.

Step 5. Suppose that k change points are detected in the response variable Y and the corresponding X values are $\{X_{l_1}, X_{l_2}, \cdots, X_{l_k}\}$. Fit the model

$$Y_i = \beta_0 + \beta_1 S_i(l_1) + \beta_2 S_i(l_2) + \cdots + \beta_k S_i(l_k) + \varepsilon_i, \qquad i = 1, 2, \cdots, n. \tag{2}$$

Then the estimated coefficients $\{\hat{\beta}_1, \hat{\beta}_2, \cdots, \hat{\beta}_k\}$ will be the k estimated level-shift values.

III. Model Comparison

Model (2) fits a step function $\beta_0 + \beta_1 S_i(l_1) + \beta_2 S_i(l_2) + \cdots + \beta_k S_i(l_k)$ to estimate the mean (or median) value of the response variable Y and the predictor variable X. In practice, many other models may be considered to describe the relationship between Y and X. In particular, if the scatter plot of observations $\{(X_i, Y_i),\ i = 1, 2, \cdots, n\}$ shows a straight line or a smooth curve pattern, a linear regression model or a nonlinear smooth-curve model should be fitted to the data instead of the step-function change point model in (2).

For the response variable Y and the predictor variable X, the linear regression model has the form:

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i, \qquad i = 1, 2, \cdots, n. \tag{3}$$

If the relationship between Y and X is nonlinear, many smooth-curve models may be considered. One of the choices is transforming the predictor variable X and fitting a regression model. For example, we may use the natural logarithm transformation log(X) instead of X as the predictor variable and fit the regression model:

$$Y_i = \beta_0 + \beta_1 \log(X_i) + \varepsilon_i, \qquad i = 1, 2, \cdots, n. \tag{4}$$

When different models are fitted to the observations $\{(X_i, Y_i),\ i = 1, 2, \cdots, n\}$, model selection techniques need to be used to decide which model fits the data better. Statistical inferences such as estimation and prediction will then be based on the best model selected. The Bayesian Information Criterion (SBC) suggested by Schwartz (1978) is one of the popular criteria for model comparison. For a fitted model (linear or nonlinear) with *p* parameters, the SBC is defined as

$$\text{SBC(p)} = -2\ \log(\text{maximum likelihood function}) + p \times \log(\text{n}),$$

where the likelihood function is based on the distribution assumption of the model such as normal or log-normal or other distribution families, and *n* is the sample size. When the random errors ε_i's have a normal distribution, the SBC(p) has the simplified form:

$$\text{SBC(p)} = n \times \log\left(\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2 / (n-p-1)\right) + p \times \log(\text{n}), \tag{5}$$

where $\hat{Y}_i$ is the fitted value based on one of the candidate models and $\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$ is the **Residual Sum of Squares (RSS)** based on the fitted candidate model.

Intuitively, there are two parts in (5), the first part is

$$n \times \log\left(\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2 / (n-p-1)\right) = n \times \log \hat{\sigma}^2,$$

which is a measure of the goodness-of-fit of the candidate model. In general, increasing the number of parameters in a model will improve the goodness-of-fit of the model to the data regardless how many parameters are in the **true model** that generated the data. When a model with too many predicators (significant or not significant ones) is fitted to a data set, we may get a perfect fit but the model will be useless for inference such as prediction. In statistics, fitting a model with too many unnecessary parameters is called *over-fitting*. The second part in SBC, $p \times \log(\text{n})$, puts a penalty term on the complexity of a candidate model, which will increase when the number of parameters in a candidate model increases. Thus the criterion SBC requires a candidate model fitting the data well and penalizing the complexity of the model. **For a group of candidate models, the SBC value can be calculated for each of the models and the preferred model is the one with the lowest SBC value.**

IV. Change Point Analysis of Suwannee River Algal Data

1. Mean Abundance (Cell Density) vs Mean NOx

a). Change Point Analysis

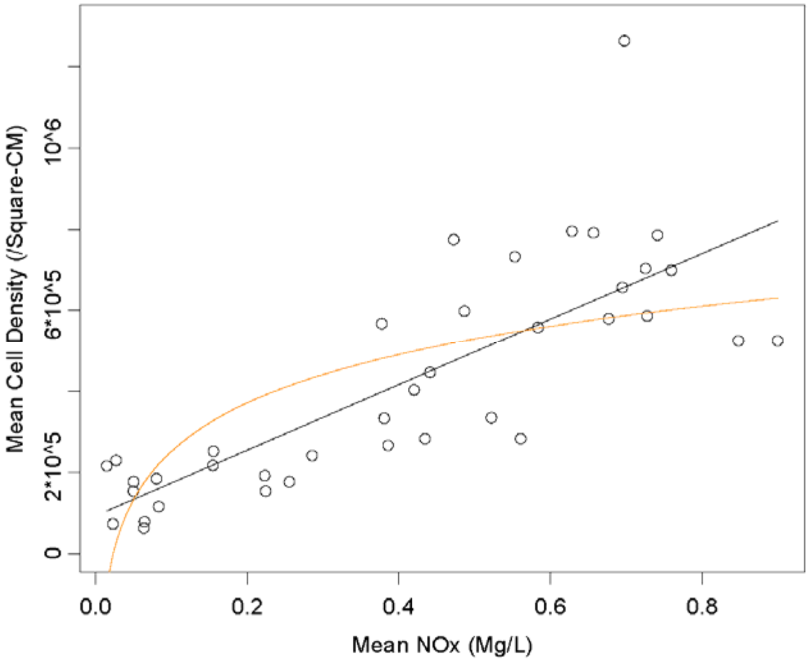
Table 1 presents the mean NOx and mean abundance data at stations along the Suwannee river and its two major tributaries (Withlacoochee and Santa Fe). The data were collected by the Suwannee River Water Management District (SRWMD).

Change point analysis was performed for mean abundance vs mean NOx. When data from the 12 stations are used, one change points was detected at the mean NOx values of 0.441. The change point has the statistic $L(l_1) = 7.68$ and is significant at the 5% level (95% confidence).

b). Model Comparison

For the purpose of model comparison, two other models, a linear regression model and a non-linear regression model, were also fitted to the data with and without the data from the four stations. Figure 3 presents the fitted models.

Figure 3. Linear model (Solid Black) and non-linear model (Mean Cell Density on log(Mean NO)) for data for the 12 stations At the Suwannee River System



The three fitted regression models for data from the 12 stations (SUW275 excluded) are presented in Table 2. The SBC values for the change-point model, the linear regression model, and the non-linear regression model are 923.3, 921.7, and 933.1, respectively. Thus, the linear regression model fits the data slightly better than the change point model. Based on the fitted change-point model, the change point at Mean NOx of 0.441 is extremely significant (with p-values =0.000). The cell density value at the change point increased 427894.7.

Table 2. Fitted Regression Models for Data from the 12 Stations

---

Model 1. Step-Function Regression (Change Point Model) :

```
Coefficients:
                   Value  Std. Error     t value    Pr(>|t|)
(Intercept) 218732.9466  38352.8296      5.7032      0.0000
         x2 427894.7336  55725.3694      7.6786      0.0000

Residual standard error: 171500 on 36 degrees of freedom
Multiple R-Squared: 0.6209
F-statistic: 58.96 on 1 and 36 degrees of freedom, the p-value is 4.316e-009
```

SBC Value: 923.3

Model 2. Linear Regression Model (Cell Density vs MN=Mean NOx):

```
Coefficients:
                   Value  Std. Error     t value    Pr(>|t|)
(Intercept)  92582.7394  49640.7291      1.8651      0.0703
         MN 809357.3381 102090.3640      7.9279      0.0000

Residual standard error: 168100 on 36 degrees of freedom
Multiple R-Squared: 0.6358
F-statistic: 62.85 on 1 and 36 degrees of freedom, the p-value is 2.073e-009
```

SBC Value: 921.7

Model 3. Non-Linear Regression Model (Cell Density vs MN1 = log(Mean NOx)):

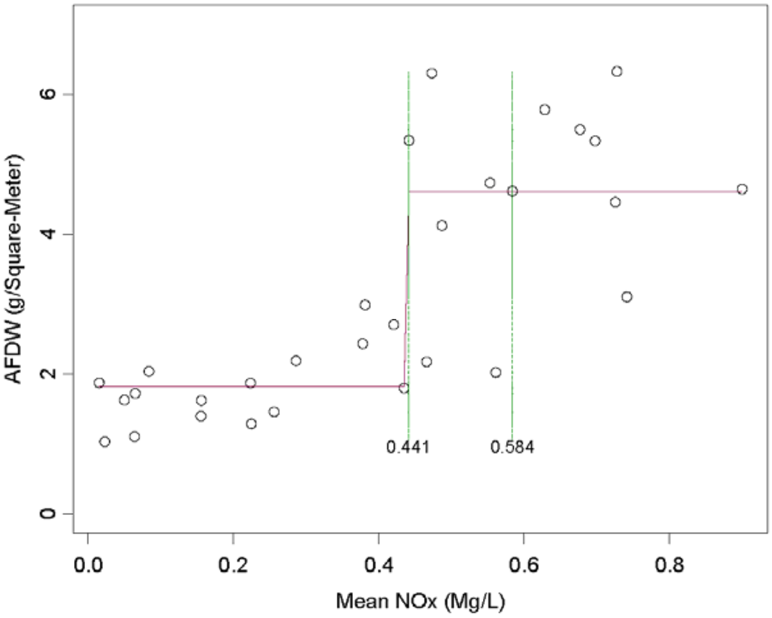
```
Coefficients:
                   Value  Std. Error     t value    Pr(>|t|)
(Intercept) 649141.0952  48888.2774     13.2781      0.0000
        MN1 172786.9495  28267.9784      6.1125      0.0000

Residual standard error: 195100 on 36 degrees of freedom
Multiple R-Squared: 0.5093
F-statistic: 37.36 on 1 and 36 degrees of freedom, the p-value is 4.918e-007
```

SBC Value: 933.1

Figure 4. Change point analysis for data from the 12 stations At the Suwannee River System (Mean Biomass vs Mean NOx).

Change Points: Mean NOx=0.441 with the test statistic of 8.74 and confidence level over 95%.

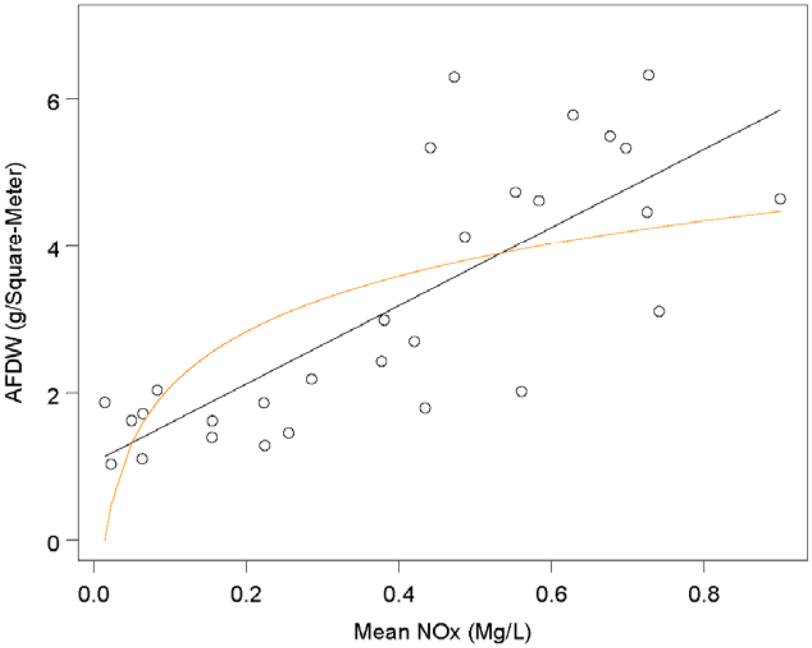
The 95% confidence interval for the change point based on 1000 Bootstrapping samples is [0.441, 0.584] with Bootstrapping average estimate for the change point at NOx=0.464. There were no potential change points at the significance level of $\alpha = 0.05$ detected below NOx=0.441.



b). Model Comparison

For the purpose of model comparison, two other models, a linear regression model and a non-linear regression model, were also fitted to the data from the 12 stations. Figure 5 presents the fitted models.

Figure 5. Linear model (Solid Black) and non-linear model (Mean Biomass on log(Mean NO)) for data for the 12 stations At the Suwannee River System.



The three fitted regression models for data from the 12 stations are presented in Table 4. The SBC values for the change-point model, the linear regression model, and the non-linear regression model are 1.29, 12.74, and 22.03, respectively. Thus, the change-point model was the best model among the three models. Based on the fitted change-point model, the change point at Mean NOx of 0.441 is extremely significant (with p-values =0.000). The mean biomass value at the change point increased 2.97.

Table 4. Fitted Regression Models for Data from all the 13 Stations

Model 1. Step-Function Regression (Change Point Model) :

```
Coefficients:
             Value Std. Error t value Pr(>|t|)
(Intercept) 1.8193 0.2276     7.9931  0.0000
 NOx_0.441  2.9717 0.3400     8.7414  0.0000

Residual standard error: 0.9105 on 27 degrees of freedom
Multiple R-Squared: 0.7389
F-statistic: 76.41 on 1 and 27 degrees of freedom, the p-value is 2.342e-009
```

SBC Value: 1.29

Model 2. Linear Regression Model (Mean Biomass vs MN=Mean NOx):

```
Coefficients:
             Value Std. Error t value Pr(>|t|)
(Intercept) 1.0551 0.3813     2.7671  0.0101
         MN 5.3270 0.8153     6.5335  0.0000

Residual standard error: 1.109 on 27 degrees of freedom
Multiple R-Squared: 0.6126
F-statistic: 42.69 on 1 and 27 degrees of freedom, the p-value is 5.254e-007
```

SBC Value: 12.74

Model 3. Non-Linear Regression Model (Mean Biomass vs MN1 = log(Mean NOx)):

```
Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)   4.5881  0.3821    12.0071  0.0000
        MN1   1.0920  0.2249     4.8549  0.0000

Residual standard error: 1.302 on 27 degrees of freedom
Multiple R-Squared: 0.4661
F-statistic: 23.57 on 1 and 27 degrees of freedom, the p-value is 0.00004498
```

SBC Value: 22.04

3. Summary and Conclusions

In this report, change point analysis was preformed for the algal data at stations along the Suwannee River and its two major tributaries (Withlacoochee and Santa Fe) based on the updated data set. **The main findings in this report are the followings:**

1) **Change point analysis of mean abundance vs mean NOx**. When data from the 12 stations are used, one change points was detected at the mean NOx values of 0.441. The change point has the statistic $L(l_1) = 7.68$ and is significant at the 5% level (95% confidence). The 95% confidence interval for the change point based on 1000 Bootstrapping samples is [0.378, 0.629] with Bootstrapping average estimate for the change point at NOx=0.480.

2) **Change point analysis of mean biomass vs mean NOx.** When data from the 12 stations are used, one change points was detected at the mean NOx values of 0.441. The change point has the statistic $L(l_1) = 8.74$ and is significant at the 5% level (95% confidence). The 95% confidence interval for the change point based on 1000 Bootstrapping samples is [0.441, 0.584] with Bootstrapping average estimate for the change point at NOx=0.464. There were no potential change points at the significance level of $\alpha = 0.05$ detected below NOx=0.441.

Based on this analysis, we conclude that the major changes in mean abundance and mean biomass happened at mean NOx around 0.441. Confidence Intervals for the change point are provided based on Bootstrapping samples. But cautions should be taken for the bootstrapping intervals when the original sample size is smaller than 30.

For the Change point analysis of mean abundance vs mean NOx, the 95% confidence interval for the change point based on 1000 Bootstrapping samples is [0.378, 0.629]. For protection of the environmental and biological conditions at the river system, threshold for NOx should be chosen below the lower bound of NOx=0.378 of the confidence interval.

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Appendix C Historic Fertilizer Sales

Table C.1 Historic Total Nitrogen Sales 1945-1991 (Tons)

	County													
Year	Alachua	Baker	Bradford	Columbia	Dixie	Gilchrist	Hamilton	Jefferson	Lafayette	Levy	Madison	Suwannee	Taylor	Union
1945	672	43	83	389	33	295	334	343	162	401	510	680	45	95
1946	714	46	88	414	35	314	355	364	172	426	542	722	48	101
1947	696	45	86	403	34	306	346	355	168	415	528	704	47	98
1948	626	40	77	363	31	275	312	320	151	374	476	634	42	89
1949	620	40	76	360	30	273	309	317	150	370	471	628	42	88
1950	762	49	94	442	37	335	380	389	184	455	579	772	51	108
1951	943	61	116	547	46	415	469	481	227	563	716	955	63	133
1952	1036	67	127	601	50	456	516	529	250	619	787	1049	69	146
1953	1206	78	148	699	59	530	600	615	291	720	916	1221	81	170
1954	1320	85	162	765	64	580	657	673	318	788	1002	1336	88	186
1956	1561	101	192	904	76	686	777	796	376	932	1185	1580	105	221
1957	1800	116	221	1043	88	791	896	919	434	1075	1367	1822	121	254
1958	1879	121	231	1089	91	826	935	959	453	1122	1427	1902	126	266
1959	1901	123	234	1101	93	835	946	970	458	1135	1443	1924	127	269
1960	2078	134	256	1204	101	914	1034	1060	501	1241	1578	2103	139	294
1961	2177	140	268	1262	106	957	1084	1111	525	1300	1653	2204	146	308
1962	2235	144	275	1295	109	982	1112	1140	538	1334	1697	2262	150	316
1963	2216	143	273	1284	108	974	1103	1130	534	1323	1682	2243	149	313
1964	2350	152	289	1362	114	1033	1170	1199	566	1403	1784	2378	158	332
1965	2547	164	313	1476	124	1120	1268	1300	614	1521	1934	2578	171	360
1966	2686	173	330	1557	131	1181	1337	1370	647	1604	2039	2719	180	380
1967	2518	162	310	1459	123	1107	1254	1285	607	1504	1912	2549	169	356
1968	2785	180	343	1614	136	1224	1386	1421	671	1663	2114	2819	187	394
1969	3265	211	402	1892	159	1435	1625	1666	787	1949	2479	3304	219	461
1970	3461	223	426	2006	169	1522	1723	1766	834	2067	2628	3503	232	489
1971	3317	214	408	1922	162	1458	1651	1692	799	1981	2519	3358	222	469
1972	3613	233	444	2094	176	1588	1799	1844	871	2158	2743	3657	242	511
1973	3802	245	468	2204	185	1671	1893	1940	916	2271	2887	3849	255	537
1974	3840	248	472	2225	187	1688	1911	1959	925	2293	2915	3887	257	543
1975	3394	219	417	1967	165	1492	1689	1732	818	2027	2577	3435	228	480
1976	3990	257	491	2312	194	1754	1986	2036	961	2383	3029	4038	267	564
1977	5260	286	1359	2971	228	2823	2046	1911	1404	3524	4659	5162	0	891
1978	4906	266	1268	2771	212	2633	1908	1782	1310	3286	4345	4814	0	831
1979	5475	297	1415	3093	237	2939	2129	1989	1462	3668	4849	5373	0	928
1980	5279	287	1364	2982	229	2833	2053	1918	1409	3537	4676	5180	0	895
1981	3984	494	349	1935	176	2150	1868	2610	1083	2762	4294	5781	245	769
1982	3773	468	330	1832	167	2036	1769	2471	1026	2616	4067	5474	232	729
1983	3693	458	323	1794	163	1993	1731	2419	1004	2560	3981	5359	227	713
1984	3787	470	332	1839	167	2044	1775	2481	1029	2626	4082	5495	233	731

1985	3417	424	299	1660	151	1844	1602	2238	929	2369	3683	4958	210	660
1986	2538	392	275	1032	58	1183	1243	1923	801	1465	1235	2859	169	523
1987	3190	493	346	1298	73	1487	1563	2417	1007	1842	1552	3594	213	658
1988	2551	394	277	1038	58	1189	1250	1932	805	1472	1241	2873	170	526
1989	2750	425	298	1119	63	1282	1347	2083	868	1587	1338	3098	183	567
1990	2798	432	304	1138	64	1304	1371	2120	883	1615	1361	3152	187	577
1991	2648	409	287	1077	60	1235	1297	2006	836	1529	1288	2983	177	546

Table C.2 Historic Total Phosphorus Sales 1945-1991 (Tons)

	County													
Year	Alachua	Baker	Bradford	Columbia	Dixie	Gilchrist	Hamilton	Jefferson	Lafayette	Levy	Madison	Suwannee	Taylor	Union
1945	426	27	52	247	21	187	212	217	103	254	323	431	29	60
1946	479	31	59	278	23	211	239	245	116	286	364	485	32	68
1947	501	32	62	290	24	220	250	256	121	299	381	507	34	71
1948	415	27	51	241	20	183	207	212	100	248	315	420	28	59
1949	432	28	53	250	21	190	215	220	104	258	328	437	29	61
1950	490	32	60	284	24	215	244	250	118	292	372	496	33	69
1951	544	35	67	315	27	239	271	278	131	325	413	551	36	77
1952	586	38	72	339	29	258	292	299	141	350	445	593	39	83
1953	606	39	75	351	30	266	302	309	146	362	460	613	41	86
1954	612	39	75	355	30	269	305	312	147	365	464	619	41	86
1955	610	39	75	354	30	268	304	311	147	364	463	618	41	86
1956	674	43	83	390	33	296	335	344	162	402	511	682	45	95
1957	745	48	92	432	36	328	371	380	180	445	566	754	50	105
1958	732	47	90	424	36	322	364	373	176	437	556	741	49	103
1959	717	46	88	416	35	315	357	366	173	428	545	726	48	101
1960	722	47	89	418	35	317	359	368	174	431	548	730	48	102
1961	739	48	91	428	36	325	368	377	178	441	561	748	50	104
1962	730	47	90	423	36	321	363	372	176	436	554	739	49	103
1963	731	47	90	424	36	321	364	373	176	437	555	740	49	103
1964	782	50	96	453	38	344	389	399	189	467	594	792	52	111
1965	2547	164	313	1476	124	1120	1268	1300	614	1521	1934	2578	171	360
1966	2686	173	330	1557	131	1181	1337	1370	647	1604	2039	2719	180	380
1967	2518	162	310	1459	123	1107	1254	1285	607	1504	1912	2549	169	356
1968	2785	180	343	1614	136	1224	1386	1421	671	1663	2114	2819	187	394
1969	3265	211	402	1892	159	1435	1625	1666	787	1949	2479	3304	219	461
1970	3461	223	426	2006	169	1522	1723	1766	834	2067	2628	3503	232	489
1971	3317	214	408	1922	162	1458	1651	1692	799	1981	2519	3358	222	469
1972	3613	233	444	2094	176	1588	1799	1844	871	2158	2743	3657	242	511
1973	3802	245	468	2204	185	1671	1893	1940	916	2271	2887	3849	255	537
1974	3840	248	472	2225	187	1688	1911	1959	925	2293	2915	3887	257	543
1975	3394	219	417	1967	165	1492	1689	1732	818	2027	2577	3435	228	480
1976	812	52	100	470	40	357	404	414	196	485	616	821	54	115

1977	1043	57	269	589	45	560	405	379	278	698	923	1023	0	177
1978	1026	56	265	579	44	550	399	373	274	687	908	1006	0	174
1979	1178	64	305	666	51	632	458	428	315	789	1044	1156	0	200
1980	1030	56	266	582	45	553	400	374	275	690	912	1011	0	175
1981	752	93	66	365	33	406	352	493	204	521	810	1091	46	145
1982	693	86	61	336	31	374	325	454	188	480	746	1005	43	134
1983	675	84	59	328	30	364	316	442	183	468	727	979	42	130
1984	712	88	62	346	31	384	334	466	194	494	768	1033	44	138
1985	1057	163	115	430	24	493	518	801	333	610	514	1190	71	218
1986	1032	160	112	420	24	481	506	782	326	596	502	1163	69	213
1987	1432	221	155	582	33	668	701	1085	452	827	697	1613	96	295
1988	1055	163	114	429	24	492	517	800	333	609	513	1189	70	218
1989	1089	168	118	443	25	508	534	825	344	629	530	1227	73	225
1990	1150	178	125	468	26	536	564	872	363	664	560	1296	77	237
1991	1055	163	114	429	24	492	517	799	333	609	513	1188	70	218

Table C.3 1998 to 2007 Fertilizer Sales (Tons)

						MULTIPLE NUTRIENT			ALL FERTILIZERS		
Year	County	TOTAL FERTILIZER	TOTAL SINGLE	TOTAL MULTI	ALL OTHER	TOTAL N	TOTAL P2O5	TOTAL K2O	TOTAL N	TOTAL P2O5	TOTAL K2O
1998	ALACHUA	12,781	3,740	8,637	404	1,171	546	879	2,081	563	1,113
1998	BAKER	3,675	1,436	2,224	13	404	663	90	1,045	664	102
1998	BRADFORD	2,886	479	2,334	72	368	122	320	523	122	323
1998	COLUMBIA	13,964	2,391	11,083	489	1,499	830	1,336	2,032	830	1,505
1998	DIXIE	2,698	235	2,446	16	72	43	58	129	43	58
1998	GILCHRIST	22,906	3,260	19,217	428	2,887	998	1,916	3,489	998	2,016
1998	HAMILTON	7,687	3,121	4,453	112	417	295	749	1,350	295	780
1998	JEFFERSON	13,307	5,647	7,619	41	1,058	710	1,077	2,358	710	1,092
1998	LAFAYETTE	14,023	5,729	8,293	0	1,068	517	1,313	2,241	517	1,729
1998	LEVY	22,365	4,750	14,630	2,984	2,289	782	1,880	3,621	784	1,921
1998	MADISON	9,418	3,470	4,664	1,283	651	283	749	1,528	284	1,016
1998	SUWANNEE	37,979	16,922	19,259	1,796	2,561	1,355	3,303	6179	1370	4775
1998	TAYLOR	1,218	386	831	1	139	211	68	226	211	91
1998	UNION	9,169	2,774	6,356	39	1,119	751	725	1804	753	753
1999	ALACHUA	18,662	5,390	11,859	1,963	1,897	628	1,513	2,995	638	1,911
1999	BAKER	1,913	105	1,769	39	356	377	87	383	377	96
1999	BRADFORD	3,960	1,091	2,831	87	398	133	269	589	133	295
1999	COLUMBIA	5,385	1,229	3,681	978	596	219	997	826	219	955
1999	DIXIE	1,585	69	1,065	950	72	27	93	90	29	95
1999	GILCHRIST	10,690	1,957	7,557	1,175	1,272	320	689	1,675	320	739
1999	HAMILTON	6,793	1,368	5,922	1	565	956	585	922	956	699
1999	JEFFERSON	11,993	9,059	7,818	70	1,057	715	1,020	2,163	715	1,030
1999	LAFAYETTE	6,959	2,892	3,965	101	529	207	592	1,126	208	715
1999	LEVY	31,609	9,887	16,291	10,926	2,809	1,320	2,031	9,195	1,320	2,052
1999	MADISON	7,926	2,708	3,570	1,697	510	226	552	1,239	226	675

1999	SUWANNEE	26,202	11,256	11,858	3,087	1,617	768	1,986	3,726	771	3,006
1999	TAYLOR	1,196	353	805	37	139	210	57	205	210	58
1999	UNION	9,023	2,192	6,597	232	1,179	502	851	1,616	539	869
2000	ALACHUA	26,662.60	4,744.95	20,592.11	1,325.54	2,806.08	1,158.75	1,925.11	4,142.84	1,195.91	2,250.87
2000	BAKER	3,090.66	539.6	2,514.86	36.2	563.88	535.17	172.71	693.04	535.79	303.62
2000	BRADFORD	5,137.27	721.86	4,387.20	28.2	532.6	200.54	375.26	697.59	200.61	386.39
2000	COLUMBIA	8,408.64	2,872.37	5,203.43	332.84	791.79	343.99	794.53	1,686.41	344.99	828.48
2000	DIXIE	5,661.71	900.97	2,845.36	1,915.37	445.38	482.45	284.41	573.4	498.56	627.16
2000	GILCHRIST	13,071.27	3,115.17	8,994.55	961.55	1,251.16	471.3	1,102.84	1,863.71	477.15	1,313.05
2000	HAMILTON	10,983.74	1,884.70	5,973.21	3,125.84	425.52	325.04	705.98	943.07	325.04	771.68
2000	JEFFERSON	11,113.62	3,793.37	7,198.65	121.6	965.1	705.93	1,019.25	1,758.99	726.86	1,027.49
2000	LAFAYETTE	6,783.95	3,516.23	3,232.82	34.9	430.08	252.2	475.76	1,144.97	254.27	547.02
2000	LEVY	19,323.26	3,230.02	12,375.32	3,717.92	2,281.22	897.3	1,467.79	3,279.49	897.4	1,504.51
2000	MADISON	8,801.44	3,492.42	3,826.20	1,482.82	543.62	261.66	591.15	1,443.78	261.91	809.19
2000	SUWANNEE	25,851.61	11,820.71	11,340.19	2,690.71	1,547.15	850.3	1,891.25	3,764.51	852.33	2,985.10
2000	TAYLOR	2,229.70	458.66	1,623.69	147.35	272.41	537.35	68.89	413.79	538.29	69.59
2000	UNION	13,512.84	3,365.69	9,580.77	566.37	1,567.02	1,117.36	1,319.70	2,453.21	1,118.11	1,440.03
2001	ALACHUA	20,005.64	4,088.52	14,839.07	1,078.06	2,275.42	953.34	1,524.39	2,932.95	957.13	1,975.97
2001	BAKER	3,092.87	355.27	2,572.47	165.13	581.53	258.65	201.96	606.99	259.37	346.8
2001	BRADFORD	4,019.25	760.37	1,676.19	1,582.69	270.95	92.84	244.95	426.86	93.54	256.45
2001	COLUMBIA	7,916.65	1,839.24	4,752.24	1,325.17	774.16	300.54	670.31	1,062.57	301.32	689.34
2001	DIXIE	5,139.28	876.52	1,687.85	2,574.90	232.17	182.97	241.77	297.94	199.51	540.73
2001	GILCHRIST	13,680.68	2,646.48	10,504.05	530.15	1,694.74	441.66	1,505.60	2,045.48	441.86	1,901.06
2001	HAMILTON	4,639.82	1,221.10	3,418.72		292.09	246.6	468.34	585.71	249.76	520.57
2001	JEFFERSON	12,194.07	4,146.35	8,003.31	44.41	1,126.05	775.4	1,193.55	2,013.91	781.51	1,239.59
2001	LAFAYETTE	6,762.37	3,250.60	3,382.77	129	467.92	249.35	485.49	849.31	249.81	594.44
2001	LEVY	20,399.59	2,799.72	12,525.82	5,074.06	2,309.19	859.05	1,582.49	2,953.30	860.02	1,609.57
2001	MADISON	8,349.64	2,932.99	4,401.34	1,015.31	633.52	295.91	673.82	1,426.49	295.91	769.14
2001	SUWANNEE	23,851.11	9,711.88	10,444.98	3,694.25	1,332.49	768.72	1,758.33	2,977.85	771.19	2,462.08
2001	TAYLOR	1,822.01	544.09	1,248.53	29.38	202.54	312.98	82.69	369.84	314.26	86.37
2001	UNION	9,656.93	2,198.15	7,394.72	64.06	1,378.33	646.34	932.94	1,788.96	647.77	970.22
2002	ALACHUA	20,080.43	2,928.39	15,291.77	1,860.27	2,015.56	781.74	1,659.21	2,568.35	786.73	1,931.12
2002	BAKER	1,441.70	127.19	1,012.14	302.37	224.06	81.19	84.81	259.75	81.95	93.89
2002	BRADFORD	4,591.10	979.24	3,331.55	280.31	360.3	135.32	229.9	573.24	136.88	260.16
2002	COLUMBIA	7,705.33	1,636.31	5,669.12	399.9	675.22	378.06	1,241.80	1,005.92	378.9	1,312.80
2002	DIXIE	4,976.72	1,028.67	1,750.63	2,197.41	222.91	188.67	302.01	192.28	203.53	681.82
2002	GILCHRIST	20,624.49	3,201.74	17,006.24	416.51	2,704.16	976.69	2,744.04	3,455.84	977.08	2,976.24
2002	HAMILTON	6,014.35	2,006.86	3,952.09	55.4	382.87	303.21	630.85	935.63	303.22	702.72
2002	JEFFERSON	11,821.07	3,672.10	7,897.27	251.7	1,129.52	778.55	1,153.94	2,013.98	799.85	1,192.49
2002	LAFAYETTE	6,839.72	3,077.00	3,511.52	251.2	472	222.34	593.35	996.99	222.35	1,040.15
2002	LEVY	22,831.88	3,499.43	14,209.69	5,122.77	2,222.37	926.85	2,215.00	3,269.09	928.86	2,331.36
2002	MADISON	9,881.17	2,954.91	4,300.51	2,625.75	625.03	241.35	707.07	1,453.08	241.38	764.49
2002	SUWANNEE	25,902.13	11,596.61	11,136.20	3,169.33	1,502.39	832.06	1,899.49	3,720.99	833.71	2,847.64

2002	TAYLOR	2,435.42	1,297.48	1,077.90	60.04	183.12	318.66	66.2	639.38	319.5	69.68
2002	UNION	6,564.75	1,022.01	5,411.96	130.78	1,010.51	443.5	721.4	1,215.74	444.2	741.53
2003	ALACHUA	20,509.71	2,990.79	15,340.13	2,178.79	1,656.53	651.59	1,239.09	2,228.36	657.3	1,509.96
2003	BAKER	2,009.40	597.49	1,294.90	117	250.86	101.97	129.87	444.75	102.54	138.42
2003	BRADFORD	3,981.11	1,191.10	2,613.80	176.2	375.5	132.18	197.18	622.21	132.72	255.63
2003	COLUMBIA	8,426.29	2,265.51	5,763.52	397.27	864.41	368.57	944.63	1,280.97	369.29	1,078.33
2003	DIXIE	4,682.94	453.51	1,994.76	2,234.67	239.46	112.91	259.31	315.03	123.82	340.81
2003	GILCHRIST	20,633.75	3,102.58	15,858.47	1,672.70	2,033.35	722.56	2,383.56	2,585.30	724.87	2,824.91
2003	HAMILTON	6,408.93	2,290.06	4,117.67	1.2	427.02	321.21	649.87	984.39	321.22	829.28
2003	JEFFERSON	12,739.43	3,516.53	8,737.67	485.23	1,241.63	824.3	1,299.87	2,134.68	847.8	1,341.82
2003	LAFAYETTE	6,993.84	2,421.19	3,986.34	586.31	554.18	215.98	638.84	1,036.63	215.98	816.06
2003	LEVY	29,202.91	4,860.48	16,699.40	7,643.03	2,543.42	1,253.56	2,589.33	3,736.76	1,256.30	2,667.93
2003	MADISON	10,547.48	3,290.26	4,795.68	2,461.54	711.59	323.78	791.61	1,575.91	324	927.61
2003	SUWANNEE	27,409.48	13,228.87	11,622.74	2,557.86	1,514.68	819.04	1,940.52	3,963.35	819.55	3,089.99
2003	TAYLOR	1,225.73	526.41	620.17	79.16	90.47	29.36	84.66	255.56	29.53	86.17
2003	UNION	13,114.29	3,963.25	9,014.54	136.5	1,277.80	997.29	1,548.59	2,186.99	997.89	1,630.59
2004	ALACHUA	17710.18	2656.63	11365.42	3688.12	1533.72	609.46	1621.71	2045.12	617.06	1850.77
2004	BAKER	1481.29	120.67	1149.21	211.41	175.93	102.89	147.8	209.67	103.56	153.06
2004	BRADFORD	4199.62	1305.72	2559.45	334.45	324.21	118.61	252.12	565.25	119.5	323.74
2004	COLUMBIA	8858.26	2163.61	5351.2	1343.45	832.69	300.08	730.05	1260.63	301.04	782.47
2004	DIXIE	7152.02	752.63	3287.43	3111.97	373.75	263.65	349.06	502.38	276.49	417.14
2004	GILCHRIST	20870.45	1988.79	14520.8	4360.86	1982.99	807.62	2352.13	2333.24	808.04	2618.73
2004	HAMILTON	6278.84	1862.18	4266.99	149.67	361.45	372.82	677.71	742.97	448.99	741.8
2004	JEFFERSON	12434.2	2896.59	9240.59	297.02	1280.49	923.36	1325.35	2067.58	924.25	1467.61
2004	LAFAYETTE	7904.63	2920.58	4646.6	337.44	617.9	257.18	687.15	1256.13	301.34	988.5
2004	LEVY	26662.24	4604.19	17167.49	4890.56	2578.25	1151.55	2746.35	3659.31	1157.25	3025.11
2004	MADISON	8826.54	2691.61	4366.73	1768.2	661.47	313	729.03	1295.74	313	931.72
2004	SUWANNEE	27980.11	13319.84	11903.25	2757.01	1342.75	891.8	2100.82	3750.73	892.3	3101.04
2004	TAYLOR	701.52	115.2	470.72	115.6	68.2	29.05	67.53	87.09	29.59	70.36
2004	UNION	9053.55	3405.1	5489.06	159.39	806.29	565.21	927.5	1565.38	565.83	1051.69
2005	ALACHUA	18082.63	2795.18	12649.93	2637.52	1690.25	563.48	1422.96	2206.58	569.66	1777.69
2005	BAKER	1530.88	336.58	1144.95	49.35	175.85	77.56	139.1	246.94	78.18	163.37
2005	BRADFORD	2771.33	1219.36	1520.84	31.13	248.1	84.05	202.58	473.39	85.17	301.85
2005	COLUMBIA	9497.09	1861.23	6819.45	816.41	1094.01	443.56	1002.58	1446.57	444.26	1151.86
2005	DIXIE	8759.74	1271.49	2301.27	5186.97	323.34	147.48	342.93	497.77	158.69	407.98
2005	GILCHRIST	20610.94	4273.11	13723.47	2614.36	1882.91	740.47	2340.73	3366.02	740.47	2641.17
2005	HAMILTON	5450.49	1677.58	3764.71	8.2	310.54	338.43	623.34	648.84	397.58	711.3
2005	JEFFERSON	7435.26	2172.84	5005.62	256.81	688.89	497.53	743.38	1278.28	497.67	780.21
2005	LAFAYETTE	6053.96	2641.57	3344.74	67.65	435.97	240.07	633.31	930.26	240.07	896.16
2005	LEVY	23687.33	3839.27	11887.86	7960.2	1698.93	769.24	2071.2	2589	772.97	2404.04
2005	MADISON	8204.55	2066.4	4277.89	1860.26	659.1	320.6	786.24	1131.88	321.5	901.29
2005	SUWANNEE	25867.33	11994.53	10551.05	3321.75	1411.57	808.77	1796.17	3772.08	809.07	2832.24
2005	TAYLOR	1252.33	287.57	939	25.76	158.43	213.09	80.65	247.82	213.17	82.38

2005	UNION	4223.4	1309.95	2517.59	395.85	362.1	186.93	419.98	636.98	187.12	486.11
2006	ALACHUA	26690.89	2380.67	19012.5	5297.72	2273.32	869.44	1290.08	2834.85	875.64	1542.56
2006	BAKER	1523.73	132.74	1210.07	180.93	184.25	76.48	137.72	217.84	77.04	155.17
2006	BRADFORD	6033.19	1176.21	4781.23	75.75	444.41	291.2	157.63	673.49	291.56	218
2006	COLUMBIA	8679.22	2024.36	5994.51	660.35	928.35	329.45	852.94	1318.51	330.43	974.79
2006	DIXIE	6545.11	563.92	2325.45	3655.74	395.11	139.08	297.14	527.89	148.81	372.27
2006	GILCHRIST	23153.77	5069.94	13446.75	4637.09	1931.27	712.82	2271.41	3315.42	712.87	2516.76
2006	HAMILTON	5177.98	1655.57	3376.3	146.11	319.63	250.88	574.45	665	276.31	693.93
2006	JEFFERSON	9703.11	2712.46	6628.76	361.9	928.19	625.13	962.74	1706.6	627.63	966.87
2006	LAFAYETTE	7635.1	3302.78	4009.49	322.83	526.52	244.32	509.02	1178.43	248.82	816.4
2006	LEVY	18571.29	3094.4	11265.41	4211.49	1734.22	822.39	1788.4	2525.55	825.86	1889.42
2006	MADISON	8076.46	2473.55	4394.75	1208.15	681	310.88	764.32	1267.1	314.21	874.4
2006	SUWANNEE	26087.35	11577.03	10308.5	4201.83	1370.12	699.97	1682.52	3479.04	700.35	2955.42
2006	TAYLOR	1288.06	685.18	514.26	88.62	87.66	31.82	76.22	227.63	32.26	79.2
2006	UNION	3452.61	881.48	2563.13	8	415.72	223.07	388.6	568.96	223.07	451.45
2007	ALACHUA	26835.87	3030.61	19313.11	4492.14	2106.85	769.28	1318.81	2734.95	778.41	1632.43
2007	BAKER	990.48	67.93	815.29	107.26	130.12	47.49	70.23	151.59	49.03	71.63
2007	BRADFORD	3002.41	1279.05	1588.55	134.81	253.9	86.33	84.03	487.09	88.03	152.82
2007	COLUMBIA	9179.55	1855.47	6786.61	537.47	1125.35	337.5	842.07	1473.54	339.59	1064.34
2007	DIXIE	6932.56	491.54	2461.86	3979.16	444.41	185.2	287.31	557.94	190.12	356.83
2007	GILCHRIST	20475.53	5211.81	12295.62	2968.1	1780.44	623.87	1876.34	2949.91	624.31	2486.98
2007	HAMILTON	5492.59	1882.87	3603.72	6	354.97	260.01	637.28	803.12	279.32	745.3
2007	JEFFERSON	8746.09	2872.58	5773.35	100.16	783.26	610.07	834.87	1647.12	610.3	835.08
2007	LAFAYETTE	7664.81	3488.3	3544.43	632.09	507.03	211.61	536.03	1207.52	216.12	827.66
2007	LEVY	20243.06	4146.19	10457.86	5639.01	1590.59	513.31	1606.9	2508.4	530.88	1841.2
2007	MADISON	9793.33	2988.41	4554.05	2250.87	788.8	234.8	724.45	1434.89	237.66	935.36
2007	SUWANNEE	29372.26	13427.71	11410.64	4533.91	1442.51	810.61	1810.39	4057.13	811.8	3071.35
2007	TAYLOR	647.2	214.84	366.19	66.17	58.48	20.93	47.18	121.02	21.8	50.48
2007	UNION	7538.5	3144.28	4225.59	168.64	642.2	342.02	654.1	1388.36	342.06	817.12

Appendix D Public Comments

Bureau of Onsite Sewage Programs
Florida Department of Health

Please find a below a few comments on the in the draft Suwannee-TMDL, mainly related to the role of onsite sewage treatment and disposal systems discussed in the document(http://www.dep.state.fl.us/water/tmdl/docs/tmdls/draft/gp1/suwanneebasinnutrienttmdl.pdf).

p. 35 "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. "
Comment: The definition appears to only address rainfall-driven or stormwater sources. Consistent with this it only mentions failing septic systems as a potential source, which would be the only ones susceptible to stormwater-runoff. With such a stormwater-centric definition how does this TMDL intend to address groundwater-driven sources of pollution, such as fertilizer or wastewater entering groundwater and eventually discharging from a spring? Groundwater contributions appear to be an important part in the Suwannee River Basin (e.g. in the cited Pittman et al. 1997 report)

p. 35 "Table 4.1 and figures 4.1-4.4 identify the facilities authorized for surface water discharges into the Suwannee River Basin. These point sources do not discharge into impaired waters or the main stems of the rivers. These point sources have an effect on the SRB on a planning unit wide basis. "
Comment: It is unclear why facilities are listed that discharge to non-impaired water bodies, but facilities that recharge to groundwater are not listed. Both could have an effect "on a planning unit wide basis".

p.40 "At this time the Department is compiling nonpoint source data on historic row crop acreage and numbers of beef cattle, dairy cattle and poultry in the basin. These nonpoint sources will be address as the information becomes available. Appendix C has tables of historic to present fertilizer sales. Figure 4.4 depicts the onsite sewage locations in the SRB. The Department at this time has an incomplete record of septic tanks in the SRB and will be add this information as it updated. "
p. 41 "Figure 4.4 Onsite Sewage in the Suwannee River Basin"

Comment: What is the source for the shown data on number and location of OSTDS? Do the points represent all systems or only recently permitted ones? How many systems are estimated to be there?

Comment: It may be of interest to DEP's efforts in this watershed that an inventory of onsite systems in the floodplain of the Suwannee River was performed in the early 1990s for the Department of Health and Rehabilitative Services, in cooperation with the Suwannee River Water Management District. This inventory included an assessment of system functioning. This office has hard copies of several annual reports from this project.

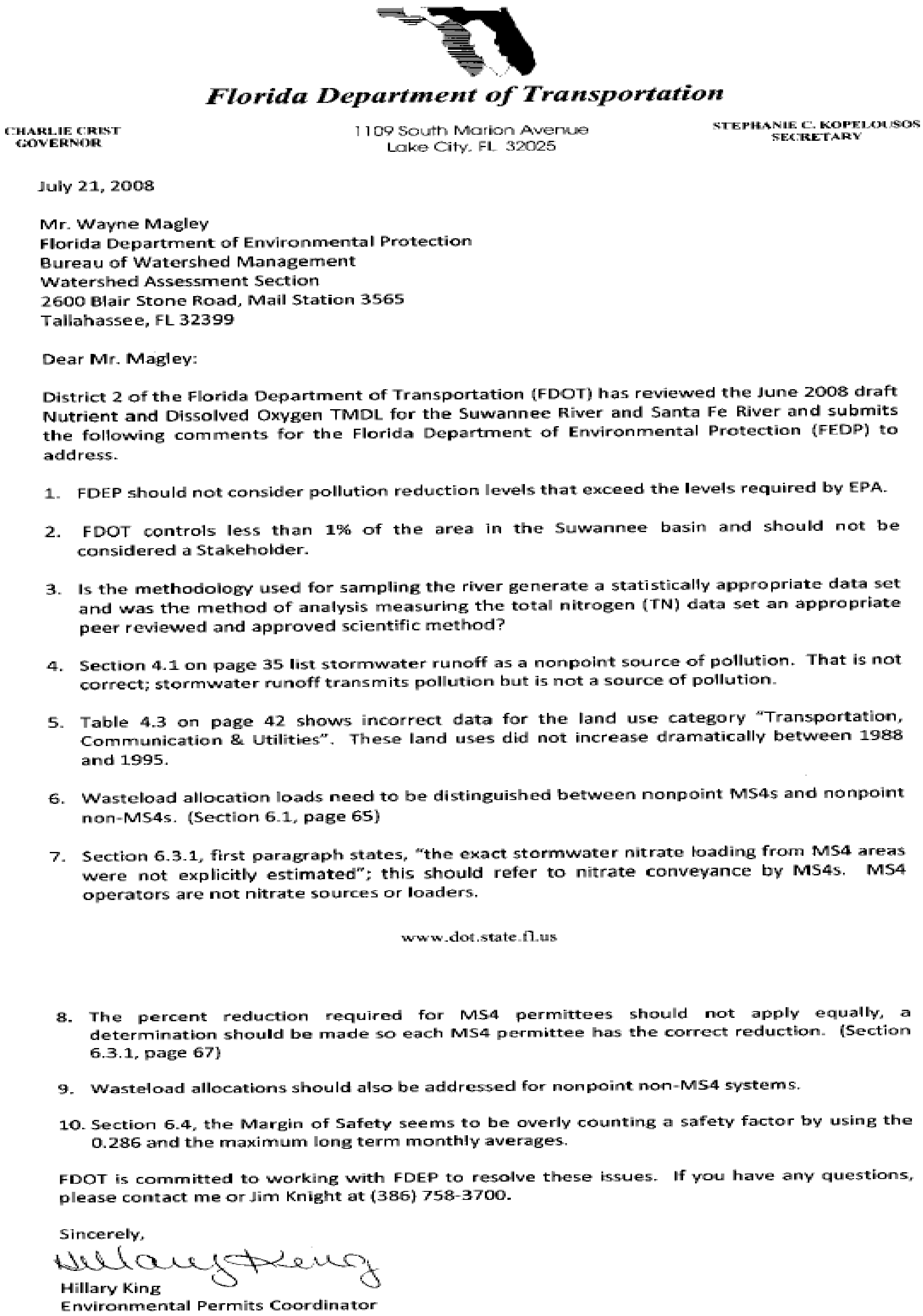
Regards,

Eberhard Roeder

Eberhard Roeder, Ph.D., Prof. Eng. III
Bureau of Onsite Sewage Programs
Florida Department of Health
4052 Bald Cypress Way, Bin# A-08
Tallahassee FL 32399-1713

In Response to Comments

Thank you for your comments they have been considered and the document has been edited where appropriate. The Suwannee river basin is a unique system the flows in lower portion of the river are dominated by groundwater. Groundwater contributions along with many other possible nonpoint sources were considered in this TMDL. Facilities that recharge to groundwater will need to be considered as possible sources. The document has been updated to reflect the source of the data (DOH 2007) and system estimates were included. Thank you for your comments and additional information.



Florida Department of Transportation

CHARLIE CRIST
GOVERNOR

1109 South Marion Avenue
Lake City, FL 32025

STEPHANIE C. KOPELOUSOS
SECRETARY

July 21, 2008

Mr. Wayne Magley
Florida Department of Environmental Protection
Bureau of Watershed Management
Watershed Assessment Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399

Dear Mr. Magley:

District 2 of the Florida Department of Transportation (FDOT) has reviewed the June 2008 draft Nutrient and Dissolved Oxygen TMDL for the Suwannee River and Santa Fe River and submits the following comments for the Florida Department of Environmental Protection (FEDP) to address.

1. FDEP should not consider pollution reduction levels that exceed the levels required by EPA.
2. FDOT controls less than 1% of the area in the Suwannee basin and should not be considered a Stakeholder.
3. Is the methodology used for sampling the river generate a statistically appropriate data set and was the method of analysis measuring the total nitrogen (TN) data set an appropriate peer reviewed and approved scientific method?
4. Section 4.1 on page 35 list stormwater runoff as a nonpoint source of pollution. That is not correct; stormwater runoff transmits pollution but is not a source of pollution.
5. Table 4.3 on page 42 shows incorrect data for the land use category "Transportation, Communication & Utilities". These land uses did not increase dramatically between 1988 and 1995.
6. Wasteload allocation loads need to be distinguished between nonpoint MS4s and nonpoint non-MS4s. (Section 6.1, page 65)
7. Section 6.3.1, first paragraph states, "the exact stormwater nitrate loading from MS4 areas were not explicitly estimated"; this should refer to nitrate conveyance by MS4s. MS4 operators are not nitrate sources or loaders.

8. The percent reduction required for MS4 permittees should not apply equally, a determination should be made so each MS4 permittee has the correct reduction. (Section 6.3.1, page 67)
9. Wasteload allocations should also be addressed for nonpoint non-MS4 systems.
10. Section 6.4, the Margin of Safety seems to be overly counting a safety factor by using the 0.286 and the maximum long term monthly averages.

FDOT is committed to working with FDEP to resolve these issues. If you have any questions, please contact me or Jim Knight at (386) 758-3700.

Sincerely,

Hillary King

Hillary King
Environmental Permits Coordinator

In Response to Comments

Thank you for your comments they have been considered and the document has been edited where appropriate.

Response to comment 1. It is unclear what level of reduction required by EPA you are referring to in this comment. EPA has not established pollutant reduction levels for the Suwannee and Santa Fe Rivers. Once the state adopts a TMDL pursuant to the Florida Watershed Restoration Act, the TMDL is submitted to EPA for their review and approval. EPA has responsibility to ensure that the TMDL is sufficient to restore the waterbody such that designated uses and their associated water quality standards will be met.

Response to comment 2. Based on 2004 land use Geographic Information System (GIS) coverages, roads and highways in the Suwannee and Santa Fe Rivers represent less than 1 percent of the acreage. However, as required by the Florida Watershed Restoration Act, pollutant load reduction allocations must be equitable and assure that all parties that contribute pollutants are part of the solution. There are certain very intensive land use activities that could represent a small percentage of a watershed yet contribute a significant fraction of a pollutant to receiving water

Response to comment 3. The data were used to designate the Suwannee and Santa Rivers as a Verified Impaired water in accordance with the procedures within Chapter 62-302, Florida Administrative Code (Impaired Waters Rule). This rule included requirements to assess data sufficiency, data quality, etc.

Response to comment 4. . It is well known that stormwater from all land uses, including roads, contains nutrientts. Additionally, please remember that the stormwater within FDOT's stormwater systems is not just from roads, but also from adjacent land uses. Accordingly, FDOT has an obligation to be a partner in reducing these pollutant loadings.

Response to comment 5. Differences in acres and total acre can be attributed to different methods of measurement and quantification of land use. This will be noted in the document.

Response to comment 6. As described in section 4.1, the source assessment section does not make a distinction between NPDES stormwater discharges and non NPDES stormwater discharges. The purpose of this section is to identify potential sources that might contribute the pollutant(s) of concern that need to be reduced to achieve designated uses and a more detailed evaluation of sources and allocation will be developed as part of the BMAP.

Response to comment 7. Pursuant to both Federal and state law and regulations, stormwater discharges are sources of pollution, are subject to regulation, and their pollutant loadings must be reduced once a TMDL is established. Development of the BMAP will focus approaches to achieve pollutant source reductions in an equitable and cost effective manner.

Response to comment 8. As discussed in the document, similar percent reductions were applied to the NPDES stormwater MS4s and the non NPDES stormwater discharges. A more detailed evaluation of sources and allocation will be developed as part of the BMAP. The BMAP process will also consider existing and proposed best management practices in the basin and approaches to achieve pollutant source reductions in an equitable and cost effective manner.

Response to comment 9. Section 6.1 describes how NPDES stormwater discharges are part of the WLA fraction of the TMDL while non NPDES stormwater discharges are represented by the LA. These categories are also reflected in the TMDL components of Table 6.1

Response to comment 10. Based on further analysis and discussion with stakeholders, the nitrate target is now 0.35 mg/L and the document has a more detailed discussion on the development of the target.

July 18, 2008

Jan Mandrup-Poulsen
Environmental Administrator, Watershed Assessment Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: Suwannee River Draft TMDL Formal Comments

Dear Mr. Mandrup-Poulsen:

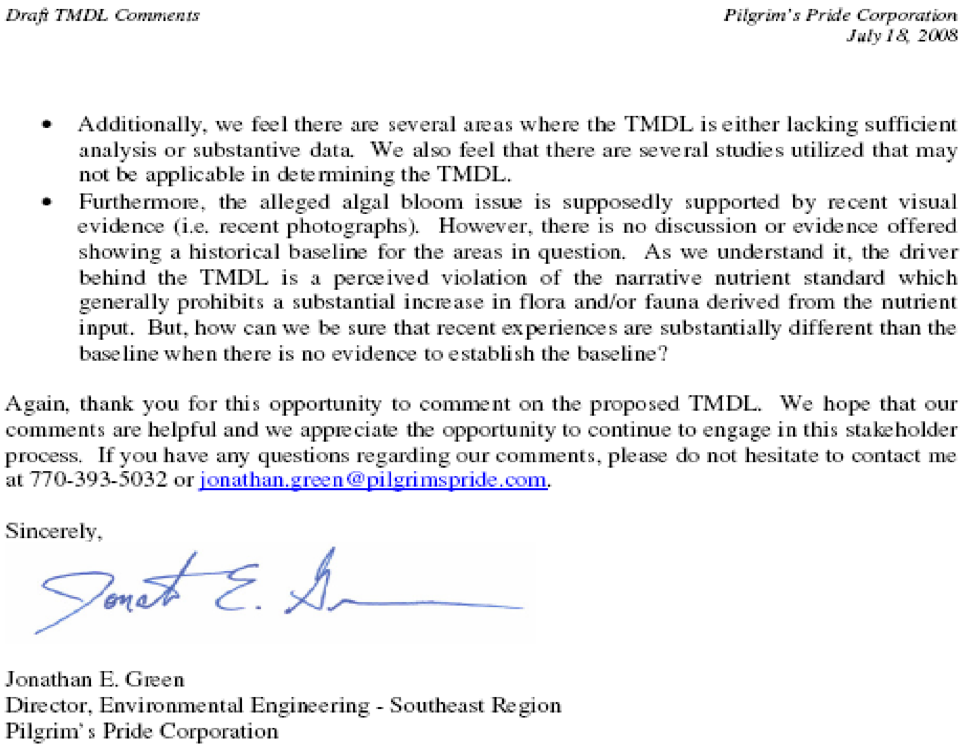
Pilgrim's Pride Corporation (Pilgrim's Pride) appreciates this opportunity to submit comments on the Draft TMDL Report "*Nutrient and Dissolved Oxygen TMDL for the Suwannee River and Santa Fe River*," June 19, 2008 (TMDL). Pilgrim's Pride operates a poultry processing plant in Live Oak, Florida, and highly treated effluent from this Facility is discharged into the Suwannee River under NPDES Permit No. FL0001465. Accordingly, Pilgrim's Pride is a significant stakeholder in any regulatory changes related to water quality requirements in the Suwannee River.

Attached are comments concerning the proposed TMDL prepared for Pilgrim's Pride by Miles M. (Bud) Smart, Ph. D. with Smart & Associates, Inc. Dr. Smart provides various services to Pilgrim's Pride related to water quality, and he is a highly respected expert in this area. Dr. Smart has thirty (30) years of experience in developing and implementing integrated environmental management strategies to protect and enhance water resources, including the performance of various water quality modeling and monitoring programs. Many of the thirty (30) years have been devoted to the effects and implementing solutions for nutrients, toxic chemicals, physical stressors, and habitat degradation in aquatic ecosystems throughout the world. Finally, Dr. Smart is familiar with water quality issues related to the Suwannee River, as he has conducted water quality and benthic macroinvertebrate studies on the Suwannee River.

In addition to the comments provided in the attached memo, we also offer the following general comments regarding the draft document.

- Overall we feel that the TMDL is substantially lacking. The document's general directive seems more an attempt to establish and support an instream water quality standard rather than the establishment and allocation of a total maximum daily load. There is no allocation of said load among point and non-point sources.

Pilgrim's Pride Corporation
244 Perimeter Center Pwky, N.E.
Atlanta, GA 30346-2302
(770) 393 – 5000



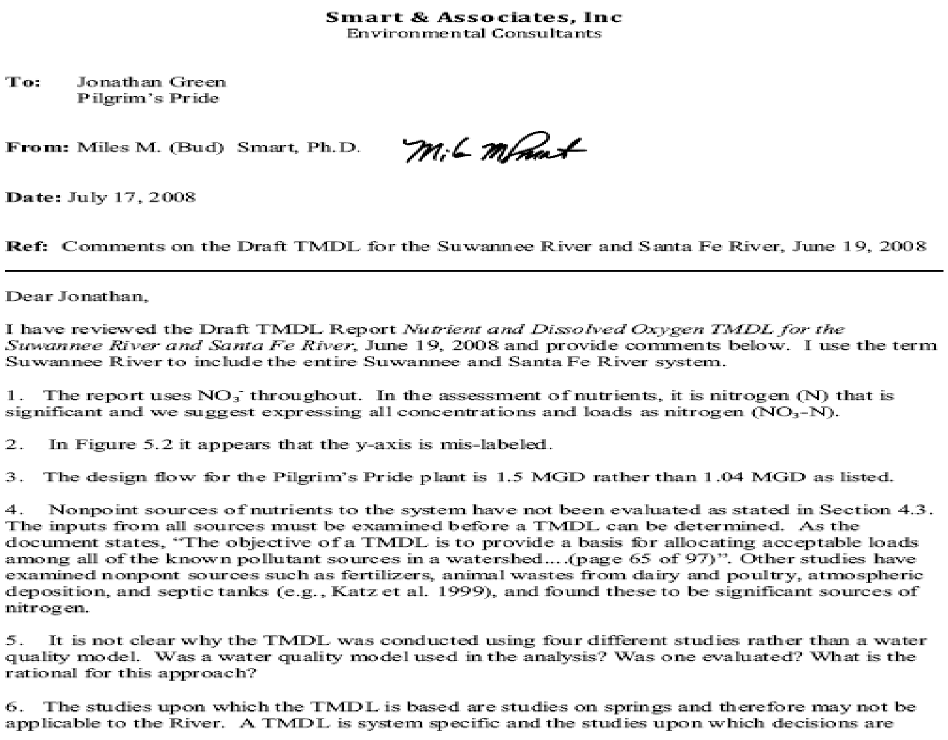
- Additionally, we feel there are several areas where the TMDL is either lacking sufficient analysis or substantive data. We also feel that there are several studies utilized that may not be applicable in determining the TMDL.
- Furthermore, the alleged algal bloom issue is supposedly supported by recent visual evidence (i.e. recent photographs). However, there is no discussion or evidence offered showing a historical baseline for the areas in question. As we understand it, the driver behind the TMDL is a perceived violation of the narrative nutrient standard which generally prohibits a substantial increase in flora and/or fauna derived from the nutrient input. But, how can we be sure that recent experiences are substantially different than the baseline when there is no evidence to establish the baseline?

Again, thank you for this opportunity to comment on the proposed TMDL. We hope that our comments are helpful and we appreciate the opportunity to continue to engage in this stakeholder process. If you have any questions regarding our comments, please do not hesitate to contact me at 770-393-5032 or jonathan.green@pilgrimspride.com.

Sincerely,

Jonath E. G

Jonathan E. Green
Director, Environmental Engineering - Southeast Region
Pilgrim's Pride Corporation



Smart & Associates, Inc
Environmental Consultants

To: Jonathan Green
Pilgrim's Pride

From: Miles M. (Bud) Smart, Ph.D.

Date: July 17, 2008

Ref: Comments on the Draft TMDL for the Suwannee River and Santa Fe River, June 19, 2008

Dear Jonathan,

I have reviewed the Draft TMDL Report *Nutrient and Dissolved Oxygen TMDL for the Suwannee River and Santa Fe River*, June 19, 2008 and provide comments below. I use the term Suwannee River to include the entire Suwannee and Santa Fe River system.

1. The report uses NO_3^- throughout. In the assessment of nutrients, it is nitrogen (N) that is significant and we suggest expressing all concentrations and loads as nitrogen (NO_3-N).

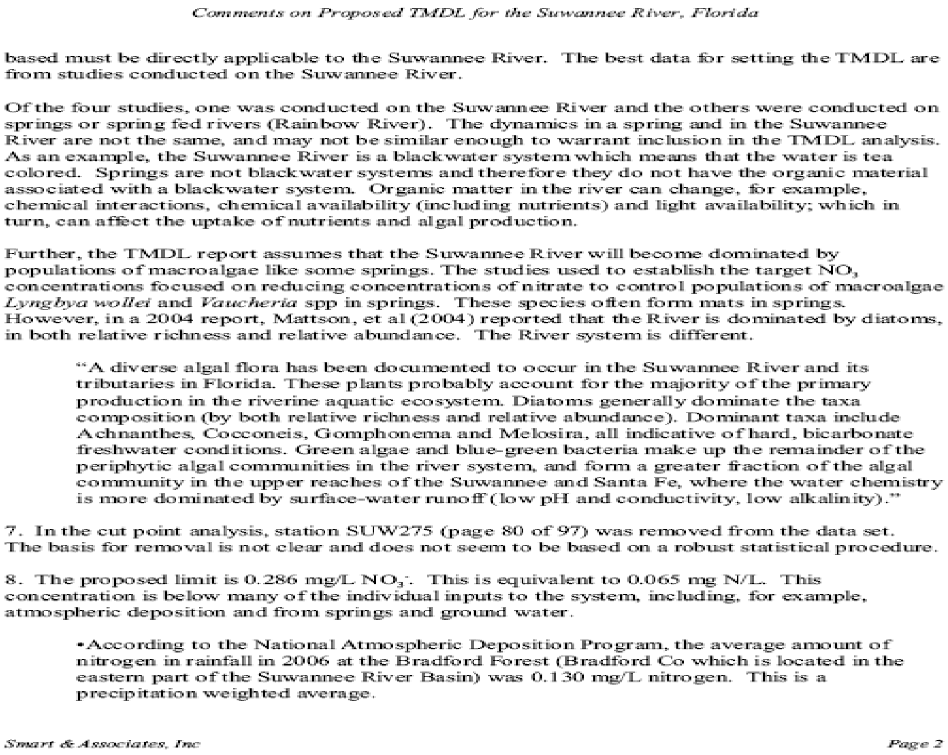
2. In Figure 5.2 it appears that the y-axis is mis-labeled.

3. The design flow for the Pilgrim's Pride plant is 1.5 MGD rather than 1.04 MGD as listed.

4. Nonpoint sources of nutrients to the system have not been evaluated as stated in Section 4.3. The inputs from all sources must be examined before a TMDL can be determined. As the document states, "The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed….(page 65 of 97)". Other studies have examined nonpont sources such as fertilizers, animal wastes from dairy and poultry, atmospheric deposition, and septic tanks (e.g., Katz et al. 1999), and found these to be significant sources of nitrogen.

5. It is not clear why the TMDL was conducted using four different studies rather than a water quality model. Was a water quality model used in the analysis? Was one evaluated? What is the rational for this approach?

6. The studies upon which the TMDL is based are studies on springs and therefore may not be applicable to the River. A TMDL is system specific and the studies upon which decisions are



based must be directly applicable to the Suwannee River. The best data for setting the TMDL are from studies conducted on the Suwannee River.

Of the four studies, one was conducted on the Suwannee River and the others were conducted on springs or spring fed rivers (Rainbow River). The dynamics in a spring and in the Suwannee River are not the same, and may not be similar enough to warrant inclusion in the TMDL analysis. As an example, the Suwannee River is a blackwater system which means that the water is tea colored. Springs are not blackwater systems and therefore they do not have the organic material associated with a blackwater system. Organic matter in the river can change, for example, chemical interactions, chemical availability (including nutrients) and light availability; which in turn, can affect the uptake of nutrients and algal production.

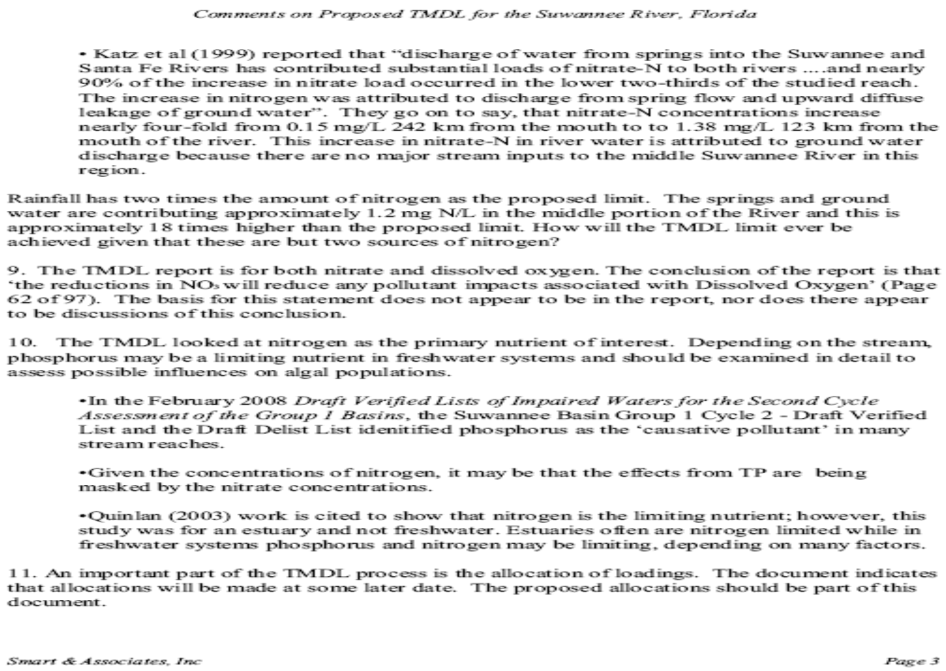
Further, the TMDL report assumes that the Suwannee River will become dominated by populations of macroalgae like some springs. The studies used to establish the target NO_3 concentrations focused on reducing concentrations of nitrate to control populations of macroalgae *Lyngbya wollei* and *Vaucheria* spp in springs. These species often form mats in springs. However, in a 2004 report, Mattson, et al (2004) reported that the River is dominated by diatoms, in both relative richness and relative abundance. The River system is different.

> "A diverse algal flora has been documented to occur in the Suwannee River and its tributaries in Florida. These plants probably account for the majority of the primary production in the riverine aquatic ecosystem. Diatoms generally dominate the taxa composition (by both relative richness and relative abundance). Dominant taxa include Achnanthes, Cocconeis, Gomphonema and Melosira, all indicative of hard, bicarbonate freshwater conditions. Green algae and blue-green bacteria make up the remainder of the periphytic algal communities in the river system, and form a greater fraction of the algal community in the upper reaches of the Suwannee and Santa Fe, where the water chemistry is more dominated by surface-water runoff (low pH and conductivity, low alkalinity)."

7. In the cut point analysis, station SUW275 (page 80 of 97) was removed from the data set. The basis for removal is not clear and does not seem to be based on a robust statistical procedure.

8. The proposed limit is 0.286 mg/L NO_3^-. This is equivalent to 0.065 mg N/L. This concentration is below many of the individual inputs to the system, including, for example, atmospheric deposition and from springs and ground water.

> •According to the National Atmospheric Deposition Program, the average amount of nitrogen in rainfall in 2006 at the Bradford Forest (Bradford Co which is located in the eastern part of the Suwannee River Basin) was 0.130 mg/L nitrogen. This is a precipitation weighted average.



- Katz et al (1999) reported that "discharge of water from springs into the Suwannee and Santa Fe Rivers has contributed substantial loads of nitrate-N to both rivers ….and nearly 90% of the increase in nitrate load occurred in the lower two-thirds of the studied reach. The increase in nitrogen was attributed to discharge from spring flow and upward diffuse leakage of ground water". They go on to say, that nitrate-N concentrations increase nearly four-fold from 0.15 mg/L 242 km from the mouth to to 1.38 mg/L 123 km from the mouth of the river. This increase in nitrate-N in river water is attributed to ground water discharge because there are no major stream inputs to the middle Suwannee River in this region.

Rainfall has two times the amount of nitrogen as the proposed limit. The springs and ground water are contributing approximately 1.2 mg N/L in the middle portion of the River and this is approximately 18 times higher than the proposed limit. How will the TMDL limit ever be achieved given that these are but two sources of nitrogen?

9. The TMDL report is for both nitrate and dissolved oxygen. The conclusion of the report is that 'the reductions in NO_3 will reduce any pollutant impacts associated with Dissolved Oxygen' (Page 62 of 97). The basis for this statement does not appear to be in the report, nor does there appear to be discussions of this conclusion.

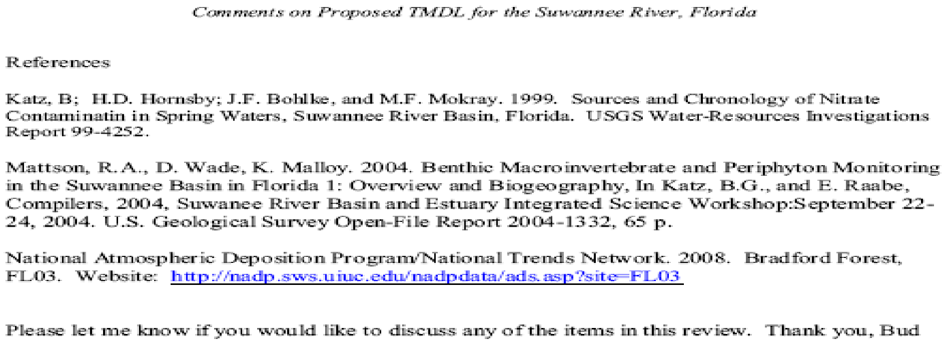
10. The TMDL looked at nitrogen as the primary nutrient of interest. Depending on the stream, phosphorus may be a limiting nutrient in freshwater systems and should be examined in detail to assess possible influences on algal populations.

- In the February 2008 *Draft Verified Lists of Impaired Waters for the Second Cycle Assessment of the Group 1 Basins*, the Suwannee Basin Group 1 Cycle 2 - Draft Verified List and the Draft Delist List idenitified phosphorus as the 'causative pollutant' in many stream reaches.

- Given the concentrations of nitrogen, it may be that the effects from TP are being masked by the nitrate concentrations.

- Quinlan (2003) work is cited to show that nitrogen is the limiting nutrient; however, this study was for an estuary and not freshwater. Estuaries often are nitrogen limited while in freshwater systems phosphorus and nitrogen may be limiting, depending on many factors.

11. An important part of the TMDL process is the allocation of loadings. The document indicates that allocations will be made at some later date. The proposed allocations should be part of this document.



References

Katz, B; H.D. Hornsby; J.F. Bohlke, and M.F. Mokray. 1999. Sources and Chronology of Nitrate Contaminatin in Spring Waters, Suwannee River Basin, Florida. USGS Water-Resources Investigations Report 99-4252.

Mattson, R.A., D. Wade, K. Malloy. 2004. Benthic Macroinvertebrate and Periphyton Monitoring in the Suwannee Basin in Florida 1: Overview and Biogeography, In Katz, B.G., and E. Raabe, Compilers, 2004, Suwanee River Basin and Estuary Integrated Science Workshop:September 22-24, 2004. U.S. Geological Survey Open-File Report 2004-1332, 65 p.

National Atmospheric Deposition Program/National Trends Network. 2008. Bradford Forest, FL03. Website: http://nadp.sws.uiuc.edu/nadpdata/ads.asp?site=FL03

Please let me know if you would like to discuss any of the items in this review. Thank you, Bud

In Response to Comments

Thank you for your comments they have been considered and the document was edited where appropriate.

Response to comment 1. The target is for nitrate as nitrogen (NO_3-N). This has been clarified in the document.

Response to comment 2. The figure axis has been corrected.

Response to comment 3. The design flow has been corrected.

Response to comment 4. Additional information has been incorporated into the document regarding potential contributions of nitrogen from a variety of anthropogenic activities in the basin.

Response to comment 5. A weight of evidence approach was used to evaluate biological responses to nutrients. Resources and information necessary to link a ground water and surface model and incorporate biological responses were not available. A long-term monitoring program of paired nutrient and periphyton data provided site specific information to establish a nutrient target that was supported by other studies in Florida.

Response to comment 6. The periphyton data set used to develop the nitrate target was based upon long-term stream monitoring sites in the Withlacoochee, Suwannee, and Santa Fe Rivers. Another line of evidence (Stevenson, 2007) included both field and laboratory measurements focused on springs and included eight springs in the Suwannee River Basin. Photographs included in the document include algal mats as well as algal blooms that have occurred in portion of the Suwannee and Santa Fe as well as springs over the past seven years.

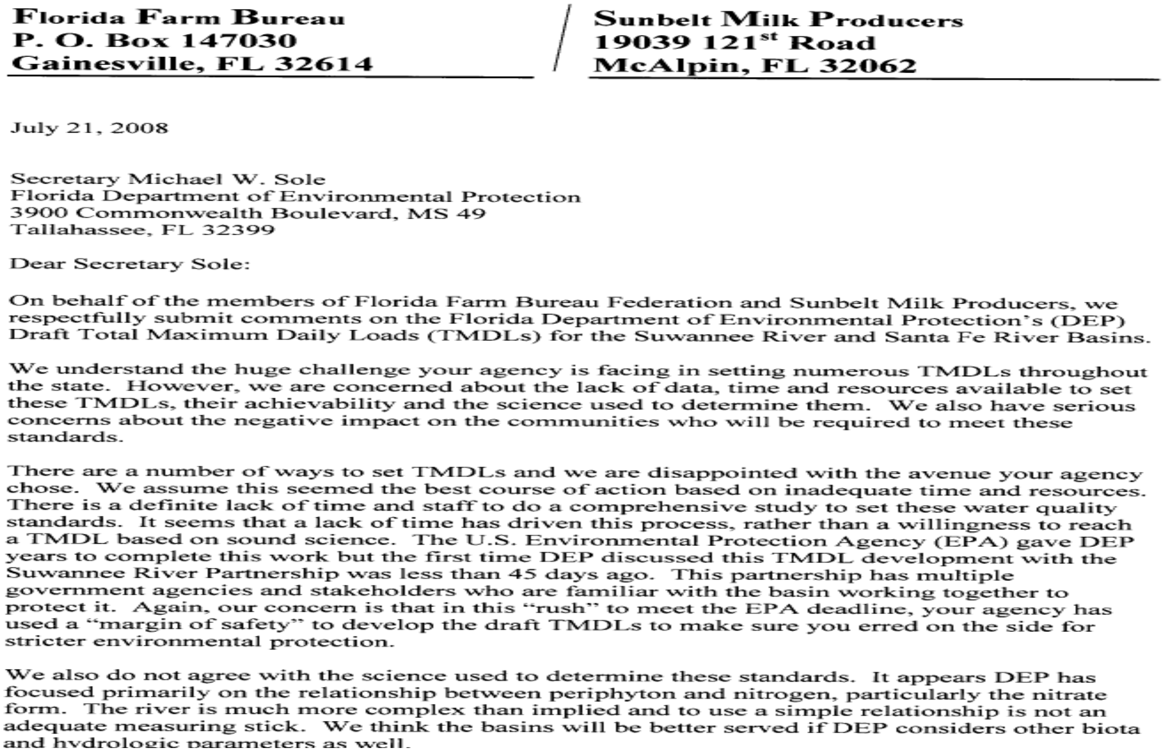
Response to comment 7. Based upon the recommendation of Mr. Rob Matteson (previous aquatic biologist at the Suwannee River Water Management District (SRWMD), station SUW275 was excluded for the analysis due to possible marine influence.

Response to comment 8. As noted in the first comment there may have been some confusion in that the nitrate target was expressed as Nitrate-N rather than as nitrate. Based upon addition periphyton data provided by the SRWMD, the period was extended to 2007 and the revised target was changed from 0.286 mg/L to 0.35 mg/L nitrate-N.

Response to comment 9. Additional text will be added to the document.

Response to comment 10. The Department could not find a link between total phosphorus concentrations and imbalances in flora or fauna. The Department will continue to monitor and collect data to evaluate whether phosphorus adversely impacts aquatic flora or fauna as nitrate concentrations are reduced.

Response to comment 11. The TMDL identifies potential sources of nutrients to the system but detailed allocations are developed as part of the basin management action plan (BMAP) process. The BMAP is a stakeholder consensus driven process with the goal of achieving the TMDL through development of allocations that are equitable and cost effective..



Florida Farm Bureau
P. O. Box 147030
Gainesville, FL 32614

Sunbelt Milk Producers
19039 121st Road
McAlpin, FL 32062

July 21, 2008

Secretary Michael W. Sole
Florida Department of Environmental Protection
3900 Commonwealth Boulevard, MS 49
Tallahassee, FL 32399

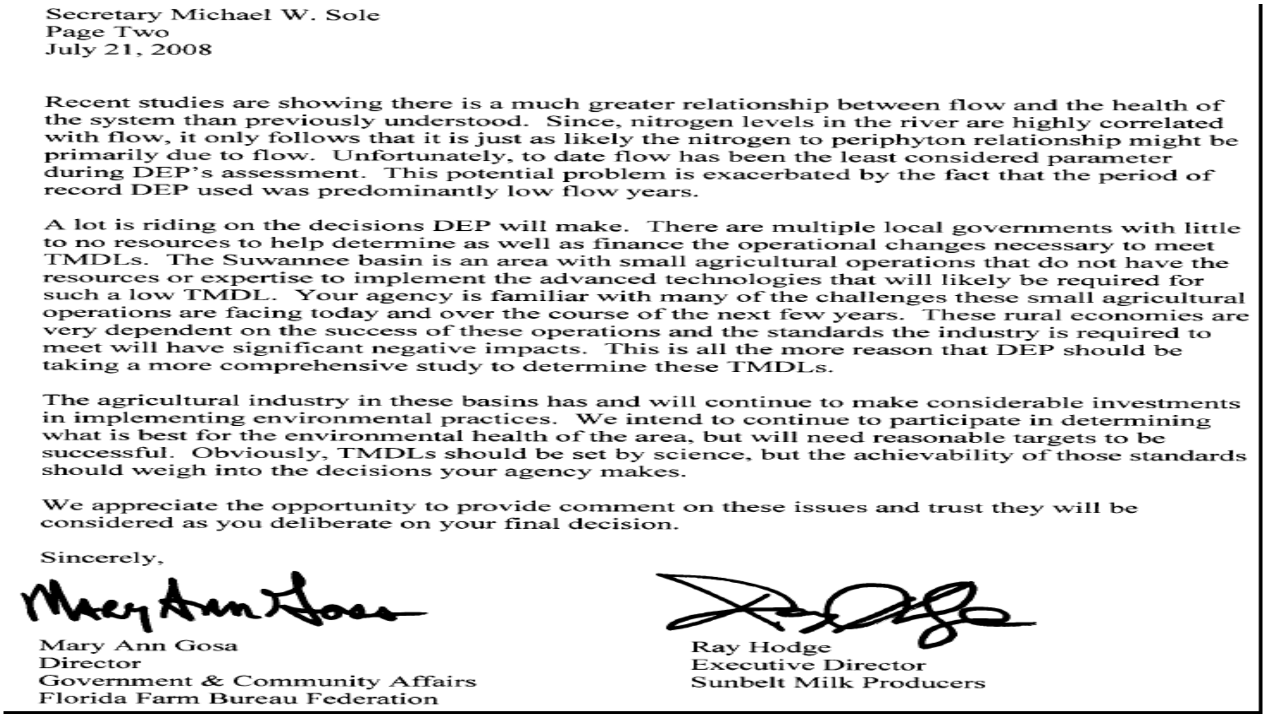
Dear Secretary Sole:

On behalf of the members of Florida Farm Bureau Federation and Sunbelt Milk Producers, we respectfully submit comments on the Florida Department of Environmental Protection's (DEP) Draft Total Maximum Daily Loads (TMDLs) for the Suwannee River and Santa Fe River Basins.

We understand the huge challenge your agency is facing in setting numerous TMDLs throughout the state. However, we are concerned about the lack of data, time and resources available to set these TMDLs, their achievability and the science used to determine them. We also have serious concerns about the negative impact on the communities who will be required to meet these standards.

There are a number of ways to set TMDLs and we are disappointed with the avenue your agency chose. We assume this seemed the best course of action based on inadequate time and resources. There is a definite lack of time and staff to do a comprehensive study to set these water quality standards. It seems that a lack of time has driven this process, rather than a willingness to reach a TMDL based on sound science. The U.S. Environmental Protection Agency (EPA) gave DEP years to complete this work but the first time DEP discussed this TMDL development with the Suwannee River Partnership was less than 45 days ago. This partnership has multiple government agencies and stakeholders who are familiar with the basin working together to protect it. Again, our concern is that in this "rush" to meet the EPA deadline, your agency has used a "margin of safety" to develop the draft TMDLs to make sure you erred on the side for stricter environmental protection.

We also do not agree with the science used to determine these standards. It appears DEP has focused primarily on the relationship between periphyton and nitrogen, particularly the nitrate form. The river is much more complex than implied and to use a simple relationship is not an adequate measuring stick. We think the basins will be better served if DEP considers other biota and hydrologic parameters as well.



Secretary Michael W. Sole
Page Two
July 21, 2008

Recent studies are showing there is a much greater relationship between flow and the health of the system than previously understood. Since, nitrogen levels in the river are highly correlated with flow, it only follows that it is just as likely the nitrogen to periphyton relationship might be primarily due to flow. Unfortunately, to date flow has been the least considered parameter during DEP's assessment. This potential problem is exacerbated by the fact that the period of record DEP used was predominantly low flow years.

A lot is riding on the decisions DEP will make. There are multiple local governments with little to no resources to help determine as well as finance the operational changes necessary to meet TMDLs. The Suwannee basin is an area with small agricultural operations that do not have the resources or expertise to implement the advanced technologies that will likely be required for such a low TMDL. Your agency is familiar with many of the challenges these small agricultural operations are facing today and over the course of the next few years. These rural economies are very dependent on the success of these operations and the standards the industry is required to meet will have significant negative impacts. This is all the more reason that DEP should be taking a more comprehensive study to determine these TMDLs.

The agricultural industry in these basins has and will continue to make considerable investments in implementing environmental practices. We intend to continue to participate in determining what is best for the environmental health of the area, but will need reasonable targets to be successful. Obviously, TMDLs should be set by science, but the achievability of those standards should weigh into the decisions your agency makes.

We appreciate the opportunity to provide comment on these issues and trust they will be considered as you deliberate on your final decision.

Sincerely,

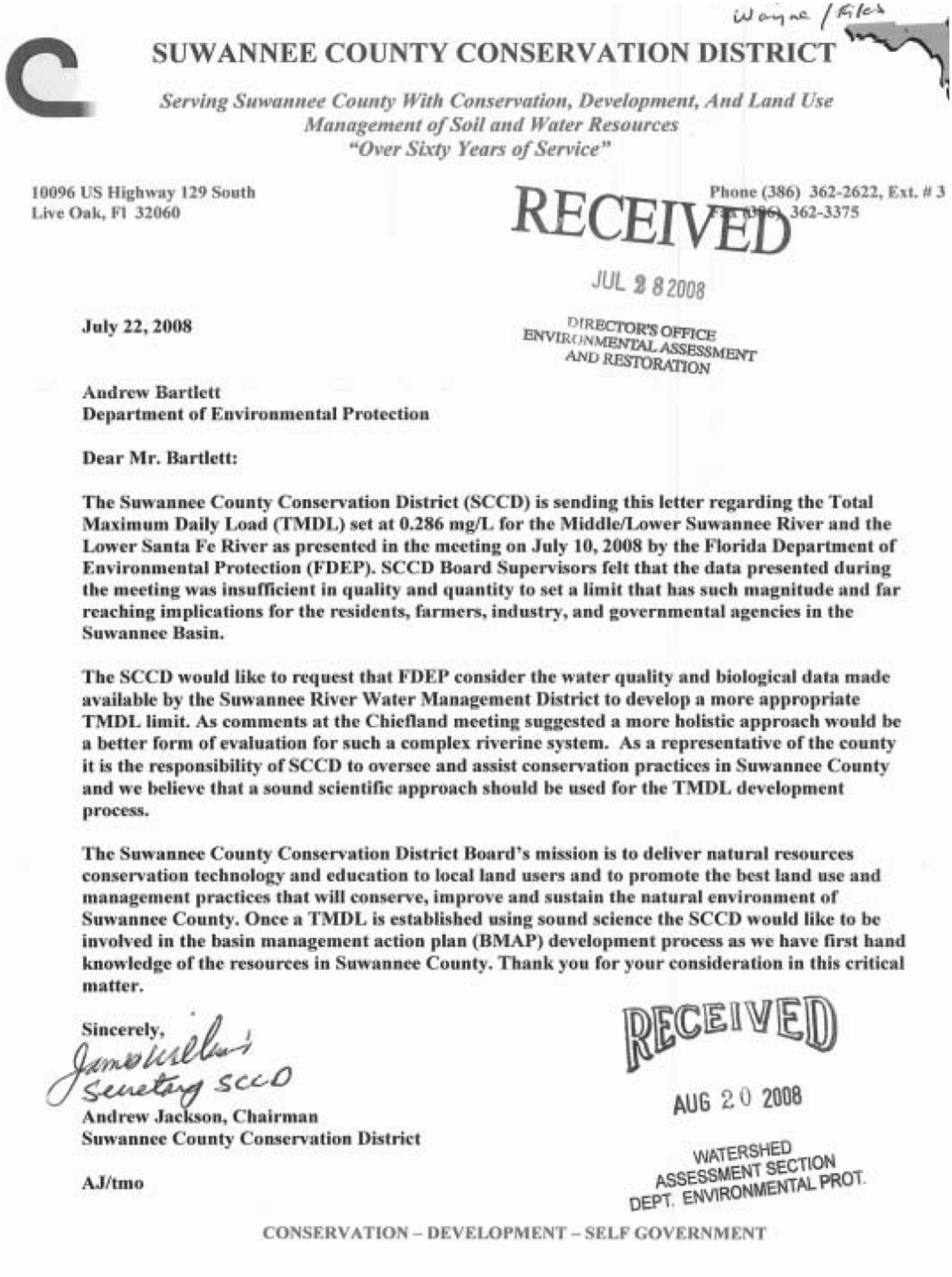
Mary Ann Gosa
Director
Government & Community Affairs
Florida Farm Bureau Federation

Ray Hodge
Executive Director
Sunbelt Milk Producers

In Response to Comments

Thank you for your comments they have been considered and the document was edited where appropriate. Following the presentation to the Suwannee River Partnership (SRP) Executive Committee on May 30, 2008 as to the approach to establishing a TMDL target, staff have had numerous meetings with technical representatives from the SRP to refine the analysis. As part of that process the Department has looked at the effects of flow, color, water temperature and Nitrate-N on cell density and biomass. Nitrate-N was found to still have significant correlation when held independent of the other parameters and was also the highest correlation. Through a collaborative process the available periphyton dataset was expanded to cover a 17 year period of record and the original target for Nitrate-N was modified from 0.286 mg/L to 0.35 mg/L. The goal of a TMDL to ensure that the designated uses are maintained.

Part of the mission of the Suwannee River Partnership formed in 1999 was to reduce nitrate levels in the surface waters and ground water within the Suwannee River basin. Components of the SRP include research, evaluation of best management practices (BMPs), public education and outreach, and funding support for implementation of BMPs. With more than 60 Federal, State, and Local agencies as well as private associations and businesses the basin management action plan process will build upon the SRP.



Wayne / Files

SUWANNEE COUNTY CONSERVATION DISTRICT

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DIRECTOR'S OFFICE
ENVIRONMENTAL ASSESSMENT
AND RESTORATION

July 22, 2008

Andrew Bartlett
Department of Environmental Protection

Dear Mr. Bartlett:

The Suwannee County Conservation District (SCCD) is sending this letter regarding the Total Maximum Daily Load (TMDL) set at 0.286 mg/L for the Middle/Lower Suwannee River and the Lower Santa Fe River as presented in the meeting on July 10, 2008 by the Florida Department of Environmental Protection (FDEP). SCCD Board Supervisors felt that the data presented during the meeting was insufficient in quality and quantity to set a limit that has such magnitude and far reaching implications for the residents, farmers, industry, and governmental agencies in the Suwannee Basin.

The SCCD would like to request that FDEP consider the water quality and biological data made available by the Suwannee River Water Management District to develop a more appropriate TMDL limit. As comments at the Chiefland meeting suggested a more holistic approach would be a better form of evaluation for such a complex riverine system. As a representative of the county it is the responsibility of SCCD to oversee and assist conservation practices in Suwannee County and we believe that a sound scientific approach should be used for the TMDL development process.

The Suwannee County Conservation District Board's mission is to deliver natural resources conservation technology and education to local land users and to promote the best land use and management practices that will conserve, improve and sustain the natural environment of Suwannee County. Once a TMDL is established using sound science the SCCD would like to be involved in the basin management action plan (BMAP) development process as we have first hand knowledge of the resources in Suwannee County. Thank you for your consideration in this critical matter.

Sincerely,

Secretary SCCD

Andrew Jackson, Chairman
Suwannee County Conservation District

AJ/tmo

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ASSESSMENT SECTION
DEPT. ENVIRONMENTAL PROT.

CONSERVATION – DEVELOPMENT – SELF GOVERNMENT

Gilchrist Soil and Water Conservation District
P.O. Box 37 – Bronson, Florida 32621 – Phone (352)

July 18, 2008

Andrew Bartlett
Department of Environmental Protection

Dear Mr. Bartlett,

The Gilchrist Soil & Water Conservation District (GSWCD) is sending this letter regarding the Total Maximum Daily Load (TMDL) set at 0.286 mg/L for the Middle/Lower Suwannee River and the Lower Santa Fe River as presented in the meeting on July 10, 2008 by the Florida Department of Environmental Protection (FDEP). GSWCD board supervisors felt that the data presented during the meeting was insufficient in quality and quantity to set a limit that has such magnitude and far reaching implications for the residents, farmers, industry, and governmental agencies in the Suwannee Basin.

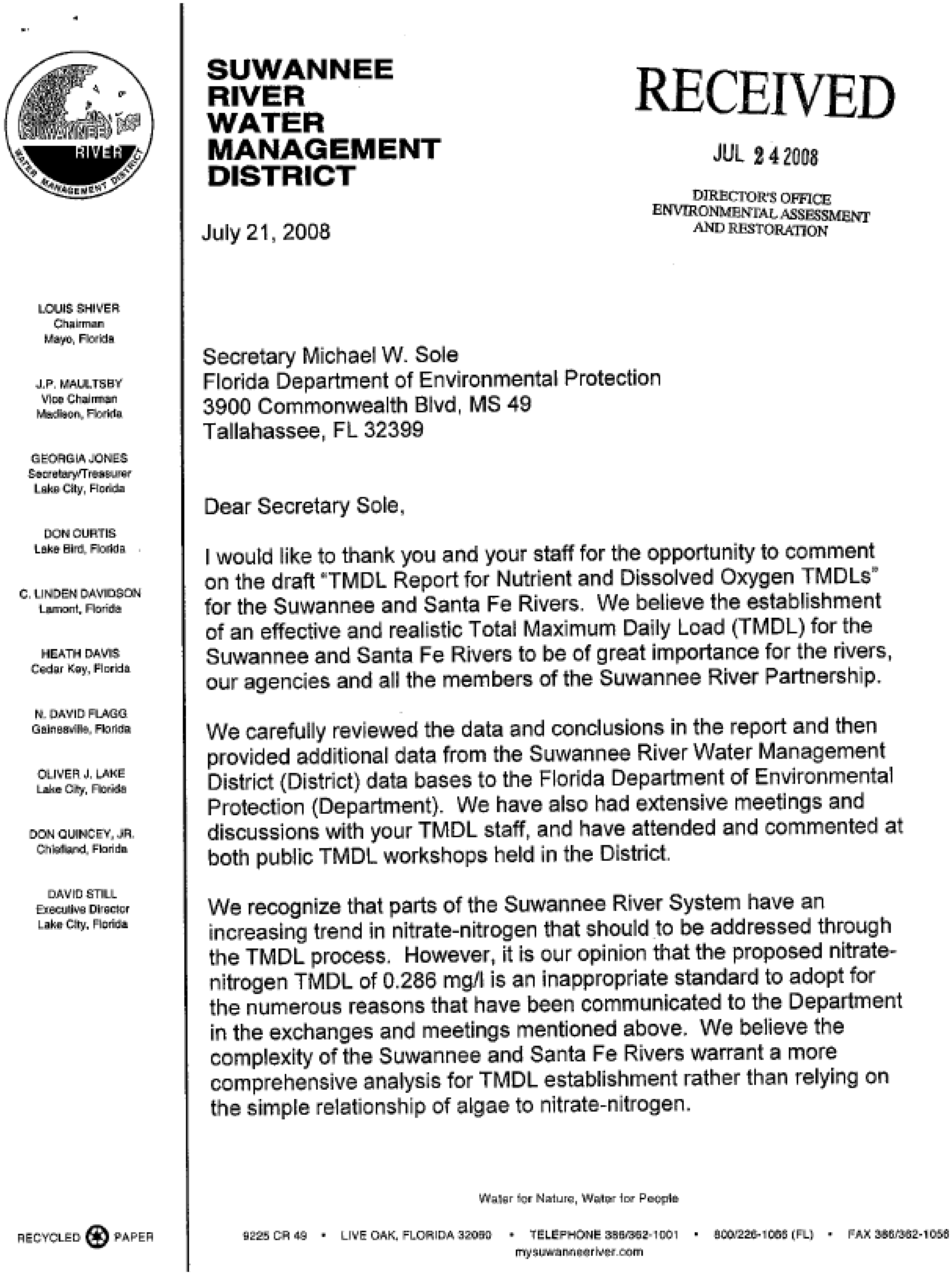
The GSWCD would like to request that FDEP consider the water quality and biological data made available by the Suwannee River Water Management District to develop a more appropriate TMDL limit. As comments at the Chiefland meeting suggested a more holistic approach would be a better form of evaluation for such a complex riverine system. As a representative of the county it is the responsibility of GSWCD to oversee and assist conservation practices in Gilchrist County and we believe that a sound scientific approach should be used for the TMDL development process.

The Gilchrist Soil and Water Conservation Board's mission is to deliver natural resources conservation technology and education to local land users and to promote the best land use and management practices that will conserve, improve and sustain the natural environment of Gilchrist County. Once a TMDL is established using sound science the GSWCD would like to be involved in the basin management action plan (BMAP) development process as we have first hand knowledge of the resources in Gilchrist County. Thank you for your consideration in this critical matter.
Sincerely,

Kelly Philman, Chairman
Gilchrist Soil & Water Conservation District
CONSERVATION – DEVELOPMENT – SELF GOVERNMENT

In Response to Comments

Thank you for your comments they have been considered and the document was edited where appropriate. As discussed at the July 10, 2008 public meeting, additional information provided by the Suwannee River Water Management District was incorporated into the analysis to establish the nitrate target. The revised analysis includes data from 1999-2007 for total of 17 years and as a result the target has been amended to 0.35 mg/L. The goal of a TMDL to protect any critical condition that may occur. Terry Hansen [terry.hansen@dep.state.fl.us, (850) 245-8561] is the Department's basin coordinator who will be facilitating the basin management action plan (BMAP) process. The BMAP process is a stakeholder consensus driven process that focuses on approaches to achieve pollutant source reductions in an equitable and cost effective manner.



**SUWANNEE
RIVER
WATER
MANAGEMENT
DISTRICT**

RECEIVED
JUL 24 2008
DIRECTOR'S OFFICE
ENVIRONMENTAL ASSESSMENT
AND RESTORATION

July 21, 2008

Secretary Michael W. Sole
Florida Department of Environmental Protection
3900 Commonwealth Blvd, MS 49
Tallahassee, FL 32399

Dear Secretary Sole,

I would like to thank you and your staff for the opportunity to comment on the draft "TMDL Report for Nutrient and Dissolved Oxygen TMDLs" for the Suwannee and Santa Fe Rivers. We believe the establishment of an effective and realistic Total Maximum Daily Load (TMDL) for the Suwannee and Santa Fe Rivers to be of great importance for the rivers, our agencies and all the members of the Suwannee River Partnership.

We carefully reviewed the data and conclusions in the report and then provided additional data from the Suwannee River Water Management District (District) data bases to the Florida Department of Environmental Protection (Department). We have also had extensive meetings and discussions with your TMDL staff, and have attended and commented at both public TMDL workshops held in the District.

We recognize that parts of the Suwannee River System have an increasing trend in nitrate-nitrogen that should to be addressed through the TMDL process. However, it is our opinion that the proposed nitrate-nitrogen TMDL of 0.286 mg/l is an inappropriate standard to adopt for the numerous reasons that have been communicated to the Department in the exchanges and meetings mentioned above. We believe the complexity of the Suwannee and Santa Fe Rivers warrant a more comprehensive analysis for TMDL establishment rather than relying on the simple relationship of algae to nitrate-nitrogen.

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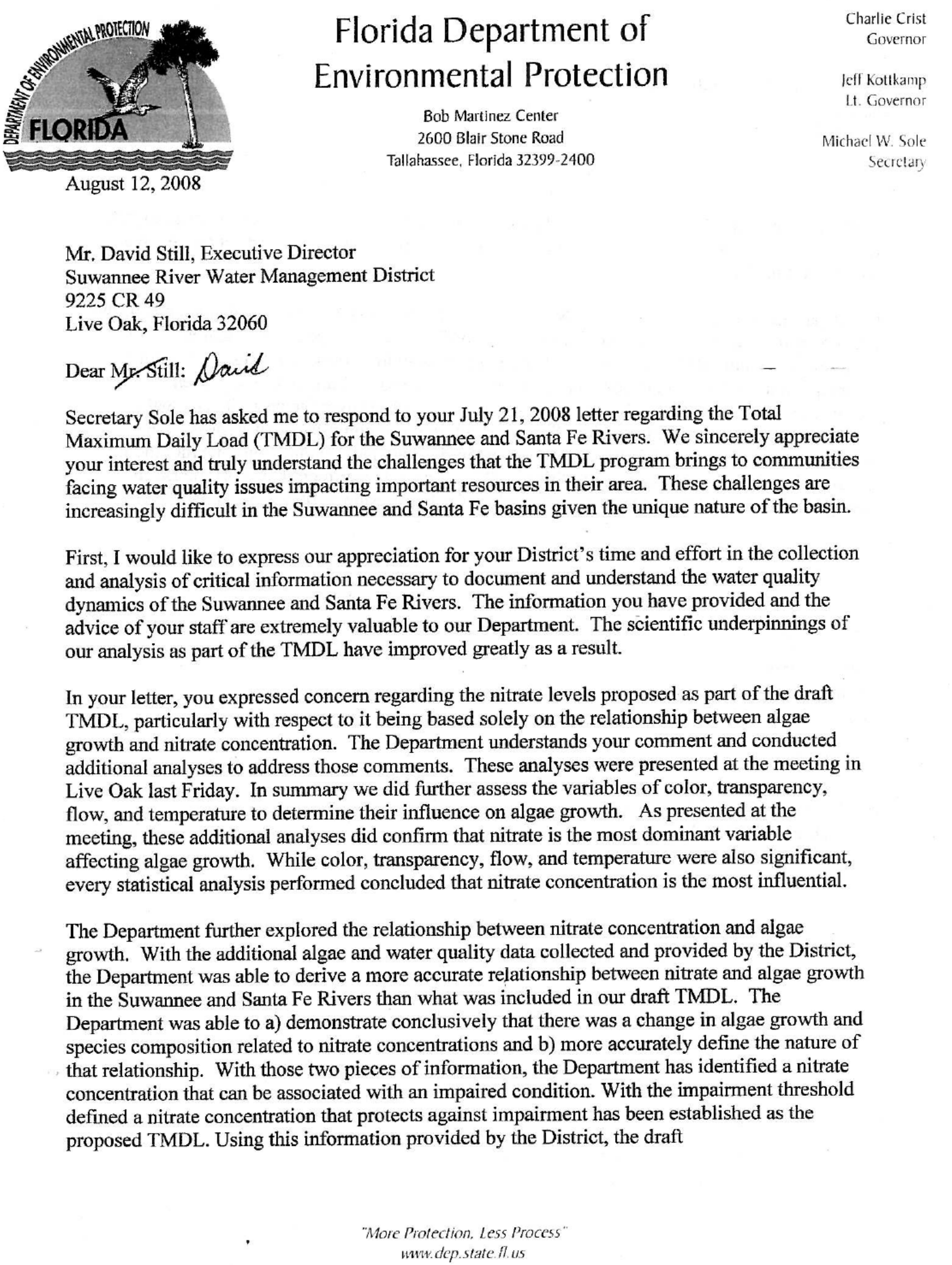

Florida Department of
Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

August 12, 2008

Mr. David Still, Executive Director
Suwannee River Water Management District
9225 CR 49
Live Oak, Florida 32060

Dear ~~Mr. Still~~: David

Secretary Sole has asked me to respond to your July 21, 2008 letter regarding the Total Maximum Daily Load (TMDL) for the Suwannee and Santa Fe Rivers. We sincerely appreciate your interest and truly understand the challenges that the TMDL program brings to communities facing water quality issues impacting important resources in their area. These challenges are increasingly difficult in the Suwannee and Santa Fe basins given the unique nature of the basin.

First, I would like to express our appreciation for your District's time and effort in the collection and analysis of critical information necessary to document and understand the water quality dynamics of the Suwannee and Santa Fe Rivers. The information you have provided and the advice of your staff are extremely valuable to our Department. The scientific underpinnings of our analysis as part of the TMDL have improved greatly as a result.

In your letter, you expressed concern regarding the nitrate levels proposed as part of the draft TMDL, particularly with respect to it being based solely on the relationship between algae growth and nitrate concentration. The Department understands your comment and conducted additional analyses to address those comments. These analyses were presented at the meeting in Live Oak last Friday. In summary we did further assess the variables of color, transparency, flow, and temperature to determine their influence on algae growth. As presented at the meeting, these additional analyses did confirm that nitrate is the most dominant variable affecting algae growth. While color, transparency, flow, and temperature were also significant, every statistical analysis performed concluded that nitrate concentration is the most influential.

The Department further explored the relationship between nitrate concentration and algae growth. With the additional algae and water quality data collected and provided by the District, the Department was able to derive a more accurate relationship between nitrate and algae growth in the Suwannee and Santa Fe Rivers than what was included in our draft TMDL. The Department was able to a) demonstrate conclusively that there was a change in algae growth and species composition related to nitrate concentrations and b) more accurately define the nature of that relationship. With those two pieces of information, the Department has identified a nitrate concentration that can be associated with an impaired condition. With the impairment threshold defined a nitrate concentration that protects against impairment has been established as the proposed TMDL. Using this information provided by the District, the draft

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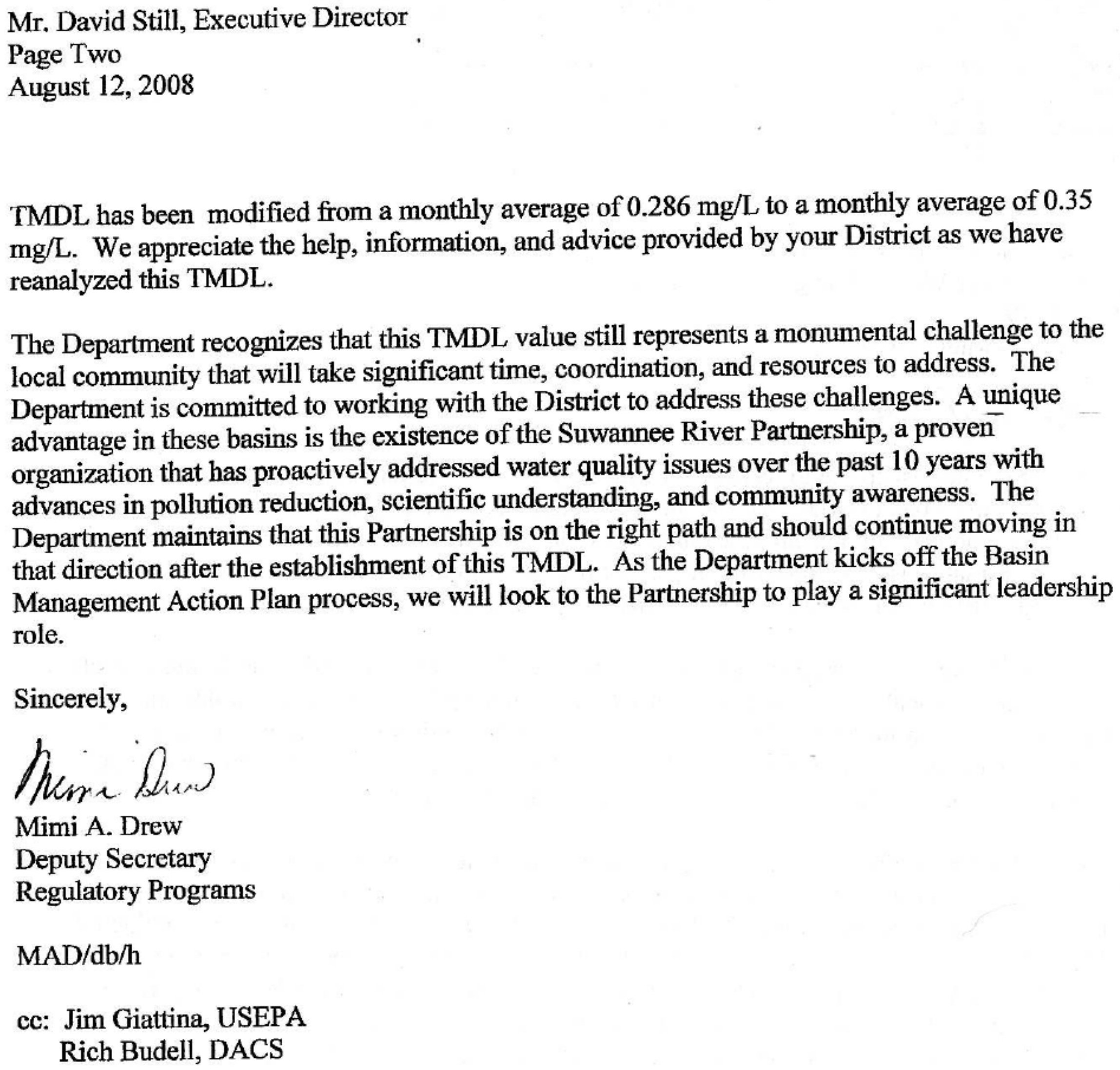

Mr. David Still, Executive Director
Page Two
August 12, 2008

TMDL has been modified from a monthly average of 0.286 mg/L to a monthly average of 0.35 mg/L. We appreciate the help, information, and advice provided by your District as we have reanalyzed this TMDL.

The Department recognizes that this TMDL value still represents a monumental challenge to the local community that will take significant time, coordination, and resources to address. The Department is committed to working with the District to address these challenges. A unique advantage in these basins is the existence of the Suwannee River Partnership, a proven organization that has proactively addressed water quality issues over the past 10 years with advances in pollution reduction, scientific understanding, and community awareness. The Department maintains that this Partnership is on the right path and should continue moving in that direction after the establishment of this TMDL. As the Department kicks off the Basin Management Action Plan process, we will look to the Partnership to play a significant leadership role.

Sincerely,

Mimi Drew

Mimi A. Drew
Deputy Secretary
Regulatory Programs

MAD/db/h

cc: Jim Giattina, USEPA
Rich Budell, DACS

From: Merrilleeart@aol.com [mailto:Merrilleeart@aol.com]
Sent: Tuesday, September 23, 2008 10:56 PM
To: Bartlett, Drew
Subject: Thursdays Meetings questions and comments from audience member

Hello Drew,
I was the sole member of the audience from the outside at the TMDL hearing last week. As per your request to e-mail my questions and comments...here they are.

1. Why was the figure .286 changed to .35 for allowable nitrates?

2. The Suwannee River and the Santa Fe River are two distinct river bodies and need to be separated while doing these kind of studies.

3. What is the situation with the Vaucheria on the Suwannee River?

Terry and Constance were very helpful after the meeting to answer any of my questions and offer me feedback on the TMDL Study.

I realize the magnitude of issuing compliance now that these levels have been set. I offer my service of including any public information to my weekly e-mail list to help get the word out on anything pertaining to protecting our waterways.

Thank You,
Merrillee Malwitz-Jipson
board member Our Santa Fe River, Inc.
High Springs, FL
Merrilleeart@aol.com
www.oursantaferiver.org

In Response to comments

Thank you for you comments.

Response to comment 1. The initial draft TMDL report included periphyton data from 1990 to 1998. Since the initial draft report additional information provided by the Suwannee River Water Management District was incorporated into the analysis to establish the nitrate target. The revised analysis includes data from 1999-2007 for a total of 17 years. The same analysis was performed on the expanded data set and provided greater statistical confidence on the exponential regression used in the target setting. The expanded data set, updated analysis, and greater statistical confidence provided the Department with assurance that the current target (0.35 mg/L nitrate) will protect the waterbody and prevent future excessive algal growth. For further explanation of the target setting please refer to section 5.5 in this report.

Response to comment 2. The Suwannee and Santa Rivers are different basins but with similar characteristics, such as land use land, karst terrain and both are dominated by groundwater inputs in their lower portions. Also both river systems have shown remarkably similar water quality trends through out the period of record. The Periphyton data set used to set the TMDL encompassed Suwannee River, Santa Fe River, and Withlacoochee River sampling locations. The TMDL report is written for both Suwannee and Santa Fe River Basins but the TMDL itself is separate for both basins and the percent reductions are calculated by basin.

Response to comment 3. The Suwannee River was listed as impaired based on photographic evidence of algal mats. *Vaucheria* spp. is a common taxa of macroalgae that occurred in extensive growths and was studied in several of the lines of evidence in this TMDL report. For more information on *Vaucheria* spp. in spring sampling please contact Connie Bersok (Connie.Bersok@dep.state.fl.us, (850) 245-8479).

Florida Department of Environmental Protection
Division of Water Resource Management
Bureau of Watershed Management
2600 Blair Stone Road, Mail Station 3565
Tallahassee, Florida 32399-2400
(850) 245-8561
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