TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Dissolved Oxygen, Nutrients, and BOD

In

Peace River above Bowlegs Creek, FL (WBID 1623J)

Prepared by:

US EPA Region 4
61 Forsyth Street SW
Atlanta, Georgia 30303

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EPA United States Environmental Protection Agency

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et., seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing Total Maximum Daily Loads (TMDLs) for dissolved oxygen, biochemical oxygen demand, and nutrients in Peace River above Bowlegs Creek, FL (WBID 1623J). Subsequent actions must be consistent with this TMDL.

__________________/s/__________________________ ______5/9/2007______

James D. Giattina, Director
Water Management Division

Date

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SUMMARY SHEET

1. **303(d) Listed Waterbody Information**
   State: Florida
   Major River Basin: Peace (03100101)
   Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
1623J	Peace River above Bowlegs Creek	Peace	Polk	DO, TN, BOD

2. **TMDL Endpoints (i.e., Targets) for Class III Fresh Waters:**
   Dissolved Oxygen: Shall not be less than 5.0 mg/l. Normal daily and seasonal fluctuations above these levels shall be maintained.

   Nutrients: The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in Section 62.302.530 of Florida Administrative Code. 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 and fauna.

   Biochemical Oxygen Demand: Shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each Class and, in no case, shall it be great enough to produce nuisance conditions.

3. **Allocation:**

Pollutant	TMDL	WLA		LA	MOS
		Wastewater NPDES	MS4		
Total Nitrogen	24,750 kg/yr (30% reduction)	15,296 kg/yr (30% reduction)	30% reduction	9,454 kg/yr (30% reduction)	Implicit
BOD	33,982 kg/yr (30% reduction)	N/A	30% reduction	33,982 kg/yr (30% reduction)	Implicit

Note: See Figure 32 and Figure 33 for daily load expressions.

4. **Endangered Species (yes or blank):** Yes

5. **EPA Lead on TMDL (EPA or blank):** EPA

6. **TMDL Considers Point Source, Nonpoint Source, or both:** Both

7. **Major NPDES Discharges to surface waters addressed in TMDLs:**

NPDES	FACILITY NAME	RECEIVING WATER	Industry Type
FL0001961	US AGRI-CHEMICALS BARTOW PLANT	PEACE RIVER	PHOSPHATIC FERTILIZERS

TOTAL MAXIMUM DAILY LOAD (TMDL) for Dissolved Oxygen, Nutrients, and Biochemical Oxygen Demand in Peace River above Bowlegs Creek, FL (WBID 1623J)

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

For assessment purposes, the Florida Department of Environmental Protection (FDEP) has divided the Peace River basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Peace River above Bowlegs Creek is contained within WBID 1623J, and is part of the Upper Peace River Planning Unit. Planning units are groups of smaller watersheds (i.e., WBIDs) that are part of a larger basin.

2. DESCRIPTION OF THE WATER QUALITY PROBLEM

Peace River above Bowlegs Creek (WBID 1623J) is on the 303 (d) list for low dissolved oxygen (DO), nutrients and biochemical oxygen demand (BOD). Upstream of Peace River above Bowlegs Creek, there are impaired waters that contribute significantly to the poor water quality in WBID 1623J. The U.S. Environmental Protection Agency (USEPA) established TMDLs for these upstream segments in 2006 (USEPA, 2006a, and 2006b). Water quality improvements in WBID 1623J is dependent on implementation of these upstream TMDLs. TMDLs for WBID 1623J are developed pursuant to EPA's commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

3. WATERSHED DESCRIPTION

The Peace River drainage basin is approximately 2,350 square miles. The Peace River flows about 105 miles from the confluence of the Peace Creek Drainage Canal and

Saddle Creek to Charlotte Harbor (see Figure 1). The impaired WBID stretches from the cities of Bartow to Ft. Meade (see Figure 2).

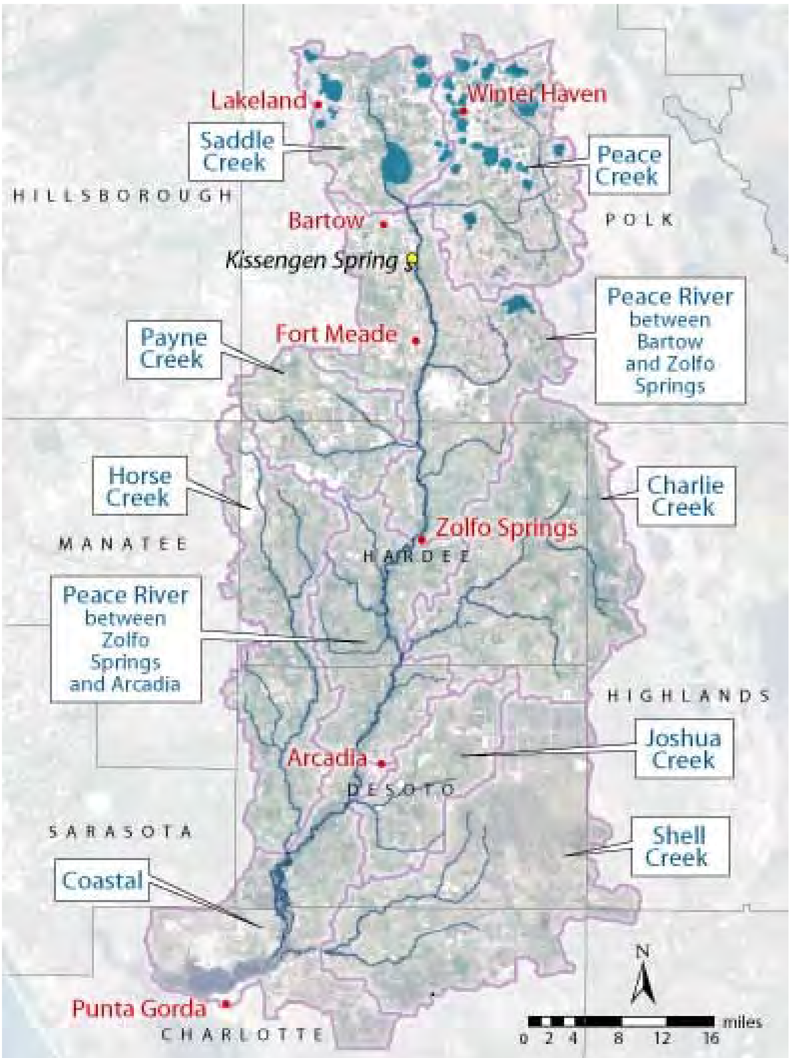

Figure 1. Peace River Basin

Flows from the Peace River are vital to the estuarine health and overall productivity of Charlotte Harbor. A steady, long-term decline in Peace River flows has been observed since the early-1960s. The causes of the decline are complex. Average annual rainfall over the last 30 years is about five inches/year lower than in the previous 30 years. Ground-water withdrawals for public supply, agriculture and mining have lowered the potentiometric surface of the Floridian aquifer since the early-1930s, which has reversed the hydraulic gradient between the river and underlying confined aquifers. This has caused gravity drainage of the river into sinkholes in the upper part of the basin (Southwest Florida Water Management District (SWFWMD), 2005).

Figure 2. Location of the Peace River above Bowlegs Creek WBID

Land within the basin has been considerably altered from the natural state by phosphate mining, agriculture, and other development. The cumulative effects of land use changes due to urbanization, agriculture, and mining can change stormwater runoff and baseflow contributions to the Peace River. Drainage of wetlands through ditching and canal construction can affect surface water storage and runoff patterns. Historic phosphate mining and reclamation of mined lands can alter the timing and magnitude of runoff, surface water storage, recharge and evapotranspiration. All of these factors contribute to changes in hydrology and ecology within the Peace River basin. To address the potential effect of the anthropogenic activities in the basin, the Florida Legislature directed FDEP in its 2003 legislative session to assess the cumulative impacts to the Peace River Basin. This study, called the Peace River Cumulative Impact Assessment, will form the basis for preparation of a resource management plan. The subsequent resource management plan (not a part of the Peace River Cumulative Impact Assessment) will identify regulatory and non-regulatory means to minimize future impacts for the basin (SWFWMD, 2005).

Landuse in WBID 1623J is 14.8% urban, 17.4% agriculture, 16.6% wetlands, and 46.1% barren and extractive. The spatial distribution and acreage of different land use categories were identified using the 1999 land use coverage (scale 1:40,000) contained in the FDEP's GIS library. This dataset was derived from Infrared Digital Orthophoto Quadrangle photo interpretations using the Florida Land Use Classification Code System (FLUCCS). Land use categories in the watershed were aggregated using the FLUCCS Level 2 codes.

4. WATER QUALITY STANDARD AND TARGET IDENTIFICATION

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)

Peace River above Bowlegs Creek is classified as Class III fresh waters, with a designated use classification for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (FAC), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in WQS, including Section 62-302.500 FAC [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in Section 62-302.530 FAC. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria that apply to WBID 1623J are described in the following sections.

4.1 Nutrients

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. 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 and fauna. Because the State of Florida does not have numeric criteria for nutrients, chlorophyll and DO levels are used to indicate whether nutrients are present in excessive amounts.

4.2 Dissolved Oxygen

Dissolved Oxygen (DO) shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained.

4.3 Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each Class and, in no case, shall it be great enough to produce nuisance conditions.

5. WATER QUALITY ASSESSMENT

FDEP assesses the quality of surface waters using data from a variety of sources including: EPA's Legacy and "new" STOrage and RETrieval (STORET) database; FDEP's Impaired Waters Rule (IWR) database; the U.S. Geological Survey (USGS); and the Florida Department of Health. The STORET and IWR databases contain water quality data from a variety of sources, including FDEP, water management districts, local governments, and volunteer monitoring groups. Water quality data used to develop the TMDLs are from IWR version 23_1. Data collected between January 1, 1998 and February 2004 were used in the TMDL analysis. Water quality monitoring stations are shown in Figure 3.

Figure 4 through Figure 10 show the observed water quality data at all stations in the WBID. Figure 4 shows dissolved oxygen violated the standard 135 times out of 293 observations from 1998 through 2004, and no long-term trends are apparent. Figure 5 shows DO data for twelve monitoring stations with violations occurring at all stations. There are 170 violations of the WQS (52%) in the upstream segments, and only 70 violations (29%) in the downstream segments. This indicates a large water quality problem upstream of this WBID and not as much within the WBID. The data show low DO concentrations at the upstream end of this WBID near Bartow, but improves downstream towards Fort Meade. Chlorophyll-a data collected after 1998 further supports the conclusion that DO is improving in WBID 1623J, as upstream stations (21FLSWFDFLO0107 and 21FLSWFDFLO41000007900) have higher chlorophyll-a concentrations than mid-stream and downstream stations (21FLPOLKPEACERIVER1,

21FLTPA27484828147401, 21FLSWFDFLO41000007800 and 21FLSWFDFLO0108) (see Figure 10).

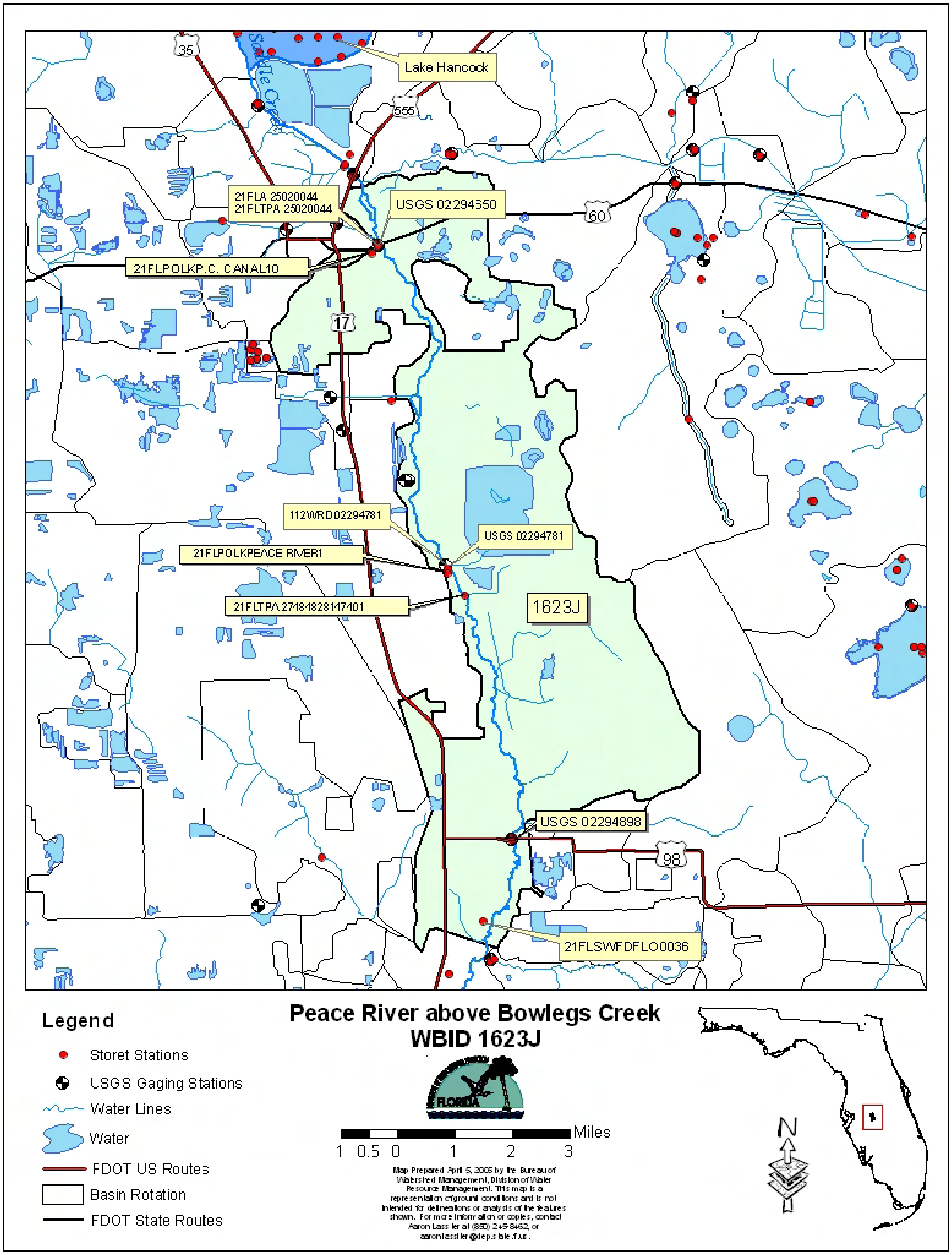

Figure 3. Water Quality Monitoring Stations

The average Total Keldjal Nitrogen (TKN) concentration measured in the WBID is 1.51 mg/l (see Table 1), and this is higher than the average TKN concentration of 1.167 mg/l for streams in the Sarasota Bay-Peace-Myakka River Basin (see Table 2). TKN data are displayed graphically in Figure 6. The average Total Phosphorus (TP) is 0.98 mg/l in the WBID (see Figure 8), and this is about two times the average TP of 0.45 mg/l for streams in the Sarasota Bay-Peace-Myakka River Basin Group (see Table 2). A comparison between average TKN and TP concentrations in WBID 1623J with EPA ecoregion values indicates that TKN in the WBID is higher than the ecoregion value of 1.1 mg/l, while TP in the WBID is less than the ecoregion value of 1.6 mg/l (USEPA, 2007).

FDEP conducted bioassessments at six locations in the WBID with scores ranging from poor to excellent (see Table 3). The Six Mile Creek station showed poor results in three tests. The Barber Branch station, located in the mid-portion of the WBID, showed good and excellent results. The bioassessment results further support the conclusion that poor water quality is being transported into WBID 1623J from upstream areas.

The ratio of Total Nitrogen (TN) to TP at the downstream station locations (112WRD02294898 and 21FLSWFDFLO0108) is 2.3 and the ratio at the upstream locations (112WRD02294650 and 21FLA25020044) is 5.4. Based on phytoplankton stoichiometry, a TN to TP ratio less than 7.2 generally indicates a nitrogen limitation and a higher ratio indicates that nitrogen is abundant and the system is phosphorus limited. The data indicates a nitrogen limitation; therefore, nitrogen is the target nutrient in this TMDL.

Growth, death and decay of plants and algae in the river can influence the water quality dynamics. An understanding of the riverine habitats is important in understanding the water quality. The benthic habitat is composed of sand, silt or bedrock or a mix of any of these substrata (SWFWMD, 2002). During spring and summer months, algal mats can cover these substrates, particularly during low flow periods. Other instream habitats include wood (such as snags and exposed roots), aquatic plants, and riparian vegetation (such as wetland trees and under story plants). Aquatic plants include rooted emergent vegetation, floating-leaved vegetation and submersed aquatic vegetation. SWFWMD reported that native submersed vegetation and water hyacinth are abundant in the Upper Peace River (SWFWMD, 2002).

Table 1. Average Nutrients (mg/l) in WBID 1623J

WBID	WBID Name	Nutrient	Average
1623J	PEACE R AB BOWLEGS CK	TKN	1.51
1623J	PEACE R AB BOWLEGS CK	TN	1.81
1623J	PEACE R AB BOWLEGS CK	TP	0.98

Table 2. Average Nutrients (mg/l) for the Peace Basin Group

Basin Group	Water Type	Nutrient	Average
Sarasota Bay - Peace - Myakka	BLACKWATER	TKN	1.650
Sarasota Bay - Peace - Myakka	BLACKWATER	TP	0.405
Sarasota Bay - Peace - Myakka	COASTAL	TKN	0.661

Basin Group	Water Type	Nutrient	Average
Sarasota Bay - Peace - Myakka	COASTAL	TN	0.205
Sarasota Bay - Peace - Myakka	COASTAL	TP	0.100
Sarasota Bay - Peace - Myakka	ESTUARY	TKN	0.687
Sarasota Bay - Peace - Myakka	ESTUARY	TN	1.129
Sarasota Bay - Peace - Myakka	ESTUARY	TP	0.228
Sarasota Bay - Peace - Myakka	LAKE	TKN	1.503
Sarasota Bay - Peace - Myakka	LAKE	TN	1.475
Sarasota Bay - Peace - Myakka	LAKE	TP	0.141
Sarasota Bay - Peace - Myakka	SPRING	TKN	0.624
Sarasota Bay - Peace - Myakka	SPRING	TP	0.036
Sarasota Bay - Peace - Myakka	STREAM	TKN	1.167
Sarasota Bay - Peace - Myakka	STREAM	TN	1.617
Sarasota Bay - Peace - Myakka	STREAM	TP	0.449

Table 3. Biological Assessments Conducted by FDEP

WBID	Score	Date	Type	Station Name	Result
1623J	Poor	9/16/2002	SCI	IMC NORALYN-PHOPHORIA FYI Control Site - Peace River above Six Mile Creek	15
1623J	Poor	9/16/2002	SCI	IMC NORALYN-PHOPHORIA FYI Control Site - Peace River above Six Mile Creek	15
1623J	Good	9/16/2002	SCI	IMC NORALYN-PHOSPHORIA FYI Test Site, Peace River below Barber Branch	23
1623J	Excellent	9/16/2002	SCI	IMC NORALYN-PHOSPHORIA FYI Test Site, Peace River below Barber Branch	29
1623J	Good	9/16/2002	SCI	IMC NORALYN-PHOSPHORIA FYI Test Site, Peace River below Barber Branch	21
1623J	Poor	9/16/2002	SCI	IMC NORALYN-PHOPHORIA FYI Control Site - Peace River above Six Mile Creek	17

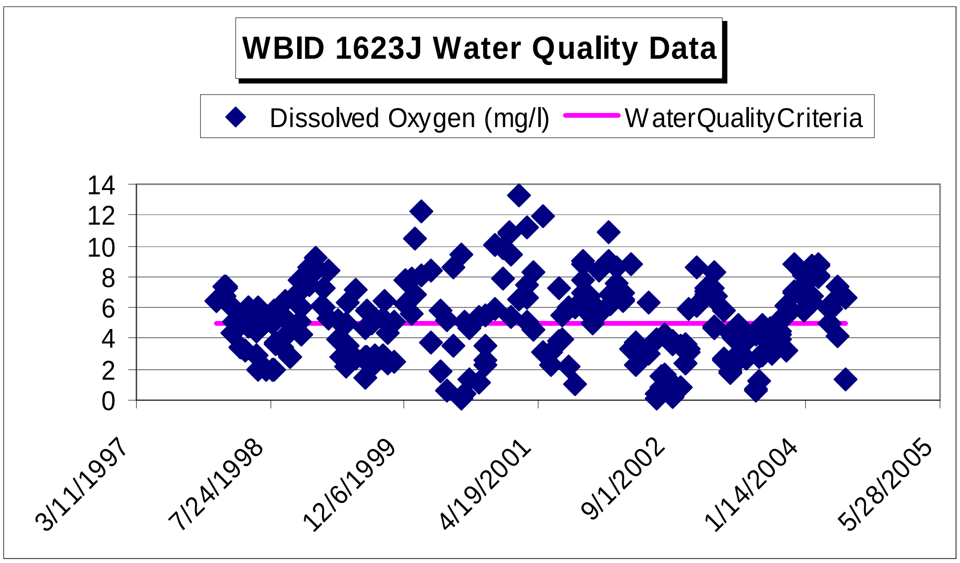

Figure 4. Comparison of DO Concentrations and WQS

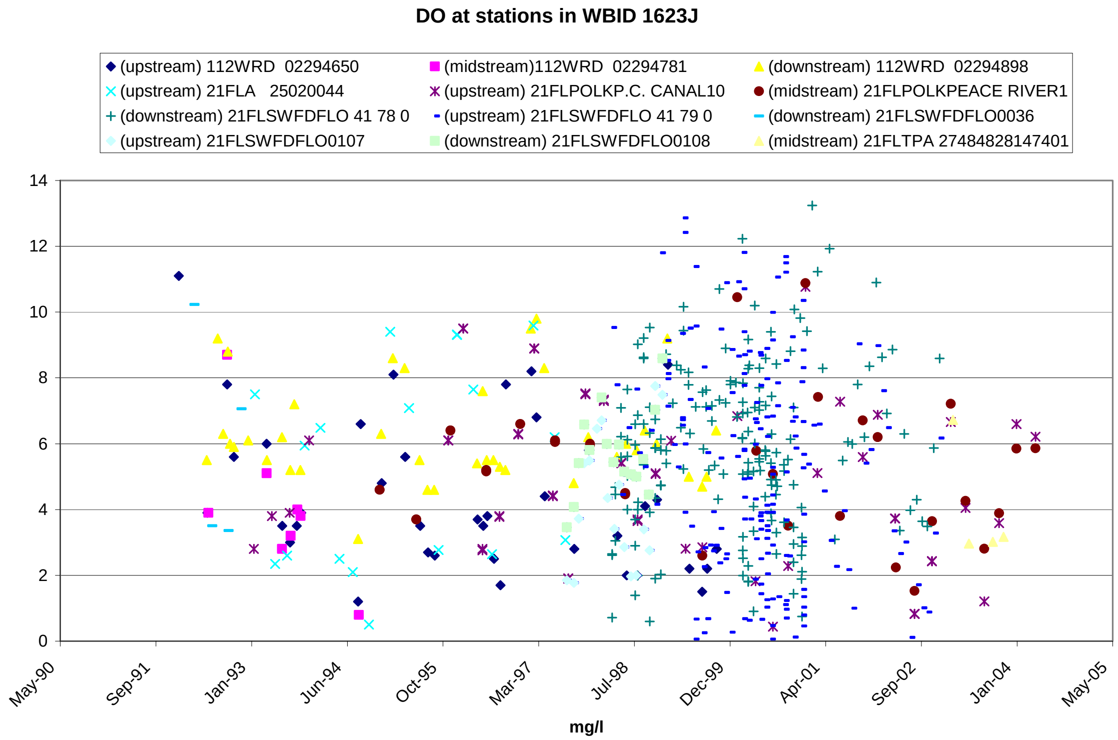

Figure 5. DO Concentrations at Monitoring Stations in WBID 1623J

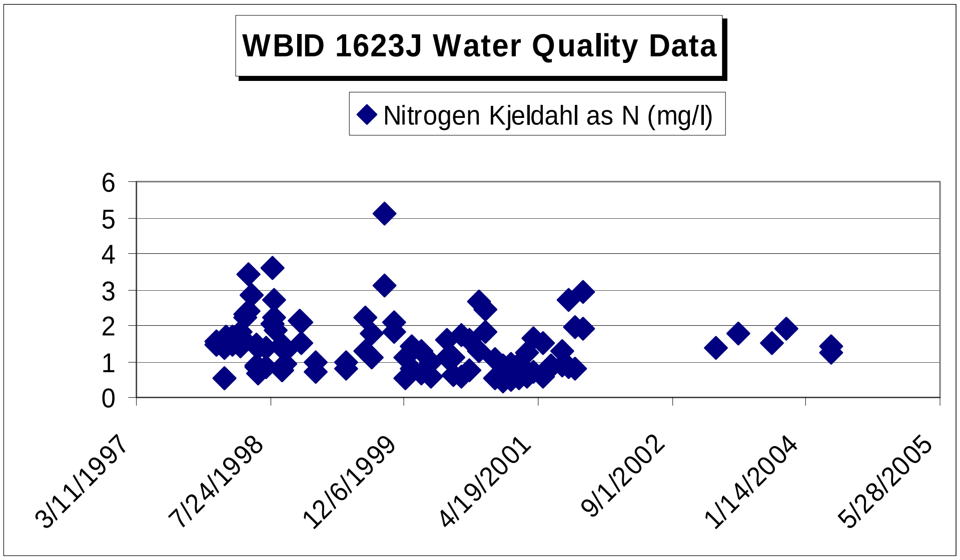

Figure 6. TKN Concentrations in WBID 1623J

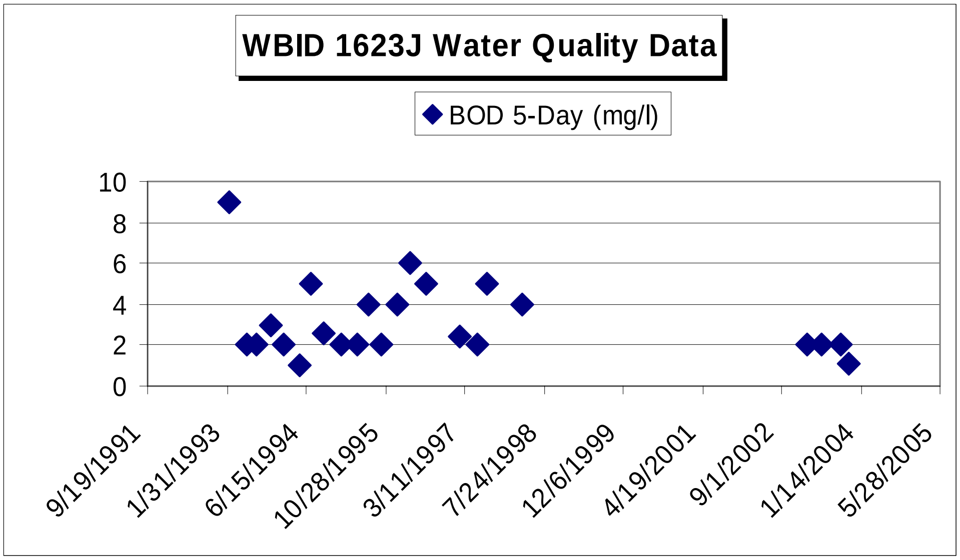

Figure 7. BOD Concentrations in WBID 1623J

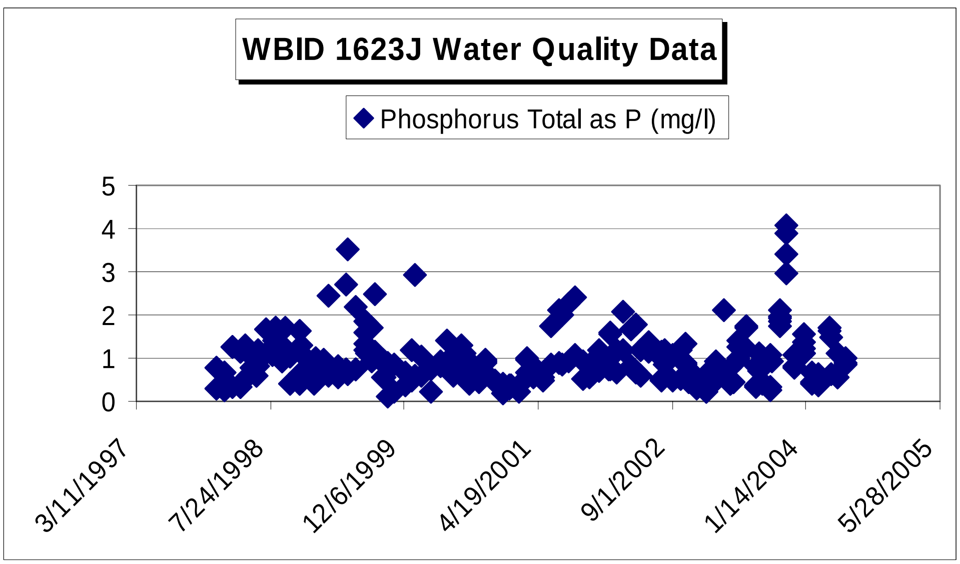

Figure 8. TP Concentrations in WBID 1623J

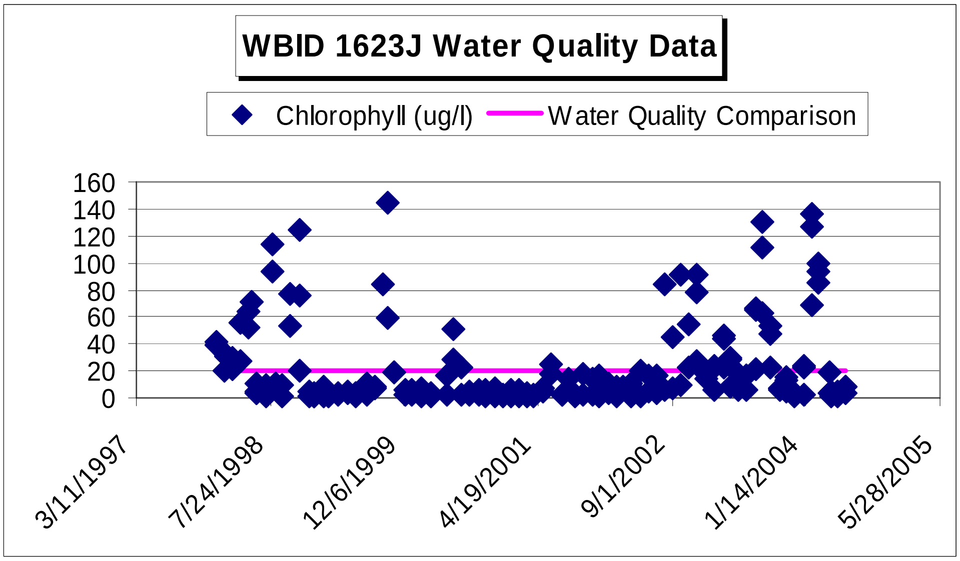

Figure 9. Chlorophyll-a Concentrations in WBID 1623J

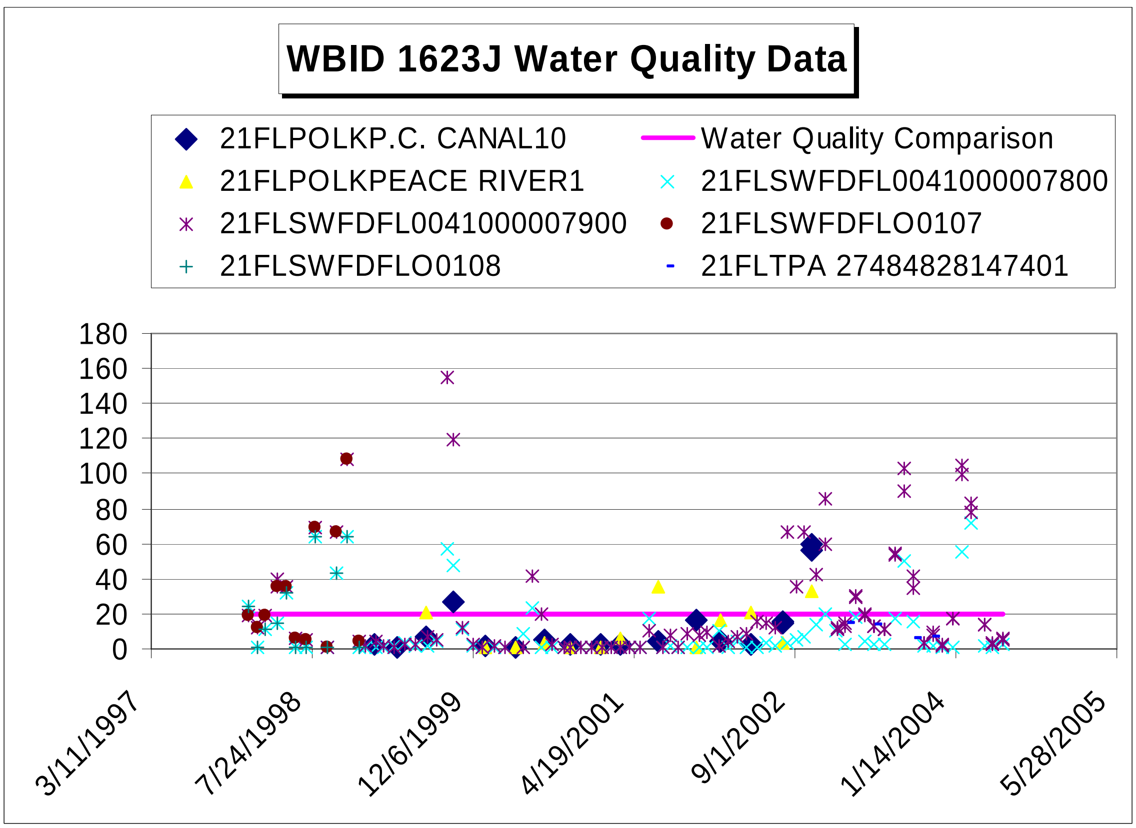

Figure 10. Chlorophyll-a Concentrations Measured at Stations in WBID 1623J

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources. Nutrients enter surface waters from both point and nonpoint sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities, including certain urban stormwater discharges such as municipal separate stormwater systems (MS4 areas), certain industrial facilities, and construction sites over one acre, are storm-water driven sources considered “point sources” in this report.

Nonpoint sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These include animal waste, septic tanks and application of fertilizers to golf courses and lawns. These sources generally, but not always, involve accumulation of nutrients on land surfaces and wash off as a result of storm events.

6.1 Point Sources

A wasteload allocation (WLA) is provided to industrial and domestic wastewater NPDES facilities and to permitted Municipal Separate Storm Sewer Systems (MS4s) discharging to surface waters.

6.1.1. Wastewater Treatment Facilities

There is one wastewater treatment facility permitted to discharge to surface waters in WBID 1623J. Agri-Chemicals Corporation operates a di-ammonium, monammonium phosphate (DAP) plant (FL0001961) in Bartow, FL that is authorized to discharge treated industrial wastewater to Bear Branch, a tributary to the Peace River. This facility produces di-ammonium phosphate fertilizer by reacting anhydrous ammonia with phosphoric acid. Wastewater from the facility consists of process water used for cooling, scrubbing, and feedwater that is recirculated in an unlined pond. Non-process water, stormwater, and treated process water from an adjacent phosphogypsum stack are discharged to a pond and lake system, and then through outfall D-001 to Bear Branch. Bear Branch flows about four miles from this outfall to its confluence with the Peace River. Contaminants of concern in the wastewaters are primarily nitrogen and phosphorus. The permit limit for TP concentration is a monthly average of 30 mg/l, with monitoring-only requirements for TP load, TN load, and ammonia concentration.

NPDES facility discharge data reported to EPA and maintained in EPA's permit compliance system (PCS) database were used in the TMDL analyses. The TN and TP loads, and ammonia and phosphorus concentrations reported from this facility are shown in Figure 11, Figure 12, Figure 13 and Figure 14, respectively.

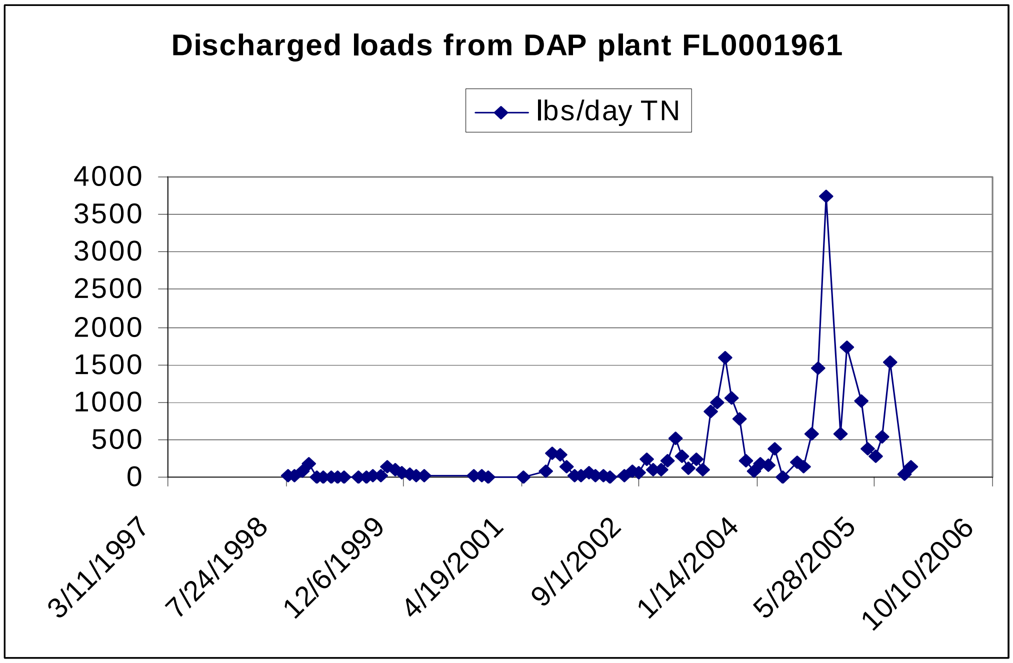

Figure 11. TN Loadings Discharged from NPDES FL0001961

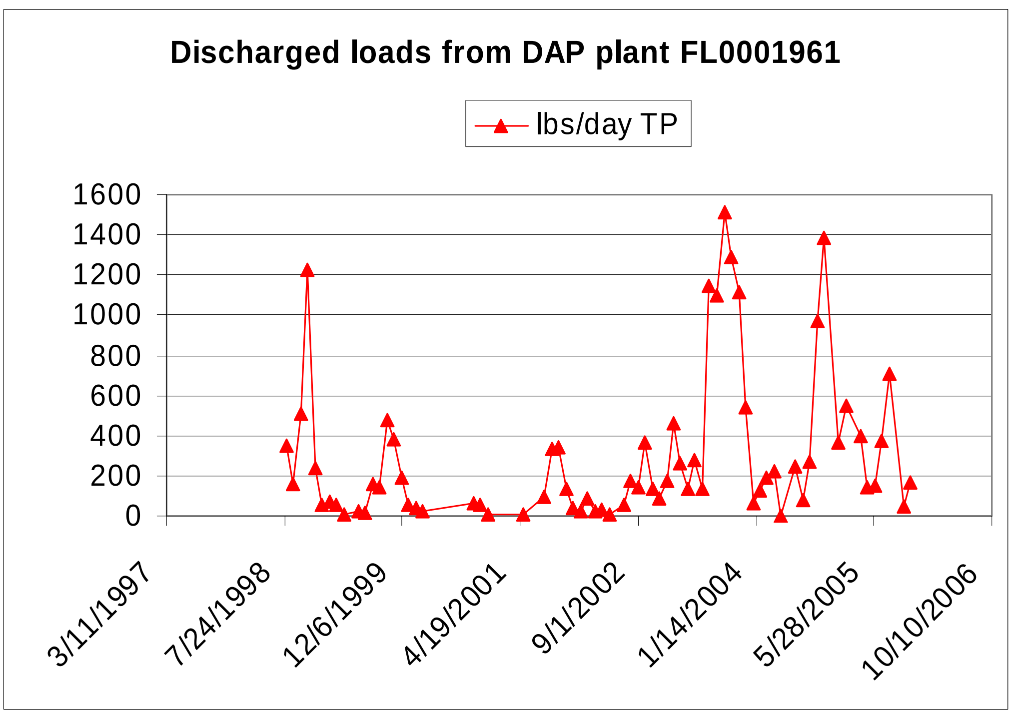

Figure 12. TP Loadings Discharged from NPDES FL0001961

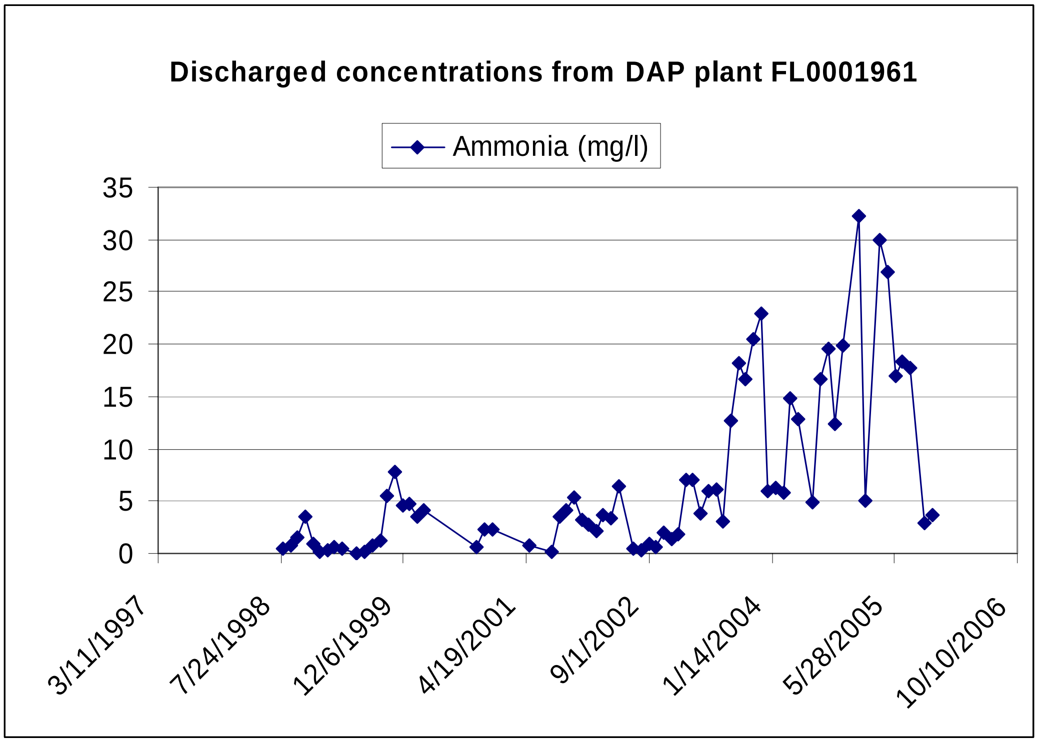

Figure 13. Ammonia Concentrations Discharged from NPDES FL0001961

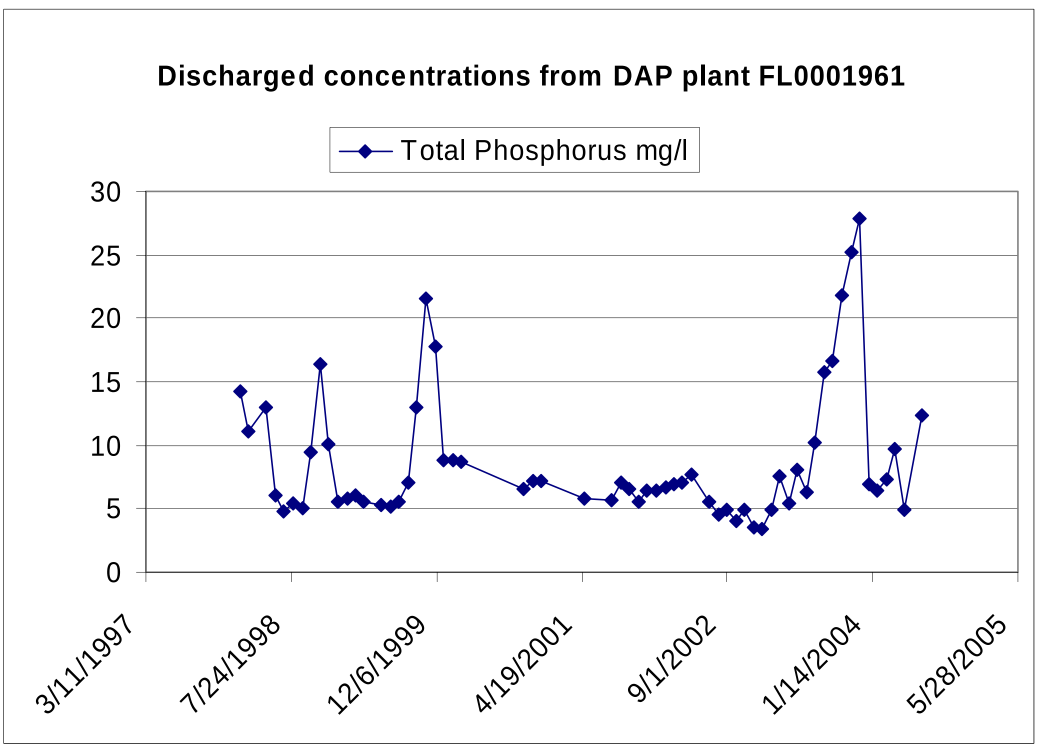

Figure 14. TP Concentrations Discharged from NPDES FL0001961

6.1.2. Municipal Separate Storm Sewer Systems (MS4s)

Municipal Separate Storm Sewer Systems (MS4s) may also discharge nutrients to waterbodies in response to storm events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit under the Phase I storm water regulations. After March 2003, small MS4s serving urbanized areas are required to obtain a permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile.

WBID 1623J falls under the Polk County Phase I MS4 permit (FLS000015). As the lead applicant in the permit, the County is responsible for the coordination of information and efforts to be reported in annual stormwater reports. Waterbodies located within the county that collect or receive stormwater discharges from regulated Phase 1 MS4 areas are subject to the appropriate provisions of the permit. Additionally, via local agreements, Polk County may be responsible for the actual implementation of stormwater requirements as stated in the permit. However, each permittee covered in the permit is ultimately responsible for the MS4 discharges resulting from their jurisdiction, including TMDLs and WLAs. Since no MS4 water quality data were available, the MS4 pollutant loads were not specifically analyzed. The MS4 loads were indirectly included in the TMDL analysis through the use of landuse GIS coverages, landuse loading rates for urban areas, and the observed in-stream water quality data.

6.2 Nonpoint Sources

Nonpoint sources that ultimately contribute to depletion of in-stream dissolved oxygen include sources of nutrients such as phosphate mines, animal waste, waste-lagoon sludge, fertilizer application to agricultural fields, lawns, and golf courses, and malfunctioning onsite sewage treatment and disposal systems, or septic tanks. The following sections summarize nonpoint sources of nutrients included in the USGS report entitled "*Water-Quality Assessment of Southern Florida—Wastewater Discharges and Runoff*" (USGS, 1998). Nonpoint source pollutant loads were estimated using landuse GIS coverages, landuse loading rates, and the observed in-stream water quality data.

6.2.1. Phosphate Mines

There are numerous phosphate mines in the Peace River Basin, and these mines are a source of phosphorous entering surface waters. Phosphate mines are also a potential source of other surface water pollutants, such as acidity, fluorides and heavy metals.
Phosphate mining is one of the three largest industries in Florida along with tourism and agriculture. Phosphate rock is a sedimentary rock that consists mainly of calcium phosphate together with other minerals such as calcium carbonate. Phosphate rock is formed from sea shells, corals and other ocean bed material. As they die, their shells, which are primarily made up of calcium, settle to the bottom of the ocean in layers. Over

millions of years large deposits are formed. The State of Florida is the leading producer of phosphate rock in the United States. Phosphate rock is used to make much of the fertilizers used in agriculture. Phosphogypsum and the process water are environmental concerns. The process water is highly acidic and spills can cause great harm to aquatic life. The phosphogypsum contains impurities such phosphorus, fluorides and heavy metals like radium and selenium.

6.2.2. Agriculture

Agriculture is another potential source of water quality impairments in the Peace River Basin. The USGS report states that citrus production is a large industry on the Lake Wales Ridge (Highlands and Polk Counties). The Florida Agriculture Statistics Service (FASS) reports 119,901 acres of citrus in Polk County and over 55,000 acres in Hardee County. Runoff from these agricultural activities can be significant, especially during rainy seasons when the soil is saturated (USGS, 1998). Some of the largest dairy and cattle operations in the United States are in south Florida. According to the FASS, there were 108,126 cattle and calves in Polk County and 94,749 in Hardee County in 2002 (FASS, 2002). High nutrient concentrations are attributed to runoff from improved pasture and dairy operations in some areas of south Florida (USGS, 1998).

6.2.3. Urban Development

Urban development is another major source of pollution in the Peace River Basin. The USGS reports that population growth and activities in the south Florida area over the past 40 years have resulted in increased water use, changes in the distribution and timing of flow, and deterioration of water quality (USGS, 1998). These changes threaten both the remaining natural ecosystem and the growing human population. Wetlands and shallow waters in the region are sensitive to increased nutrient and contaminant inputs that are often associated with wastewater discharges and storm water runoff. The storm water that collects in retention ponds, canals, or ditches often contains bacteria, viruses, oil and grease, toxic metals, nutrients, and pesticides. These contaminants seep into the ground and adversely affect public water supplies, or they are discharged from canals into lakes and bays, degrading these waters. Landfills are another source of nonpoint pollutants associated with urban areas. Contaminants from landfills leach into the ground and surface waters, adversely affecting water quality (USGS, 1998).

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 outlined in Chapter 403 Florida Statutes (FS), was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC. Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: “the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water” (Section 62-4-.432 (5)(c), FAC). Nonstructural and structural BMPs are an integral part of the State’s stormwater programs. Nonstructural BMPs, often referred to as “source controls”, are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

6.2.4. Onsite Sewage Treatment and Disposal Systems

According to the USGS, septic tanks are mostly used for individual households or small commercial establishments (e.g., churches, convenience stores, small motels, restaurants, and campgrounds) that are in rural or remote areas, or in urban areas that are not served by a domestic wastewater facility (USGS, 1998). Effluent from septic tanks is generally released to the subsurface through on-site subsurface drain fields that allow the water to percolate into the ground (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water. Concentrations of septic tanks are common in highly suburbanized counties, where housing growth often occurs in unincorporated areas immediately adjacent to city limits. In many cases, these areas are not served by domestic wastewater facilities. The USGS states that waste generated from each septic tank can add high levels of nitrogen (nearly 24 pounds per year) and phosphorus (9 pounds per year) to the surficial aquifer and adjacent surface water. The State of Florida Department of Health publishes septic tanks data on a county basis, and the data are available on their web page (www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). Table 4 summarizes the number of septic systems installed in Hardee and Polk counties since the 1970 census. The data does not reflect septic tanks removed from service.

Table 4. County Estimates of Septic Tank Installation

County	Number of Septic Tanks (1970 – 2002)
Hardee	8,293
Polk	112,848

7. ANALYTICAL APPROACH AND MODEL DEVELOPMENT

Methods for linking the target to the pollutant sources include empirical approaches based on observed information, simple approaches, screening level model analysis, and detailed modeling. TMDLs can include one or more of these approaches to characterize this linkage between a target and source (USEPA, 1999). The purpose of utilizing water quality models for the development of DO, nutrient and BOD TMDLs in this river basin is to understand the linkages between low in-stream DO and the factors that cause the low DO. Some of the major factors impacting DO include: stream flow and geometry; nutrient loads and flows from the watershed; BOD loads from the watershed; in-stream plants and algae; and sediment oxygen demand (SOD). The TMDLs for nutrients, BOD, and low DO are addressed by targeting the dissolved oxygen water quality standard.

7.1 Approach and Model Setup

A dynamic hydrologic and water quality model was set-up on this stretch of the Peace River from Bartow to Fort Meade to better evaluate the water quality. Water Quality Analysis Simulation Program version 7 (WASP7) was used for estimating the effects of all nutrient and oxygen consuming loads on dissolved oxygen. WASP7 is an enhancement of the original WASP (USEPA, 2001a).

Estimated nonpoint source loads of BOD, nitrogen, and phosphorus for WBID 1623J are shown in Table 5. These loads were calculated using the EPA simple method formula shown in Table 6 from the BASINS PLOAD version 3.0 model (USEPA, 2001b). Event Mean Concentrations (EMC) values assumed in the PLOAD analysis are shown in Figure 15 (Harper and Baker, 2003). Landuse was based on the SWFWMD 1999 land use/cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS).

FLUCCS ID	Land Use	BOD (mg/L)	Total N (mg/L)	Total P (mg/L)
4000	Forest/rural open	1.23	1.09	0.046
1000-(1100+1200+1300)	Urban open	7.4	1.12	0.18
2000	Agriculture	3.8	2.32	0.344
1100	Low-density residential	4.3	1.64	0.191
1200	Medium-density residential	7.4	2.18	0.335
1300	High-density residential	11.0	2.42	0.49
8000	Communication and transportation	6.7	2.23	0.27
3000+7000	Rangeland	3.8	2.32	0.344
5000	Water	1.6	1.60	0.067
6000	Wetlands	2.63	1.01	0.09

Figure 15. EMCs from Harper and Baker (2003)

Table 5. Estimated Nonpoint Source Loads (1996 through 2003 average daily loads)

Parameter	Total Load (kg/d)	Total Load (kg/year)
BOD	93	33982
TN	26	9454
TP	4	1278

Table 6: Pollutant Load Equation from EPA BASINS PLOAD users manual

$LP = \Sigma u (P * PJ * RVu * Cu * Au * 2.72 / 12)$

Where: LP = Pollutant load, lbs

P = Precipitation, inches/year

PJ = Ratio of storms producing runoff (default = 0.9)

RVu= Runoff Coefficient for land use type u, inches of runoff/inches of rain

Cu = Event Mean Concentration for land use type u, milligrams/liter

Au = Area of land use type u, acres

Monthly point source loads from the Agri-Chemicals Corporation's DAP facility were input to the water quality model as monthly average flows and concentrations (see Table 7). This discharge was stormwater driven as illustrated by Figure 16. To verify that these loads were related to flow, the point source discharge was divided by the average discharge to get a "normalized discharge". This normalized discharge was plotted with the normalized flow to show the relationship between flow and discharge (Figure 16).

Table 7. Annual Average Point Source Loads Included in Model

year	ammonia (kg)	nitrate (kg)	ortho-p (kg)
1998	5269	70	83507
1999	3863	93	17986
2000	674	556	3708
2001	5296	3471	13676
2002	3758	6304	22909
2003*	52800	9619	79229

Note: Year 2003 is Jan. 1 through Sept. 30.

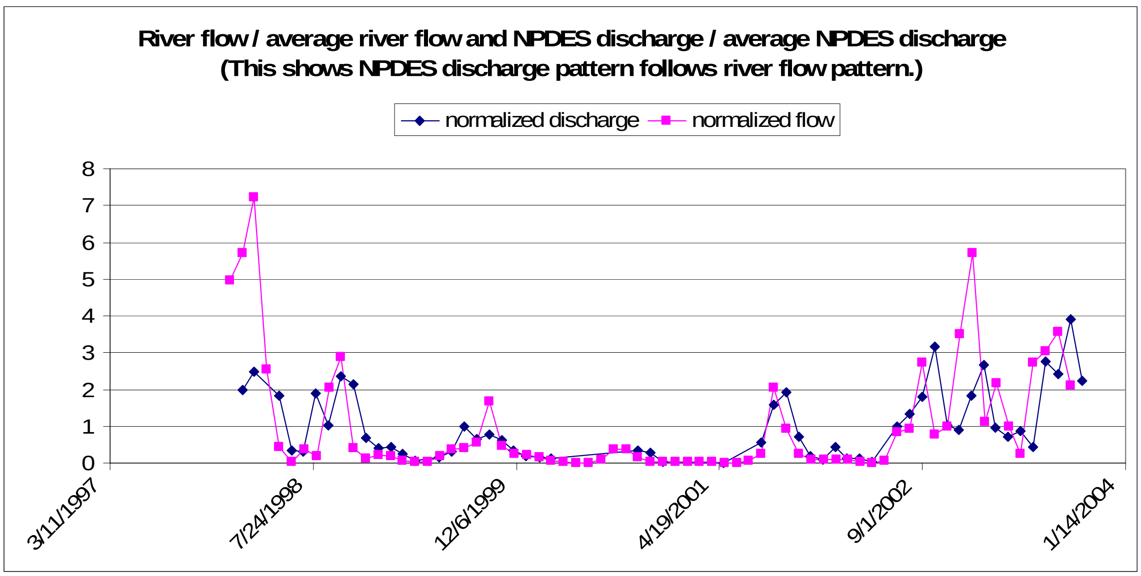

Figure 16. Comparison of Point Source Discharge and River Flow

The WASP kinematic wave and eutrophication model was developed for approximately 13 miles of the Peace River from river mile (RM) 105 at the U.S. Highway 60 Bridge near Bartow to RM 92 at the U.S. Highway 98 Bridge near Fort Meade. Upstream boundary conditions were described with flow measured by the USGS at gage 02294650 and water quality observations by the USGS, EPA (USEPA, 2005) and FDEP (stations 21FLA25020044 and 21FLTPA25020044). The model was calibrated to water quality data at RM 97 and RM 92 as shown in Figure 19 through Figure 28. USGS station 02294781, Polk County station 21FLPOLKPeaceRiver1, and FDEP station FLTPA27484828147401 are located near RM 97, and USGS station 02294898, and SWFWMD stations 21FLSWFDFLO0036 and 21FLSWFDFLO0108 are near RM 92.

River geometry, slopes and roughness values were obtained from a U.S. Army Corps of Engineers and SWFWMD HECRAS model. Since this stretch of the Peace River has a low gradient with an average slope of 0.0002, it was necessary to verify that the kinematic wave model assumption that backwater (pressure head and acceleration terms of the underlying hydrodynamic equations) is insignificant. The kinematic wave assumption was valid as the model predicted flow very well (see Figure 19 and Table 8).

Water quality kinetic rates and constants were estimated from literature values and direct measurements. To enhance model development, oxygen diffusion, flow velocity, SOD, nutrient exchange, photosynthesis and respiration, and diurnal DO in the Peace River and major tributaries were measured by EPA's Science and Ecosystem Support Division (SESD) during June 2003. Diurnal DO in the Peace River as measured by EPA in 2003 is shown in Figure 17 and Figure 18. The magnitudes of these low flow DO swings are only 1 to 2 mg/l. This and the low DO concentrations indicate the low DO is not due to plant production and respiration, but rather high DO demand from decaying matter and oxygen demanding substances. Color ranged from 100 to 250 Pt-Co units, which indicates high organic matter in the river. Additional information regarding this EPA field study can be found in the SESD report (USEPA, 2005).

Carbonaceous BOD (CBOD) concentrations and decay rate were determined from nitrogen inhibited BOD tests of river water analyzed by FDEP. The five day CBOD was 1.2 and the 30 day was 4.5 mg/l. This results in an estimated decay rate of 0.05 per day and an ultimate to 5-day ratio of 4.8. These values are within the typical range found in southeastern natural waters.

Reaeration rate coefficients determined through diffusion dome measurements ranged from 0.28 per day in the river segment near Homeland to 0.57 per day in the segment below Bartow. A constant reaeration rate of 0.5 per day was selected for the model and resulted in simulated DO concentrations that were a good match with observed data (see Figure 21 and Figure 22, and Table 9). SOD was measured by the in-situ chamber method to be 3.35 grams oxygen per square meter per day $g/m^2/day$) near Homeland and 1.01 $g/m^2/day$ near Ft. Meade. EPA measured SOD values in Florida streams and found values ranging from 0.48 to 6.58. The values measured in the Peace River are within the range for low gradient, Florida streams. A SOD rate of 3.35 would result in about 26,800 grams oxygen per day consumed over a 20 meter (m) wide by 400 m long river reach. Assuming average May flow conditions in the Peace River of 111 cfs (271,296,000 liters/day) this SOD rate would consume about 0.1 mg/l of DO. Since DO deficits are as high as 8 mg/l and average 3 mg/l in this reach of the Peace River, SOD contributes to only a small part of the deficit.

Primary production, respiration, chlorophyll-a and algal growth potential (AGPT) measurements were used to quantify the potential productivity and oxygen consumption of aquatic plants in the river. Chlorophyll in Saddle Creek was high at 170 µg/l, but chlorophyll ranged from 3 to 15 µg/l in the Peace River stations. This compares well with the observed DO swings; in Saddle Creek diurnal DO ranged from 0.6 to 17.6 mg/l, contrasted with the DO swings from 2.9 to 4.9 mg/l in the Peace River at Bartow. Also worth noting is the high gross primary production in Saddle Creek of 7.89 grams oxygen per square meter per day. In contrast, the gross primary production was measured to be about 0.7 grams of oxygen per square meter per day at the Homeland station and about 0.1 at the Ft. Meade station. This production of oxygen would offset about 0.7 / 3.35, or approximately one-fifth of the SOD oxygen consumed. According to these measurements, neither the gross primary production nor the SOD is a significant contributor to the DO balance within the Peace River reach. The AGPT indicate high levels of available nutrients with nitrogen as the limiting nutrient. These values were higher in the Peace River stations near Bartow, Homeland and Ft. Meade than in the upstream Saddle Creek station. The high concentrations of algae in Saddle Creek may have consumed much of the nutrients there, and although nutrients are available in the Peace River, some other limiting factor such as color inhibition of radiant energy is preventing excess algae growth.

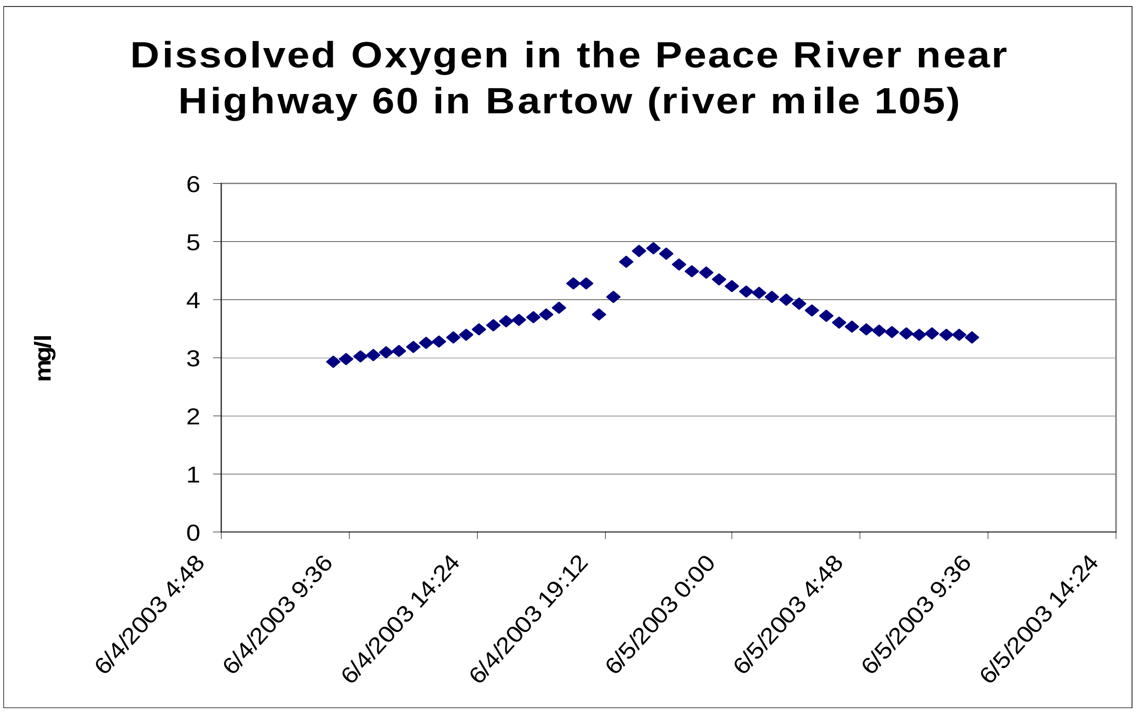

Figure 17. DO Concentrations at RM 105

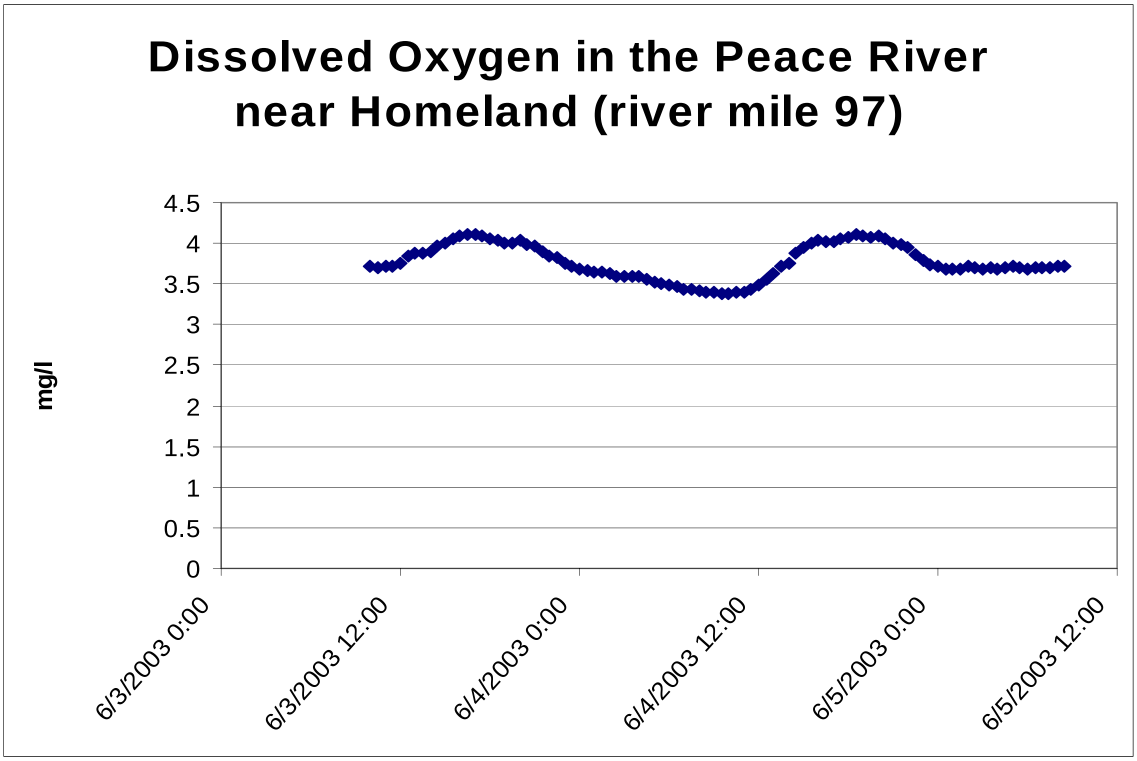

Figure 18. DO Concentrations at RM 97

7.2 Existing Condition Model Results

Figure 19 shows predicted flow and observed flow at Ft. Meade. Table 8 shows the calibration statistics for flow in the Peace River near Ft. Meade, FL. Mean absolute error (MAE), root mean square error (RMSE), and forecast efficiency are measures that incorporate both systematic error and random error (Maidment, 1993). The mean error, MAE, and RMSE are measures of the size of the discrepancies between predicted and observed values. Values near zero indicate a close match. If the RMSE is significantly greater than the MAE then there are instances where the prediction error is significantly greater than the average prediction error. The means and standard deviations show the central tendency and the spread of the predicted and observed values. In this model the flow is extremely well predicted, primarily because flow data were also available at the upstream boundary of the model and river cross section elevations were available from the SWFWMD. The correlation coefficient measures the tendency of the predicted and observed flows to vary similarly. The forecast efficiency measures how well a model predicts relative to the average of the observations. The forecast efficiency ranges from negative infinity to one, with higher values indicating better agreements. This model predicts peaks and valleys as well as the average flows extremely well.

Table 8. Flow Calibration Statistics at RM 92

Mean Error	-1.20502
Mean Absolute Error (MAE)	1.54954
Root Mean Square Error (RMSE)	2.93692
Mean Predicted	6.03496
Standard Deviation Predicted	9.98177
Mean Observed	7.23998
Standard Deviation Observed	11.6424
Correlation Coefficient, R^2	0.962343
Forecast Efficiency	0.832348

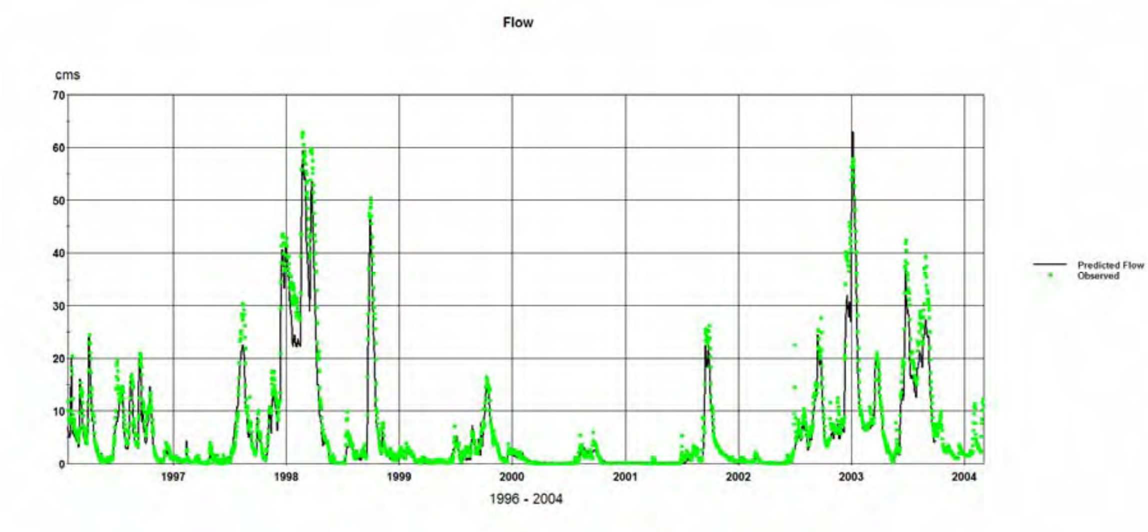

Figure 19. Comparison of Simulated and Observed Flows at RM 92

Figure 22 through Figure 28 show the predicted and observed dissolved oxygen, chlorophyll-a, biochemical oxygen demand, ammonia, total nitrogen, and total phosphorus in the Peace River at Ft. Meade. Figure 27 and Figure 28 show the predicted phosphorus in 1996 and 1997 is higher than the observed. This is inaccurate due to two factors. No U.S. Agri-chemicals Corporation discharge data were available in the EPA PCS database before Jan. 1998, therefore a value equal to the Jan. 1998 concentration was assumed for 1996 to 1998. This led to model predictions of high concentrations in the river during times when actual river flows were very low. Since phosphorus was not the limiting nutrient, this inaccuracy had little impact on the DO predictions.

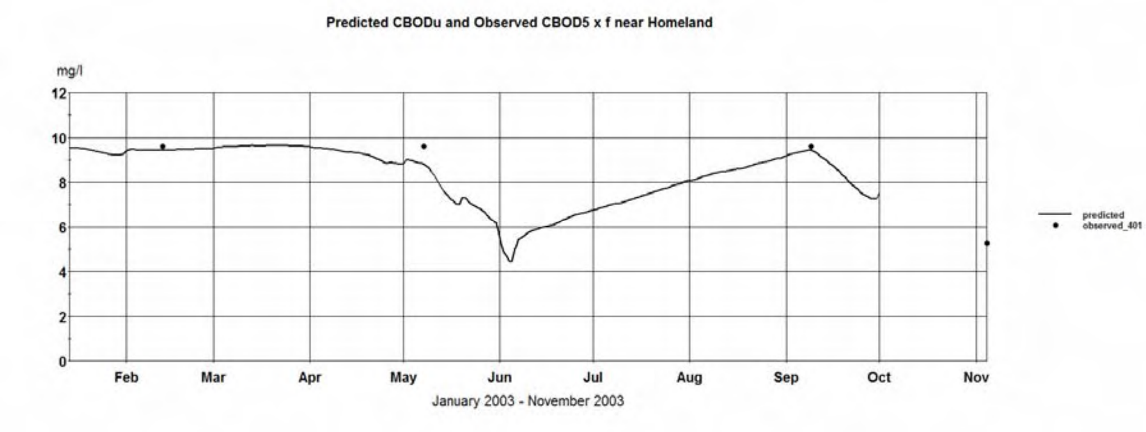

Figure 20. Predicted CBODu and observed CBOD5*f-ratio in the Peace River at RM 97

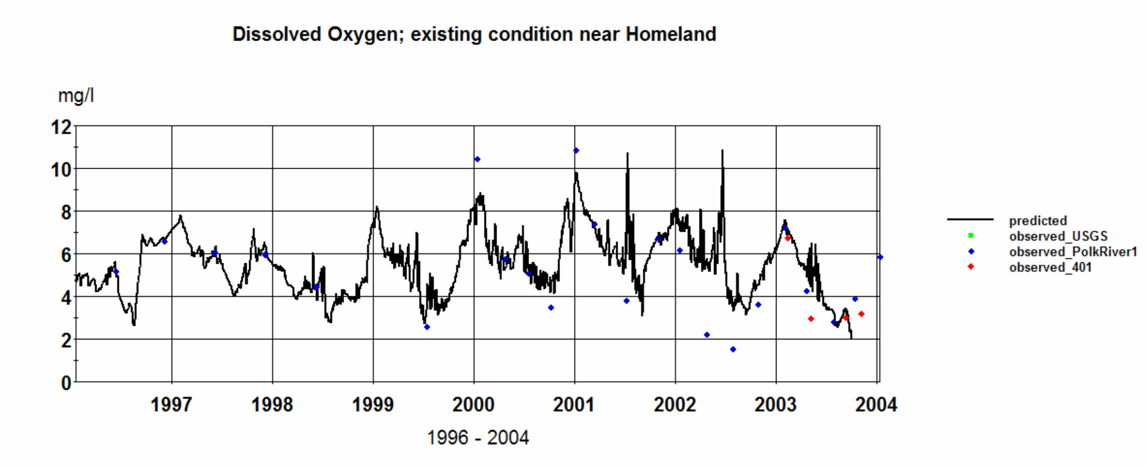

Figure 21. Predicted and Observed DO Concentrations at RM 97

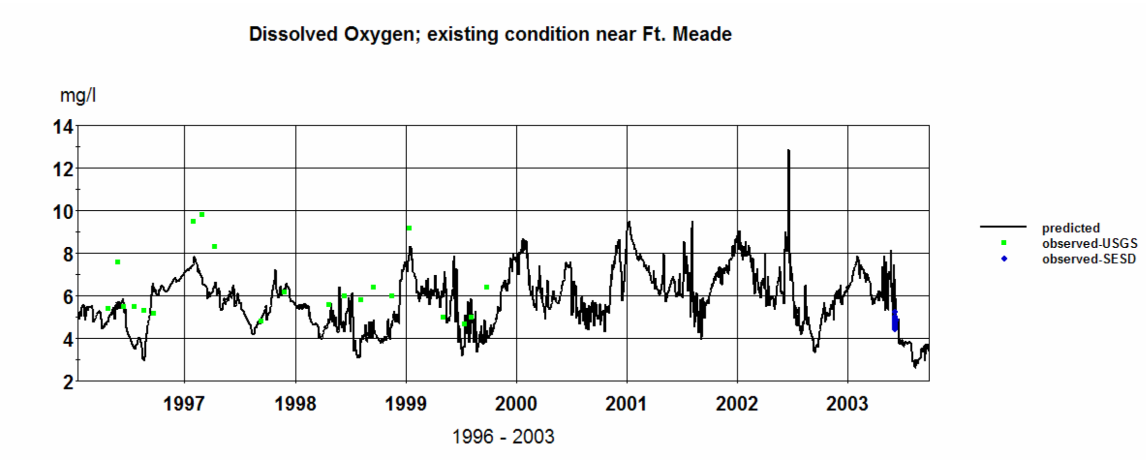

Figure 22. Predicted and Observed DO Concentrations at RM 92

Table 9. Calibration Statistics for DO at RM 92

Mean Error	-1.09
Mean Absolute Error (MAE)	1.43
Root Mean Square Error (RMSE)	1.64
Mean Predicted	5.25
Standard Deviation Predicted	1.36
Mean Observed	6.34
Standard Deviation Observed	1.58
Correlation Coefficient, R^2	0.415
Forecast Efficiency	0.226

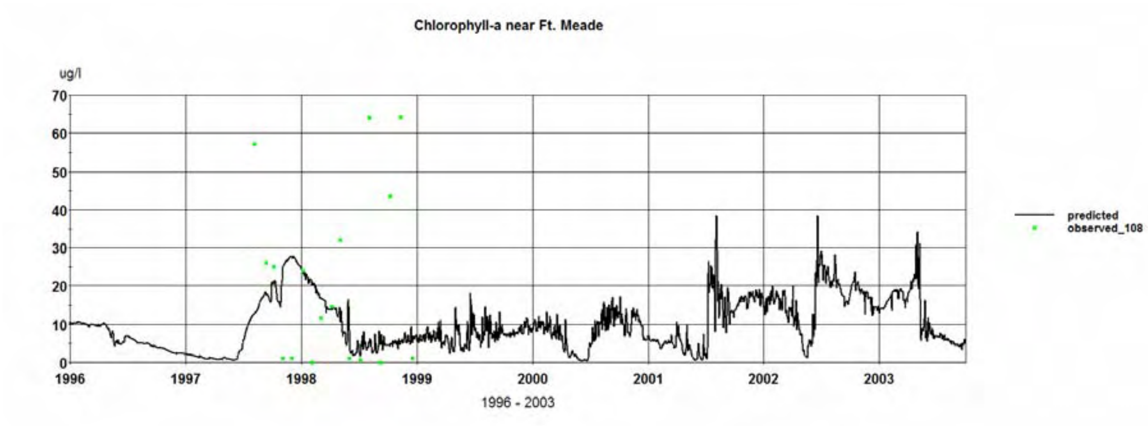

Figure 23. Predicted and Observed Chlorophyll-a Concentrations at RM 92

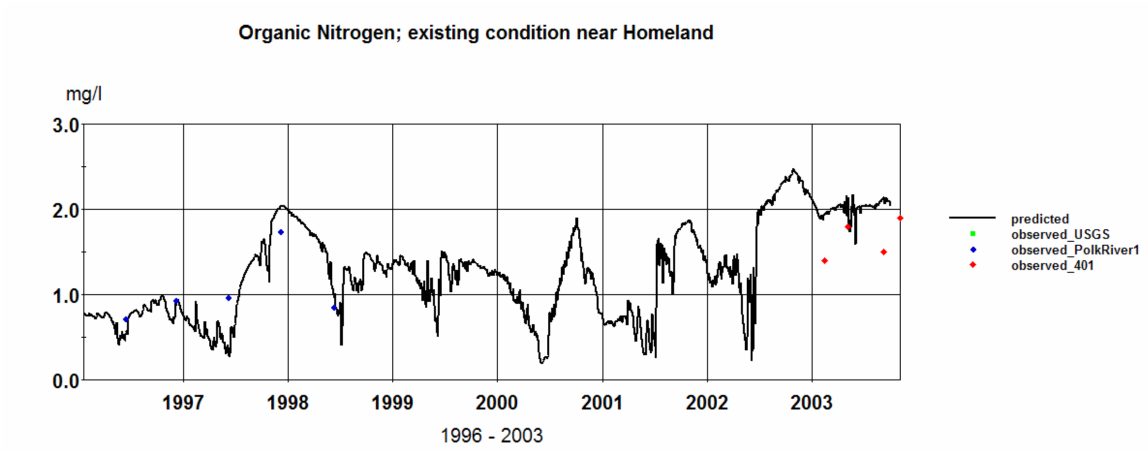

Figure 24. Predicted and Observed Organic Nitrogen Concentrations at RM 97

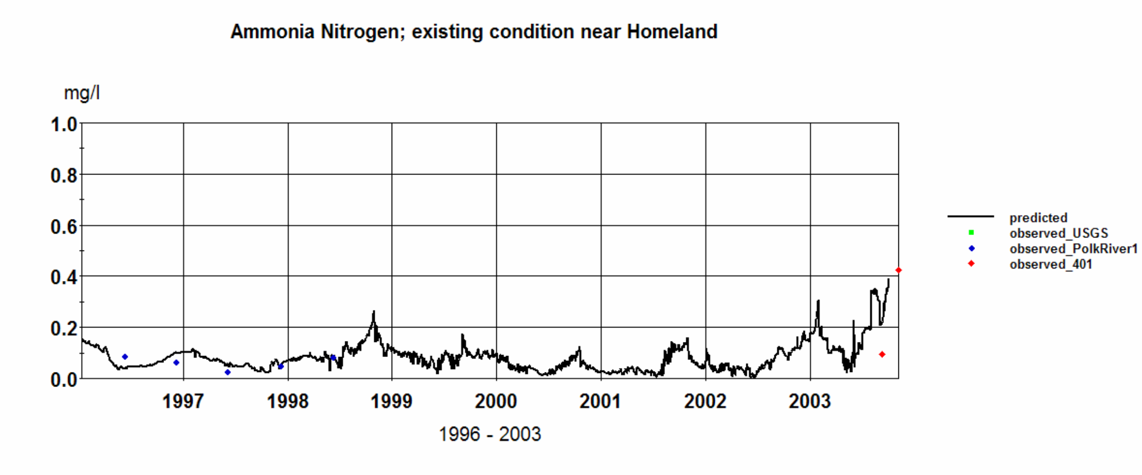

Figure 25. Predicted and Observed Ammonia Nitrogen Concentrations at RM 97

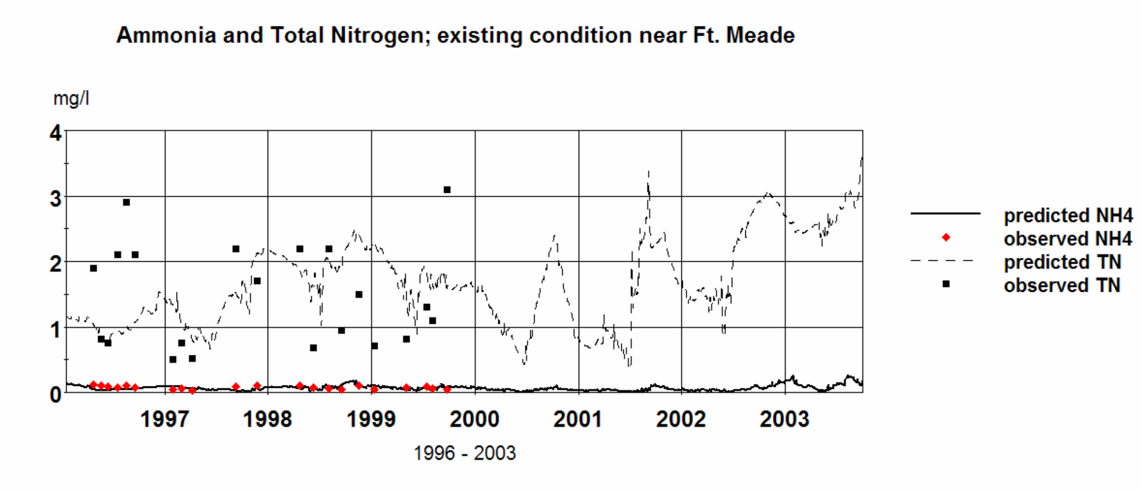

Figure 26. Predicted and Observed Ammonia and TN Concentrations at RM 92

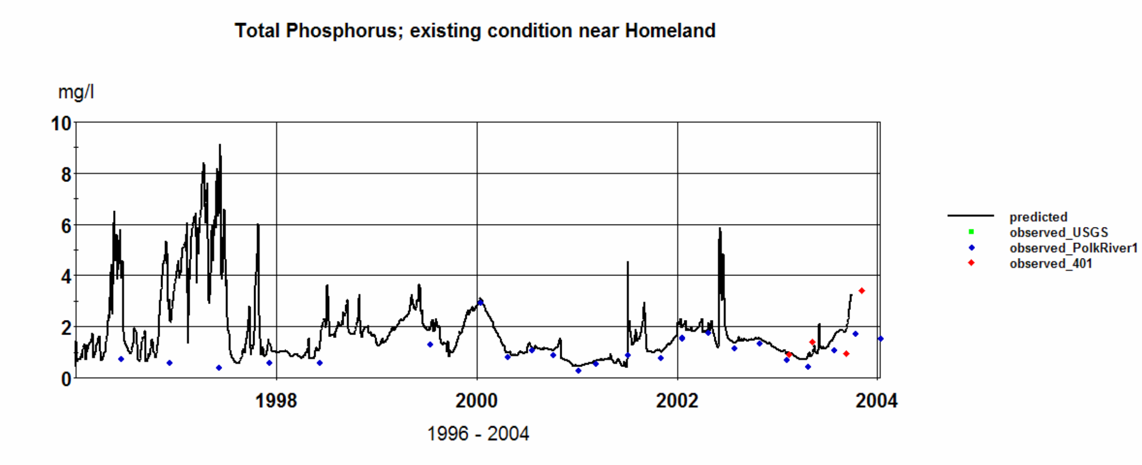

Figure 27. Predicted and Observed TP Concentrations at RM 97

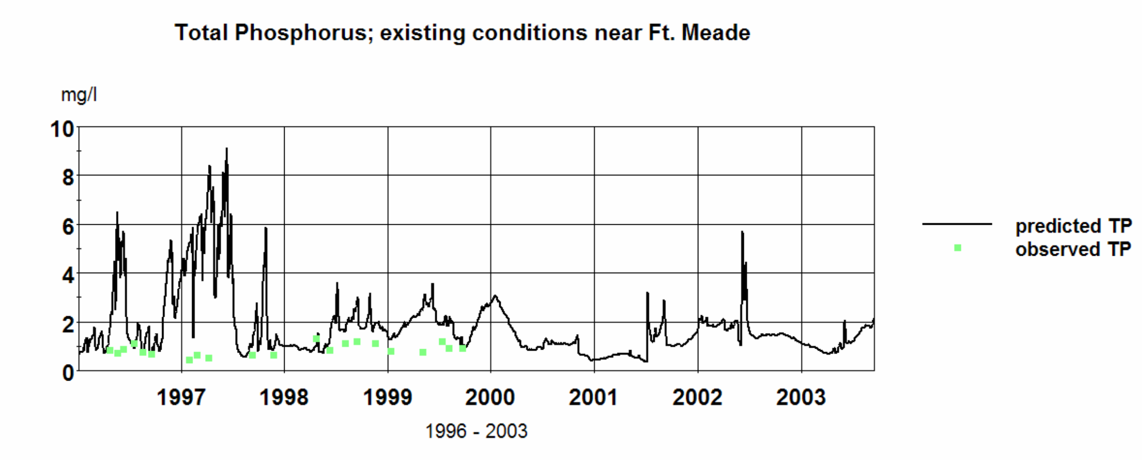

Figure 28. Predicted and Observed TP Concentrations at RM 92

7.3 TMDL Condition Model Results

The TMDL analysis shows that a 30 percent reduction of nitrogen and oxygen demanding substances (i.e., BOD) within the WBID would result in attainment of water quality standards as long as the upstream tributary (Peace Creek Drainage Canal and Saddle Creek) TMDLs are implemented to meet the water quality standard for DO (see Figure 31). These upstream TMDLs include reductions in nutrients, and oxygen demanding substances necessary to improve DO (USEPA, 2006a and 2006b). Nonpoint source loads, point source loads and upstream boundary loads are summarized in Figure 29. These figures show most of the nitrogen and BOD loads are from upstream even after TMDLs are implemented for the watersheds. Phosphorus is supplied about equally from the point source and upstream conditions.

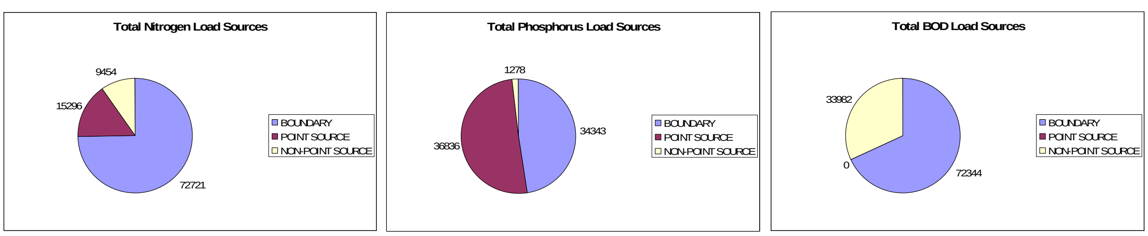

Figure 29. TMDL loads from all sources in kg/year

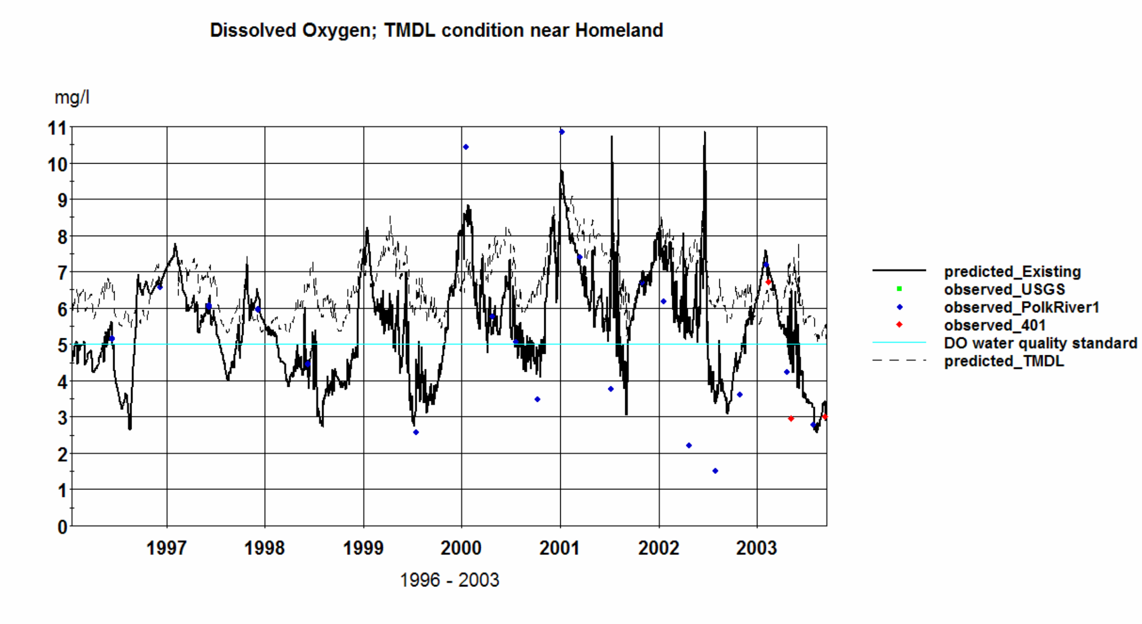

Figure 30. Post TMDL DO Concentrations at RM 97

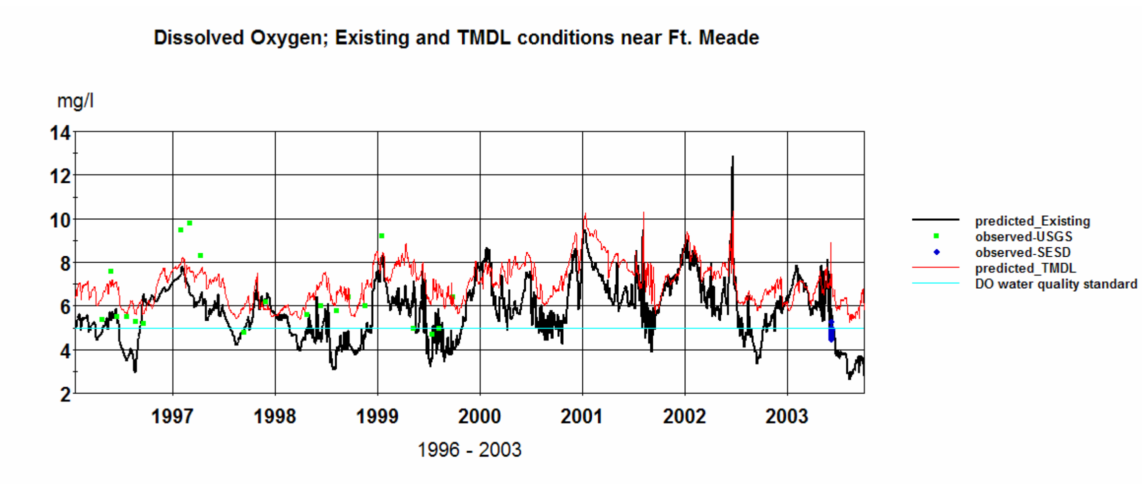

Figure 31. Post TMDL DO Concentrations at RM 92

8. DETERMINATION OF THE TMDL

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocation), nonpoint source loads (Load Allocation), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. kilograms per day), toxicity, or <u>other appropriate measures</u>. The TMDL for Peace River above Bowlegs Creek, WBID 1623J, is expressed in terms of a percent reduction of the estimated annual loads (see Table 10).

Table 10. TMDL Allocations

Pollutant	TMDL	WLA		LA	MOS
		Wastewater NPDES	MS4		
Total Nitrogen	24,750 kg/yr (30% reduction)	15,296 kg/yr (30% reduction)	30% reduction	9,454 kg/yr (30% reduction)	Implicit
BOD	33,982 kg/yr (30% reduction)	N/A	30% reduction	33,982 kg/yr (30% reduction)	Implicit

Note: See Figure 32 and Figure 33 for daily load expressions.

8.1 Waste Load Allocations

There is one regulated point source facility and one MS4 permit discharging in the Peace River above Bowlegs Creek watershed. The TMDL analysis shows that a 30 percent reduction in TN from the point source facility and a 30 percent reduction in both TN and BOD from the MS4 permit are necessary to meet the DO standard. These reductions are necessary for the watershed draining to the Peace River from City of Bartow at USGS gage 02294650 to just upstream of Ft. Meade. The reductions are in addition to the TMDL reductions recommended in the contributing watersheds of Peace Creek Drainage Canal and Saddle Creek.

The permit for U.S. Agri-Chemicals Corporation's Bartow DAP plant (FL0001961) has a target five year average load for TP and TN. The long-term (Jan. 1998 through Sept. 2003) average TN load recommended by this TMDL is 15,296 kg/year for the DAP plant. The TMDL BOD load for the DAP plant is not necessary because the effects on DO from this discharge are addressed through nitrogen reductions. For nutrients, the primary adverse impact of changing the trophic state occurs over a long time, and so the daily load is not as important as the seasonal or annual loading. Even so, it is necessary to express these loads on a daily basis. For this reason the long-term waste load allocation for the industrial wastewater facility is expressed in terms of daily loads as a function of flow in Figure 32.

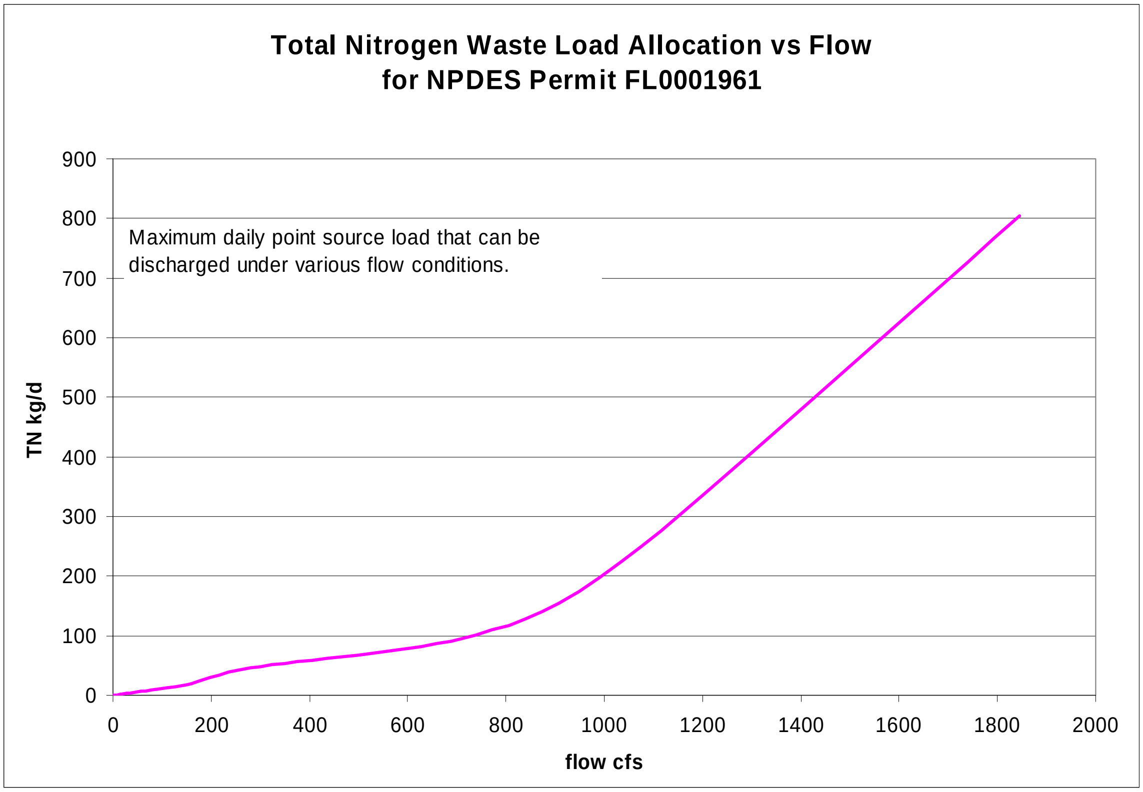

Figure 32. TN Waste Load Allocation for NPDES Permit FL0001961

8.2 Load Allocations

Model results indicate that a 30 percent reduction in BOD and TN is required from nonpoint sources to achieve the water quality standard for DO (see Table 10). The annual average nonpoint source TN load is 9454 kg and BOD load is 33982 kg. These nonpoint source load allocations are expressed as daily loads in Figure 33.

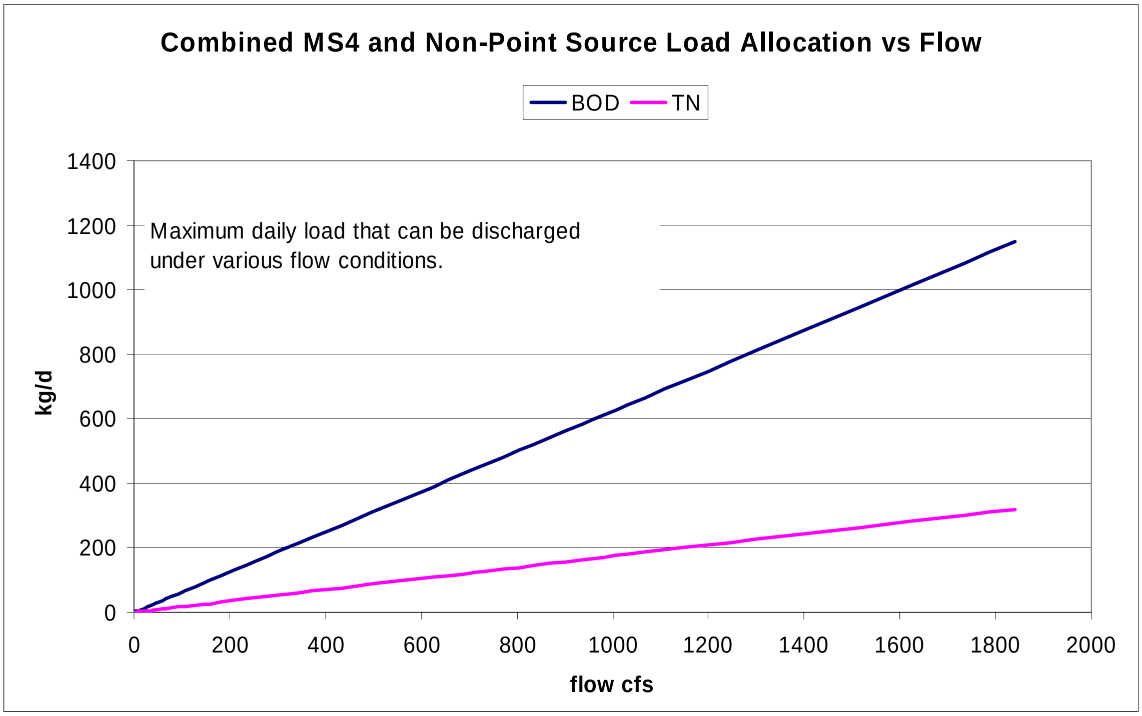

Figure 33. Combined MS4 and Nonpoint Source Load Allocations

8.3 Margin of Safety

A margin of safety is used to account for any lack of knowledge concerning the relationship between effluent limitations and the in-stream water quality. The margin of safety for this TMDL is implicit, as TMDL reductions are based on worst case conditions simulated in the eight-year period.

8.4 Critical Conditions

Critical conditions were considered by analyzing several years containing wet, normal, and dry conditions. Both wet and dry events were simulated in the water quality model.

8.5 Seasonal Variation

Seasonal variation was considered by analyzing several years of data containing all seasons and conditions (i.e., wet, normal, and dry).

8.6 Recommendations

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

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

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