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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

NORTHEAST DISTRICT • LOWER ST. JOHNS BASIN

TMDL Report

Total Maximum Daily Load for Nutrients for the Lower St. Johns River

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ACKNOWLEDGMENTS

The development of this Total Maximum Daily Load (TMDL) was a cooperative effort between the Florida Department of Environmental Protection (Department) and the St. Johns River Water Management District (SJRWMD). Throughout the several years that this project spanned, there was excellent cooperation and coordination between the staff of the two agencies, and the Department wishes to express its appreciation to the SJRWMD for its cooperative spirit.

While this was a joint effort between the two agencies, the authors want to acknowledge that the main work that constitutes the scientific basis for the Total Maximum Daily Load (TMDL) (the determination of the river's assimilative capacity) was conducted by SJRWMD staff. In particular, John Hendrickson and Pete Sucsy should be commended for their outstanding contributions and unwavering dedication to completing the modeling work. Thanks to their efforts, the water quality model for the Lower St. Johns River (LSJR) is undoubtedly one of the best in the nation, and will likely result in improved modeling for other TMDLs as other practitioners adopt some of the innovations/adaptations that John and Pete incorporated into the LSJR model.

We also wish to thank and acknowledge the contributions of staff from the Department's Northeast District office. Special thanks are due to Jim Maher and Jeremy Richarde for their continuous contributions as technical reviewers and liaison with local stakeholders who participated in the meetings of the LSJR Technical Advisory Committee, the TMDL Stakeholders Committee, and the TMDL Executive Committee. Their work to develop the starting points for the point source loads and the allocation spreadsheets was particularly invaluable, and we simply could not have completed the project without their outstanding contributions. We also thank former Northeast District Directors Ernie Frey and Mario Taylor and current District Director Greg Strong for their dedication to the TMDL Program and their leadership of the LSJR Executive Committee.

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1. INTRODUCTION

1.1 Purpose of Report

This document presents Total Maximum Daily Loads (TMDLs) for total nitrogen (TN) and total phosphorus (TP) for the Lower St. Johns River (LSJR). The river was verified as impaired by nutrients based on elevated chlorophyll *a* and Trophic State Index (TSI) levels in the freshwater and marine portions of the river, and was included on Florida's Verified List of impaired waters for the Lower St. Johns River Basin (LSJRB) that was adopted by Secretarial Order on September 4, 2003. The TMDLs establish the allowable loadings of TN and TP to the freshwater and marine portions of the LSJR that would restore the river so that it meets its applicable water quality criteria for nutrients and dissolved oxygen (DO).

1.2 Development of the TMDL

This TMDL was developed in cooperation with the St. Johns River Water Management District (SJRWMD) as part of its development of Pollutant Load Reduction Goals (PLRGs) for the river. In recognition of the eutrophication-related impairment of the river, the Florida Department of Environmental Protection (Department) and SJRWMD cooperatively developed a draft Plan of Study (POS) for the TMDL (Hendrickson and Magley, 2001) before the river was assessed for impairment under Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR). As indicated in the POS, the SJRWMD (in conjunction with its contractor, the U.S. Army Corps of Engineers [USACE]) was the lead agency for modeling activities, including the development of a watershed model to estimate nonpoint source loads and the development of a linked hydrologic/water quality model to determine the assimilative capacity of the river.

Both agencies also actively coordinated with a variety of local stakeholders throughout the TMDL development process, including meetings to discuss the POS and subsequent monthly meetings (for over a year) with the TMDL Stakeholders Committee and the TMDL Executive Committee. The TMDL Executive Committee is a broad-based stakeholder group that was convened by the Department's Northeast District in July 2002 (see **Appendix A** for a list of members). It has advised the Department on such issues as water quality targets and allocation processes. While the Department is clearly charged with implementing the TMDL Program, including the adoption of this TMDL by rule, this TMDL reflects the consensus recommendations of the TMDL Executive Committee.

1.3 Revision of the TMDL

Florida originally adopted a nutrient TMDL for the LSJR on December 3, 2003 (Rule 62-304.415, F.A.C.), and formally submitted it to the U.S. Environmental Protection Agency (EPA) Region 4 on March 15, 2004. While the EPA initially approved the TMDL on April 27, 2004, the agency was challenged on the basis that the Class III marine daily average DO criterion would not be met at all times under the TMDL. EPA therefore rescinded its April 27, 2004 approval, and subsequently established a nutrient TMDL for the Lower St. Johns River that would meet the DO criteria on January 23, 2006.

At the time EPA disapproved the state's TMDL, it recognized that (1) the TMDL for the marine portion of the river was based on meeting DO levels that were protective of aquatic life use support as an indirect way to evaluate the state's narrative nutrient criterion (i.e., shall not cause an imbalance in flora or fauna); (2) the appropriate DO levels were based on an EPA methodology for the development of DO criteria; and (3) the state intended to develop a site-specific alternative criterion (SSAC) based on the EPA methodology. This acknowledgment was specifically mentioned in the introduction to the EPA TMDL document, which stated:

> **EPA is aware that FDEP is continuing to pursue development of a site specific criterion for dissolved oxygen for the River that would be both protective of aquatic life and consistent with the previously submitted TMDL. While EPA's disapproval action triggers EPA's duty to establish a replacement TMDL, EPA recognizes that the FDEP TMDL could be considered for approval in the future should the State adopt and EPA approve a site specific criterion.**

This revised document presents a reassessment of the TMDL based on an SSAC for DO for the marine portion of the Lower St. Johns River that was adopted by the state and approved by EPA.

1.4 Identification of Waterbody

The LSJR is that portion of the St. Johns River that flows between the mouth of the Ocklawaha River, its largest tributary, and the Atlantic Ocean, encompassing a 2,750-square-mile (mi^2) drainage area (**Figure 1**). Within this reach, the St. Johns River is 101 miles long and has a water surface area of approximately 115 square miles. Major centers of population within the LSJRB include Palatka, a city of 10,700 at the southern entrance to the basin; Green Cove Springs, a city of 4,700 at the midpoint; and the Orange Park, Middleburg, and Jacksonville metropolitan area, with a population of over 1 million, in the northern portion of the basin (Floyd *et al.,* 1997). The LSJR is a sixth-order, darkwater river estuary, and, along its length, it exhibits characteristics associated with riverine, lake, and estuarine aquatic environments (Phlips *et al.,* 2000). Additional information about the river's hydrology and geology are available in the Basin Status Report for the LSJRB (Department, 2002).

The LSJR is divided into the following three ecological zones based on salinity (**Figure 2**): (1) a predominantly freshwater, tidal, lakelike zone that extends from the city of Palatka north to the mouth of Black Creek; (2) an alternately freshwater and marine, oligohaline zone extending from Black Creek northward to the Fuller Warren Bridge (I-95) in Jacksonville; and (3) a predominantly marine and much narrower zone downstream from I-95 to the mouth (Hendrickson and Konwinski, 1998).

For assessment purposes, the Department has divided the LSJRB 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 LSJR is divided into 15 segments, as shown in **Figure 3**.

Figure 1. The Lower St. Johns River

Figure 2. Ecological Zones of the Lower St. Johns River Basin

(Note: This figure inadvertently includes Lake George, which is not part of the LSJRB.)

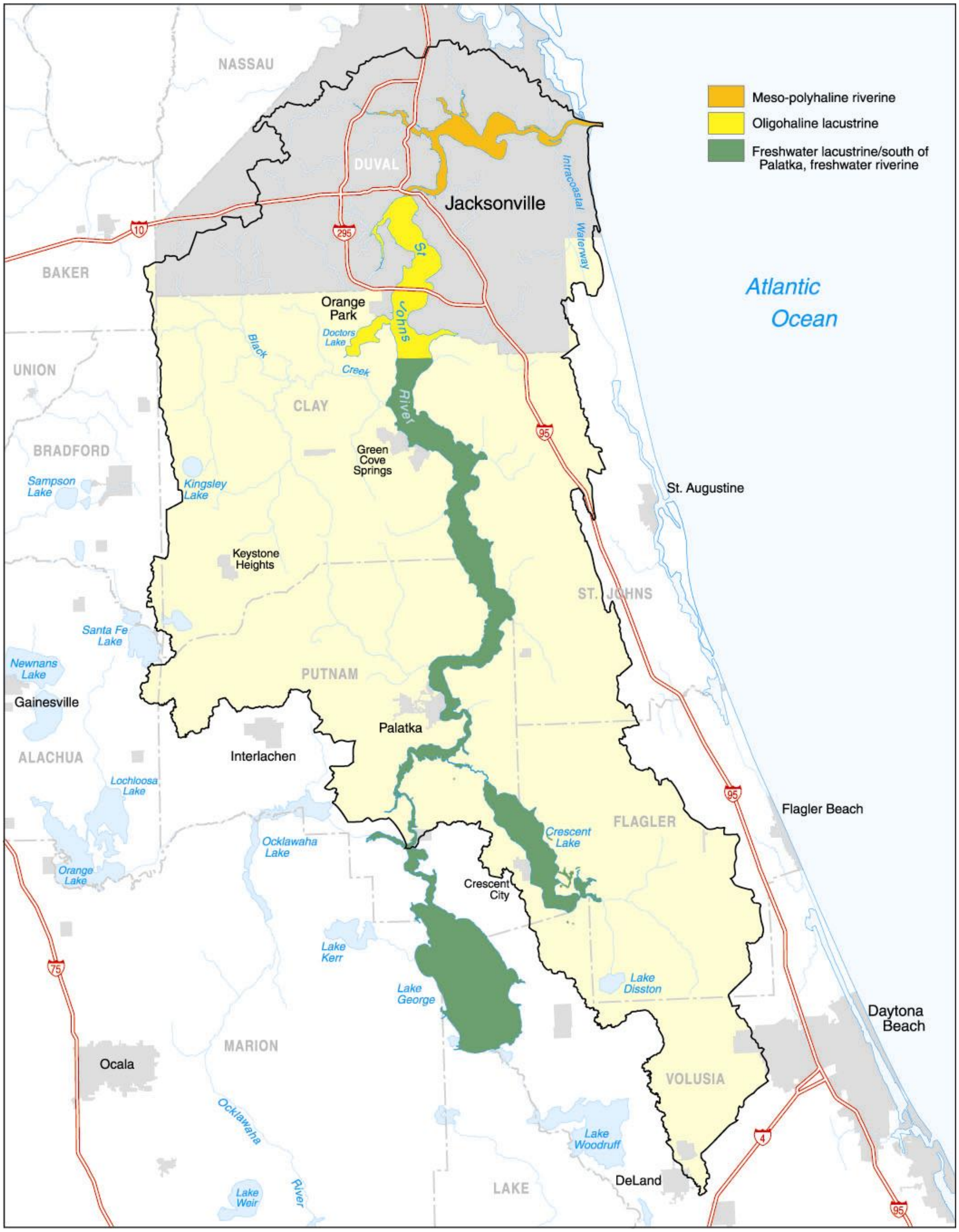
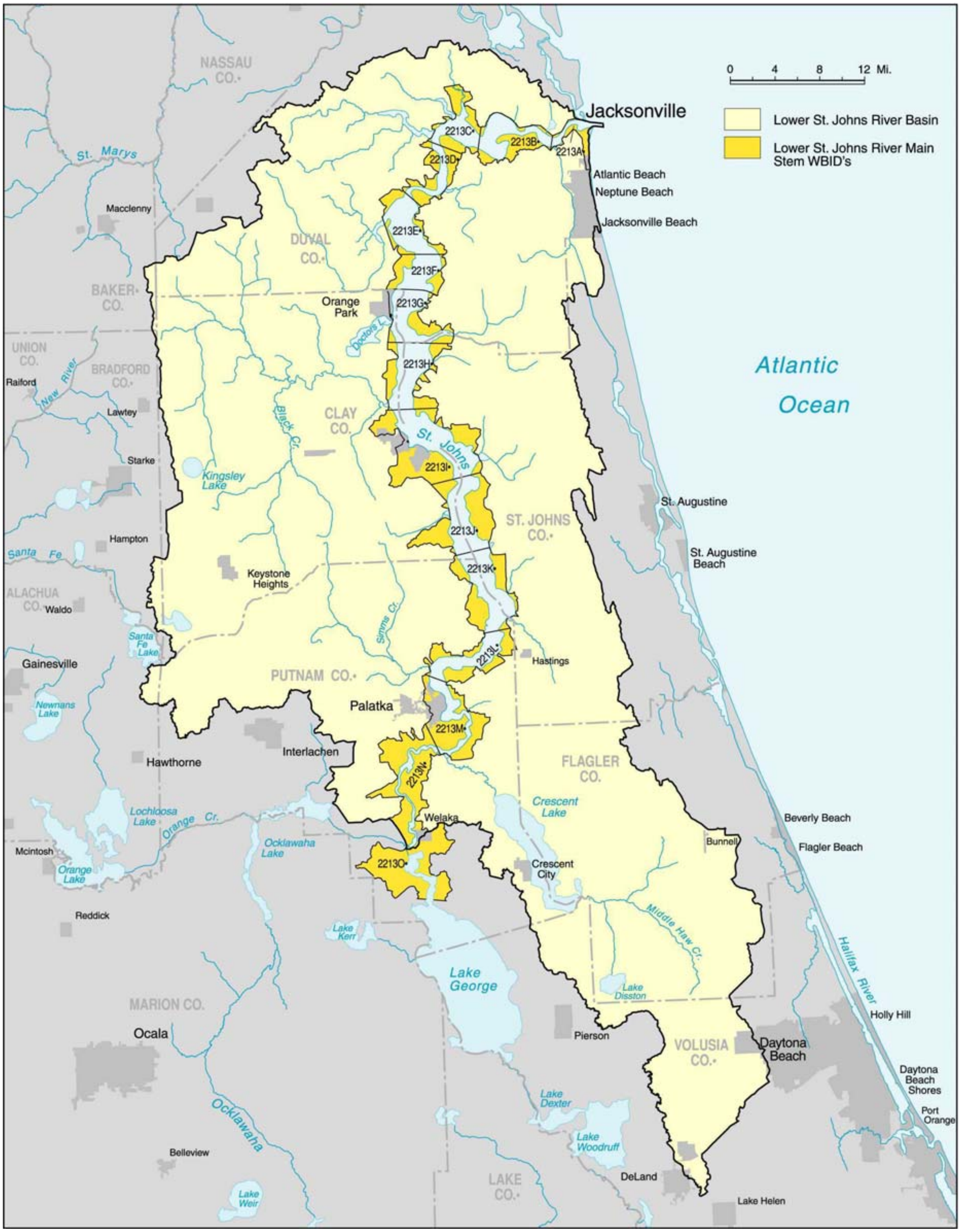


Figure 3. Waterbody Identification Numbers for the Main Stem of the LSJR



2. STATEMENT OF WATER QUALITY PROBLEM

2.1 Verified Nutrient Impairment of the LSJR

Under Section 303(d) of the federal Clean Water Act, states are required to submit to the EPA lists of waters that are not fully meeting their applicable water quality standards (designated uses). The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. However, the 1999 Florida Watershed Restoration Act (FWRA) (Section 403.067, Florida Statutes [F.S.]) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rule-making process, the Environmental Regulation Commission (ERC) adopted the new methodology as Rule 62-303, F.A.C. (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The ERC subsequently revised the rule in 2006 and 2007.

The Department used the IWR to assess water quality impairments in the main stem of the LSJR in 2003 and verified that the majority of the freshwater and estuarine segments of the river are impaired by nutrients (see **Table 1**). As noted in **Table 1**, 11 of the 15 LSJR segments were verified as impaired by nutrients based on annual mean chlorophyll *a* concentrations or annual mean TSI values. **Appendix I** provides annual mean chlorophyll *a* and TSI values for the verification period for each segment.

As required by the FWRA, the Verified List of impaired waters for the LSJR was adopted by Secretarial Order (on September 4, 2003) before the original TMDL was adopted by rule. The TMDL was subsequently adopted by rule on September 30, 2003, and went into effect on December 3, 2003. Impairment associated with parameters other than nutrients will be addressed in separate TMDL development efforts in the time frames indicated in the table.

Table 1. Verified Impaired Segments of the Main Stem of the LSJR

WBID	Waterbody Segment	Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development
2213A	STJ RIV AB MOUTH	Nutrients (Histchla)	Low	2008
2213A	STJ RIV AB MOUTH	Iron	Medium	2008
2213B	STJ RIV AB ICWW	Nutrients (Histchla)	Medium	2008
2213B	STJ RIV AB ICWW	Lead	Medium	2008
2213B	STJ RIV AB ICWW	Copper	Medium	2008
2213B	STJ RIV AB ICWW	Iron	Medium	2008
2213B	STJ RIV AB ICWW	Nickel	Medium	2008
2213C	STJ RIV AB DAMES PT	Nutrients (Histchla)	(High)	(2002)
2213C	STJ RIV AB DAMES PT	Copper	Medium	2008
2213C	STJ RIV AB DAMES PT	Iron	Medium	2008
2213C	STJ RIV AB DAMES PT	Nickel	Medium	2008
2213D	STJ RIV AB TROUT RIV	Copper	Medium	2008
2213D	STJ RIV AB TROUT RIV	Iron	Medium	2008
2213D	STJ RIV AB TROUT RIV	Nickel	Medium	2008
2213E	STJ RIV AB WARREN BRG	Nutrients (Chla)	(High)	(2002)
2213E	STJ RIV AB WARREN BRG	Copper	Medium	2008
2213E	STJ RIV AB WARREN BRG	Iron	Medium	2008
2213F	STJ RIV AB PINEY PT	Nutrients (Chla)	(High)	(2002)
2213I	STJ RIV AB BLACK CK	Nutrients (TSI)	Medium	2008
2213J	STJ RIV AB PALMO CK	Nutrients (TSI)	Medium	2008
2213K	STJ RIV AB TOCIO	Nutrients (TSI)	High	2002
2213L	STJ RIV AB FEDERAL PT	Nutrients (TSI)	High	2002
2213M	STJ RIV AB RICE CK	Nutrients (Chla)	Medium	2008
2213N	STJ RIV AB DUNNS CK	Nutrients (Chla)	Medium	2008
2213G	STJ RIV AB DOCTOR LAKE	Cadmium	Medium	2008
2213I	STJ RIV AB BLACK CK	Silver	Medium	2008

Note: Table 1 also includes segments impaired by parameters other than nutrients (certain metals). These parameters are shown to provide a complete picture of the impairment in the river, but this TMDL only addresses the nutrient impairment.

2.2 Other Indications of Nutrient Impairment

In addition to the elevated chlorophyll *a* values (algal blooms) and low DO levels, a number of widespread water quality problems have been identified throughout the river that are indicative of an imbalance in the flora and fauna of the LSJR (Department, 2002). These problems include the following: (1) fish kills; (2) submersed aquatic shoreline vegetation covered in algal mats; (3) excessive epiphyte growth further blocking light from submerged aquatic vegetation; (4) anecdotal accounts of shoreline vegetation losses and reduced recreational fishing quality; (5) river sediment conditions indicative of low benthic animal diversity; (6) excessive organic matter sedimentation and prolonged anoxia; and (7) the presence of potentially toxic dinoflagellates such as the *Pfiesteria*-like *Crytoperidiniopsoids* (Burkholder and Glasgow, 1997a; 1997b) and *Prorocentrum minimum* (Phlips *et al.,* 2000), often co-occurring with fish kills or ulcerative disease syndrome in fish. All of these problems are connected by a common thread—they indicate accelerated eutrophication in an estuarine environment (see **Appendix B** for a discussion of eutrophication).

Numerous other studies have identified either high nutrient concentrations or eutrophic conditions (Bricker *et al.,* 1999; EPA, 2001; Janicki and Morrison, 2000) in the LSJR. In their assessment of nutrient loads to the LSJR and the potential effects, Hendrickson and Konwinski (1998) determined the following:

1. *A combination of point and nonpoint source pollution has increased the within-basin nutrient load to the LSJR 2.4 times over natural background for TN and 6 times for TP.*
2. *Areal nutrient loading, at 9.7 and 2.1 kilograms of nitrogen and phosphorus per hectare of watershed contributing area per year in the LSJRB, is one of the highest reported from studies in the southeastern United States.*
3. *Point sources were the greatest contributor of anthropogenic nutrient load from within the basin. However, because this load enters the river nearer to the mouth, its incremental effect is presumed to be less than that caused by nonpoint sources and upper and middle St. Johns River loads that enter upstream.*
4. *Changes in the amounts of river algae appear to correlate significantly with changes in inorganic nitrogen and DO, suggesting that algae use much of the nitrogen supplied to them for growth. During this cycle of growth and ultimate death, the algae exert a dominant influence over river oxygen content.*

Based on these findings, it is clear that the LSJR receives high nutrient loads and is nutrient enriched, and that it exhibits the symptoms of estuarine eutrophication. While nutrient enrichment is not the only problem leading to impaired water quality in the LSJR, it is probably the most widespread and multifaceted.

3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND WATER QUALITY TARGETS

3.1 Classification of the LSJR and Criteria Applicable to the TMDL

The LSJR is a Class III waterbody, with a designated use of recreation, propagation, and the 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 the DO criterion and the narrative nutrient criterion. It should be noted that none of the LSJR WBIDs was verified for DO impairment using the IWR methodology, which uses a 10 percent exceedance frequency to verify impairment. However, continuous DO monitoring data collected in both the freshwater and marine reaches of the river (at the Dames Point Bridge station and, to a lesser extent, the Acosta Bridge station) from 1996 through 2001 indicated periods when DO concentrations were below the criterion in each of these portions of the river. As these values were at levels that could adversely impact aquatic fauna, the nutrient TMDL also needed to address the impact of nutrients on DO levels.

3.2 DO Criterion

The applicable Class III DO criterion varies depending on whether a waterbody is "predominantly marine"[1] or "predominantly fresh." The freshwater criterion applies in the predominantly freshwater, tidal lakelike zone that extends from the city of Palatka north to the mouth of Julington Creek, and in the alternately freshwater and marine, oligohaline zone extending from Julington Creek northward to the Fuller Warren Bridge (I-95) in Jacksonville. The marine criterion applies in the predominantly marine zone downstream from the Fuller Warren Bridge to the mouth.

The Class III DO criterion for predominantly fresh waters is a minimum DO of 5 mg/L, and the criterion for predominantly marine zones is a minimum DO of 4 mg/L, with a minimum daily average of 5 mg/L. However, DO levels are known to fluctuate naturally below the DO criterion for both predominantly fresh and marine waters in the LSJR, and Florida Water Quality Standards (Rule 62-302, F.A.C.) state that natural conditions should not be abated. In Section 403.021(11), F.S., [2] the Florida Legislature recognized that water quality can naturally vary below the applicable criteria and directed that water quality standards should be reasonably established and applied to take natural variability into account.

[1] Surface waters in which the surface chloride concentration at the surface is greater than or equal to 1,500 milligrams per liter (mg/L) are considered "predominantly marine" (Rule 62-302, F.A.C.).

[2] (11) It is the intent of the Legislature that water quality standards be reasonably established and applied to take into account the variability occurring in nature. The Department shall recognize the statistical variability inherent in sampling and testing procedures that are used to express water quality standards. The Department shall also recognize that some deviations from water quality standards occur as the result of natural background conditions. The Department shall not consider deviations from water quality standards to be violations when the discharger can demonstrate that the deviations would occur in the absence of any human-induced discharges or alterations to the waterbody.

To address this natural variation below the criterion, the Department, in cooperation with the SJRWMD, evaluated a more appropriate DO target for the estuarine portions of the river using a methodology developed by EPA and documented in *Ambient Water Quality Criteria for Dissolved Oxygen (Salt Water): Cape Cod to Cape Hatteras* (EPA, 1999). This methodology provides for a more appropriate DO criterion because it addresses both absolute minimum DO values for protection against acute effects, and sublethal DO values for protection against reductions in growth and recruitment. Under the EPA methodology, these values are combined into one relationship, termed the "persistent exposure criteria," that can be used to evaluate the intensity and duration of a given low-DO event.

The Department's application of the EPA methodology to develop a SSAC for DO for the marine portion of the river between Julington Creek and the mouth was documented in the publication, *Site Specific Alternative Dissolved Oxygen Criterion to Protect Aquatic Life in the Marine Portions of the Lower St. Johns River Technical Support Document* (**Appendix L**). The SSAC was expressed as follows:

The first part of the proposed SSAC is a minimum DO concentration of 4.0 mg/L. In addition, the Total Fractional Exposure to DO levels in the 4.0 to 5.0 mg/L range must also be at or below 1.0 for each annual evaluation period as determined by the equation:

$$\left(\begin{array}{c}\textbf{Total Fractional}\\\textbf{Exposure}\end{array}\right)=\frac{\begin{array}{c}\textbf{Days between}\\\textbf{4.0 - < 4.2 mg/L}\end{array}}{\textbf{16 day Max}}+\frac{\begin{array}{c}\textbf{Days between}\\\textbf{4.2 - < 4.4 mg/L}\end{array}}{\textbf{21 day Max}}+\frac{\begin{array}{c}\textbf{Days between}\\\textbf{4.4 - < 4.6 mg/L}\end{array}}{\textbf{30 day Max}}+\frac{\begin{array}{c}\textbf{Days between}\\\textbf{4.6 - < 4.8 mg/L}\end{array}}{\textbf{47 day Max}}+\frac{\begin{array}{c}\textbf{Days between}\\\textbf{4.8 - < 5.0 mg/L}\end{array}}{\textbf{55 day Max}}$$

Where:
The number of days within each interval is based on the daily average DO concentration.

The SSAC was submitted to the ERC in accordance with Subsection 62-302.800(2), F.A.C., and was approved by the ERC on May 25, 2006. The Department subsequently submitted it to the EPA, and it was subsequently approved by the EPA on October 10, 2006.

Since this TMDL proposes nutrient reductions to address nutrient impairment, it will only have beneficial impacts on DO. Therefore, the TMDL has been evaluated to ensure that nutrient reductions in the marine portions of the Lower St. Johns are sufficient to meet the DO SSAC.

3.3 Nutrient Criterion

Florida's nutrient criterion is narrative only—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 at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for streams and estuaries based on annual average chlorophyll *a* levels, these thresholds are not standards and need not be used as the nutrient-related water quality target for TMDLs. In fact, in recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Section 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

As part of PLRG development, the SJRWMD established a site-specific threshold for nutrient impairment for the freshwater zone based on chlorophyll *a* values (Hendrickson *et al.,* 2003). Hendrickson evaluated the maximum algal biomass levels that would (1) maintain the diversity of the plankton community, (2) facilitate the upward transfer of primary production to higher trophic levels (and maintain zooplankton diversity), and (3) minimize the potential dominance of detrimental algal species and the production of algal toxins. He found that a chlorophyll *a* target of 40 micrograms per liter (µg/L), not to be exceeded more than 10 percent of the time, would protect the aquatic flora and fauna of the river. Studies have shown that when chlorophyll *a* levels rise above 40 µg/L, a shift in algal types occurs: blue-green algae begin to dominate the system, toxic algal species begin to increase, and zooplankton communities begin to decline.

This alternative threshold for the freshwater portion of the river was discussed extensively at several meetings of the LSJR TMDL Stakeholders Committee and TMDL Executive Committee, and both groups recommended it be used for this TMDL rather than the IWR threshold. These groups also recommended that the threshold be applied over a long-term period (several years representing slightly drier than average conditions), rather than a worst-case, dry year. The Department agreed with these recommendations and established the TMDL using the alternative chlorophyll *a* threshold and long-term average model output, rather than model predictions for a worst-case year.

Maintaining chlorophyll *a* levels below 40 µg/L 90 percent of the time should prevent an imbalance in natural populations of aquatic flora and fauna under average conditions, and combined with other conservative aspects of the modeling (focusing on the worst-case WBID, for example) should protect the river during low-flow conditions as well. However, there is some uncertainty whether these levels will be fully protective in this portion of the river under critical, low-flow conditions or during the extended growing season with less than average flows. For this reason, the river system will continue to be evaluated to determine if a seasonal average maximum or yearly average maximum level of chlorophyll *a* should be established to protect against imbalances in natural populations of aquatic flora and fauna.

Specifically, studies will be conducted to demonstrate the following: (1) that progress is being made towards reducing nutrient loads by the amount required under the TMDL (30 percent) or that progress towards reaching the percent reduction goal is being made; (2) that once the 30 percent reduction goal is reached, it results in chlorophyll *a* levels that do not exceed 40 µg/L more than 10 percent of the time; and (3) that once the chlorophyll *a* target is reached, it has resulted in the achievement of the narrative nutrient criterion (i.e., balanced, natural populations of aquatic flora and fauna).

4. DETERMINATION OF CURRENT LOADING

4.1 Types of Sources

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

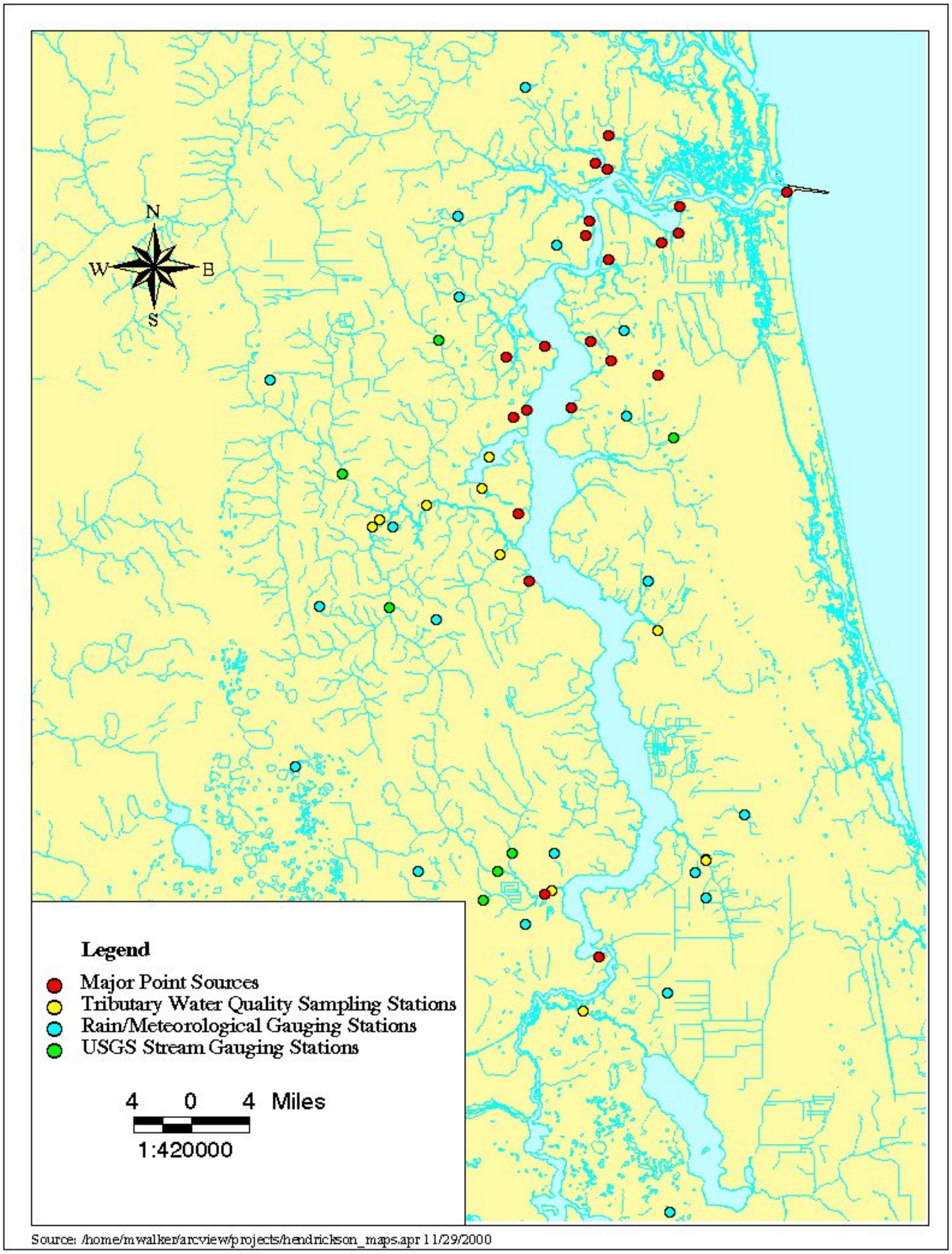
However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those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

To be consistent with Clean Water Act definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) **AND** stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Background

This section describes the approach used to determine external nutrient loads to the LSJR. The external load assessment was intended to determine (1) the spatial and temporal characteristics of the external load to the LSJR and, ultimately, (2) the effectiveness and costs associated with strategies for reducing this load. Assessing the external load entailed monitoring and research projects to determine the volume, concentration, timing, location, and underlying nature of point, nonpoint, and atmospheric source additions to the river stem and tributary mouths below the head of tide. The subsections below describe the approaches used for assessing each of these major external load categories. **Figure 4** identifies tributary water quality sampling stations, stream gauging stations, and major point sources in the basin. Because the computations involved in the development of the external load for the LSJR are so instrumental in the outcome of TMDLs and PLRGs, they were reported in a separate document (Hendrickson *et al.,* 2003).

Figure 4. Data Collection and Monitoring Stations of the External Load Assessment



4.3 Permitted Point Sources

4.3.1 Inventory of Point Sources

There are 36 permitted wastewater treatment facilities that discharge nutrient loads directly into the LSJR (**Table 2**): 32 domestic wastewater facilities and 4 industrial wastewater facilities. These facilities, which are permitted through the NPDES Program, are estimated to contribute approximately 27 and 55 percent of the annual average above-background TN and TP loads, respectively, to the LSJR.

Domestic wastewater facilities that discharge to surface waters are concentrated along the St. Johns River from Green Cove Springs to its mouth north of Jacksonville, and farther south near Palatka. The largest domestic wastewater dischargers in the basin are the wastewater treatment facilities associated with the city of Jacksonville in the northern (downstream) end of the basin, including the Buckman Street, Arlington East, JEA District II, Southwest District, and Mandarin wastewater treatment facilities. Several of these facilities participate in reuse programs, and most are seeking ways to either include or improve nutrient removal treatment (Department, 1997; Hendrickson and Konwinski, 1998).

All domestic wastewater facilities discharging to the St. Johns River are required, at a minimum, to monitor for conventional pollutants such as total suspended solids (TSS), carbonaceous biological oxygen demand ($CBOD_5$), and fecal coliform bacteria (Department, 1997). While most permits do not include nutrient effluent limits, nutrients must be monitored in many systems because of their potential negative effects on surface water, including their role in the formation of nuisance and harmful algal blooms.

Large industrial dischargers in the basin include power plants, pulp and paper mills, chemical plants, and manufacturing plants. The majority of industrial plants send their process wastewater through pretreatment facilities to publicly owned treatment works (POTWs) such as the Buckman plant. Facilities with significant nutrient discharges to the main stem of the LSJR include the Georgia-Pacific Corporation (which produces bleached and unbleached pulp and paper), Smurfit-Stone Container (which changed from a pulp and paper mill to a recycling mill in the 1990s, reducing the volume of discharge), and Anheuser-Busch (a brewery). Remaining discharges include nonprocess wastewater, such as cooling water, softener regenerate, and boiler blowdowns, that do not contribute a significant nutrient load.

The original modeling work did not consider the Seminole Electric Power Plant near Palatka as a significant source of nutrients because its discharge is primarily once-through cooling water. However, during the permit renewal process, representatives of Seminole Electric indicated that there was a net increase in nitrogen loads to the St. Johns from the discharge, and a nitrogen load of 5,724 kilograms per year (kg/yr) from this facility was added to WBID 2213L (there is no net increase in phosphorus loads for the facility).

Table 2. Permitted Wastewater Facilities Discharging to the LSJR

Name of Facility	Facility ID	Permitted Flow (mgd)	1997–98 Nutrients	
			TN (mg/L)	TP (mg/L)
Smurfit-Stone Container Corporation	FL0000400	20	6.8	1.1
Jefferson Smurfit – JAX	FL0000892	6	8.8	1.2
USN – NS Mayport WWTF	FL0000922	2	3.2	2.1
USN – NAS Jacksonville WWTF	FL0000957	3	8.5	1.7
Georgia-Pacific	FL0002763	40	5.5	1.4
Jacksonville Beach WWTF	FL0020231	4.5	9.1	2.2
Neptune Beach WWTF	FL0020427	1.5	8.8	1.4
Green Cove Springs – Harbor Road WWTF	FL0020915	0.75	9.2	2.9
Westminster Woods – (Wesley Manor Retirement Village)	FL0022489	0.09	4.6	2.0
Atlantic Beach – Buccaneer WWTF	FL0023248	1.9	13.4	1.4
JEA – Mandarin WWTF	FL0023493	7.5	5.34	2.3
JEA – Monterey WWTF (operated by UWF)	FL0023604	3.6	11.3	2.6
JEA – Holly Oaks WWTF (formerly UWF)	FL0023621	1	8.3	2.1
JEA – San Jose WWTF (formerly UWF)	FL0023663	2.25	10.0	2.9
JEA – Jacksonville Heights WWTF (formerly UWF)	FL0023671	2.5	10.1	2.9
Orange Park WWTF	FL0023922	2.5	-	3.7
JEA – San Pablo WWTF (formerly UWF)	FL0024767	0.75	6.5	3.5
CCUA – Miller Street WWTF	FL0025151	4.99	4.5	3.2
JEA – Ortega Hills WWTF (formerly UWF)	FL0025828	0.22	16.8	2.3
JEA – Buckman WWTF	FL0026000	52.5	10.5	4.7
JEA – Arlington WWTF	FL0026441	20	14.3	2.6
JEA – Northeast WWTF (aka JEA – District II WWTF)	FL0026450	10	22.7	5.9
JEA – Southwest WWTF	FL0026468	10	10.5	1.4
JEA – Royal Lakes WWTF (formerly UWF)	FL0026751	3.25	7.8	3.8
FWSC – Beacon Hills SD WWTF	FL0026778	1.3	11.9	2.0
FWSC – Woodmere SD WWTF	FL0026786	0.7	11.6	1.7
Green Cove Springs – South WWTF	FL0030210	0.5	13.6	2.3
CCUA – Fleming Oaks WWTF	FL0032875	0.49	3.0	1.9
Atlantic Beach – Main WWTF (D001)	FL0038776	3	11.4	2.1
Palatka WWTF	FL0040061	3	14.7	2.4
Anheuser Busch – Main St. – Land Application	FL0041530	2.6	3.9	0.3
Hastings WWTF	FL0042315	0.12	4.5	0.6
JEA – Julington Creek WWTP	FL0043591	0.476	12.0	3.0
CCUA – Fleming Island WWTF (combined)	FL0043834	6.365	-	-
UWF – Saint Johns North WWTF	FL0117668	-	6.5	1.7
Brierwood SD – Beauclerc STP	FL0023370	-	-	-

4.3.2 Estimating Point Source Loads

Point source effluent loads were calculated through a combination of monitoring data and statistical extrapolation to fill monitoring gaps. Point source loads were estimated for only those facilities that discharge directly to the LSJR or to tributary mouths below the head of tide.

Monthly operating report data from treatment facilities were used to create a time-varying input dataset for effluent flow and nutrient, suspended solids, and biological oxygen demand concentrations. Weekly, monthly, or quarterly monitoring data for water quality concentrations were multiplied by daily flow data to determine the daily load. For facilities that lacked complete chemistry data, mean values from the facility or from similar facilities were used to complete the missing record.

Water quality monitoring data collected for facilities during a 1993–95 point source assessment project were also available and were combined into a geographic information system (GIS) database that also includes outfall locations and sewer service coverage area. Outfall locations were then used to identify the appropriate model grids where these sources entered the system.

4.3.3 Municipal Separate Storm Sewer System Permittees

Like other nonpoint sources of pollution, urban stormwater discharges are associated with land use and human activities, and are driven by rainfall and runoff processes leading to the intermittent discharge of pollutants in response to rainstorms. The 1987 amendments to the federal Clean Water Act designated certain stormwater discharges from urbanized areas as point sources requiring NPDES stormwater permits. The three major components of the NPDES stormwater regulations are as follows:

- *Municipal Separate Storm Sewer System (MS4) permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.*
- *Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce the contamination of stormwater runoff.*
- *Construction activity generic permits for projects that ultimately disturb one or more acres of land and that require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.*

In addition to the NPDES stormwater construction permitting regulations, Florida was the first state in the country to require the treatment of stormwater for all new developments with the adoption of the Stormwater Rule in late 1981. The Stormwater Rule is a technology-based program that relies on 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 Rule 62-40, F.A.C. In 1994, state legislation created the Environmental Resource Permitting

Program to consolidate stormwater quantity, stormwater quality, and wetlands protection into a single permit. Currently, the majority of Environmental Resource Permits are issued by the state's water management districts, although the Department continues to do the permitting for specific projects.

The NPDES Stormwater Program was implemented in phases, with Phase I MS4 areas including municipalities having a population above 100,000. Because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase 1 of the MS4 permitting program on a countywide basis, bringing in all cities, Chapter 298 urban water control districts, and the Florida Department of Transportation (FDOT) throughout the 15 counties meeting the population criteria. Phase II of the NPDES Program was expanded in 2003 and requires stormwater permits for construction sites between 1 and 5 acres, and for local governments with as few as 10,000 people.

Although MS4 discharges are 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. All Phase 1 MS4 permits issued in Florida include a reopener clause allowing permit revisions for implementing TMDLs once they are formally adopted by rule. Florida's Phase II MS4 Generic Permit has a "self-implementing" requirement once TMDLs are adopted that requires the MS4 permittee to update its stormwater management program as needed to meet its TMDL allocations.

Within the LSJRB, the stormwater systems owned and operated by local governments and FDOT within the urbanized areas of Duval County are covered by an NPDES MS4 permit. Additionally, several other local governments in the basin have applied for coverage under the Phase 2 NPDES MS4 permit. Within Clay, Duval, Flagler, and St. Johns Counties, 223 industrial facilities have received coverage under the multisector generic permit or the no-exposure exemption.

4.4 Nonpoint Sources

Nonpoint sources of nutrient loading to the LSJR include septic tanks, marinas, silviculture, row crop agriculture, dairies, stormwater from urban development and tributaries (including Black Creek, Dunns Creek, Deep Creek, Rice Creek, Julington Creek, Trout Creek, Sixmile Creek, Governors Creek, Clarkes Creek, Cedar Creek, Camp Branch, Mill Branch, and Dog Branch). Unlike traditional point source effluent loads, nonpoint source loads enter at so many locations and exhibit such large temporal variation that a direct monitoring approach is infeasible except for the largest, most significant inputs. Those largest inputs are the upstream boundary of the LSJR at Buffalo Bluff, Dunns Creek, and the downstream boundary at the Atlantic Ocean. For all other nonpoint entry points, watershed modeling was used to complete the external load budget. As part of the revised TMDL, additional nonpoint loading from the Pablo Creek watershed was incorporated into the model.

4.4.1 Pollution Load Screening Model

The watershed model used to estimate nonpoint source loads was the Pollution Load Screening Model (PLSM) (Adamus and Bergman, 1995; Hendrickson and Konwinski, 1998). The PLSM uses a computer-driven GIS framework to develop aggregate whole-basin loads of relevant water quality constituents. The computational approach of the PLSM calculates constituent load as the product of concentration and runoff water volume, using nonpoint source pollutant export concentrations specific to 1 of 15 different land use classes, and water quantity through a hybrid of the Soil Conservation Service (SCS) curve number method.

In the LSJR application, four significant modifications were made to the model framework, as follows:

1. *The model time step was shortened to seasonal, rather than annual average loading rates, to account for seasonal differences in specific land use export concentrations and runoff quantity;*

2. *Eight additional water quality variables were added: orthophosphate, total inorganic nitrogen, labile (easily broken down) organic carbon, nitrogen*, *phosphorus*, *and refractory (slowly broken down) organic carbon, nitrogen, and phosphorus;*

3. *Land-use loading rates were adjusted to monitoring data collected in the LSJRB using a linear multiple regression best-fit approach based on contributing land use fractions in calibration watersheds; and*

4. *Hydrologic predictions were improved by using an adjusted water quantity based on the deviations in long-term rainfall patterns.*

4.4.2 Atmospheric Deposition

A review by Paerl (1993) showed that atmospheric deposition contributes 10 to 50 percent to the nitrogen budget of estuaries worldwide. In Chesapeake Bay, it is estimated that 25 percent of the human-caused nitrogen load originates as atmospheric deposition (Fisher and Oppenheimer, 1991). In Tampa Bay, atmospheric deposition provides 29 percent of the total nitrogen load (Pribble and Janicki, 1998), making it the second leading source of nitrogen to the bay (Greening *et al.,* 1997).

In their original calculation of nutrient budgets for the LSJR, Hendrickson and Konwinski (1998) estimated that atmospheric wet deposition contributed 15 percent of the total inorganic nitrogen to the river on an annual average basis and 21 percent during the peak algal bloom season, from April through July. However, a reporting unit error was subsequently discovered, and the estimated contribution from atmospheric deposition was reduced to about 4 percent per year. Due to the coarseness of this original estimate, a more detailed atmospheric deposition load assessment was deemed necessary.

A recently completed assessment of atmospheric deposition load to the LSJR (Pollman and Roy, 2003) determined that approximately 2 percent of the total nitrogen load, and 10 percent of the inorganic nitrogen load, is supplied through direct atmospheric deposition. The objective of this assessment was to increase the precision of the atmospheric load estimate and to determine if spatially and temporally varying input is needed to adequately describe nutrient enrichment. The assessment also included a greater number of nutrient forms, dry and wet deposition, an increased number of stations, and an examination of existing data.

Atmospheric deposition of phosphorus was not included in the modeling and TMDL assessment because it is expected to be a very minor source of phosphorus to the basin.

4.4.3 Sediment Flux

The bottom sediment–water interface represents an important boundary for the exchange of nutrients, carbon, and oxygen. As such, the upward and downward flux of these constituents must be assessed to properly account for the water quality characteristics of the water column. This is particularly true of broad, shallow, slow-moving rivers such as the LSJR, where positive (i.e., upward) flux from the sediment undoubtedly makes up a significant portion of the bioavailable nutrient load during certain times of the year. While river sediments represent a transient source of relevant constituents, sediments differ from other sources in that they are not a net positive source (i.e., not a true *external* source), and hence are not listed as a general allocation category in the following section. Over the long term, the accrual of material to the sediment is positive, and long-term net upward sediment flux is negative. In general, long-term net accrual to the sediments is proportional to the sources to a particular river reach; thus the effect exerted by transient upward nutrient flux can likewise be considered proportional to the external sources.

Several studies have been performed to quantify the composition and accretion rate of LSJR sediments. Presentations at the October 14–15, 2002, St. Johns River Symposium by Malecki and White; Jaeger and Mausner; Chavan and Ogram; and DePinto, Kaur, and Bierman Jr. summarized findings from these studies. The studies were designed specifically to provide input data necessary for dynamic sediment flux modeling for the LSJR TMDL and PLRG determination.

4.5 Loading Inventory

Appendix D (**Tables D1** through **D5**) shows estimated nonpoint source loads for the LSJR, and **Figures 5** and **6** summarize TN and TP loads for 1995 through 1999, respectively. As noted in the pie charts, upstream sources are the dominant TN load to the LSJR, while LSJR nonpoint and point source TP loads are roughly equivalent to the upstream TP load.

Figure 5. TN Loading to the LSJR by Source Category

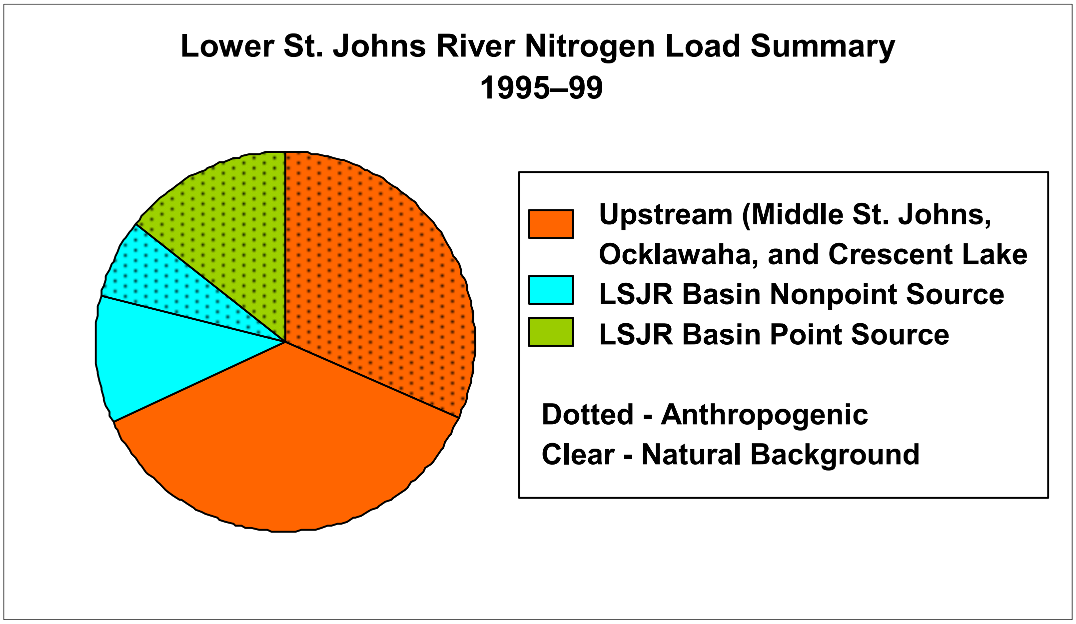
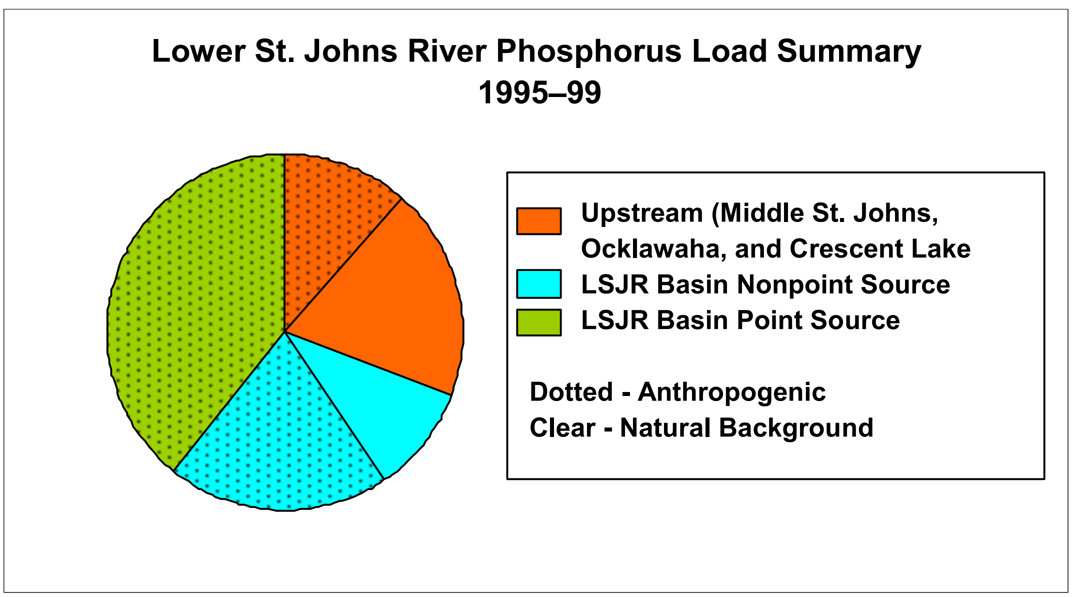


Figure 6. TP Loading to the LSJR by Source Category



5. DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Use of Modeling

Nutrient enrichment and the resulting problems related to eutrophication are usually widespread and are frequently manifested at a distance (in both time and space) from their source. Addressing eutrophication involves relating water quality and biological effects (such as photosynthesis, decomposition, and nutrient recycling), as acted upon by hydrodynamic factors (such as flow, wind, tide, and salinity) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. Dynamic computer simulation models have become indispensable tools to describe these relationships. Calibrated models also provide opportunities to predict water quality conditions under alternative constituent loadings.

5.2 Models Used

An interconnected suite of basinwide hydrologic, hydrodynamic, and water quality models was assembled to develop this TMDL. The suite of models includes the following: (1) a hydrologic model that calculates seasonal runoff and nutrient loads for each sub-basin within the LSJRB (PLSM, described previously); (2) a hydrodynamic model of the river that simulates the mixing and transport of nutrients in the river; and (3) a water quality model that simulates the transformation of nutrients and processes affecting eutrophication in the river.

The river hydrodynamics and salinity of the LSJR were simulated with the Environmental Fluid Dynamics Code (EFDC) model (Hamrick, 1992; Sucsy and Morris, 2002). The EFDC solves finite-differenced forms of the hydrostatic Navier-Stokes equations, together with a continuity equation, and transport equations for salinity, temperature, turbulent kinetic energy, and turbulent macroscale. The equations are solved horizontally on a curvilinear, orthogonal grid and vertically on a stretched sigma-grid. **Figure 7** illustrates the grid used for both the hydrodynamic and water quality models. This grid is composed of 2,210 horizontal cells and 6 vertical layers. The mean cell length is 492 meters, and the maximum achievable time-step for stability of the hydrodynamics simulation is approximately 30 seconds. With the EFDC application to the LSJR, remarkably precise simulations of tidal range, tidal occurrence, and river flow have been achieved (Sucsy and Morris, 2002).

The three-dimensional, time-variable water quality process model code used was the USACE Quality Integrated Compartment Model (CE-QUAL-ICM), Version 2 (Cerco and Cole, 1993). CE-QUAL-ICM is among the most sophisticated water quality process models in existence and was originally developed for the Chesapeake Bay Program to examine factors leading to bay hypoxia. Version 1 of the model contained 22 variables that simulated oxygen dynamics and included the interaction of 3 phytoplankton groups, nutrients, and organic carbon. A benthic sediment diagenesis submodel was dynamically coupled with the water column to produce sediment oxygen demand and nutrient fluxes. In its current version, the model has been expanded to include compartments for benthos, zooplankton, and submerged aquatic vegetation. **Table 3** summarizes the variables included in the LSJR version of the CE-QUAL-ICM model.

Figure 7. Model Cells for the LSJR Modeling

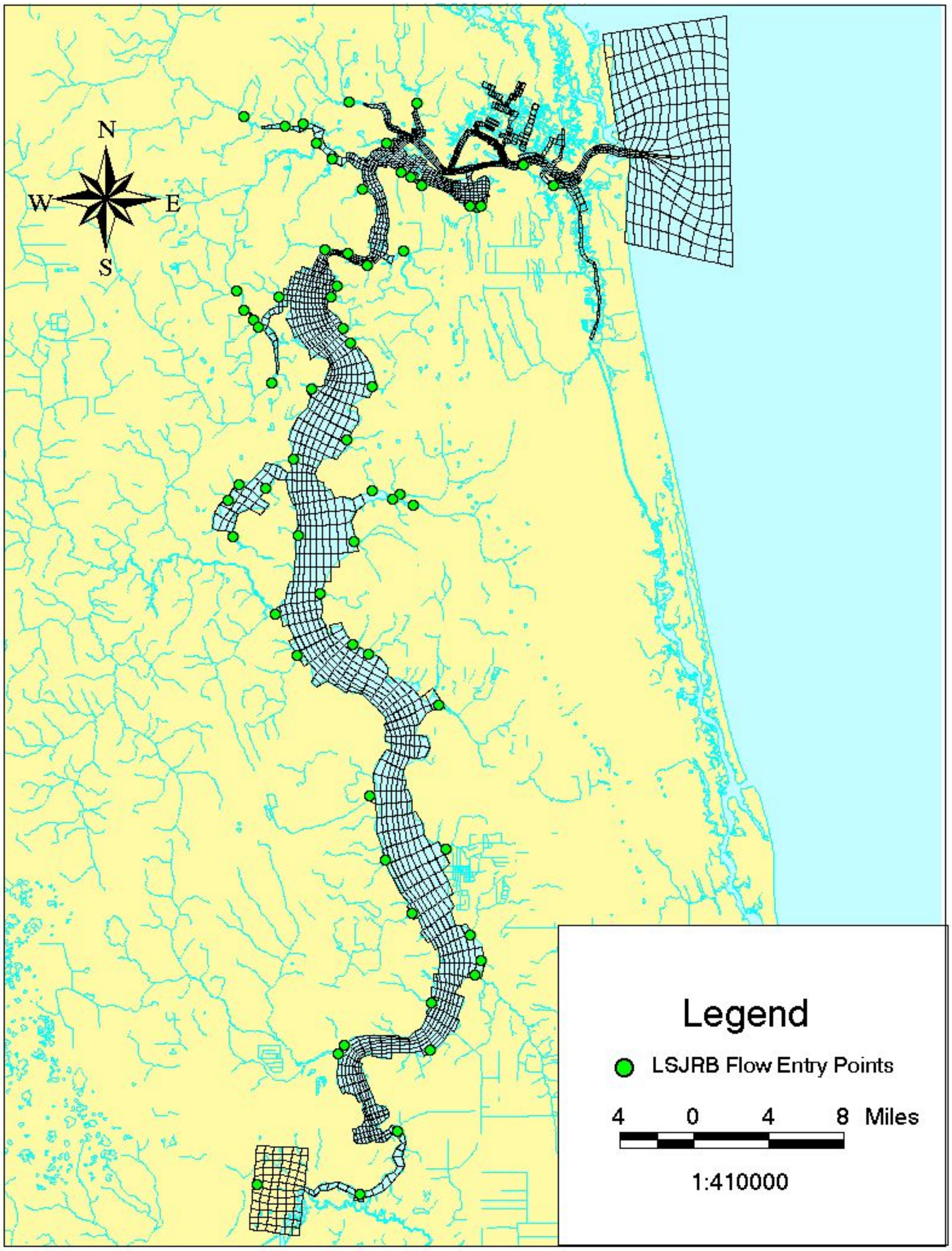


Table 3. Modeled Variables Included in the CE-QUAL-ICM Model

Model State Variables	
Nitrate + nitrite nitrogen	Internal phosphorus, algal group 1
Ammonium nitrogen	Internal phosphorus, algal group 2
Urea	Internal phosphorus, algal group 3
Refractory dissolved organic nitrogen	Refractory dissolved organic carbon
Labile dissolved organic nitrogen	Labile dissolved organic carbon
Refractory particulate organic nitrogen	Refractory particulate organic carbon
Labile particulate organic nitrogen	Labile particulate organic carbon
Total nonvolatile suspended solids	Green algae biomass as carbon
Dissolved orthophosphate P	Cyanobacteria biomass as carbon
Particulate inorganic P	Diatoms biomass as carbon
Refractory dissolved nonorthophosphate P	Temperature
Labile dissolved nonorthophosphate P	Salinity
Refractory particulate nonorthophosphate P	Dissolved oxygen
Labile particulate nonorthophosphate P	Available silica
Chemical oxygen demand	Particulate biogenic silica
Sediment Model	
State Variables	**Sediment-Water Flux**
Temperature	
Particulate organic carbon	Sediment oxygen demand
Sulfide/methane	Release of chemical oxygen demand
Particulate organic nitrogen	
Ammonium	Ammonium flux
Nitrate	Nitrate flux
Particulate organic phosphorus	
Phosphate	Phosphate flux
Particulate biogenic silica	
Dissolved silica	Silica flux
Benthic algal biomass	Dissolved oxygen, nutrients
State Variables for Submersed Aquatic Vegetation	
Deposit feeding benthos as carbon	Filter feeding benthos as carbon
Micro zooplankton as carbon	Meso zooplankton as carbon
Submerged aquatic vegetation (SAV) shoot biomass as carbon	SAV root biomass as carbon
Epiphyte biomass on SAV as carbon	Inorganic suspended solids
Benthic algae as carbon	

The USACE Research and Development Center (ERDC) applied CE-QUAL-ICM to the LSJR through a combination of modifications to existing subroutines and through the development of new subroutines and state variables, where appropriate. LSJR–EFDC hydrodynamics were linked to CE-QUAL-ICM.

New subroutines were added to the water quality model, including processes for the photochemical decomposition of colored dissolved organic matter, nitrogen fixation by one of the phytoplankton groups, and a flocculation subroutine to account for the transfer of organic carbon from the dissolved to particulate phase at the turbidity maximum. New state variables added included refractory dissolved organic carbon, nitrogen, and phosphorus. The full sediment diagenesis submodel was utilized and three phytoplankton compartments were simulated (freshwater blue-green algae, freshwater diatoms, and marine diatoms). Both Tillman *et al.* (2004) and Sucsy and Hendrickson (2004) document the modifications to CE-QUAL-ICM that were made for this application of the model.

Key changes to the oligohaline/mesohaline component of the water quality model included the following:

1. *Separation of the algal communities into a freshwater group and a marine group, with optimum salinities of 5 parts per thousand (ppt) and 20 ppt, respectively;*
2. *A 50 percent increase in the values for KLDC (the labile dissolved organic carbon dissolution rate) and KLPC (the labile particulate organic carbon dissolution rate), from 0.05/day to 0.075/day;*
3. *Revision such that all organic carbon from predation was labile; and*
4. *A new subroutine to allow for nitrogen fixation by one of the phytoplankton groups.*

5.3 Model Setup

Hendrickson and Konwinski (1998) described the setup of the PLSM to provide daily flows and loads from contributing sub-basins to the St. Johns River. **Figure 7** shows points in the hydrodynamic/water quality grid where sub-basin and point source contributions enter. The upstream boundary for the EFDC and CE-QUAL-ICM models was placed at Buffalo Bluff where total daily river discharge is recorded. Water quality measurements are also routinely collected at Buffalo Bluff and were used to define time variable boundary loads. The downstream boundary for the EFDC and CE-QUAL-ICM models included a tidal water-level open-ocean boundary and a time series of water quality measurements.

5.4 Model Calibration

Sucsy and Morris (2002) described the calibration procedure and presented hydrodynamic model results for the January 1, 1995 through November 30, 1998 calibration period. The calibration of the EFDC involved examination and adjustments to the following data and input parameters: bottom bathymetry, bottom roughness, tidal water level at the open-ocean boundary, the specification of an adequate number of vertical layers, and the specification of a nonreflective upstream open boundary.

The model was first calibrated for only the M_2 tide, but then the following components were added: (1) low-frequency, subtidal water level at the ocean boundary; (2) main stemflow at Buffalo Bluff; (3) dynamically-coupled salinity; (4) tributary inflows; and (5) meteorologic components for wind, rainfall, and evaporation. Sucsy and Morris (2002) describe error analytical techniques used to compare observed and simulated results. These techniques include (a) regression analysis, (b) calculation of median relative error, (c) comparison of means, (d) calculation of root mean square error (RMSE), and Kologorov-Smirnov tests for determining the likelihood that two sample populations have identical cumulative distribution functions.

The calibrated EFDC model was provided to the ERDC for linkage to the modified CE-QUAL-ICM model (June 2000). The ERDC was contracted to provide a model calibrated to data collected from the period from December 1, 1995, through November 30, 1998. SJRWMD staff performed skill assessments of the model using data collected outside the calibration period (1995, 1996, and 1999). Because of the dramatic differences that occurred in the high-flow and low-flow years of 1998 and 1999, the calibration effort was shifted to these two years to better encompass the total potential environmental variation.

Sucsy and Hendrickson (2004), and Tillman *et al.* (2004) present the calibration and verification results for the water quality model. Some of the same analytical techniques used to evaluate the hydrodynamic calibration were used to evaluate the calibration of key water quality parameters at long-term monitoring sites. **Appendix F** (**Figures F1** and **F2**) shows examples of the results from a RMSE analysis of DO predictions at Acosta Bridge and Dames Point, respectively, and **Appendix G** (**Figures G1** through **G4**) shows the calibration results for chlorophyll *a*.

5.5 Model Results Used To Determine Assimilative Capacity

Based on a recommendation from the LSJR TMDL Executive Committee, point sources directly discharging to the St. Johns were evaluated based on their 1997–98 discharge flows and loads, with an allowance for anticipated growth over the next few years (rather than assuming permitted design flows and loads). **Table 4** summarizes the starting conditions assumed for each facility that were considered as part of the TMDL process. Nonpoint source contributions to the river varied in response to fluctuations in annual rainfall.

The LSJR TMDL Executive Committee also recommended the addition of two discharges to the TMDL simulations to represent future domestic wastewater discharges under the Apricot Act requirements (advanced wastewater treatment and discharge only during wet weather) and reverse osmosis (RO) discharges to the St. Johns into the freshwater portion (WBID 2213I) and marine portion (WBID 2213H). The annual freshwater discharge load was set at 9,961 kg/yr TN and 3,320 kg/yr TP. In the marine portion, an annual discharge load of 4,979 kg/yr TN was used.

Appendix M describes the methodology used to determine projected growth in the basin through 2008 and how changes in urban stormwater were associated with various jurisdictions. These changes were incorporated into the TMDL simulation and are reflected in the allocation spreadsheets found in **Appendix J**.

The SJRWMD staff presented results from model simulations for the freshwater zone for 1995, 1997, 1998, and 1999. Each year was evaluated with respect to whether the predicted chlorophyll *a* levels met the alternative chlorophyll *a* threshold of 40 µg/L less than 10 percent of the time.

Sucsy and Hendrickson (2004) described the process of assessing the relative influence of anthropogenic nitrogen and phosphorus loads from point and nonpoint sources and the upstream boundary by simulating incremental reductions (25 percent, 50 percent, 75 percent, and 100 percent) to the river. The exceedance of the alternative chlorophyll *a* target was calculated for each year, along with the estimated reduction in the anthropogenic load necessary to meet the target. Based on the long-term average results for the 4 years, the SJRWMD-recommended PLRG was a 30 percent reduction in anthropogenic point, nonpoint, and upstream boundary nitrogen and phosphorus loads.

A similar analysis was completed for the combined oligohaline/mesohaline portion of the river. In these zones, model DO predictions were evaluated to determine whether the "persistent exposure criterion" impairment index (1.0) was met for each set of incremental reductions for each model year (Hendrickson *et al.,* 2003). In this portion of the river, nitrogen was the key nutrient that needed to be reduced to meet the target. Due to depressed DO conditions and a large fish kill in 1999, 1999 was selected as the period to establish nitrogen load reductions to protect the ecological health of the aquatic community. The modeling indicated that a 28.5 percent reduction in anthropogenic point and nonpoint nitrogen loads was needed from within this reach to attain the DO SSAC (percent reductions were calculated based on the initial starting points used by the SJRWMD for 1997–98). This load reduction was contingent on the 30 percent reduction occurring in the upstream, freshwater reach.

It should be noted that the loading capacities of both portions of the river were originally determined by interpolation and that the interpolated loading capacities were then used to develop detailed wasteload and load allocations. To confirm that the interpolated values (and resultant allocations) would achieve water quality standards, a final model run was made with modeled loads set at the allocated loads. **Appendix N** presents comparisons between simulation results for the existing 1999 scenario and the final TMDL scenario for both the marine (DO) and freshwater (chlorophyll) portions.

Table 4. Starting Point TN and TP Loads for Point Sources

Name of Facility	Current Flow (mgd)	Projected Increase (mgd)	Permitted Flow (mgd)	Starting Point Flow (mgd)	1997–98 Nutrients		Starting Point	
					TN (mg/L)	TP (mg/L)	TN (lbs/day)	TP (lbs/day)
Smurfit-Stone Container Corporation	6.88	-	20	8.85	6.8	1.1	502	85
Jefferson Smurfit – JAX	-	-	6	6.0	8.8	1.2	441	58
USN – NS Mayport WWTF	0.88	0.044	2	1.03	3.2	2.1	27	18
USN – NAS Jacksonville WWTF	0.955	0.048	3	1.13	8.5	1.7	80	16
Georgia-Pacific	24.49	-	40	34.2	5.5	1.4	1556	385
Jacksonville Beach WWTF	2.5	0.13	4.5	3.2	9.1	2.2	242	59
Neptune Beach WWTF	0.744	-	1.5	0.94	8.8	1.4	69	11
Green Cove Springs – Harbor Road WWTF	0.514	0.236	0.75	0.75	9.2	2.9	57	18
Westminster Woods – (Wesley Manor Retirement Village)	0.03	-	0.09	0.050	4.6	2.0	1.9	0.83
Atlantic Beach – Buccaneer WWTF	0.91	0.13	1.9	1.13	13.4	1.4	127	13
JEA – Mandarin WWTF	5.88	1.1	7.5	7.0	5.34	2.3	312	134
JEA – Monterey WWTF (operated by UWF)	2.66	0.94	3.6	3.6	11.3	1.6	341	49
JEA – Holly Oaks WWTF (formerly UWF)	0	0	1	0	8.3	2.1	0	0
JEA – San Jose WWTF (formerly UWF)	1.65	0.60	2.25	2.25	10.0	2.9	188	55
JEA – Jacksonville Heights WWTF (formerly UWF)	1.07	0.43	2.5	1.62	10.1	2.9	136	40
Orange Park WWTF	1.16	-	2.5	-	-	3.7	150	41
JEA – San Pablo WWTF (formerly UWF)	0.58	0.18	0.75	0.75	6.5	3.5	40	22
CCUA – Miller Street WWTF	3.54	1.46	4.99	4.99	4.5	3.2	189	133
JEA – Ortega Hills WWTF (formerly UWF)	0.09	0	0.22	0	16.8	2.3	0	0
JEA – Buckman WWTF	32.04	0.96	52.5	34.02	10.5	4.7	2966	1331
JEA – Arlington WWTF	12.86	5.14	20	18	14.3	2.6	2143	393
JEA – Northeast WWTF (fka JEA - District II WWTF)	3.2	1.05	10	5.4	22.7	5.9	1016	263
JEA – Southwest WWTF	7.30	4.70	10	10	10.5	1.4	875	116
JEA – Royal Lakes WWTF (formerly UWF)	1.64	0.66	3.25	2.99	7.8	3.8	193	94
FWSC – Beacon Hills SD WWTF	0.66	0.25	1.3	0.99	11.9	2.0	99	16.8
FWSC – Woodmere SD WWTF	0.43	0.21	0.7	0.64	11.6	1.7	61	8.8
Green Cove Springs – South WWTF	0.21	0	0.5	0.27	13.6	2.3	31	5.3
CCUA – Fleming Oaks WWTF	0.37	0.03	0.49	0.40	3.0	1.9	10.1	6.5
Atlantic Beach – Main WWTF (D001)	1.73	0.07	3	1.8	11.4	2.1	170	31

Name of Facility	Current Flow (mgd)	Projected Increase (mgd)	Permitted Flow (mgd)	Starting Point Flow (mgd)	1997–98 Nutrients		Starting Point	
					TN (mg/L)	TP (mg/L)	TN (lbs/day)	TP (lbs/day)
Palatka WWTF	2.22	0.35	3	3.0	14.7	2.4	367	60
Anheuser Busch – Main St. – Land Application	1.46	-	2.6	2.6	3.9	0.3	84	7.6
Hastings WWTF	0.085	0.018	0.12	0.103	4.5	0.6	3.9	0.53
JEA – Julington Creek Creek WWTP	0.21	2	0.476	0.476	12.0	3.0	48	12
CCUA – Fleming Island WWTF (combined)	1.078	-	6.365	-	-	-	172	64
UWF – Saint Johns North WWTF	-	0	-	0	6.5	1.7	0	0
Brierwood SD – Beauclerc STP	-	0	-	0	-	-	0	0
Seminole Electric Cooperative, Inc., Palatka Plant			7.46			-	346	-

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:

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

As mentioned in **Section 4.1**, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\mathbf{TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is accounted for within the LA, and (2) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as "percent reduction" because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges is also different than 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 LSJR are expressed in terms of kilograms per year, and represent the maximum annual TN and TP load the freshwater and estuarine reaches of the river can assimilate and maintain the narrative nutrient criterion (**Tables 5** and **6**). As described in the note for **Tables 5** and **6**, a daily expression of the TMDLs can be calculated by dividing the annual average load by 365.25. The resultant loads represent the total maximum annual average daily loads. However, the TMDLs to be implemented are those expressed on a mass per year basis, and the expression of the TMDL on a mass per day basis is for information purposes only. As noted in Section 5.5, the TMDL for the estuarine portion of the river is for TN only because nitrogen is the limiting nutrient for this portion of the river.

Appendix J provides the allocation to specific wastewater facilities. The division of the available assimilative capacity between the WLA and LA was determined using information about individual sources and source categories. The allocation methodology followed the recommendations in the *2001 Report to the Governor and Legislature on the Allocation of Total Maximum Daily Loads* (Department, 2001), with site-specific revisions to the allocation methodology recommended by the LSJR TMDL Executive Committee. Under this approach, initial reductions for the river were targeted at nonpoint source loads assuming the implementation of BMPs. As BMP implementation alone did not result in sufficient reductions, all anthropogenic sources, including the upstream load, were reduced by the same percentage until the assimilative capacity was met, except that that prior treatment or prior commitments in treatment improvements was taken into account for individual point sources.

For the case of domestic wastewater facilities in the marine portion of the river, the allocations are based on their starting point flow and a target TN concentration of 5.4 mg/L. Using this approach, facilities that already provided advanced waste treatment (typically defined as a TN of 3 mg/L) did not have to make additional reductions, and in fact could increase their discharged load or generate credits.

Allocation calculations were conducted using an Excel spreadsheet, and Appendix J provides table versions of the spreadsheets used to allocate loadings in the freshwater and estuarine portions of the river (interested parties can request an electronic copy of the spreadsheet if they would like to see spreadsheet formulas).

Table 5. TMDL Components for the Freshwater Portion of the LSJR

WBIDs	Parameter	TMDL (kg/yr)	WLA[3] (kg/yr)	LA (kg/yr)	MOS
2213I to 2213N	Total Nitrogen	8,571,563	236,695	8,334,868	Implicit
2213I to 2213N	Total Phosphorus	500,325	46,357	453,968	Implicit

Table 6. TMDL Components for the Estuarine Portion of the LSJR

WBIDs	Parameter	TMDL (kg/yr)	WLA (kg/yr)	LA (kg/yr)	MOS
2213A to 2213H	Total Nitrogen	1,376,855	1,027,590	349,265	Implicit

Note: To calculate the total maximum annual average daily load that should be expected, divide the annual average load by 365.25.

It should be noted that some facilities requested that the Department combine their WLAs into an aggregate WLA to allow flexibility, so that reductions from one facility can be shifted to another as long as the net reduction reaches the aggregate WLA. For these aggregate allocations, the Department plans to issue watershed permits that will require compliance with the aggregate WLA.

[3] As described in **Section 6.2**, this WLA includes a percent reduction in current loading from sources covered by the NPDES Stormwater Program.

6.2 Load Allocations

The LA for the freshwater portion of the LSJR includes the following loads: (1) the natural background nonpoint source load (which includes background upstream loads from the Middle St. Johns River [MSJR] and background loads from Dunns Creek); (2) augmented nonpoint source loads (again including augmented upstream loads from the MSJR and Dunns Creek); and (3) atmospheric deposition. To determine the allocation between the WLA and LA, the augmented TN and TP nonpoint source loads were first reduced by the amounts estimated for the implementation of applicable BMPs on agricultural lands and urbanized areas, and then augmented nonpoint sources (excluding atmospheric deposition) and point sources were reduced by the same percentage until the assimilative capacity was met. Using this approach, the LA takes into account reductions expected in the upstream load from the MSJR. It should also be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix E**).

Appendix J provides allocations of urban nonpoint source loads to individual jurisdictions in the freshwater portion of the river. These allocations were developed in the same manner as for MS4s (see **Appendix M**) and were expressed as percent reductions rather than load.

The load allocation for the marine portion of the river was developed in the same manner as for the freshwater portion. Allocations to individual jurisdictions (shown in **Appendix J**) were expressed as percent reductions.

6.3 Wasteload Allocations

The WLA for the estuarine portion of the river is a combination of the sum of the WLAs for all of the NPDES wastewater facilities and the stormwater discharges from the MS4 jurisdictions (**Appendix J**). As noted in **Section 6.1**, the TMDLs to be implemented are those expressed on a mass per year basis, and effluent limits for wastewater discharges to the river will be based on the annual expression. While the loads for individual MS4s were calculated, the allocations to the MS4s are expressed as a percent reduction rather than loads. **Appendix M** describes the methodology to determine the required percent reduction in urban stormwater for each MS4 discharging to the estuarine portions of the river.

The WLA for the freshwater portion of the river is the sum of the WLAs for all of the NPDES wastewater facilities and a percent reduction assigned to stormwater discharges subject to the Department's NPDES Stormwater Program. As with the marine portion of the river, allocations to each MS4 in the freshwater portion of the river are expressed as a percent reduction.

It should be noted that any MS4 permittee is only responsible for reducing the loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Aggregate Loads and Pollutant Trading

Some facilities requested that the Department combine their WLAs into an aggregate WLA to allow flexibility in how they meet the required load reductions. While this aggregation was straightforward for entities with multiple wastewater facilities, the aggregation was slightly more complex for municipalities that wanted to aggregate their wastewater and MS4 allocations, because the allocations to MS4s were expressed as percent reductions. The approach was to simply convert the percent reduction back into a load using the loading in the allocation spreadsheet.

This approach clearly works for the TMDL for the freshwater portion of the river, which is based on a long-term average condition (based on the chlorophyll *a* target of not exceeding 40 ug/L more than 10 percent of the time). This approach also works in the marine portion of the river, even though the TMDL is based on a dry year (1999 was the worst-case year for DO, when tributary flows were low, nutrients were concentrated in the river due to less dilution, and residence times were longer). Model runs[4] indicate that the percent reductions needed in other model years are about half of the reductions in 1999 (a 15 percent reduction required in 1996 and 1997, compared with a 28.5 percent reduction required in 1999), while the urban stormwater loads for these years are less than twice the 1999 load. As such, it is adequately protective to use the 1999 load for aggregation purposes.

For the aggregate allocations, the Department plans to issue watershed permits that will require compliance with the aggregate WLA. These permits will be in addition to the facilities' current permits, and will focus on compliance with the WLA.

This approach of converting the percent reduction back into the allowable load for 1999 is also applicable if MS4s decide to meet their required reductions through water quality credit trading. The WLAs given to point sources can be modified via trading as long as the overall load does not exceed the TMDL. The combined WLA (both total and facility-specific) is provided to allow flexibility so that reductions from one discharger can be shifted to another as long as the net allocation achieves the TMDL. The Department plans to address the permitting process and requirements for water quality credit trading, including trading factors, in the Basin Management Action Plan (BMAP) for the TMDL.

6.5 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was assumed in the development of this TMDL. An implicit MOS was provided by the conservative decisions associated with a number of modeling assumptions, the development of site-specific alternative water quality targets, and the development of assimilative capacity.

In the freshwater zone, multiple years of phytoplankton and zooplankton field measurements were evaluated to establish the site-specific chlorophyll *a* level beyond which zooplankton abundance and diversity started to decline. Hydrodynamic/water quality simulations over four different years were then evaluated to determine the appropriate long-term average TN and TP load reductions necessary to meet the chlorophyll *a* target. These four years represent flows that were slightly drier than average conditions and, given that the effects of nutrient impairment are more prominent in dry conditions, this long-term, yet dry period is considered conservative.

The expression of the TMDL also provided an implicit MOS because equal percent reductions of both TN and TP were required, even though both nutrients may not be the limiting factor for a

[4] These model runs were evaluated because the Department was concerned that the amount of load aggregated, if based on the dry year loading, could conceivably be inadequately protective during wetter years when MS4 loads would be higher, **depending on the percent reduction required for the wetter years**.

given year in the freshwater zone. In addition, reductions were based on meeting the target within all five WBIDs in the freshwater zone. As such, the “worst-case” WBID controlled the amount of reduction needed. Finally, point source flows and loads used in the WLA for the freshwater zone were based on existing flows and loads with an allowance for growth rather than assuming permitted limits. This approach provides an implicit MOS because it is extremely unlikely that all of the point sources would simultaneously discharge at their full WLA.

Conservative assumptions were also part of the development of the TMDL for the oligohaline/ mesohaline portion of the river. As in the freshwater zone, four different years were simulated. However, in this case, the worst-case year (1999) was used to establish necessary nitrogen load reductions in the oligohaline/mesohaline zone because the controlling factor, DO, can result in impairment in shorter time frames than increased algal biomass. In 1999, there were reduced rainfall and increased residence times, which resulted in reduced DO levels and a large fish kill. As in the freshwater zone, the percent reduction needed for the oligohaline/mesohaline zone was based on ensuring that the target was met in all of the WBIDs in these zones.

Another conservative assumption involved the methodology used to establish the DO SSAC in the marine portion of the river. For example, a minimum DO of 4.0 mg/L was specified and certain conservative assumptions were made regarding larval recruitment and growth in the development of the SSAC.

Finally, point source flows and loads used in the WLA for the oligohaline/mesohaline zones were based on existing flows and loads with an allowance for growth rather than assuming permitted limits. As noted previously, this approach provides an implicit MOS because it is extremely unlikely that all of the point sources would simultaneously discharge at their full WLA.

6.6 Seasonal Variability

Seasonal variability was assessed during the development of this TMDL as part of the development of the site-specific water quality targets and the determination of assimilative capacity. The site-specific targets developed for the freshwater and oligohaline/mesohaline zones account for the seasonal cycles in algal growth. In the freshwater zone, the critical period occurred from April through August, when excessive algal growth led to imbalances in the algal community structure (dominance by only a few species) and impacts to the food web (undesirable prey for zooplankton and fish species). The chlorophyll *a* target for the freshwater zone (40 µg/L not to be exceeded more than 10 percent of the time) was specifically designed to prevent algal blooms of sufficient duration to cause these imbalances in flora and fauna in the future.

The TMDL for the oligohaline/mesohaline zone also accounted for seasonal variability. As discussed earlier in the MOS section, the summer of 1999 was a critical period, during which DO was below 4.0 mg/L at levels and for durations that could adversely impact the aquatic fauna in the oligohaline/mesohaline zones. The method used to develop the DO target accounts for these critical, seasonal (and diurnal) periods and ensures that excursions of DO levels below the chronic threshold will not occur at a magnitude or duration that would result in impacts to aquatic fauna.

7. NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of the TMDL by rule in 2004, the LSJR TMDL Executive Committee continues to meet and provide input on a more detailed allocation. These efforts will be reflected in the BMAP for the LSJRB, which is currently scheduled for adoption in summer 2008. 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 agreements;*
- *Local ordinances defining actions to be taken or prohibited;*
- *Local water quality standards, permits, or load limitation agreements; and*
- *Monitoring and follow-up measures.*

TMDL development and implementation is an iterative process, and this TMDL will be re-evaluated during the BMAP development process and subsequent watershed management cycles. The Department recognizes that it may be appropriate to revise the TMDL in the future when more information has been collected and analyzed.

With such possible revisions in mind, this TMDL is characterized as an adaptive management TMDL, in which the Department uses the best available information at the time to develop the TMDL. However, the adaptive management approach recognizes that additional data and information may be necessary to validate the assumptions of the TMDL, and that the additional information should be pursued to improve the next iteration of the TMDL

One of the key issues that determined the allowable loading for this TMDL was the Department's interpretation of the narrative nutrient criterion for the water quality target (40 ug/L not to be exceeded more than 10 percent of the time) for the TMDL. Given the importance of the water quality target, the Department plans to work with stakeholders to conduct monitoring of the river (see **Section 3.3**) designed to further evaluate the water quality target for nutrients and to determine the effectiveness of the pollution control activities required by this TMDL.

It should also be noted that this TMDL does not directly address nutrient impacts on SAV. The Department and the SJRWMD agree that the TMDL would ideally address nutrient impacts on the SAV community in the LSJR. In fact, one of the reasons the CE-QUAL-ICM model was selected for this TMDL was that it had the capability to simulate SAV, including epiphytic growth effects on SAV.

However, specific studies of the effects of nutrients, light, and salinity on the dominant SAV species in the LSJR were not completed in time to allow for the SAV modeling component of CE-QUAL-ICM to be used for this version of the TMDL. The SJRWMD is actively pursuing these studies and they should be completed over the next two years (see **Appendix K** for a list of ongoing and proposed studies that will provide the necessary information to model SAV response).

As this information becomes available, the model code will be revised to incorporate a site-specific light model and additional state variables that influence SAV growth, and the model will be recalibrated for use in the next iteration of the TMDL. If there are any changes in the estimate of the assimilative capacity as a result of the revisions to the water quality target or model code to address SAV, the rule adopting this TMDL will be revised, providing a point of entry for interested parties.

REFERENCES

Adamus, C.L., and M.L. Bergman. 1995. Estimating nonpoint source pollution loads with a GIS screening model. *Water Resources Bulletin 31(4):647-655.*

Bricker, S.B, C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. September 1999. *National estuarine eutrophication assessment: Effects of nutrient enrichment in the nation's estuaries.* Silver Spring, Maryland: National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science.

Burkholder, J.M., and H.B. Glasgow, Jr. 1997a. *Pfiesteria piscicida* and other *Pfiesteria*-like dinoflagellates: Behavior, impacts, and environmental controls. *Limnology & Oceanography 42(5, part 2):1052-1075.*

Burkholder, J.M., and H.B. Glasgow, Jr. 1997b. Trophic controls on stage transformations of a toxic ambush-predator dinoflagellate. *J. Euk. Microbiology 44:200-205.*

Cerco, C., and T. Cole. 1993. Three-dimensional eutrophication model of Chesapeake Bay. *Journal of Environmental Engineering. 119:1006-1025.*

Florida Department of Environmental Protection. 1997. Personal communication with Northeast District permitting staff.

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

———. 2002. *Basin status report for the Lower St. Johns River Basin.* Tallahassee, Florida: Bureau of Watershed Management.

Fisher, D.C., and M. Oppenheimer. 1991. Atmospheric nitrogen deposition and the Chesapeake Bay estuary. *Ambio 20(3-4): 102-108.*

Floyd, S.S., E.M. Irwin, and D.A. Evans (Eds.). 1997. *Florida statistical abstract.* University of Florida, Bureau of Economic and Business Research. Gainesville, Florida: University Presses of Florida.

Florida Marine Research Institute. 2002. *Fisheries Independent Monitoring Program 2001: Annual data summary report.* St. Petersburg, Florida.

Greening, H., L.K. Dixon, A. Squires, P. Hessling, T. D'Aquila and T. Rogers. 1997. *Contribution of atmospheric deposition to nitrogen and toxic materials loadings to Tampa Bay.* In: S. Treat (Ed.), Proceedings, Tampa Bay Area Wide Scientific Information Symposium 3: Applying Our Knowledge.

Hamrick, J.M. 1992. *A three-dimensional environmental fluid dynamics computer code: Theoretical and computational aspects.* Special Report 317. Gloucester, Virginia: College of William and Mary, Virginia Institute of Marine Science.

Hendrickson, J., and J. Konwiniski. 1998. *Seasonal nutrient import-export budgets for the Lower St. Johns River, Florida.* St. Johns River Water Management District.

Hendrickson, J., and W. Magley. 2001. *Development of total maximum daily loads and pollutant load reduction goals for the Lower St. Johns River Basin: Plan of study.* St. Johns River Water Management District.

Hendrickson, J., N. Trahan, E. Stecker, and Y. Ouyang. 2004. *Estimation and assessment of the current and historic external load of nitrogen, phosphorus and organic carbon to the*

Lower St. Johns River for the fulfillment of TMDL and PLRG objectives. Palatka, Florida: St. Johns River Water Management District, Department of Water Resources.

Hendrickson, J.C., E.F. Lowe, D. Dobberfuhl, P. Sucsy, and D. Campbell. 2003. *Characteristics of accelerated eutrophication in the Lower St. Johns River Estuary and recommended targets to achieve water quality goals for the fulfillment of TMDL and PLRG objectives.* Palatka, Florida: St. Johns River Water Management District, Department of Water Resources.

Janicki, A., and G. Morrison. 2000. Developing a Trophic State Index for Florida's estuaries. Submitted to the Florida Department of Environmental Protection. St. Petersburg, Florida: Janicki Environmental, Inc.

Paerl, H.W. 1993. Emerging role of atmospheric nitrogen deposition in coastal eutrophication: Biogeochemical and trophic perspectives. *Can. J. Fish. Aquat. Sci. 50: 2254-2269.*

Phlips, E.J., M. Cichra, F.J. Aldridge, J. Jembeck, J. Hendrickson, and R. Brody. June 2000. Light availability and variations in phytoplankton standing crops in a nutrient-rich blackwater river. *Limnology & Oceanography 45:(4) 916-929.*

Pollman, C.D., and S. Roy. 2003. *Examination of atmospheric deposition chemistry and Its potential effects on the Lower St. Johns Estuary*. Final Report Submitted to the St. Johns River Water Management District, Contract No. SE706AA. Gainesville, Florida: Tetra Tech, Inc.

Pribble, R.J., and A.J. Janicki. 1998*. Atmospheric deposition contributions to nitrogen and phosphorus loadings in Tampa Bay: Intensive wet and dry deposition collection and analysis.* Report prepared for the Tampa Bay National Estuary Program, St. Petersburg, Florida.

St. Johns River Water Management District. January 1993. *SWIM Plan for the Lower St. Johns River.* Palatka, Florida.

Sucsy, P.V., and F.W. Morris. 2002. *Calibration of a three-dimensional circulation and mixing model of the Lower St. Johns River.* Technical Memorandum. St. Johns River Water Management District. Palatka, Florida.

Sucsy, P., and J. Hendrickson. 2004. *Calculation of nutrient reduction goals for the Lower St. Johns River by application of CE-QUAL-ICM, a mechanistic water quality model.* Palatka, Florida: St. Johns River Water Management District, Department of Water Resources.

Tillman, D., C. Cerco, M. Noel, J. Martin, and J. Hamrick. 2004. *Three-dimensional eutrophication model of the Lower St. Johns River, Florida.* ERDC/EL TR-04-13. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

U.S. Environmental Protection Agency. September 1999. *Ambient water quality criteria for dissolved oxygen (salt water): Cape Cod to Cape Hatteras.* EPA 822-D-99-002. Washington, D.C.: Office of Water, Office of Science and Technology.

———. October 2001. *Nutrient criteria technical guidance manual: Estuarine and coastal marine waters.* EPA 822-B-01-003. Washington, D.C.: Office of Water.

Appendix A: The LSJR TMDL Executive Committee

This broad-based group, convened by the Department's Northeast District, has been meeting since July 2002. It has advised the Department on issues such as water quality targets and allocation processes. The committee will play a critical role in the development of the BMAP to implement TMDLs. The committee membership as of July 2003 is listed below.

LSJR TMDL Executive Committee	
Interest Group	**Representative**
Florida Department of Environmental Protection	Mario Taylor, Northeast District (Chair)
Industry	Mike Burch, Plant Manager, Rayonier
Agriculture	Wayne Smith, President, North Florida Growers Exchange
Builders	Neil Aikenhead, Northeast Florida Builders Association
Utility Authorities	Susan Hughes, JEA
Environmental Interest Groups	Roger Bass, St. Johns Riverkeeper
	Don Loop, Stewards of the St. Johns River
Regional Planning Council	Brian Teeple, Northeast Florida Regional Planning Council
Forestry	Jim Kuhn, Shadow Lawn Farms
Local Government	Honorable Glen Lassiter, Clay County Commission
Florida Department of Agriculture and Consumer Services	Jody Lee
MSW – Public Works	Ed Hall, City of Jacksonville Public Works
St. Johns River Water Management District	Casey Fitzgerald (for Executive Director Kirby Green)
U.S. Army Corps of Engineers	Richard Bonner

LSJR Executive Committee Mission Statement

The LSJR TMDL Executive Committee advises the Department on the development and implementation of TMDLs for the basin. The committee represents and communicates with key stakeholders to secure local input and consensus on pollutant reductions. The committee is charged with recommending a "reasonable and equitable" allocation of pollutant load reductions for achieving TMDLs in the lower basin and, in conjunction with the Department, developing a BMAP to implement those load reductions.

Appendix B: Eutrophication Defined

Eutrophication is generally described as a process of changing the ecological status of a waterbody by increasing the baseline (e.g., primary) level of productivity, almost invariably as a result of increasing nutrient supply. Some researchers (Nixon, 1995) have suggested that estuarine eutrophication be defined as “an increase in the rate of supply of organic matter to an ecosystem,” as the effect of eutrophication in most systems is an increase in plant (algae and/or nuisance aquatic plants) biomass.

The general sequence of eutrophication effects is as follows. In the enrichment phase, there is an episodic or continuous increase in algal and plant biomass. Above a certain level of nutrient availability, changes in plant species composition occur that can have profound effects on the habitat and structure of the rest of the food web, potentially affecting energy flow in the entire ecosystem. Secondary effects can include reductions in light penetration that can reduce the species composition and depth distribution of benthic plants, the increased probability of the occurrence of toxic/nuisance phytoplankton blooms, hypoxia (commonly used to describe DO concentrations at or below 2.0 mg/L), and behavioral effects on other organisms in the food web (Gray, 1992). Extreme effects can include the mass growth of undesirable plants, regular blooms of toxigenic and other nuisance algae, and, ultimately, the migration or mortality of various species.

Appendix C: Basis for LSJR Water Quality Targets

(Excerpts[5] from Hendrickson *et al.*, 2003, *Characteristics of Accelerated Eutrophication in the Lower St. Johns River Estuary and Recommended Targets to Achieve Water Quality Goals for the Fulfillment of TMDL and PLRG Objectives*)

Water Quality Targets for the LSJR

Some measure of the three most commonly identified water quality effects of estuarine eutrophication—nuisance levels of algal biomass, reduced dissolved oxygen and reduced transparency—were recommended in the original Plan of Study (POS) document as the response variables in establishing nutrient TMDLs and PLRGs for the LSJR. These TMDL and PLRG targets were originally established consistent with standards or thresholds set forth in Chapter 62-302, F.A.C., and Chapter 62-303, F.A.C. However, in the process of data analysis and investigation to describe nutrient enrichment effects and to quantify these relationships through water quality modeling, these targets have undergone refinement in order to more closely address the most problematic aspects of eutrophication in the LSJR.

Relevant questions driving the re-definition of targets were:

1. *Is the dissolved oxygen State standard sufficiently protective, or conversely, unnecessarily protective, for biota endemic to the LSJR?*

2. *Is the maintenance of transparency, based upon open water changes in compensation depth, relevant to SAV colonization in the LSJR?*

3. *Do algal biomass targets, based upon mean annual chlorophyll* a *concentrations, sufficiently address the most problematic aspects of nuisance algal blooms?*

Because of the weak linkage between open water, planktonic algal attenuation that is embodied in the transparency standard as stated in Chapter 62-302, F.A.C., and the more realistic case of epiphytic algal attenuation for littoral submerged grasses, it was felt that the transparency criteria is not the appropriate target for protection of SAV in the LSJR. Investigations relating nutrient enrichment effects to SAV health, and the interactions between natural factors of light, color and substrate and nutrient enrichment are ongoing and can be used to revise the LSJR nutrient TMDL if warranted.

In light of the great amount of research in support of oxygen criteria, and the recent work accomplished in compiling and refining this research in EPA's *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras*, it was felt that sufficient effort could not be mustered, nor was warranted, to refute these recommendations for the LSJR TMDL. Therefore, methodologies provided in this guidance have been relied upon

[5] Text provided is from the DRAFT available at the time the TMDL was adopted. Readers should refer to the referenced document for more up-to-date text. Only text was excerpted. Figures and tables referenced in the text are available in the final document and may be obtained from the SJRWMD.

for establishing algal biomass targets for the predominantly marine reach of the river. While these methods apply a less restrictive criteria for maintenance of aquatic life based on dissolved oxygen than the current Florida Water Quality Standard, they are arguably more realistic given the natural stressors to oxygen level in a southern temperate blackwater river estuary.

And finally, as experimental evidence suggests that the greatest level of harm from algal blooms occurs from extreme bloom events, the chlorophyll *a* targets for the LSJR were redefined to emphasize the reduction of high concentration and long duration events.

LSJR Freshwater Phytoplankton Community Composition Dynamics and Zooplankton Interactions

The fundamental objective for LSJR TMDL and PLRG nutrient load reduction modeling was the enhancement of plankton ecology for both freshwater and marine environments. This approach was taken because 1) the LSJR is largely a plankton based system, with the majority of its autochthonous carbon produced through phytoplankton primary production, and 2) a large database composed of five years of phytoplankton and zooplankton monitoring data exists for the LSJR, representing the most powerful biological evaluation tool available.

For the freshwater river, three elements of plankton ecology were assessed:

1) *What maximum levels of algal biomass maintain diversity in the plankton community?*

2) *What maximum levels of algal biomass, or what phytoplankton community composition, facilitates the upward transfer of planktonic primary production to higher trophic levels?*

3) *What levels of algal biomass minimize the potential for the expansion of detrimental algal species or the production of algal toxins?*

Freshwater LSJR Algal Biomass Target

Maintenance of Phytoplankton Diversity

The maintenance of organism diversity is a fundamental goal of biological restoration. Diversity in biological systems promotes stability; conversely, ecosystems with narrow species diversity are prone to large perturbations in communities. The loss of phytoplankton diversity, and the dominance of cyanobacteria during the spring and summer growth seasons is one of the most conspicuous aspects of freshwater blooms of the LSJR. As total phytoplankton community biomass (expressed as chlorophyll *a*) increases, the fraction of the total community biomass composed of blue-greens (determined from biovolume estimates) increases (Figure 27). Blue green relative composition is variable and often low for chlorophyll *a* concentrations to about 40 mg/m^3. After this point, blue green biomass represents the majority of phytoplankton community composition. At chlorophyll *a* concentration above 60 mg/m^3, blue green relative abundance is regularly between 80 to 90 percent.

Facilitation of Upward Trophic Transfer of Primary Production

In its Chesapeake Bay Water Quality Criteria Guidance Manual, EPA outlines an approach to the development of chlorophyll *a* criteria for the purpose of enhancing the upward transfer of phytoplankton carbon to the zooplankton community. The conceptual model utilized in the Chesapeake Bay (CB) Guidance relating mesozooplankton response to increases in algal biomass is depicted in Figure 28. This model is based on the premise that at low to moderate phytoplankton densities, zooplankton populations respond favorably and increase with increase in algal biomass associated with increase in food supply. At some point, however, the increase in toxic or otherwise unpalatable taxa in the phytoplankton community, and an increase in feeding effort due to the density of unfavorable species, leads to a leveling off and perhaps even decline in the desirable zooplankton. The point of the departure from the linear increase in zooplankton – phytoplankton biomass represents the maximum desirable algal biomass.

Plankton monitoring data (Nov. 1996 through Oct. 2001) were examined to determine if a relationship similar to that described above existed for the freshwater LSJR. The zooplankton – algal biomass relationship is shown in Figure 29. Desirable zooplankton in these graphs are estimated by summing the organism counts for copepods and cladocerns only. Rotifers are excluded, as they are believed to be feeding on small detrital particles and bacteria, and are not believed to be as important a group of zooplankters in supporting the upward transfer of carbon to the fish community. Although a good deal of spread exists in this graph in zooplankton abundance at low to moderate chlorophyll *a* concentration, it is possible to discern a pattern that matches the conceptual model forwarded by the CB guidance.

This graph suggests that the linear increase in zooplankton abundance with increasing chlorophyll *a* concentration begins to decline somewhere between chlorophyll *a* concentrations of 40 to 60 mg/m^3. The adverse response of zooplankton numbers to high levels of algal biomass can be seen in Figure 29 for the specific case of the severe algal blooms that occurred at Racy Point in 1999. At this station, zooplankton numbers increase initially as chlorophyll concentration increases, but then decline as chlorophyll continues to increase. This pattern is repeated for the year's second bloom, which peaks in late August.

Algal Toxin Formation Potential

In recently completed work, Paerl and Charmichael (2002) examined levels of the algal toxins microcystin, anatoxin, and cylindrospermopsin in nutrient enrichment assays performed on LSJR samples collected from October 2000 through August 2001. All toxins were detected during the sampling, with microcystin present in every assay. Microcystin was found to be positively correlated to chlorophyll *a* (e.g., algal biomass), and this relationship is shown in Figure __. Generally, microcystin levels remained low for chlorophyll a concentrations below 40 µg/L. Above this level, microcystin levels were found to be variable, but on occasion reached very high levels, near the World Health Organization standard for drinking water of 1 µg/L. The LSJR is not a drinking water source, and relevance of this standard for the protection of aquatic life has not been quantified. However, the result of these assay experiments suggests that at concentrations of chlorophyll *a* that exceed 40 µg/L, the potential for the appearance of microcystin in ambient water increases greatly.

Algal Bloom Duration

Plankton monitoring data and algal toxin assays indicate that blue green algal blooms of the LSJR freshwater reach begin to exhibit detrimental effect as bloom biomass, measured as chlorophyll *a*, exceeds 40 mg/m^3. These effects would not be expected to be instantaneous at concentrations above 40 mg/m^3, but instead to require some level of duration and intensity. When the numbers of copepods and cladocerans (again, considered to be an indicator of beneficial zooplankton) in plankton sampling are compared to the durations of above 40 mg/m^3 chlorophyll *a* excursions (Figure 30), it can be see that as durations exceed 40 days, copepods and cladoceran numbers are noticeably reduced. In the duration analysis of Figure 10, between 20 to 45 percent of blooms within the freshwater reach exceeded this duration.

The mean duration of above 40 mg/m^3 episodes is between 20 to 30 days within the freshwater reach (Figure 10), but bloom duration increases disproportionately as blooms exceed 30 days. For example, the increase in duration from the 40^{th} percentile bloom to the 50^{th} percentile is approximately 10 days, while the increase from the 50^{th} to the 60^{th} percentile event is on the order of 20 days. When the maximum concentration of blooms is compared to the bloom duration (Figure 31), the maximum concentrations (based on the linear regressions) corresponding to 40-day durations range between 50 to 74 mg/m^3 chlorophyll *a*. Using the Racy Point station data, it is possible to parameterize a new distribution of chlorophyll *a* that hypothetically would meet the conditions for the maintenance of phytoplankton and zooplankton diversity. This was done by proportionally scaling the synthesized statistical distribution of the existing data (shown in Figure 32 by the dark navy blue line; the natural log of chlorophyll *a* is used to normalize the distribution) to form a new distribution (Figure 32 light blue line) for which the 1 percentile occurrence was the same as the observed data, and the 99^{th} percentile occurrence ($p = 0.01$ for a one tailed test) was equivalent to a chlorophyll *a* of 74 mg/m^3. This synthesized distribution had a mean of 20.1 mg/m^3, a variance of 0.56 mg/m^3, and a 10.6 percent occurrence rate for chlorophyll *a* concentrations greater than 40 mg/m^3.

Marine LSJR Dissolved Oxygen Targets

Dissolved Oxygen Effects

As demonstrated in the previous section outlining eutrophication effects, low dissolved oxygen excursions (persistent episodes below the State criteria of 5 mg/L) occur in both the freshwater and oligo/mesohaline reaches of the LSJR. These excursions occur coincident with high summertime temperatures, and appear to be associated with the decline or crash of significant algal blooms, and on an inter-annual basis are correlated with mean spring-summer algal biomass levels. The improvement of the dissolved oxygen regime for the river and estuary was one of the originally stated objectives of the TMDL and PLRG plan for the river, and the State standard of 5 mg/L (instantaneous for freshwater reaches, and as a daily average for predominantly marine reaches) was identified as the target on which to base nutrient reduction scenario modeling. Even at the time of the proposition of this target, however, considerable uncertainty existed regarding its appropriateness and achievability. Low dissolved oxygen episodes have long been known to occur in southeast U.S. estuaries (Schroeder and Wiseman, 1988), and naturally low dissolved oxygen concentrations are known to be a feature of blackwater river systems. For these reasons, effort has been directed toward refining oxygen regime targets that are based upon the minimum levels necessary for the protection of native estuarine aquatic communities.

As an alternative to the fixed standard of 5 mg/L, the procedure described in the recently published U.S. Environmental Protection Agency Guidance, *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hattaras*, (U.S. EPA, 200) has been used to define the dissolved oxygen target on which reductions of nutrient enrichment effects are to be based. The *Guidance* contains several elements that offer superiority over the oxygen standard of *F.A.C.* 62-302. First, it is based upon the tolerance of low oxygen by estuarine fish and invertebrates, as opposed to both fresh and saltwater species. Second, the *Guidance* establishes an absolute minimum oxygen level for the protection of most estuarine species against acute low concentrations that result in organism mortality, and distinguishes this level from a sub-lethal range that results in reductions in growth and recruitment, and with this, presumably fish health and survival probability. Fish community effects within this sub-lethal range are based upon the intensity and duration of hypoxic events. Third, the *Guidance* offers approaches for assessing effects of two common types of low dissolved oxygen common to eutrophic estuaries: persistent, low dissolved oxygen associated with late season algal bloom decline; and diurnal patterns of low oxygen associated with high algal standing stock photosynthesis and respiration cycles or tidal transport of low oxygen water masses. In the LSJR, the most common and severe low oxygen episodes are long term, persistent events associated with late season algal community decline, and the *Guidance* procedure for assessing these types of events has been used to define oxygen targets.

Organism Acute Oxygen Levels

The data set used in the *Guidance* to develop criteria minimum concentration (CMC) was assimilated from previous studies that examined species or genus-specific survival under continuous low dissolved oxygen exposures. These studies covered 12 invertebrate and 11 fish estuarine species, mostly at juvenile life stages. The Florida Marine Research Institute's Fisheries Independent Monitoring Program (FMRI, 2002) has confirmed the presence of five of these species in the northeast Florida region (includes one site in the St. Mary's River, one in the Nassau, and 3 in the lower St. Johns estuary), and these are listed in Table 4. Because the FMRI sampling is performed using river seines, haul seines and otter trawls, some benthic invertebrate species may be under-reported. A trend is evident between the numbers of individuals of a given species present in the FMRI sampling, and their low oxygen LC50, in that as an individual species low dissolved oxygen tolerance decreases, its abundance declines in the northeast Florida sampling region (Figure 33). A numbers of factors could account for this, including species natural ranges, sampling methodology, migration patterns or competitive interactions, though the possibility that these species are excluded due to prevailing low dissolved oxygen, either as a natural occurrence or through accelerated eutrophication, should be considered as a contributing factor.

Following the procedure established in the development of toxics criteria, the CMC is determined by adjusting upward LC50 data to estimate the LC5 concentration, using the mean LC5/LC50 ratio for all studies, applied to the most sensitive species mean acute value (SMAV). In the studies compiled in the *Guidance*, pipe fish (*Syngnathus fuscus*), exhibited the highest SMAC, at an LC50 concentration of 1.63 mg/L. Pipe fish was reported in northeast Florida region in the FMRI sampling, but in only one sampling event. For spot (*Leiostomus xanthurus*) the most commonly seen species in the northeast Florida region for which a SMAV is reported, the *Guidance* lists a SMAV of 0.70 mg/L, considerably lower that that of pipe fish. Following the approach used in toxics criteria development, the *Guidance* uses the mean LC5/LC50 ratio, here given as 1.38, to adjust upward the maximum tolerable acute value. Thus the CMC that is considered as protective of most species is give as 2.3 mg/L, and this value has been used for the assessment of low dissolved oxygen effects in the LSJR estuary.

Growth Effects

To develop a measure of sub-lethal effects due to low dissolved oxygen, the *Guidance* relied upon previous studies that examined reductions in fish growth, usually during larval or juvenile life stages, due to low dissolved oxygen concentration. Growth is usually more sensitive than survival to low dissolved concentrations, though the *Guidance* notes several exceptions in which studies report greater rates of mortality than growth reduction. In general, invertebrates exhibit low acute dissolved oxygen concentrations, but a large range in growth reduction. Fish, on the other hand, exhibit higher acute concentrations but a relatively narrow range in growth reduction, and it is not unusual for fish species to exhibit considerable overlap in oxygen levels that cause mortality and growth reduction. Based upon a smaller number of studies that reported similar reductions in reproductive success at low dissolved oxygen levels, the *Guidance* concluded that oxygen levels that are protective of growth effects would also likely be protective of reproductive success.

Of the 11 species for which growth effects data were found, 2 were collected in FMRI sampling: summer flounder (*Paralichthys dentatus*), a total of 9 individuals collected, and sheepshead minnow (*Cyprinodon variegates*), a total of 3 individuals collected. One of the most commonly caught fish in the FMRI sampling, silverside (*Menidia* spp.), at 10,342 individuals collected, is also listed in the Guidance growth effects data, though specifically for *Menidia menidia*, Atlantic silverside. The reported no observed effects levels (concentrations above which one would expect no reduction in growth) for summer flounder, sheepshead minnow, and Atlantic silverside are 4.39 – 7.23, 2.5 – 7.5, and 3.9, respectively. Based upon these ranges, it appears that the final chronic value (FCV) at which low dissolved oxygen is not expected to effect growth of 4.8 mg/L is appropriate for northeast Florida.

Larval Recruitment

To estimate the effects of hypoxic conditions at concentrations between 2.3 and 4.8 mg/L, the *Guidance* applies a larval recruitment model to estimate the number of individuals that are “recruited” from early life stages to juvenile stage. This model is based upon larval development time, larval season, attrition rate and patterns of vertical distribution. Nine genus had sufficient data to parameterize the model as developed in the *Guidance*. Two of these, *Menidia* and *Scianops*, are known to be present in northeast Florida based upon the FMRI sampling. The model develops recruitment curves based on the intensity and duration of low dissolved oxygen, and genus-specific curves for the two species found in northeast Florida developed the lowest and third lowest curves (Figure below from *Guidance*).

The larval recruitment model can be adapted with regionally specific data. However, due to lack of specific data for northeast Florida species, and the possibility that species that have not been collected in the FMRI sampling program have been excluded due to human-induced changes in oxygen regime, the model formulation as provided in the *Guidance* has been used for the LSJR TMDL/PLRG process.

Additional Considerations

The methodology descried in the EPA estuarine dissolved oxygen guidance addresses only acute and chronic (growth) direct effects from low dissolved oxygen. Because of predator-prey interactions, the timing of reproductive activities, additional stressor effects under conditions of nutrient enrichment and eutrophication, direct effects may be mitigated or enhanced. Breitburg (2002), in her review of hypoxia effects on coastal fisheries, addresses many of the permutations of trophic alterations that may potentially occur.

While the approach used is expected to be appropriate for other regions outside the Virginian Province estuaries, the *Guidance* does note that animals may have adapted to lower oxygen levels in regions of higher temperatures or with naturally high demands for dissolved oxygen. In particular, it may be appropriate at some point to develop regionally specific data for revising the larval recruitment model on which cumulative, sub-lethal effects are based. However, based upon the presence of species in northeast Florida that have been shown to exhibit reduced growth in the range of dissolved oxygen between 4 and 5 mg/L, and the possibility that certain species that are not shown to be present in this region from the FMRI sampling have been excluded due to human-induced reductions in dissolved oxygen, it is felt that the larval recruitment model represents a conservative estimate of potential harm that is less restrictive that the application of a strict 5 mg/L standard.

Application of the Criteria

The maximum acute value, growth effects threshold and larval recruitment model are combined into one relationship relating the intensity and duration of a given continuous, low dissolved oxygen event. This approach is graphically depicted in Figure 34. Above 4.8 mg/L, pelagic, estuarine organisms are assumed to suffer no chronic effect from hypoxia (defined as dissolved oxygen below saturation concentration; oxygen saturation concentration at 30 ^{o}C. and 15 ppt chlorinity = 6.5 mg/L). Oxygen levels below 2.3 mg/L are expected to have acute lethal effects to at least some organisms. Between these two values, the degree of mortality in the population is proportional to the duration of exposure, and the compilation of data from numerous dose-response studies was used to develop the relationship seen in this figure. A given interval of low dissolved oxygen is considered to be a "dose" of potentially low dissolved oxygen, and is expressed as the fraction of the total duration of the interval at that concentration needed to cause mortality in at least 5 percent of the most sensitive species of the fish community. For example, the impairment index calculated duration of exposure to dissolved oxygen at 3 mg/L is 5.57 days. A one day duration of 3 mg/L dissolved oxygen is considered to be 1/5.57 or 18 percent of a lethal dose. Individual doses of continuous exposure that sum up to greater than 1 are considered to be a lethal dose.

Following the approach, 3 out of the 6 years of data collected at the Dames Point station exhibited one, long excursion of continuous low D.O., with durations from 4 to 7 weeks. Calculated impairment scores for Dames Point were 1.74, 3.57, and 1.07 for 1997,1999 and 2001. In 1999, a large fish kill of many thousands of adult shad and menhaden occurred in this reach of the river, associated with this low D.O. event. No low D.O. events were measured at the Acosta Bridge station between 1996 and 2001 that qualify for chronic impairment under the EPA guidance approach, with the greatest score being 0.73, recorded in 1998.

Dinoflagellate Bloom Potential

The potential for nutrient and organic matter enrichment to stimulate the growth of marine dinoflagellate algal species represents one of the most significant detrimental effects attributable to estuarine eutrophication. Several toxic dinoflagellate species have been identified in regular plankton monitoring, including *Karolina breve* (red tide) and *Prorocentrum minimum*, and dinoflagellate infections have been postulated as a possible factor in ulcerative disease syndrome that plagued the LSJR during much of the early 1990's. A monitoring program conducted in 19__ with the objective of determining the presence of *Pfiesteria*–like species discovered a previously unidentified dinoflagellate, subsequently named *Cryptoperidineopsis brodii*, to reside in LSJR mesohaline reach sediments.

The tendency for dinoflagellate populations to increase in relative abundance under conditions of increasing potential diatom silica limitation leads to the possibility that high levels of nutrient enrichment, in excess of that balanced by bioavailable silica, may contribute disproportionately to dinoflagellate blooms. Dinoflagellate life cycles and survival strategies are extremely complex, however, and occurrence of high populations is poorly correlated with nutrient concentration or diatom biomass. For this reason, the limitation of dinoflagellate blooms exists as a qualitative target in LSJR TMDL development. In recent work investigating the relationship between nutrient enrichment effects on nuisance algal growth in the Indian River Lagoon, the occurrence of potentially toxic dinoflagellate blooms is identified as a significant water quality impairment (Phlips *et al.,* 2003)). In this work, a level of 1,000,000 μm^3/ml algal biovolume (roughly equivalent 6 µg/L chlorophyll *a*) is suggested to define a marine bloom condition.

Appendix D: Estimated Loads to the LSJR, 1995–99

Table D1. Summary of Loads to the Lower St. Johns River, 1995. All values in metric tons per year.

Source or Source Category	Total N	Labile TON	Refractory TON	Total Inorganic N	Total P	Labile TNOP	Refractory TNOP	Total PO4	Total Organic C	Labile TOC	Refractory TOC
Buffalo Bluff Total	10765.1	4336.2	5373.0	1056.0	511.2	207.3	96.9	207.0	138347.0	12976.2	125370.9
Natural Background	6659.7	1006.7	5432.5	220.5	290.8	97.9	97.3	95.6	131539.8	5727.6	125812.3
Dunns Creek Total	1372.5	290.7	919.0	162.8	108.2	33.6	35.4	39.1	23100.5	718.7	22381.9
Natural Background	915.7	112.0	779.9	23.7	61.3	15.0	31.4	14.9	19272.6	636.9	18635.7
Upstream Total	12137.7	4627.0	6291.9	1218.8	619.3	240.9	132.3	246.1	161447.5	13694.8	147752.7
Fresh Tidal NP Total	1068.4	371.7	505.6	191.1	211.2	54.9	22.7	133.6	23875.4	1709.8	22165.6
Natural Nonpoint	626.3	203.8	387.9	34.6	56.8	11.1	6.7	38.9	23213.7	1255.7	21957.9
Agriculture Contribution	384.1	126.1	124.7	133.4	136.9	35.4	13.4	88.1	217.9	173.7	44.2
Urban Contribution	53.2	39.3	-3.5	17.4	15.4	8.5	1.7	5.2	-507.8	171.4	-679.2
Other Nonpoint	4.7	2.5	-3.5	5.7	2.1	-0.1	0.9	1.3	951.7	109.0	842.7
Point Source	306.7	151.5	12.0	143.2	70.2	32.0	0.8	37.4	1417.6	814.6	603.0
Oligohaline NP Total	1141.3	517.8	447.3	176.3	186.8	79.2	16.7	90.9	25692.0	2584.6	23107.4
Natural Nonpoint	746.3	236.9	468.9	40.5	65.6	13.0	8.3	44.2	26852.0	1413.6	25438.4
Agriculture Contribution	26.2	10.7	2.0	13.5	10.9	2.1	0.5	8.3	1.5	46.5	-45.0
Urban Contribution	370.7	269.2	-10.1	111.6	110.0	64.0	7.8	38.2	-2062.9	1028.6	-3091.5
Other Nonpoint	-1.8	1.0	-13.5	10.7	0.5	0.0	0.2	0.3	901.5	96.0	805.5
Point Source	333.5	49.6	3.9	279.9	72.1	11.2	0.3	60.6	287.1	165.0	122.1
Meso-Polyhaline NP Total	440.2	223.2	120.6	96.4	92.0	44.0	6.6	41.4	6524.5	1002.8	5521.6
Natural Nonpoint	218.4	68.0	138.5	11.9	19.8	3.8	2.5	13.6	7509.0	385.0	7124.1
Agriculture Contribution	13.4	5.3	1.1	7.0	5.3	1.2	0.2	4.0	17.4	20.2	-2.8
Urban Contribution	209.9	151.9	-10.7	68.8	66.6	39.2	3.8	23.6	-1238.7	567.6	-1806.3
Other Nonpoint	-1.5	-2.1	-8.2	8.8	0.2	-0.2	0.2	0.2	236.7	30.1	206.6
Point Source	1147.4	238.9	18.9	889.6	294.4	46.9	1.2	246.2	1920.7	1103.7	817.0
Total Atmospheric Dep.	243.0				5.0						
LSJRB Summary											
Total Natural Nonpoint	1591.0	508.7	995.3	86.9	142.2	28.0	17.5	96.7	57574.7	3054.3	54520.4
Total Augmented Nonpoint	1059.0	603.9	78.2	376.8	347.9	150.2	28.6	169.1	-1482.8	2243.0	-3725.8
Total Point Source	1787.6	440.0	34.9	1312.7	436.6	90.2	2.3	344.2	3625.4	2083.3	1542.1
Grand Total	**16818.3**	**6179.6**	**7400.4**	**2995.2**	**1551.0**	**509.2**	**180.6**	**856.1**	**221164.9**	**21075.5**	**200089.4**

Notes: N= Nitrogen; P=Phosphorus; C=Carbon. NP=Nonpoint Sources. LSJRB Summary sums loads for only the LSJRB downstream of Dunns Creek.

Table D2. Summary of Loads to the Lower St. Johns River, 1996. All values in metric tons per year.

Source or Source Category	Total N	Labile TON	Refractory TON	Total Inorganic N		Total P	Labile TNOP	Refractory TNOP	Total PO4		Total Organic C	Labile TOC	Refractory TOC
Buffalo Bluff Total	8609.9	4828.1	3252.4	529.4		385.0	241.4	48.1	95.3		103597.6	17027.1	86570.5
Natural Background	4451.6	1100.3	3252.4	98.9		221.1	122.7	48.1	50.4		92828.8	6258.3	86570.5
Dunns Creek Total	898.0	172.5	595.7	129.8		42.5	11.8	13.7	17.1		16639.5	523.2	16116.3
Natural Background	716.0	85.8	595.7	34.5		34.1	9.6	13.7	10.9		16604.5	488.2	16116.3
Upstream Total	9507.9	5000.6	3848.1	659.2		427.5	253.2	61.7	112.5		120237.1	17550.3	102686.8
Fresh Tidal NP Total	578.6	187.5	289.3	101.8		93.6	25.7	11.5	56.4		13718.0	869.5	12848.4
Natural Nonpoint	365.6	105.5	243.7	16.5		32.0	6.0	4.5	21.5		13597.2	623.4	12973.8
Agriculture Contribution	177.0	56.0	49.7	71.3		51.8	15.0	5.6	31.2		-24.3	88.7	-113.0
Urban Contribution	30.8	25.7	-5.1	10.2		8.6	4.7	0.9	2.9		-334.6	118.2	-452.8
Other Nonpoint	5.2	0.3	1.0	3.9		1.3	0.0	0.6	0.7		479.7	39.2	440.4
Point Source	285.6	144.6	11.5	129.6		66.0	30.5	0.8	34.7		1340.4	770.2	570.1
Oligohaline NP Total	676.8	300.0	264.0	112.8		113.7	47.0	10.1	56.6		14393.1	1440.3	12952.7
Natural Nonpoint	427.3	124.3	281.9	21.0		38.3	7.1	5.2	26.1		15176.5	707.0	14469.4
Agriculture Contribution	18.0	7.2	1.8	9.0		6.6	1.2	0.2	5.1		8.0	29.6	-21.5
Urban Contribution	230.5	51.4	-13.5	77.0		68.0	38.6	4.5	24.9		-1383.4	645.9	-2029.3
Other Nonpoint	1.0	117.0	-6.2	5.8		0.8	0.1	0.2	0.4		592.0	57.8	534.2
Point Source	322.5	42.3	3.4	276.8		65.6	10.5	0.3	54.9		351.8	202.2	149.7
Meso-Polyhaline NP Total	422.7	210.3	119.2	93.2		87.2	39.6	6.3	41.3		6400.3	949.3	5451.0
Natural Nonpoint	211.3	62.5	137.7	11.0		19.6	3.5	2.5	13.5		7243.0	345.8	6897.3
Agriculture Contribution	17.8	6.6	1.8	9.4		7.5	1.6	0.3	5.6		42.9	25.0	17.9
Urban Contribution	193.3	141.7	-14.2	65.8		59.4	34.5	3.3	21.6		-1161.2	545.2	-1706.4
Other Nonpoint	0.4	-0.6	-6.2	7.1		0.8	-0.1	0.3	0.6		275.6	33.3	242.3
Point Source	1144.4	251.6	20.0	872.9		328.9	50.8	1.3	276.9		2199.7	1264.0	935.7
Total Atmospheric Dep.	243.0					5.0							
LSJRB Summary													
Total Natural Nonpoint	1004.2	292.3	663.4	48.5		89.8	16.6	12.1	61.2		36016.7	1676.3	34340.5
Total Augmented Nonpoint	673.9	405.5	9.1	259.3		204.6	95.7	15.8	93.1		-1505.4	1582.9	-3088.3
Total Point Source	1752.5	438.5	34.8	1279.3		460.5	91.7	2.3	366.5		3891.9	2236.4	1655.4
Grand Total	**13181.5**	**6136.9**	**4555.3**	**2246.3**		**1187.5**	**457.1**	**91.9**	**633.2**		**#####**	**23045.9**	**135594.5**

Table D3. Summary of Loads to the Lower St. Johns River, 1997. All values in metric tons per year.

Source or Source Category	Total N	Labile TON	Refractory TON	Total Inorganic N		Total P	Labile TNOP	Refractory TNOP	Total PO4		Total Organic C	Labile TOC	Refractory TOC
Buffalo Bluff Total	4849.3	3606.6	1061.3	181.4		173.2	148.6	12.9	11.6		55541.4	17236.2	38305.2
Natural Background	1880.2	792.5	1061.3	26.4		117.5	85.7	12.9	18.8		42814.0	4508.8	38305.2
Dunns Creek Total	933.4	318.0	564.3	51.2		59.9	27.1	15.6	17.2		17202.9	996.6	16206.3
Natural Background	711.2	133.1	564.3	13.8		35.8	15.2	15.6	4.9		16963.6	757.3	16206.3
Upstream Total	5782.7	3924.6	1625.5	232.6		233.1	175.7	28.6	28.8		72744.4	18232.8	54511.5
Fresh Tidal NP Total	992.8	341.2	430.4	221.2		158.4	54.4	20.6	83.4		20214.2	1522.6	18691.6
Natural Nonpoint	532.7	181.2	321.9	29.6		44.8	9.7	5.5	29.5		20183.5	1163.8	19019.7
Agriculture Contribution	405.3	122.0	109.6	173.7		97.5	35.5	12.1	49.9		-112.0	132.2	-244.1
Urban Contribution	49.1	39.2	-1.0	10.9		14.4	9.0	2.0	3.4		-439.7	167.9	-607.6
Other Nonpoint	5.7	-1.2	0.0	7.0		1.7	0.1	1.0	0.5		582.3	58.7	523.6
Point Source	299.6	86.6	73.1	139.7		69.1	24.0	7.0	38.1		4789.3	585.6	4203.6
Oligohaline NP Total	728.4	325.9	302.4	100.1		110.4	46.5	10.8	53.0		17709.8	1684.1	16025.7
Natural Nonpoint	501.7	163.3	310.9	27.4		42.8	8.9	5.4	28.4		18268.7	996.5	17272.1
Agriculture Contribution	16.4	6.8	1.3	8.4		6.9	1.3	0.3	5.3		-8.7	30.0	-38.7
Urban Contribution	211.9	156.1	-1.4	57.3		60.6	36.3	5.0	19.3		-1101.0	602.7	-1703.7
Other Nonpoint	-1.6	-0.3	-8.3	7.0		0.1	0.0	0.1	0.0		550.9	54.9	496.0
Point Source	341.3	45.9	9.8	285.6		73.6	11.5	0.7	61.5		321.6	143.8	177.8
Meso-Polyhaline NP Total	342.7	182.4	88.7	71.6		69.6	35.1	4.7	29.8		4914.8	822.6	4092.2
Natural Nonpoint	162.7	52.0	101.9	8.8		13.9	2.9	1.8	9.2		5644.2	300.8	5343.4
Agriculture Contribution	9.9	4.0	0.4	5.5		3.5	0.6	0.0	2.9		-8.1	14.7	-22.8
Urban Contribution	170.9	128.3	-8.5	51.1		52.0	31.6	2.7	17.7		-865.4	490.0	-1355.4
Other Nonpoint	-0.8	-1.9	-5.0	6.1		0.2	0.1	0.2	-0.1		144.1	17.0	127.1
Point Source	1187.7	251.1	33.7	902.9		334.6	71.4	3.1	260.1		2233.5	1354.5	879.0
Total Atmospheric Dep.	243.0					5.0							
LSJRB Summary													
Total Natural Nonpoint	1197.1	396.5	734.6	65.9		101.4	21.5	12.7	67.2		44096.4	2461.2	41635.2
Total Augmented Nonpoint	867.0	453.0	87.0	327.0		236.9	114.6	23.3	99.0		-1257.7	1568.1	-2825.7
Total Point Source	1828.6	383.6	116.6	1328.2		477.4	106.9	10.8	359.7		7344.4	2083.9	5260.5
Grand Total	**9918.4**	**5157.8**	**2563.7**	**1953.6**		**1053.8**	**418.7**	**75.4**	**554.7**		**#####**	**24346.0**	**98581.5**

Table D4. Summary of Loads to the Lower St. Johns River, 1998. All values in metric tons per year.

Source or Source Category	Total N	Labile TON	Refractory TON	Total Inorganic N		Total P	Labile TNOP	Refractory TNOP	Total PO4		Total Organic C	Labile TOC	Refractory TOC
Buffalo Bluff Total	8561.5	4942.4	3175.9	443.1		341.8	201.8	42.5	97.4		127323.1	21218.1	106105.0
Natural Background	4428.1	1189.7	3175.9	62.5		246.4	140.0	42.5	63.9		112873.9	6768.9	106105.0
Dunns Creek Total	971.2	217.6	681.9	71.7		51.3	15.8	15.9	19.7		21379.6	778.7	20600.9
Natural Background	813.6	108.2	681.9	23.5		39.4	11.1	15.9	12.4		21216.6	615.7	20600.9
Upstream Total	9532.7	5160.0	3857.8	514.9		393.1	217.6	58.4	117.1		148702.7	21996.9	126705.9
Fresh Tidal NP Total	1652.2	480.2	935.0	237.0		222.9	53.8	31.1	138.0		44053.4	2272.1	41781.4
Natural Nonpoint	1188.3	284.7	864.2	39.4		103.4	17.3	16.7	69.4		43976.7	1525.1	42451.6
Agriculture Contribution	350.3	111.7	93.9	144.7		92.2	27.3	11.9	53.0		-257.6	256.3	-513.9
Urban Contribution	110.4	92.5	-21.4	39.4		25.8	13.4	2.8	9.6		-817.6	443.8	-1261.4
Other Nonpoint	3.1	-8.7	-1.7	13.6		1.5	-4.2	-0.2	5.9		1151.9	47.0	1105.0
Point Source	274.2	82.4	57.1	134.5		62.1	21.9	5.1	35.0		4154.4	582.3	3572.2
Oligohaline NP Total	1236.9	492.7	565.8	178.4		171.8	63.8	18.4	89.6		28792.1	2331.6	26460.5
Natural Nonpoint	830.1	199.7	601.6	28.8		72.4	12.1	11.6	48.7		29623.8	1041.0	28582.8
Agriculture Contribution	35.9	17.9	9.5	8.5		8.7	5.9	2.4	0.5		-51.2	53.9	-105.1
Urban Contribution	374.4	282.0	-33.2	125.6		90.6	50.4	6.3	33.9		-1540.4	1200.2	-2740.6
Other Nonpoint	-3.5	-6.9	-12.1	15.4		0.1	-4.5	-1.9	6.5		759.8	36.5	723.3
Point Source	301.3	53.7	9.6	238.0		81.4	13.2	0.7	67.5		363.5	184.3	179.2
Meso-Polyhaline NP Total	867.0	436.2	254.1	176.7		152.0	68.5	11.4	72.1		13343.1	1966.9	11376.3
Natural Nonpoint	426.5	109.6	299.9	17.0		37.7	6.5	5.7	25.5		14672.1	570.9	14101.2
Agriculture Contribution	38.3	7.3	-1.5	32.5		11.8	-3.1	-1.1	16.1		29.8	49.8	-20.0
Urban Contribution	404.1	315.7	-40.2	128.6		101.5	59.8	4.8	36.9		-1741.7	1310.4	-3052.1
Other Nonpoint	-1.8	3.6	-4.1	-1.3		0.9	5.3	2.0	-6.3		382.9	35.8	347.1
Point Source	1267.0	279.4	38.3	949.3		341.5	70.7	3.3	267.6		2468.4	1500.7	967.7
Total Atmospheric Dep.	243.0					5.0							
LSJRB Summary													
Total Natural Nonpoint	2444.9	594.0	1765.7	85.2		213.5	35.8	34.0	143.6		88272.7	3137.0	85135.7
Total Augmented Nonpoint	1311.2	815.2	-10.8	506.8		333.2	150.3	26.8	156.1		-2084.0	3433.6	-5517.6
Total Point Source	1842.4	415.5	105.1	1321.8		485.0	105.8	9.1	370.1		6986.3	2267.2	4719.1
Grand Total	**15374.2**	**6984.7**	**5717.8**	**2428.7**		**1429.8**	**509.5**	**128.4**	**786.9**		**241877.7**	**30834.6**	**211043.1**

Table D5. Summary of Loads to the Lower St. Johns River, 1999. All values in metric tons per year.

Source or Source Category	Total N	Labile TON	Refractory TON	Total Inorganic N	Total P	Labile TNOP	Refractory TNOP	Total PO4	Total Organic C	Labile TOC	Refractory TOC
Buffalo Bluff Total	5280.2	3876.3	1268.0	182.0	183.4	150.2	17.2	17.9	62627.4	17164.1	45463.3
Natural Background	2091.0	815.0	1250.3	25.7	121.3	83.3	16.9	21.1	50350.1	4637.0	45713.1
Dunns Creek Total	-166.6	-120.9	-45.0	-0.8	-8.9	-6.5	-1.9	-0.6	-1443.5	-401.8	-1041.7
Natural Background	-80.4	-35.3	-45.2	0.2	-3.9	-2.0	-1.9	0.0	-1263.6	-201.0	-1062.6
Upstream Total	5113.6	3755.4	1223.0	181.2	174.5	143.7	15.3	17.4	61183.8	16762.3	44421.6
Fresh Tidal NP Total	248.7	84.8	119.4	44.5	54.5	13.4	5.6	35.5	5143.3	352.4	4790.9
Natural Nonpoint	139.6	39.3	93.9	6.5	13.2	2.3	1.7	9.2	5064.1	221.0	4843.1
Agriculture Contribution	103.1	35.0	35.1	33.0	38.9	9.6	3.7	25.6	64.3	46.8	17.5
Urban Contribution	9.3	7.6	-1.4	3.2	2.6	1.5	0.2	0.9	-90.9	32.7	-123.5
Other Nonpoint	-3.3	3.0	-8.1	1.8	-0.2	0.0	0.0	-0.3	105.7	51.9	53.8
Point Source	275.3	144.0	11.4	119.8	64.5	30.3	0.8	33.4	1232.2	708.0	524.1
Oligohaline NP Total	236.9	103.3	93.4	40.2	40.8	16.0	3.6	21.2	5286.4	512.6	4773.7
Natural Nonpoint	162.4	45.3	109.1	7.9	15.6	2.6	2.0	10.9	5700.0	247.9	5452.1
Agriculture Contribution	5.9	2.3	0.5	3.1	2.6	0.5	0.1	2.0	9.5	10.2	-0.8
Urban Contribution	74.9	51.9	-3.5	26.5	23.4	12.8	1.7	9.0	-494.5	197.1	-691.6
Other Nonpoint	-6.3	3.8	-12.7	2.6	-0.8	0.1	-0.2	-0.7	71.4	57.3	14.0
Point Source	305.2	46.3	3.7	255.2	81.9	13.1	0.3	68.5	249.4	143.3	106.1
Meso-Polyhaline NP Total	156.5	76.9	44.0	35.7	33.1	14.9	2.4	15.9	2332.0	342.7	1989.3
Natural Nonpoint	79.9	21.9	54.1	3.9	7.6	1.3	1.0	5.4	2719.0	116.0	2603.0
Agriculture Contribution	6.9	2.6	0.8	3.6	2.8	0.6	0.1	2.0	16.6	9.6	7.0
Urban Contribution	71.4	51.6	-5.6	25.5	22.8	13.0	1.2	8.5	-451.4	195.3	-646.7
Other Nonpoint	-1.8	0.8	-5.3	2.7	0.0	0.0	0.0	0.0	47.9	21.8	26.1
Point Source	1121.5	206.0	16.3	899.2	330.3	50.0	1.2	279.1	1401.0	805.1	595.9
Total Atmospheric Dep.	243.0				5.0						
LSJRB Summary											
Total Natural Nonpoint	381.9	106.5	257.1	18.3	36.4	6.2	4.8	25.5	13483.1	584.9	12898.2
Total Augmented Nonpoint	260.2	158.5	-0.3	102.0	92.0	38.1	6.8	47.0	-721.5	622.8	-1344.2
Total Point Source	1702.0	396.4	31.4	1274.2	476.7	93.4	2.3	381.0	2882.5	1656.4	1226.1
Grand Total	**7700.7**	**4416.8**	**1511.2**	**1575.7**	**784.6**	**281.4**	**29.2**	**470.9**	**76828.0**	**19626.4**	**57201.6**

Appendix E: Description of State and Federal Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the state's water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations

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

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES Stormwater Permitting Program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and FDOT throughout the 15 counties meeting the population criteria. The EPA authorized the Department to implement the NPDES Stormwater Program (with the exception of Indian lands) in October 2000.

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

Appendix F: Examples of DO Calibration Figures for the Water Quality Model

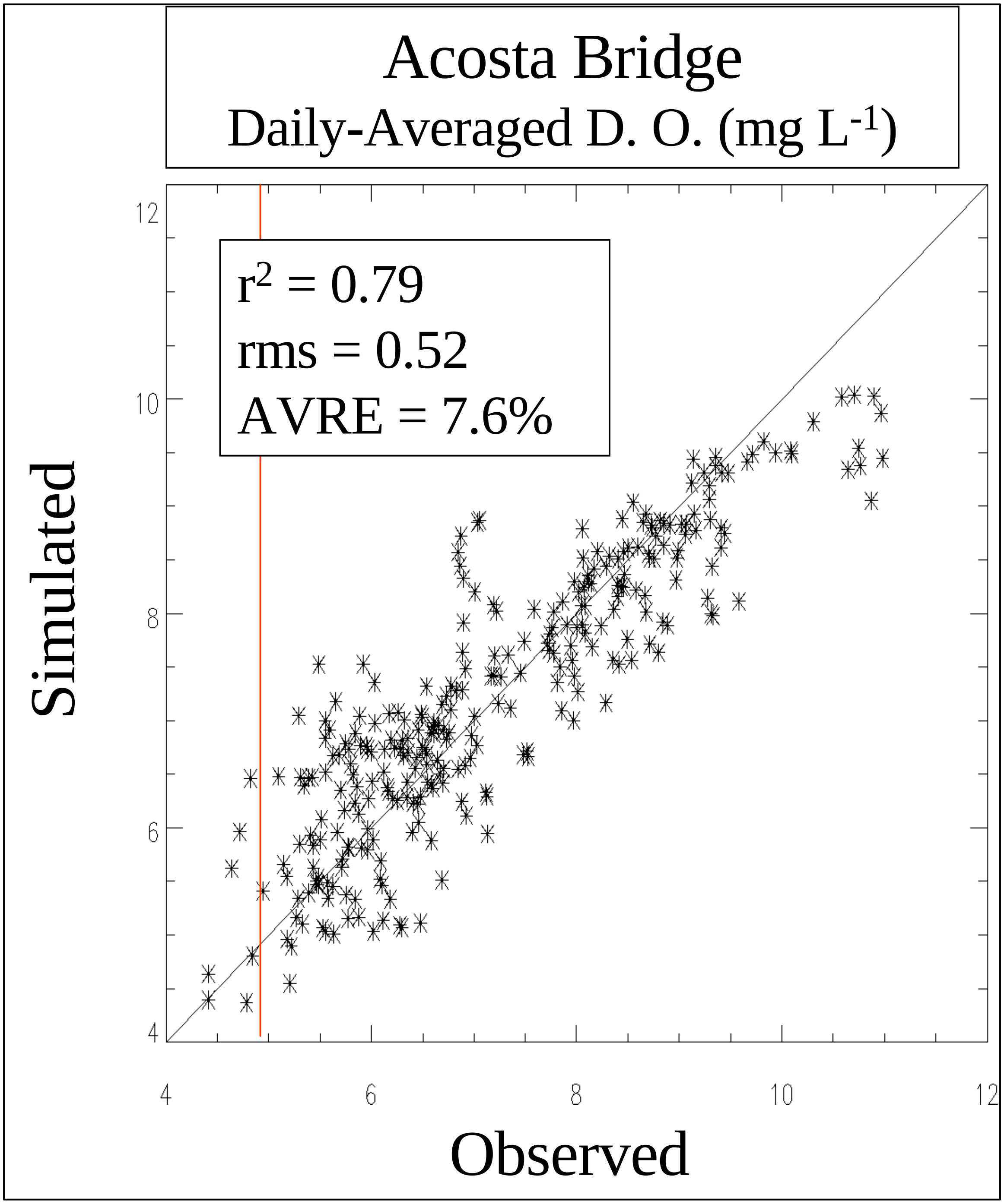


Figure F1. Accuracy of Model DO Predictions for Acosta Bridge

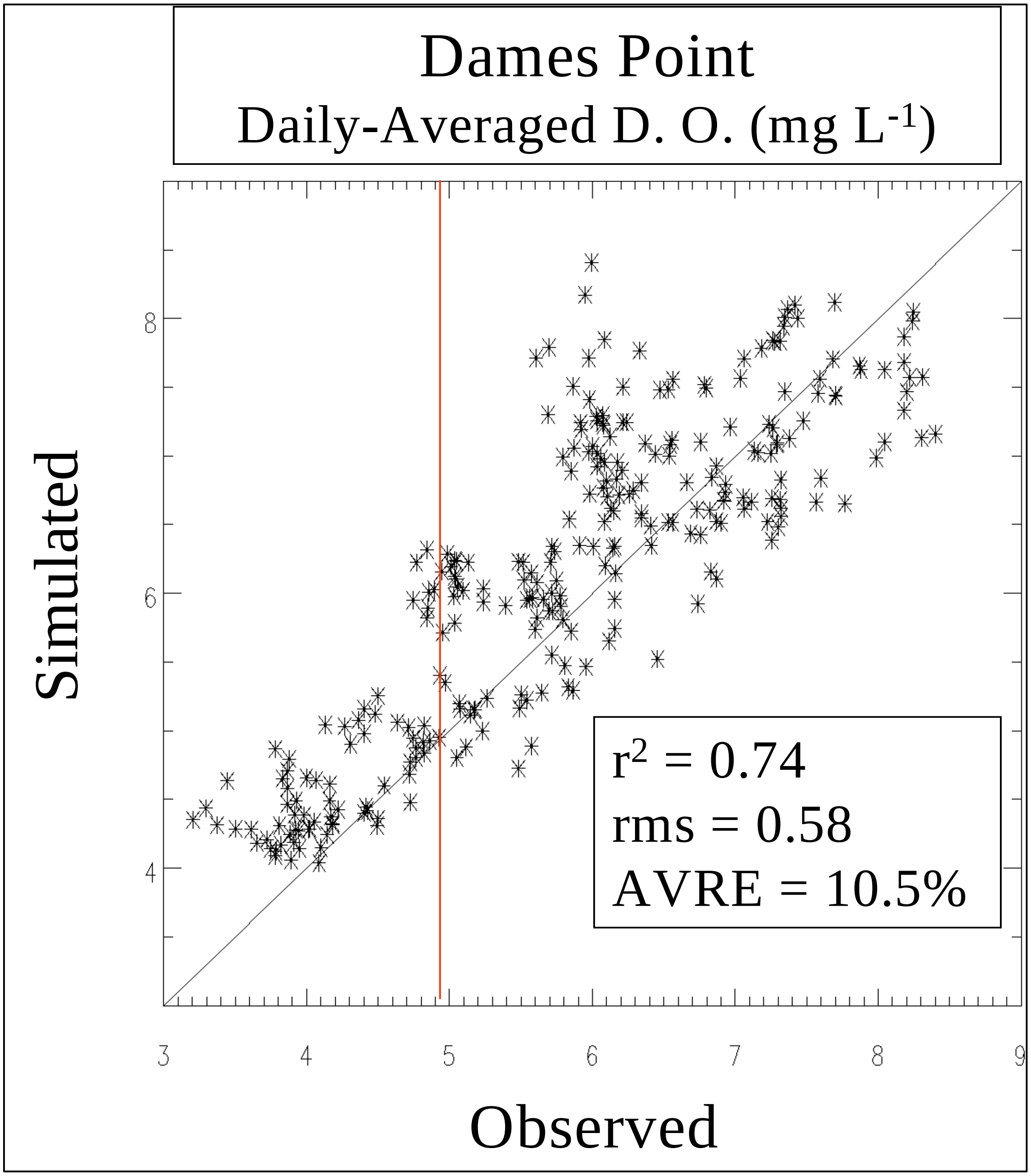


Figure F2. Accuracy of Model DO Predictions for Dames Point

Appendix G: Examples of Chlorophyll *a* Calibration Figures for the Water Quality Model

Figure G1. Comparisons of Model Predictions Versus Measured Values for Chlorophyll *a* at Racy Point

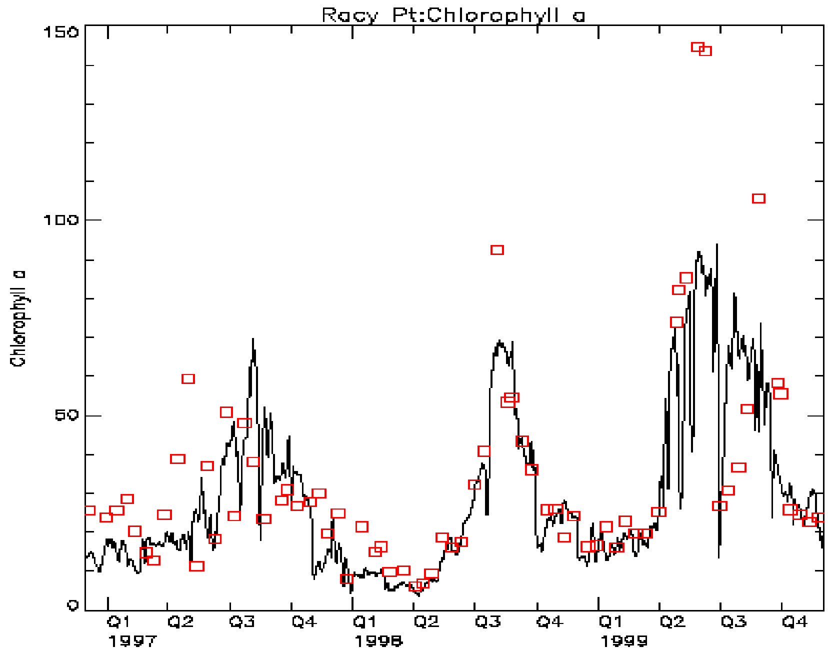


Figure G2. Comparisons of Model Predictions Versus Measured Values for Chlorophyll *a* at Watson Island

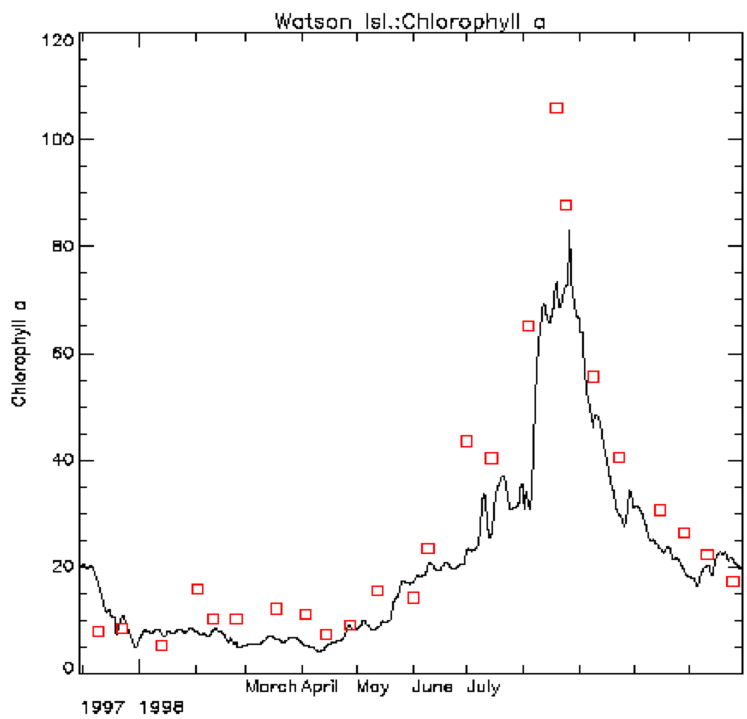


Figure G3. Accuracy of Model Predictions of Average Annual Chlorophyll *a* for the Freshwater Section

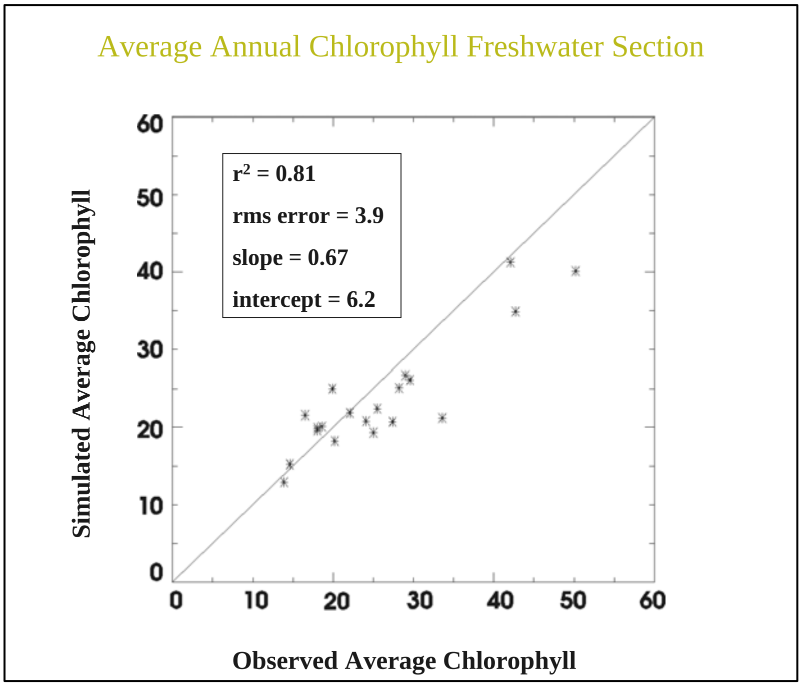
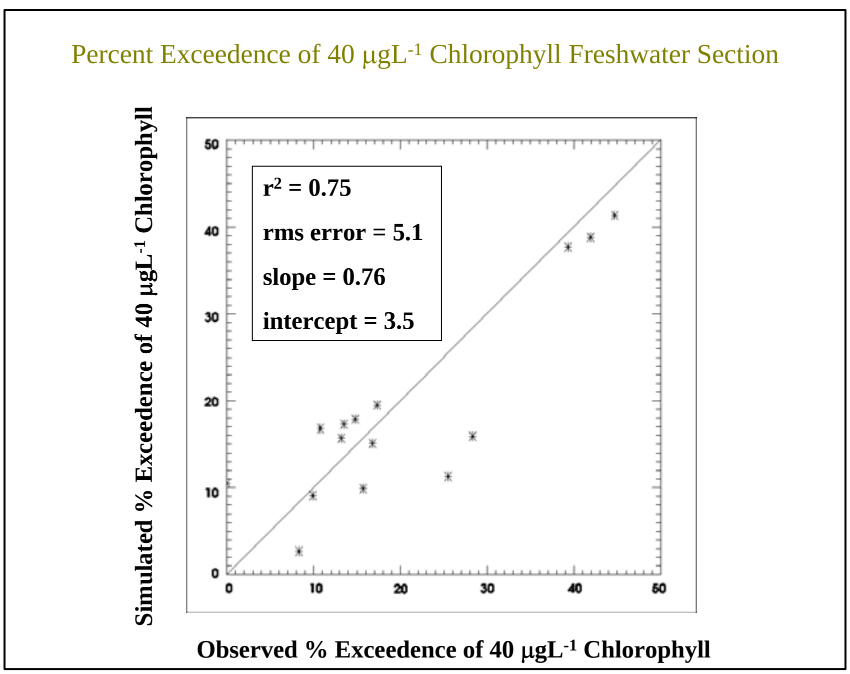


Figure G4. Accuracy of Model Predictions for Chlorophyll *a* Percent Exceedances for the Freshwater Section



Appendix H: Responsiveness Summary to Public Comments on Draft TMDL of 2003

EPA Comments on the Department's Nutrients TMDL for the Lower St. Johns River, August 28, 2003

1. **In order for EPA to accept the water quality target, the concepts in the following paragraph should be addressed in the TMDL development discussion in section 1.2:**

   The Department recognizes that it may be appropriate to revise the TMDL in the future when more information has been collected and analyzed. With such possible revisions in mind, this TMDL is characterized as an adaptive management TMDL. In an adaptive management TMDL, the Department used the best available information at the time to establish an interpretation of their narrative nutrient standard to derive the water quality end point as the basis for the TMDL. However, the adaptive management approach recognizes that additional data and information may be necessary to validate assumptions of the TMDL, specifically the interpretation of the nutrient narrative criterion as 40 µg/L chlorophyll a not to be exceeded more than 10 percent of the time, and to provide greater certainty that the TMDL will achieve use support of the St. Johns River and prevent an imbalance in natural populations of aquatic flora and fauna.

   Response: The Department added similar text to Section 7.

2. **The background information in section 1.3 should include hydrologic and geologic information about the Lower St. Johns River since nonpoint sources contribute significantly to the nutrient impairment. A good source of information is FDEP's "Basin Status Report: Lower St. Johns" dated June 2002.**

   Response: A sentence was added to Section 1.3 referencing the Basin Status Report.

3. **The problem statement in section 2 should describe the declining water quality in the Lower St. Johns River. Good information is included in the Basin Status Report mentioned above (see p. 53 & 54).**

   Response: A sentence was added to Section 1.3 referencing the Basin Status Report.

4. **The problem statement in section 2 should include a summary of the water quality data used to verify segments of the river as impaired. The data should be compared to water quality criteria noting the frequency and extent of any violations.**

   Response: A table was added to the document (**Appendix I**) summarizing the annual average chlorophyll *a* values and TSIs for the segments of the main stem that were verified as impaired.

5. **Please inform EPA about the status of adopting the LSJR verified list by Secretarial Order since it is a prerequisite for adopting this TMDL.**

Response: Text in Sections 1.1 and 2.1 was revised to note that the Verified List for the main stem of the LSJR was adopted by Secretarial Order on September 4, 2003.

6. The last paragraph in section 3.2 needs to be deleted. The concepts in the following paragraph should be discussed in the TMDL report:

The current nutrient TMDL for the estuarine portion of the St. Johns River is based on maintaining DO levels above those that have been calculated using the EPA method in the document Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras (EPA-822-R-00-012, November 2000). This method does not implement the Florida water quality standards that are currently in place for the river at this location. Since this new approach is being used, the SJRWMD and FDEP are pursuing development of a SSAC for DO for this portion of the river in accordance with 62-302.500(2)(f) F.A.C. Since the segments in this portion of the river meet water quality standards for DO and this TMDL proposes nutrient reductions to address a nutrient impairment, it will only have beneficial impacts on DO. Therefore, even though FDEP is not using the approved water quality standard as a target for this TMDL, implementation will not result in degradation with respect to DO. In addition, the SJRWMD will continue work related to nutrient loads and algal response for this section of the river. Algal response to increased nutrient loads would be more appropriate to use when evaluating the narrative nutrient criterion, which has balanced, natural populations of aquatic flora and fauna as its endpoint.

Response: The last paragraph in Section 3.2 of the draft document was deleted, and the requested text was added to the section (with the exception of the last two sentences).

7. In order for EPA to accept the water quality target, the concepts in the following paragraph should be discussed in section 3.3:

Studies have shown that when chlorophyll a levels rise above 40 µg/L , a shift in algal types occurs: blue-green algae begin to dominate the system, toxic algal species begin to increase, and zooplankton communities begin to decline. While maintaining chlorophyll a levels below 40 µg/L 90 percent of the time may prevent an imbalance in natural populations of aquatic flora and fauna under average conditions, it is uncertain whether these levels will be fully protective in this portion of the river under critical flow conditions, in a prolonged low flow situation, or during the extended growing season with less than average flows. For this reason, continued study of the river system is necessary to determine if a seasonal average maximum or yearly average maximum level of chlorophyll a should be established to protect against imbalances in natural populations of aquatic flora and fauna due to high nutrient levels. Specifically, a series of studies is needed to demonstrate: (1) that progress is being made towards reducing nutrient loads by the required 30 percent or that progress towards reaching the percent reduction goal is being made, (2) that once the 30 percent reduction goal is reached, it has resulted in chlorophyll a levels that do not exceed 40 µg/L more than 10 percent of the time, and (3) that once the chlorophyll a target is reached, it has resulted in achievement of the narrative nutrient criterion (i.e., balanced, natural populations of aquatic flora and fauna).

Response: The Department added similar text to Section 3.3.

8. According to the nutrient criterion discussion in section 3.3, “the water quality target

is being implemented as a long-term average value rather than a worst case year..." However, it appears from the discussion in section 5.5 that the model was applied on an annual basis. Since the target is based on not exceeding a chlorophyll a value of 40 µg/L for more than 40 consecutive days (which would primarily apply over the summer months/growing season), EPA cannot support the target if it is applied for more than an annual duration. FDEP must apply the target on an annual basis in order for EPA to accept it as a reasonable interpretation of the narrative nutrient criterion.

Response: Based on subsequent discussions with EPA Region 4 staff, it was agreed that the application of the chlorophyll *a* target on a long-term average basis was appropriate as long as the Department added the text requested in Comments 1 and 7, and provided additional explanation (as follows) about how application of the target as a long-term average basis is adequately protective.

The TMDL stakeholders, TMDL Executive Committee, SJRWMD, and Department all agreed that it would be overly conservative to apply the threshold in a worst-case year and that a long-term average was adequately protective of the river. There were many reasons for this position, including the fact that there are already conservative elements of the modeling (applied in the worst-case WBID, for example), it is common practice for nutrient TMDLs to be based on "design runs" that estimate long-term average conditions, stormwater treatment design criteria and BMPs (implementation of which will be how most of the nonpoint source reductions will be achieved) are typically designed for rain events that would not be typical of the worst case year, and external load model estimates of nonpoint source loading would overestimate loading for dry years because they would not adequately take into account the increased removal provided by stormwater treatment facilities. Nutrient management activities for nonpoint sources will naturally be more effective at dry conditions such that additional nonpoint source reductions required for a worst-case dry year are not needed and would result in the overdesign of stormwater facilities.

It should be noted that the target is for the chlorophyll *a* to be less than 40 µg/L less than **10 percent of the time**, rather than less than 40 days as stated in the EPA's comment.

9. A land use map and a tabular breakdown of the land use categories in the basin would be a helpful accompaniment to the source information contained in section 4.

Response: The document by Hendrickson *et al.* (2002), which describes the external load assessment and which is referenced in Section 4.1, provides detailed information about land uses. Further, the key output of the external load assessment (the estimated loads from each major land use) were provided in **Appendix D** of this document.

10. Please provide EPA with a copy of the document described in section 4.1 as containing a report on the computations involved in developing the external load for the Lower St. Johns River.

Response: A final copy of the document will be provided with the TMDL when it is submitted to the EPA.

11. According to section 4.2, "[t]here are 36 permitted wastewater treatment facilities that discharge nutrient loads directly into the LSJR (Table 2), with a total of 32 domestic wastewater facilities and 4 industrial wastewater facilities." However, the

previously mentioned Basin Status Report states the following:

"The basin contains 184 point sources, which are permitted to discharge to surface waters or land application systems, or both...One hundred and thirty-seven of these are domestic wastewater treatment facilities (the largest component of point sources), 45 are industrial waste facilities, 2 are concrete batch plants, and 1 is a residual/septage management facility...One hundred and nine point sources are permitted to discharge to surface waters under the National Pollutant Discharge Elimination System (NPDES)..."

Please explain the discrepancy in the reported numbers of permitted facilities in the basin. Are the additional point sources discharging to waters that do not directly impact the TMDL segments?

Response: Yes, the additional point sources listed in the Basin Status Report do not directly discharge to the LSJR. Their loadings are indirectly assessed as part of the load from tributaries to the basin.

12. **The non-point source discussion in section 4.3 needs to identify what non-point sources exist in the basin. According to the previously mentioned Basin Status Report, non-point sources of nutrient loading to the Lower St. Johns River basin include onsite sewage treatment and disposal systems (OSTDSs), tributaries (e.g., Black Creek, Dunns Creek, Deep Creek, Rice Creek, Julington Creek, Trout Creek, Sixmile Creek, Governors Creek, Clarkes Creek, Cedar Creek, Camp Branch, Mill Branch, Dog Branch, etc.), stormwater runoff, marinas, silviculture, row crop agriculture (notably the Tri-County Agricultural Area), dairies, and urban development.**

    Response: As noted in the response to Comments 9 and 10, the referenced document by Hendrickson *et al.* (2002) provides a detailed assessment of the pollutant loadings to the river, including the major tributaries. Predicted loadings from this report were then provided in Appendix D of the TMDL document.

13. **The atmospheric deposition discussion in section 4.3.2 only mentions nitrogen loading. Please explain why phosphorus loading by atmospheric deposition was not considered.**

    Response: Text was added to Section 4.4.2 noting that atmospheric deposition of phosphorus was not included in the modeling and TMDL assessment because it is expected to be a very minor source of phosphorus to the basin.

14. **The method that was used to identifying sources in the LSJR basin should be identified in the TMDL. For example, the Watershed Characterization System (WCS) was used to characterize sources for the Hatchet Creek total coliforms TMDL.**

    Response: As noted in the response to Comments 9 and 10, the referenced document by Hendrickson *et al.* (2002) provides a detailed assessment of the pollutant loadings to the river, including a description of the methods used to identify sources.

15. **The source assessment discussion should also include information about applicable stormwater rules. Please consider incorporating the language in Attachments A and**

B.

Response: Text on the state's stormwater rules and NPDES Stormwater Program have been added as **Appendix A**.

16. Please explain why the point sources discharging directly to the St. Johns River were evaluated based on their 1997-98 discharge flows and loads rather than a more current time period.

Response: It is important to note that the referenced point source loads were the loads used as the starting point for the allocation process, which is designed to equitably assign reductions to both point sources and nonpoint sources (percent reductions were calculated against these starting points rather than current loading or design loads). The Allocation Technical Advisory Committee Report actually recommends that the Department use the permitted load (if available) as the starting point, but it was determined that in many cases the permitted load was significantly higher than current loading. Based on discussions at Stakeholders Committee and TMDL Executive Committee meetings, stakeholders recommended that we use the 1997–98 loadings with an allowance for anticipated growth over the next few years as the starting point for load reductions.

17. According to section 5.5, nitrogen was determined to be the key nutrient that needed to be reduced to meet the target. How was this determination made?

Response: As described in the TMDL document, nitrogen is the key limiting nutrient in the oligohaline/mesohaline portion of the river, while both nitrogen and phosphorus are colimiting in the freshwater portion of the river. Nitrogen alone is the limiting nutrient in the saline portions of the river because the dominant nitrogen-fixing algae in the river are freshwater species and die out as they move downstream.

18. Based on the attached maps of the Jacksonville MS4 area, small municipalities in the freshwater section of the river (including Fruit Cove and Green Cove Springs) are covered by Phase II of the NPDES stormwater program. The wasteload allocation discussion in section 6.3 needs to be revised accordingly.

Response: The wasteload allocation in Section 6.3 was revised to include an allocation (expressed as a percent reduction) to NPDES stormwater discharges.

19. The following statement in section 6.4 does not appear to provide a margin of safety for preventing imbalance: "In the freshwater zone, multiple years of phytoplankton and zooplankton field measurements were evaluated to establish the site-specific chlorophyll a level beyond which zooplankton abundance and diversity started to decline." Rather, this statement appears to provide a margin of safety for preventing toxicity.

Response: The quoted text merely provides background information relevant to determination of the chlorophyll *a* target. The key concept related to providing a margin of safety in the paragraph was the fact that the long-term conditions used were slightly drier than normal.

20. The following statement in section 6.4 is not a valid margin of safety because TMDLs should never assume that permit limits are protective: "Finally, point source flows

and loads used in the WLA for the freshwater zone were based upon existing flows and loads with an allowance for growth rather than assuming permitted limits." Waste load allocations should only be calculated considering in-stream water quality effects, not current permit limits.

Response: Again, the quoted text was meant to provide background information relevant to how the point source loads were established. The key text, which we strongly agree with, was that an implicit margin of safety is provided by this approach because it is extremely unlikely that all point sources would simultaneously discharge at their full WLA.

21. **Use of the DO minimum threshold from the 1999 EPA document does not quality (sic) as a margin of safety because no site-specific evidence has been provided that the threshold is applicable in the Lower St. Johns River. Moreover, it is not an approved water quality criterion.**

    Response: We are confident that applying this methodology to Florida is conservative because Florida species are acclimated to lower DO values given the warmer temperatures in Florida, which result in lower DO saturation levels.

22. **The seasonal variability section is mis-numbered. It should be section 6.5.**

    Response: The section was renumbered.

Comments by Michael Hartman (as Private Citizen), August 1, 2003

Mr. Hartman provided comments on several aspects of the TMDL, including the TMDL development process and the technical basis of the TMDL. Comments on the process included: (1) comments about the role of the facilitator hired by FDEP and SJRWMD to coordinate with stakeholders and facilitate stakeholder and Executive Committee meetings, (2) a request to attract broader public participation in the process, (3) a suggestion to include academia in the process, and (4) a comment noting how the organizational structure took a long time to evolve. Technical comments included: (1) a comment that the TMDL should make reference to a strong commitment to conducting bioassessments to determine effectiveness of TMDL implementation, with local universities playing some role in the bioassessments, (2) a comment that all wastewater facilities should be required to reduce TN and TP by at least 50 percent based on fairness issues, (3) a request for a bigger margin of safety, (4) a comment that using long-term average conditions is not a conservative approach and that a statistical approach should be used to determine the lower 90 percent confidence interval around the mean river flow over a 10-20 year period, and (5) comments about the alternative DO threshold used in the estuarine portion of the river (that our ecology is vastly different than in the more northern coastal estuaries and that DO levels in the river and area tributaries are likely below the DO criterion.

Response: The comments on the TMDL development process will be considered by the Department as we continue with development of the BMAP for the TMDL and as we move to other basins. While we did not make any changes to the document in response to Mr. Hartman's technical comments, our general responses are as follows: (1) we plan to develop a monitoring plan as part of the B-MAP and this monitoring will assess how the river responds to reductions in nutrient loading, (2) the ultimate reductions for each wastewater facility will be determined as part of the stakeholder driven B-MAP development process, (3) we believe the implicit margin of safety is adequate, (4) we believe that the application of the nutrient targets using long-term average conditions is appropriate, and (5) we acknowledge that conditions in the LSJR are different than Cape Cod to Cape Hatteras, but that the warmer temperatures in Florida actually add an implicit margin of safety because Florida species are likely acclimated to lower DO levels.

Comments from Ray Avery, Executive Director, Clay County Utility Authority, August 8, 2003

Mr. Avery provided several comments about the draft allocation table, and requested that the Department determine a uniform TN concentration for all facilities to achieve the necessary load reductions. He noted Clay County voluntarily reduced its TN concentrations to an average of 3.5 mg/L and that the current allocation approach may penalize facilities that proactively reduce loadings because it did not allow any room to increase their flow.

Response: Department staff from the Northeast District met with Mr. Avery and subsequently revised the allocation spreadsheet provided in the TMDL document upon discussion with Clay County and other dischargers. It should be noted however, that the actual allocations will be developed as part of the BMAP process.

Comments from Bill Bartnick, Environmental Administrator, Florida Department of Agriculture and Consumer Services, August 26, 2003

Mr. Bartnick expressed concern about a statement in the draft document that "the nutrient TMDL also needed to address the impact of nutrients on DO levels" and commented about the importance of color on DO in the freshwater portion of the river (noting that the river acts more like a "tannic lake" than a true riverine system). He also requested that the Department use more updated land use information for dairies and potato farming in the oligohaline/mesohaline reach of the river, and commented about the allocation process for agricultural operations.

Response: We agree that color and organic load have an important impact on river DO values, but stand by the original comment that the TMDL should also address the impact of nutrients on DO levels. As for the comments about land use information and the allocation process, we plan to use the updated land use information during the B-MAP development process to refine the allocations, which will take into account participation rates of area farmers.

Comments from Donna Kaluzniak, Public Utilities Director, Atlantic Beach, August 26, 2003

Ms. Kaluzniak provided comments on several aspects of the TMDL, including expressing concern about the accuracy of loading values used for wastewater facilities at the mouth of the river, asking about the source of metals in domestic wastewater discharges, asking several questions about nutrient loading from the city of Atlantic Beach's wastewater treatment plants and about potential treatment and disposal alternatives,

expressing the opinion that the document contradicts itself regarding DO levels, commenting about verification of the model, and asking about the sources of loading to the river.

Response: We are confident that the loads used for the wastewater facilities are as accurate as possible. Regarding the question about metals in the effluent, we are not sure of the relevance of the question to this particular TMDL and assume the comment was in response to the list of verified impaired segments in the main stem of the river (Table 1), which included several metal listings. As for the questions about the city of Atlantic Beach WTP, these issues will be addressed during the development of the B-MAP for the TMDL. It is not clear what Ms. Kaluzniak found contradictory about DO levels. And finally, comments regarding the verification of the model and the pollutant source load estimates should be well addressed by the referenced documents by the SJRWMD.

Comments from Captain L. S. Cotton, Naval Air Station, Jacksonville, August 28, 2003

Captain Cotton expressed concern about the starting point used for wastewater facilities, noting that not using the permitted load severely impacts military operational flexibility because they are not operating at full capacity. He also asked about the method for projecting future growth, why the commitment by Jacksonville Electric Authority (JEA) to reduce nitrogen loadings by 50 percent was not taken into account, and why the allocation spreadsheet did not take into account reuse. He concluded with a request to not use the allocation spreadsheet provided in the report as the starting point for TMDL implementation.

Response: The Department did not use the permitted load as the starting point because many facilities were discharging far below their permitted load and stakeholders recommended that we use the 1997–98 loadings with an allowance for anticipated growth over the next few years as the starting point for load reductions. The allowance for growth was site-specific and was based on discussions between Northeast District staff and individual permittees. The previous commitment by JEA to reduce nitrogen by 50 percent was not reflected in the allocation spreadsheet in the document because JEA requested a more equitable allocation. It is our understanding, however, that JEA will stand by its commitment and will negotiate with other parties in a form of pollutant trading. And finally, it is our intent to take reuse into account in the allocation process, and if the allocation failed to take reuse into account, we recommend that Captain Cotton raise the issue during development of the B-MAP for the TMDLs.

Comments from Michael Wadel, Water Program Manager, Naval Air Station, August 28, 2003

Mr. Wadel asked a variety of questions related to nonpoint sources and the wasteload allocation to Phase II MS4s (Municipal Separate Storm Sewer Systems). He was specifically concerned about how the WLAs were incorporated into the model, how the suggested nonpoint source reductions were allocated, and whether any additional reductions/BMPs required by the TMDL will be redundant with previously required stormwater treatment activities.

Response: As noted in Section 6.3 of the document, the WLA for the estuarine portion of the river was a combination of the sum of the WLAs for all of the NPDES wastewater facilities and the stormwater discharge from Duval County Municipal Separate Storm Sewer Systems (MS4s). To estimate the load from the Duval County MS4s, the urban stormwater component of the nonpoint source loads to the estuarine portions of the river (as estimated by the Pollution Load Screening Model) were moved from the nonpoint source inventory to the WLA. Consistent with the recommended allocation methodology, the TN load estimated for urban nonpoint sources was then reduced by the expected reduction that would be achieved through implementation of stormwater BMPs in 90 percent of the urbanized area. This description notwithstanding, we acknowledge that there is a lot of uncertainty in the estimation of nonpoint source loads and whether additional BMPs beyond the Maximum Extent Practicable will be required to implement WLAs for MS4s. Many of these issues will be discussed with stakeholders during B-MAP development.

Comments from T. Niles Glasgow, State Conservationist, NRCS, August 29, 2003

Mr. Glasgow commented that it was unclear how the allocation spreadsheets were developed, specifically in regard to reductions for agricultural operations which will vary by the type of agricultural operation. Mr. Glasgow also commented that the document did not include a monitoring/evaluation plan nor an Implementation Plan.

Response: The reductions used for agricultural sources were based on documented reductions for TN and TP from BMPs developed for the Tri County Agricultural Area by the SJRWMD. As for the monitoring and implementation plan, these important elements of the overall TMDL process will be developed as part of the B-MAP.

Comments from Neil Armingeon, St. Johns Riverkeeper, August 28, 2003

Mr. Armingeon started his comment letter by expressing his gratitude to the Department for its inclusionary TMDL development process, commended the Department for initiating a process to reduce nutrient loading to the river, and commended the SJRWMD on its model development efforts. However, he expressed his concern with how the model was used to arrive at the TMDL, and had the following specific comments:

(1) He expressed concerns about the chlorophyll *a* target for the freshwater portion of the river, commenting that allowing 10 percent of the values to be above 40 µg/L may allow a violation of the narrative nutrient criteria, that it would not be protective of filamentous algal blooms that could impact SAV populations, that it could still result in toxin production, and that it should be applied for a worst-case year rather than a long-term average.

(2) He expressed concerns about the DO target used in the estuarine portion of the river, which was based on an EPA methodology for Cape Cod to Cape Hatteras, and requested that the Department develop site-specific alternative criteria (SSACs) for DO and then determine a new TMDL based on the SSAC.

(3) He expressed concerns that the loading inventory did not include the “required” five-year growth projection and requested that this growth be evaluated as part of the TMDL rather than during BMAP development.

(4) He requested we add text to the document stating that the TMDL process will result in reductions from all nutrient sources.

Responses:

(1) The chlorophyll *a* target was specifically designed by the SJRWMD as a better interpretation of the narrative nutrient criteria than the annual average chlorophyll *a* value that is used to identify waters impaired by nutrients in the Impaired Surface Waters Rule (Rule 62-303, F.A.C.). As noted in the TMDL document, Hendrickson evaluated the maximum algal biomass levels that would (a) maintain diversity of the plankton community, (b) facilitate upward transfer of primary production to higher trophic levels (and maintain zooplankton diversity), and (c) minimize the potential of dominance of detrimental algal species and production of algal toxins. He found that a chlorophyll *a* target of 40 µg/L not to be exceeded more than 10 percent of the time would protect the aquatic flora and fauna of the river. Studies have shown that when chlorophyll a levels rise above 40 µg/L, a shift in algal types occurs: blue-green algae begin to dominate the system, toxic algal species begin to increase, and zooplankton communities begin to decline. As such, we do not expect filamentous blue-green algae or toxic algae once the reductions required by the TMDL are implemented.

The Department readily acknowledges that the current modeling effort was not designed to assess impacts on submerged aquatic vegetation (SAV). As we have discussed with stakeholders, the SJRWMD is actively working on a variety of studies that will allow the district to revise the model to address SAV impacts, and the Department plans to use the revised model to update the TMDL for the LSJR during the next basin management cycle.

Regarding application of the chlorophyll a threshold, the TMDL Stakeholders, TMDL Executive Committee, SJRWMD, and Department all agreed that it would be overly conservative to apply the threshold in a worst-case year and that a long-term average was adequately protective of the river. There were many reasons for this position, including the fact that there are already conservative elements of the modeling (applied in the worst-case WBID, for example), it is common practice for nutrient TMDLs to be based on “design runs” that estimate long-term average conditions, stormwater treatment design criteria and BMPs (the implementation of which will be how most of the nonpoint source reductions will be achieved) are typically designed for rain events that would not be typical of the worst-case year, and external load model estimates of nonpoint source loading would overestimate loading for dry years because they would not adequately take into account the increased removal provided by stormwater treatment facilities. Nutrient management activities for nonpoint sources will naturally be more effective at dry conditions such that additional nonpoint source reductions required for a worst-case dry year are not needed and would result in the overdesign of stormwater facilities.

(2) The Department is confident that the DO threshold developed by the SJRWMD more accurately reflects conditions at which low DO levels would impact aquatic life use support than the current state DO criterion and plans to develop either a SSAC for the area or perhaps revise the statewide criteria using the EPA methodology.

(3) It should be noted that there is no requirement to include a 5-year growth projection in the TMDL. We assume Mr. Armingeon is referring to the Allocation Technical Advisory Committee recommendation to include a 5-year projection for growth when allocating TMDLs. We agree with this recommendation, and the SJRWMD made some preliminary 5-

year growth projections by extrapolating growth over the last 10 years. However, the Stakeholders Committee and TMDL Executive Committee recommended that the Department use actual growth projections from the Northeast Florida Regional Planning Council instead. As it turned out, the projections were not ready by the time the TMDL was due to be submitted to the EPA, and it was decided that growth projections would be addressed during BMAP development. Any increased nonpoint source load from future growth will need to be offset by reductions in current nonpoint source loadings.

(4) The TMDL allocation spreadsheet in the appendix was revised to reflect reductions at all facilities, rather than just JEA facilities. However, we do not agree with Mr. Armingeon's position that all sources should be required to reduce their loadings by the same percent. Our allocation strategy tries to equitable allocate load reductions by taking prior treatment into account and allows for informal pollutant trading—both of which will be addressed during BMAP development.

Response from Jim Maher, Northeast District Office, August 19, 2003

Mr. Armingeon also indirectly provided comments to the Department in the form of an e-mail to Riverkeeper Members, which include some Department staff. Attached below is a copy of a response to that e-mail from Jim Maher (Northeast District), which provides responses to the issues raised in Mr. Armingeon's e-mail (Mr. Armingeon's comments are shown in bold italics).

From: Maher, Jim
Sent: Tuesday, August 19, 2003 4:39 PM
To: 'Breen, Katherine'; Armingeon, Neil
Subject: RE: RIVER ISSUE

Good Morning Riverkeepers

Per my discussion with Neil yesterday, I would appreciate your forwarding my comments to the membership if you still see fit to do so. Thank you very much for the opportunity.

Dear Riverkeeper Member,

As a fellow Riverkeeper member and also a DEP employee who has been working on the TMDL for some time, I'd like the chance to add to and address the issues Neil outlined in a recent email. Under the direction of Jerry Owen, our Water Facilities Administrator, we here at the DEP have been working closely with the Riverkeeper, the St. Johns River Water Management District and many other stakeholders in monthly meetings for more than a year now to help shape this TMDL to be the most scientifically accurate and environmentally useful tool ever developed to date to reduce the nutrient enrichment in the St. Johns. Thanks to insightful contributions from the Riverkeeper, the Stewards of the St. Johns and other stakeholders, we have made many changes that strengthen the TMDL and make it more effective. This is what community consensus does best. Our District Director, Mario Taylor, has elevated working with the stakeholders and executives from all affected groups to a high priority.

Some of the issues that Neil outlined have been improved thanks to your collective input. That may not have been well communicated yet as some of the changes were fairly recent, so please allow me to show how we currently do address these important concerns, taken in order as Neil presented them:

the proposed TMDL: - does not require a reduction of nitrogen from upstream, the largest source of nitrogen pollution in the lower St. Johns;

The TMDL as modelled and as shown in a draft allocation strategy does indeed apply the same reduction in fresh water section (30 percent) to the total of the nutreint load coming from upstream. The load from upstream will have to be reduced to meet their share of the nutrient reduction responsibility. Modelling shows that this, along with the reductions within the basin will eliminate the severe algae blooms and species shift from good algae to undesirable species which is indicative of an unhealthy system.

- does not take into account planned growth and development;

This is true for what has been presented so far, but we have only just received growth and development estimates from the Northeast Florida Planning Council (requested by the stakeholder meetings) and the very next computer run the Water Mangement District does of the river modelling WILL include the growth and development. This was an important issue for a number of the stakeholders, including agriculture, and the process is improved with this addition. While adding this to the next computer run may alter who has to reduce what by how much, the total reduction requirement will be unchanged, and that is what is being proposed in the actual TMDL, what must the Total Load get down to. HOW we get down to it will be the subject of Basin Management Action Plan (BMAP) discussions over the next year, which will also heavily rely on community input. But what we're legally dealing with right now is the total load to get down to, and it will be the same, even if loads from new growth prompts additional reductions elsewhere.

- *does not consider the possibility of using the St. Johns River as a source for drinking water; if this occurs, the River's volume will be reduced and may not be able to effectively absorb the nitrogen;*

We don't have any projections that this will occur during the next 5 year period. The TMDL will be revised on a 5 year cycle. If we have information that this is going to happen in the next year cycle, it will be included in the model's projections.

and is not fair. The amount of reduction is not the same for all sources of nitrogen.

This is another example of how the process has been improved due to stakeholder input. The inital draft allocation relied only on some large facility reductions in the marine section. In response to Riverkeeper and other stakeholder calls for a more fair allocation, the draft strategy has been changed to require every point source to get dowm to the same level of treatment.

1. The TMDL should be based upon EPA approved water quality standards;

While there are no numeric standards for nutrients, the narrative standard of not causing an imbalance of flora and fauna has been translated by Water Management District researchers with cutting edge scientific development. I submit the work done by key WMD scientists rivals that done any where else in the country. The tools they have developed and incorporated into the model and evaluative process are so sophisticated and are more intricate than the work done anywhere else, save perhaps the Everglades. The St. Johns is an intricate, complex system that behaves like a lake sometimes, a stream others, and has tidal exchange 100 miles inland. There is nothing else like it, so the evaluative requirements are complex and demanding. These folks have risen to the occasion.

That said, one of the translations of the nutrient criteria identifies Dissolved Oxygen (DO) sags as evidence of enrichment due to the oxygen demand of algal detritus, or decaying dead algae. This indirect use of Dissolved Oxygen actually identifies appropriate oxygen sags between 3.2 mg/L and 4.8 mg/L, depending on length of the sag. While we believe this to be appropriate for the system, and it was originally borrowed from an EPA generated oxygen limit profile for another waterbody, it is less than the non-site specific criteria of 5 mg/L we have in Florida Administrative Code (FAC) that has been approved by EPA for all of Florida. EPA can approve a site-specific alternative criteria (SSAC) of less than 5 if it is appropriate for the system. The WMD researchers have provided compelling evidence that this range is appropriate for the St. Johns given our species composition, physical characteristics and dark water. The case was presented at stakeholders meetings and will be used to officially obtain and SSAC for EPA. While this process takes a while, we will pursue it concurrently with the TMDL and believe, with all stakeholder input, including other scientists in regulatory agencies and outside government, that it is the correct thing to do.

2. The proposed TMDL will continue to allow harmful algae blooms which can be toxic to humans and aquatic life;

We believe that if the reductions projected to be required from these scientists' work can truly be implemented (our next great challenge), the harmful algae blooms won't be allowed to continue. Of course there are no guarantees, but if these efforts don't do the trick, we'll have to cut deeper in the next cycle. But the greater task at hand is ensuring that we can implement this much. The point sources should be no problem as we can put their requirements into their permits. But without public funding and project support, getting this level of nutrient reductions in non-point source runoff and upstream will be doomed. WE NEED YOUR HELP HERE!

3. The TMDL ignores growth and development occurring in the lower St. Johns area; and

As mentioned above, we have numbers from the planning council to update the model input and work this out in the allocation process. We invite all concerned to look at those inputs and ensure they accurately reflect expected growth and development, but again that will be an allocation issue and won't affect the total load we must get down to.

4. If a 20 -30 percent reduction is the target, all sources of nitrogen pollutants, not a select few, should be required to reduce their discharges by that percentage.

All sources will now have to share in the pain, thanks to changes made by your Riverkeeper's insistence. However, for those facilities that have already made treatment upgrade investment, they may have to only reduce a lesser amount than those who currently have no nutrient reduction treatment at all, so that everybody gets down to the same level of treatment efficiency. This is the most fair way (and the only physically possible way) to do this, and I know that is your intent.

Neil is right, this is YOUR River and only with your help and participation can we provide the protections and restorations it needs. This is why the Riverkeeper group, as well as the Stewards of the St. Johns and other river advocacy groups must remain strong, and your voice must be heard, so please keep supporting them and stay involved. Let your representatives know that protecting the river is your priority and insist adequate resources be provided to implement this TMDL. With your voice we can heal the river together.

Jim Maher

Comments from Riverkeeper Members

Mr. Armingeon's e-mail resulted in approximately 21 e-mails from Riverkeeper members that echoed the same four concerns: (1) the TMDL should be based upon EPA-approved water quality standards, (2) the proposed TMDL will continue to allow harmful algae blooms that can be toxic to humans and aquatic life, (3) the TMDL ignores growth and development occurring in the lower St. Johns area, and (4) if a 20 to 30 percent reduction is the target, all source of nitrogen pollutants, not a select few, should be required to reduce their discharges by that percentage.

Response: Mr. Maher's e-mail addressed all four issues, and several additional issues.

Comments from the St.Johns Riverkeeper Provided at the TMDL Adoption Hearing

Mr. Armingeon provided additional comments in writing at the TMDL adoption hearing on September 30, 2003. The comments reiterated his previous comments on the chlorophyll *a* target, the DO target, and the five-year growth projections, but he added some additional detail based on his review of the files at the SJRWMD. Mr. Armingeon commented that this review strengthened his belief that the TMDL would not protect the biological integrity of the system and will allow continued degradation of the LSJR. He included the following specific recommendations:

1. **Consider water column light attenuation that is deleterious to SAV when establishing chlorophyll a levels.**
2. **Correlate chlorophyll a standards with SAV growing season and periods of low DO due to high water temperatures.**
3. **Establish continuous monitoring DO meters in the estuaries and freshwater portions of the river. Reassess DO impairment in these sections.**
4. **Determine the effect of phytoplankton levels on total suspended solids load in the oligohaline reach of the river.**
5. **Reduce the chlorophyll *a* target to levels below current ambient levels.**
6. **Reevaluate nutrient levels relative to littoral zone filamentous algal loads.**
7. **Investigate the environmental factors driving the production of algal toxins and their potential relationship to nutrient enrichment.**

Response: We had previously addressed most of Mr. Armingeon's comments and recommendations, but it should be noted that the TMDL is based on the worst-case WBID rather than the average chlorophyll for the river, and the worst case WBIDs currently have chlorophyll *a* values well above 40 µg/L (see Recommendation 5).

Appendix I: Annual Average Chlorophyll *a* Values and TSIs for the LSJR Main Stem

WBID	Waterbody Segment	Chla or TSI[1]	Annual Average Chlorophyll or TSI for Given Year					
			1996	1997	1998	1999	2000	2001
2213A	STJ RIV AB MOUTH	Chla	NA[2]	NA	NA	NA	4.42	4.67
2213B	STJ RIV AB ICWW	Chla	4.65	3.52	10.31	8.40	7.21	9.79
2213C	STJ RIV AB DAMES PT	Chla	4.35	3.61	NA	6.12	4.54	7.89
2213E	STJ RIV AB WARREN BRG	Chla	9.02	12.31	14.98	12.0	9.21	8.55
2213F	STJ RIV AB PINEY PT	Chla	7.50	NA	14.89	9.31	12.55	6.16
2213I	STJ RIV AB BLACK CK	TSI	61.4	61.5	62.6	58.6	56.2	57.8
2213J	STJ RIV AB PALMO CK	TSI	63.6	63.0	64.1	61.6	56.3	59.7
2213K	STJ RIV AB TOCIO	TSI	66.0	64.6	64.5	66.0	63.4	63.9
2213L	STJ RIV AB FEDERAL PT	TSI	65.4	63.6	62.2	64.7	60.9	60.4
2213M	STJ RIV AB RICE CK	Chla	31.14	30.06	25.09	37.79	25.07	25.23
2213N	STJ RIV AB DUNNS CK	Chla	34.04	31.81	21.30	31.42	24.40	NA

[1] Chlorophyll in µg/L and TSI unitless.
[2] NA = Not available.
[3] Listed based on increase over historical levels.

Appendix J: Allocation Spreadsheets for the Freshwater and Estuarine Portions of the LSJR

Wasteload and Load Allocations for Freshwater Portion of River – Total Phosphorus (kg/yr)

Source Category or Name of Facility	Wasteload Allocation (kg/yr)	Required Percent Reduction
Point Sources - Wastewater		
Georgia-Pacific	33,181.8	48.05%
Palatka WWTF	6,669.5	33.00%
Green Cove Springs - Harbor[1]	1,851.5	38.00%
Green Cove Springs - South[1]	545.2	38.00%
Future Apricot/RO Dischargers	3,320.1	0.00%
Point Sources - MS4s[2]		
Green Cove Springs[1]	575.9	47.44%
Clay County	212.6	47.44%
Load Allocations[2]		
Agriculture	70,974.2	14.96%
Non-MS4 Stormwater[2]		
Putnam County	3,964.9	33.81%
Palatka	792.5	47.44%
St. Johns Co.	3,296.6	11.56%
Clay Co. non-MS4	499.4	34.92%
Welaka	90.4	47.44%
Hastings	49.3	46.93%
Pomona Park	15.8	0.00%
Alachua County	83.8	0.00%
Flagler Co.	0.9	0.00%
Atmospheric Deposition	**1,355.9**	**0.00%**

[1] Green Cove Springs has requested that its MS4 and wastewater loads be aggregated into one WLA, which would be 2,972.6 kg/yr.

[2] Loads shown for MS4s and non-MS4s are provided only for the purposes of pollutant trading and aggregation of loads. The allocations are expressed in percent reduction.

Freshwater Portion of River – Nitrogen (kg/yr) **Average of 95,97,98,99**

Source Category or Name of Facility	Allocation	Net Reduction from Current
Point Sources - Wastewater		
Georgia-Pacific	165,909.1	35.73%
Palatka WWTF	40,795.4	33.00%
GCS Harbor[1]	5,863.2	38.00%
GCS South[1]	3,188.8	38.00%
Seminole Electric	4,006.7	30.00%
Future Apricot/RO Dischargers	9,960.5	0.00%
Point Sources - MS4s[2]		
Green Cove Springs[1]	4,986.6	28.37%
Clay County	1,984.2	28.37%
Load Allocations[2]		
Agriculture	195,120.2	37.20%
Non-MS4 Stormwater[2]		
Putnam County	34,113.4	21.79%
St. Johns Co.	25,442.2	6.73%
Palatka	6,936.1	28.37%
Clay Co. non-UA	4,418.5	20.80%
Welaka	841.4	28.37%
Hastings	449.4	28.03%
Alachua Co. non-UA	0.0	0.00%
Pomona Park	107.9	0.00%
Flagler Co. non-UA	6.9	0.00%
Atmospheric Deposition	**105,688.2**	**0.00%**

[1] Green Cove Springs has requested that its MS4 and wastewater loads be aggregated into one WLA, which would be 14,038.6 kg/yr.

[2] Loads shown for MS4s and non-MS4s are provided only for the purposes of pollutant trading and aggregation of loads. The allocations are expressed in percent reduction.

Marine Portion of River – Nitrogen (kg/yr) 99

Source Category or Name of Facility	Allocation	Net Reduction from Start Point
Point Sources - Marine Wastewater		
An Busch - Mn St	12,413.4	49.12%
Atl Beach - Buccanneer[2]	8,428.5	60.00%
Atl Beach - Main[2]	13,425.9	52.40%
CCUA - Fleming Island[4]	43,820.5	-53.56%
CCUA - Fleming Oaks[4]	2,983.5	-78.05%
CCUA - Miller St[4]	37,219.5	-18.70%
Jax Beach WWTF[1]	23,868.2	40.55%
JEA - Arlington[3]	134,258.7	62.24%
JEA - Beacon Hiils[3]	7,384.2	55.04%
JEA - Brierwood SD[3]	0.0	0.00%
JEA - Buckman[3]	253,748.9	48.43%
JEA - District II[3]	40,277.6	76.11%
JEA - Holly Oaks[3]	0.0	0.00%
JEA - Jax Heights[3]	12,083.3	46.45%
JEA - Jul Crk[3]	3,550.4	55.42%
JEA - Mandarin[3]	52,211.7	-0.87%
JEA - Monterey[3]	26,851.7	52.54%
JEA - Ortega Hills[3]	0.0	0.00%
JEA - Royal Lakes[3]	22,301.9	30.35%
JEA - San Jose[3]	16,782.3	46.19%
JEA - San Pablo[3]	5,594.1	15.71%
JEA - St. Johns North[3]	0.0	0.00%
JEA - SW[3]	74,588.1	48.62%
JEA - Woodmere[3]	4,773.6	52.83%
Neptune Beach WWTF[5]	7,011.3	38.75%
Orange Park WWTF[6]	9,994.8	59.84%
Smurfit - Jax	0.0	0.00%
Smurfit-Stone Container	74,274.6	49.12%
USN - Mayport WWTF[7]	7,682.6	44.94%
USN - NAS Jax WWTF[7]	8,428.5	36.50%
Westminster Woods	0.0	0.00%
Future Apricot/RO Dischargers	4,979.3	0.00%
JEA Total	654406.5	53.14%
CCUA - Total	84,023.5	-36.47%
Point Sources - MS4s[8]		
Atlantic Beach	975.4	60.57%
Clay_marine_UA	10,551.8	58.21%
NAS Jax	1,769.1	62.86%

Source Category or Name of Facility	Allocation	Net Reduction from Start Point
Point Sources - MS4s[8]		
Jacksonville,City	95,977.0	60.57%
Jax Beach	1,940.0	61.00%
SJ Co	4,537.3	56.82%
Orange Park	1,288.9	62.65%
Mayport UA	1,027.9	62.85%
Neptune Beach	585.2	60.57%
Load Allocations[8]		
Agriculture	4,167.8	67.44%
Non-MS4 Stormwater[8]		
Clay_marine_nonUA	4,973.4	58.73%
Camp Blanding	1,572.8	58.61%
SJC remaining marine	1,060.1	55.29%
Penney Farms	163.0	0.00%
Atmospheric Deposition - Marine	**95,028.1**	**0.00%**

[1] Jacksonville Beach requested that its MS4 and wastewater loads be aggregated into one WLA, which would be 25,808.2 kg/yr .

[2] Atlantic Beach requested that its wastewater loads be aggregated into one WLA, which would be 22,829.7 kg/yr.

[3] JEA requested that all its wastewater allocations be aggregated into one WLA, which would be 654,406.5 kg/yr.

[4] Clay County Utilities Authority requested that its wastewater allocations be aggregated into one WLA, which would be 84,023.5 kg/yr.

[5] Neptune Beach requested that its wastewater allocations be aggregated into one WLA, which would be 7,596.5 kg/yr.

[6] Orange Park requested that its wastewater allocations be aggregated into one WLA, which would be 11,283.8 kg/yr.

[7] The United States Navy requested that its wastewater allocations be aggregated into one WLA, which would be 18,908.0 kg/yr.

[8] Loads shown for MS4s and non-MS4s are provided only for the purposes of pollutant trading and aggregation of loads. The allocations are expressed in percent reduction.

Appendix K: Ongoing and Proposed Studies by the SJRWMD Designed To Revise the TMDL To Address Submerged Aquatic Vegetation and Further Evaluate Nutrient Impacts in the Lower St. Johns

The list below summarizes some of the key projects. It is not intended to identify all of the ongoing projects and programs that are part of the SJRWMD activities in the LSJR and its designation as a SWIM water at the state level or an American Heritage River at the federal level.

1. The SJRWMD recently amended its contract with the USACE/WES to add money to complete necessary code changes in the SAV components of CE-QUAL-ICM, improve model simulation speed by parallel processing of grids, and set up a sigma grid option. The contract is scheduled to be completed by the end of the year (2004).

2. Dr. Carl Gallegos is completing further work on his light model for the St. Johns by addressing salinity influences. A final report is due at the end of the year (2004).

3. Dr. Hans Paerl has one more year of field studies to complete his three-year study on nitrogen fixation in the LSJR. This summer, he will conduct monthly surveys and three one-week assays. A final report is due next March (2005).

4. Funding for Dr. Ed Philps' phytoplankton and zooplankton sampling was extended for two more years. He will conduct some studies in conjunction with Dr. Paerl this summer.

5. The SAV project with the U.S. Geological Survey lab in Louisiana was completed and final reports should be available this summer (2004). Information obtained through those studies will be used in the CE-QUAL-ICM model.

6. A contract was recently signed with researchers at the University of Alabama to study the export and degradation of terrestrially derived organic material in the LSJR.

7. An ongoing project that has evaluated sediment fluxes and denitrification rates will continue through the fall and will involve monthly sampling during this summer. The results of this work will be used to review rates that were used in the model to establish the TMDL.

Appendix L: Site-Specific Alternative Dissolved Oxygen Criterion Documentation

Site Specific Alternative Dissolved Oxygen Criterion to Protect Aquatic Life in the Marine Portions of the Lower St. Johns River Technical Support Document

April 28, 2006

Prepared by:

Florida Department of Environmental Protection
Tallahassee, FL
&
St. Johns River Water Management District
Palatka, FL

For Submittal to:

U.S. Environmental Protection Agency

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Introduction

The purpose of this report is to provide the technical basis for establishing Site Specific Alternative Criteria (SSAC) for dissolved oxygen (DO) for the protection of aquatic life in the predominately marine portions of the Lower St. John's River (LSJR) between Julington Creek and the mouth of the river. The SSAC for DO in the LSJR presented herein was developed in accordance with the procedures set forth in subsection 62-302.800(2), Florida Administrative Code, for Type II Site Specific Alternative Criteria. The proposed DO SSAC was derived by the Florida Department of Environmental Protection (FDEP) and the St. John River Water Management District (SJRWMD) based on an application of the methodology developed by the U.S. Environmental Protection Agency (EPA) for the Virginian Province (EPA 2000). As described below, EPA's Virginian Province approach uses knowledge regarding the biological response of sensitive aquatic organisms to hypoxic stressors to derive DO criterion that provide adequate protection from acute and chronic effects of exposure to low DO levels in marine waters.

Description of Existing Conditions

Persistent, low (below 5 mg/L) concentrations of dissolved oxygen in the meso/polyhaline reach of the LSJR are well documented but poorly understood phenomena (Hendrickson, et al. 2003). The incidences of low dissolved oxygen conditions occur simultaneous with high summertime temperatures, and appear to be associated with the decline of significant algal blooms. The U.S. Geological Survey has established continuous monitoring stations within the marine reach of the LSJR at Dames Point and the Acosta Bridge (**Figure 1**). Monitoring data from these two stations are available for the period from 1996 through 2001 and are summarized in **Table 1**. For the period of record, dissolved oxygen levels were below 5 mg/L for 0.5, 2.7, and 3.9 % percent of the time, in the surface, mid depth waters, and bottom, respectively, at the Acosta Bridge Station (**Figure 2**). Further downstream at the Dames Point site, DO concentrations were below 5.0 mg/L for 15% of the time at the surface, 22% of the time at mid depth, and 35% of the time at the bottom during the same period.

Table 1. Summary statistics for daily dissolved oxygen concentrations (mg/L) measured at USGS automated monitoring stations at Acosta Bridge and Dames Point between 1996 and 2001

Station	Depth	N	Mean	Median	Std Dev.	Minimum	25th Percentile	75th Percentile	Maximum
Acosta Bridge	Surface	918	7.4	7.3	1.27	3.7	6.4	8.3	11.0
	Middle	1059	7.0	6.9	1.26	2.9	6.1	7.8	11.0
	Bottom	1049	6.8	6.6	1.21	3.7	5.9	7.6	10.9
Dames Point	Surface	839	6.2	5.9	1.21	3.7	5.3	7.1	9.5
	Middle	808	5.8	5.6	1.19	3.2	5.0	6.5	9.2
	Bottom	707	5.6	5.4	1.11	3.4	4.7	6.3	9.0

Figure 1. USGS water quality monitoring stations in the estuarine reach of the Lower St. Johns River

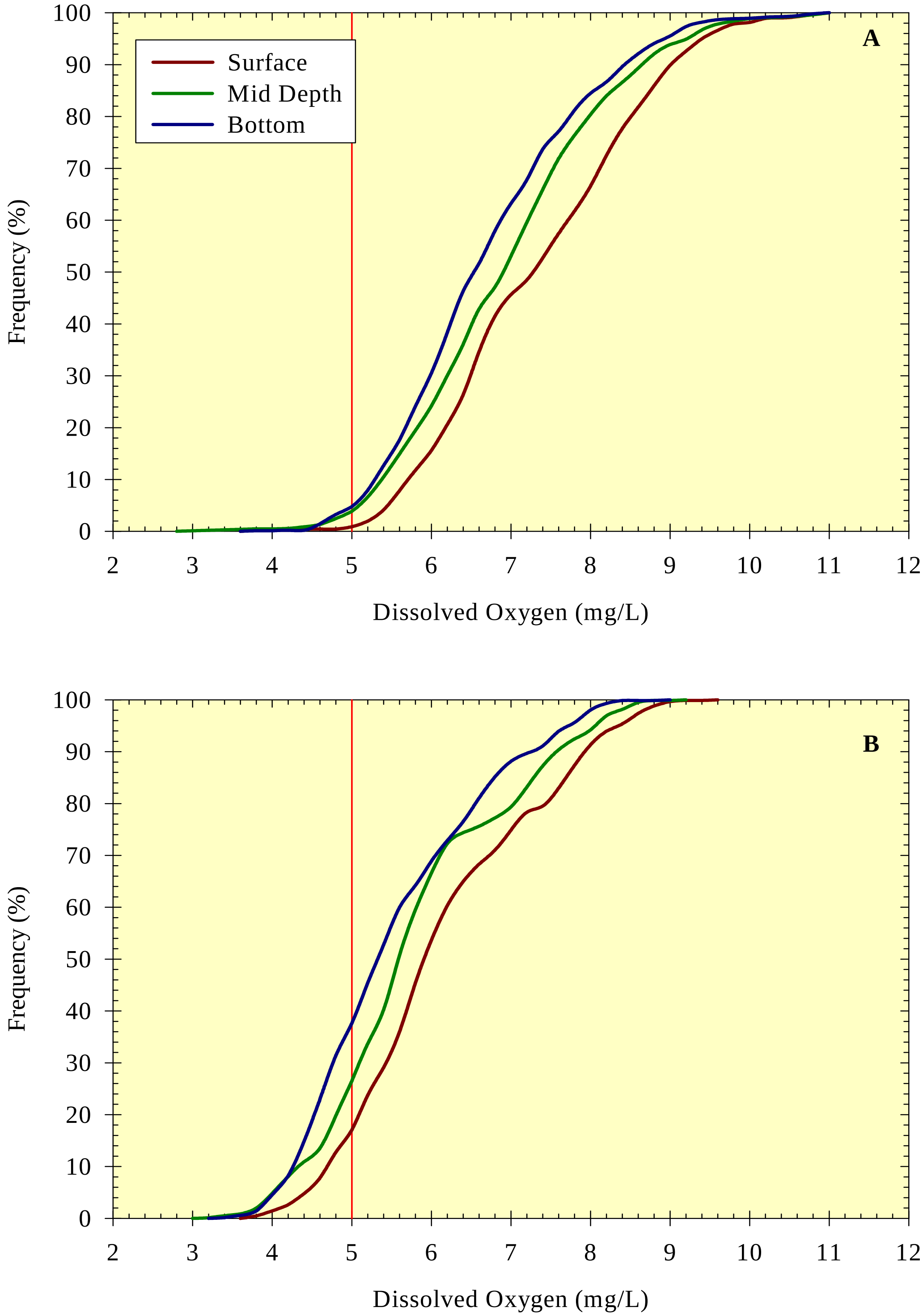

Figure 2. Cumulative DO frequency distribution at the USGS (A) Acosta Bridge and (B) Dames Point stations from 1996 through 2001. The red vertical line indicates the current one day average Class III marine criteria of 5.0 mg/L.

Overview of the EPA Virginian Province DO Criteria Approach

The EPA Virginian Province document (EPA 2000) recommends an approach for deriving dissolved oxygen levels necessary to protect coastal and estuarine organisms in the Virginian Province. The document also provides guidance regarding the application of the recommended methodology to other coastal or estuarine systems. The proposed DO SSAC presented herein was derived based on an application of the methodology developed by the U.S. Environmental Protection Agency (EPA) for the Virginian Province (EPA 2000) to the Lower St. Johns River.

The EPA Virginian Province methodology represents a synthesis of current knowledge regarding biological responses to hypoxic stressors in aquatic ecosystems. This approach considers the response to both continuous and cyclic exposures to low DO levels in the derivation of criteria which are protective of aquatic life. The aquatic life based approach utilized for the Virginian Province (EPA 2000) identifies three important DO concentration levels as follows:

- The Criterion Continuous Concentration (CCC), which is defined as a mean daily DO concentration above which continuous exposure is not expected to result in unacceptable biological effects.
- The Criterion Minimum Concentration (CMC), which is defined as a daily DO concentration below which any exposure for a 24-hour period would result in unacceptable acute effects (mortality). The CMC applies a lower limit for continuous exposures by using the final acute value (FAV) calculations outlined in Stephen *et. al*. (1985).
- A set of mean daily DO concentrations between the CCC and CMC that identify conditions that may be tolerated for specific limited durations as defined by the Final Recruitment Curve (FRC).

Aquatic life and its uses are assumed to be fully supported as long as DO conditions remain at or above the (CCC) chronic criterion for growth (EPA value = 4.8 mg/L). Conversely, if DO conditions fall below the juvenile/adult survival criterion (CMC) of 2.3 mg/L (EPA value), there is insufficient DO to prevent unacceptable effects to aquatic life. When DO conditions are between these two values (2.3 to 4.8 mg/L), further evaluation of the duration and intensity of low DO is needed to determine whether the level of oxygen can support a healthy aquatic life community (EPA 2000). This evaluation is conducted via comparison between monitored data and the FRC. To derive the CCC, CMC, and FRC, the EPA Virginian Province method utilizes biological responses of sensitive species during various life stages to low DO concentrations as briefly summarized below.

Juvenile and Adult Survival

Data regarding the acute sensitivity of juvenile and adult saltwater organisms to continuous low DO exposures ranging from 24 to 96 hours were used to derive the Criterion Minimum Concentration (CMC) in EPA's Virginian Province method. Acute response data were available for 12 invertebrate and 11 fish species (**Table 2**). 15 of the 23 species used by EPA for the Virginian Province are also known to inhabit estuarine waters of northeast Florida based on sampling and expert knowledge (Hendrickson, et al., 2005; FMRI 2002; CSA, Inc., 1993;

Frydenborg 2005). The species known to be indigenous in Florida generally span the range of acute DO sensitivities and include the most sensitive species (pipe fish, *Syngnathus fuscus*) used by EPA (**Table 2**).

EPA calculated the criteria for exposure to continuous low DO by using a modified version of the procedure for the derivation of a final acute value (FAV) for toxicants presented in Stephen *et al*., (1985). The standard procedure was modified to account for the fact that organisms respond to DO in an opposite manner than that to toxicants; that is, the greatest negative response is low levels rather than high levels. The FAV for the Virginian Province was calculated to be 1.64 mg/L, which is the value representative of the LC50 for the 95th percentile genus (as ranked in order of sensitivity to low DO levels). The FAV was then adjusted to a CMC of 2.27 mg/L by multiplying by the average LC5 to LC50 ratio (1.38) for juveniles. Similarly, a CMC of 2.3 mg/L was derived by Hendrickson *et al.,* (2003) based on a calculation performed using the 12 species known to inhabit the study area and based upon the FAV for the most sensitive species (pipe fish).

Growth

To protect against sub-acute effects, the Virginian Province DO criteria also included an evaluation of the effect of low DO levels on marine organism growth. EPA (2000) noted that growth is generally more sensitive to low DO than survival, although the document does mention exceptions for *Menidia menidia* and *Dyspanopeus sayi* where survival was the more sensitive endpoint in some tests.

EPA (2000) evaluated data on the effects of low DO on the growth of 11 species (4 fish and 7 invertebrates) from a total of 36 tests. Geometric mean chronic values (GMCV) for the 11 species ranged from 1.97 mg/L (sheepshead minnow,*Cyprinodon variegatus*) to 4.67 mg/L (longnose spider crab, *Libinia dubia*). A DO level protective of growth was determined to be 4.8 mg/L, which represented the chronic value that would not result in a greater than 25 percent reduction in growth in species at the 95th percentile of the values for sensitive species represented. Long-term, continuous exposures at or above this level should not cause unacceptable effects to marine organisms.

Larval Recruitment

U.S. EPA (2000) developed a generic model to evaluate the cumulative effect of low DO on early life stages of aquatic animals. This model was used to estimate the effects of DO concentrations between the acute value (CMC) of 2.3 mg/L and the CCC (4.8 mg/L). The model used for the Virginian Province estimates the duration a DO concentration can be tolerated without causing unacceptable effects on larval recruitment, defined as greater than 5% reduction in larval recruitment during the entire recruitment season. A final recruitment curve (FRC) was developed between the CCC and CMC.

The FRC was fit using the larval dose-response curves from the four most sensitive genera (*Morone, Homarus, Dyspanopeus*, and *Eurypanopeus*). The equation for the FRC was derived by fitting the line of best fit through the points generated by output of the recruitment model (**Figure 2**). The equation for the FRC is given as:

$$\mathbf{P(t)} = \frac{\mathbf{P_0 L}}{\mathbf{P}_0 + \mathbf{e}^{-\mathbf{Lkt}}(\mathbf{L} - \mathbf{P}_0)}$$

where: $P(t)$ = the DO concentration at time t
P_0 = the y-intercept
L = the upper DO limit
k = a rate constant, and
t = time in days, the number of days over which P(t) may be tolerated

EPA (2000) and Thursby (2003) suggested that the FRC developed for the Virginian Province may be overprotective for areas to the south. This is due to the fact that recruitment seasons lengthen and larval development times decrease, with increased distance south from the Virginian Province. Both factors would act to decrease the sensitivity of the FRC and shift the curve in **Figure 2** down and to the right.

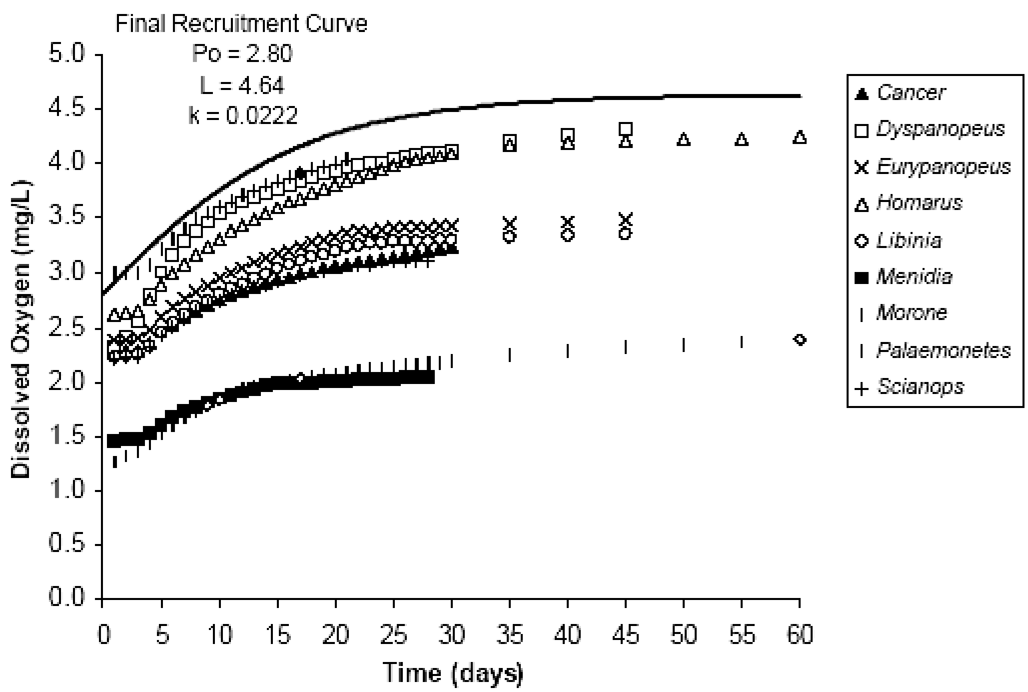

Figure 2. Plot of model outputs that protect against greater than a 5% cumulative impairment of larval recruitment. The solid line is regression of best fit for the FRC based on the 4 most sensitive species. Figure taken from EPA (2000).

Table 2. Acute sensitivity of juvenile and adult saltwater animals to low dissolved oxygen. Exposure durations ranged from 24 to 96 hr. (Re-created from EPA 2000). Highlighted species are known to be indigenous to the St. Johns River.

Species	Common Name	Life Stage	SMAV LC50[a]	SMAV LC5	SMAV LC5/LC50	GMAV LC50	GMAV LC50[a]	GMAV LC5	GMAV LC5/LC50	GMAV Rank[b]
Carcinus maenus	Green Crab	Juvenile/Adult	<0.34			<0.34	0.34			1
Spisula solidissima	Atlantic Surf Clam	Juvenile	0.43	0.7	1.63	0.43	0.43	0.70	1.63	2
Rithropanopeus harrisii	Harris Mud Crab	Juvenile	0.51			0.51	0.51			3
Prionotus carolinus	Northern Sea Robin	Juvenile	0.55	0.8	1.45	0.55	0.55	0.80	1.45	4
Eurypanopeus depressus	Flat Mud Crab	Juvenile	0.57			0.57	0.57			5
Leiostomus xanthurus	Spot	Juvenile	0.7	0.81	1.16	0.7	0.7	0.81	1.16	6
Tautoga onitis	Tautog	Juvenile	0.82	1.15	1.40	0.82	0.82	1.15	1.40	7
Palaemonetes vulgaris	Marsh Grass Shrimp	Juvenile	1.02	1.4	1.37	0.86	0.86	1.24	1.44	8
Palaemonetes pugio	Daggerblade Grass Shrimp	Juvenile	0.72	1.1	1.53					
Ampelisca abdita	Amphipod	Juvenile	<0.9			<0.9	0.9			9
Scopthalmus aquosus	Windowpane Flounder	Juvenile	0.81	1.2	1.48	0.9	0.9	1.20	1.33	10
Apeltes quadracus	Fourspine Stickleback	Juvenile/Adult	0.91	1.2	1.32	0.91	0.91	1.20	1.32	11
Homarus americanus	American Lobster	Juvenile	0.91	1.6	1.76	0.91	0.91	1.60	1.76	12
Crangon septemspinosa	Sand Shrimp	Juvenile/Adult	0.97	1.6	1.65	0.97	0.97	1.60	1.65	13
Callinectes sapidus	Blue Crab	Adult	<1.0			<1.0	1			14
Brevoortia tyrannus	Atlantic Menhaden	Juvenile	1.12	1.72	1.54	1.12	1.12	1.72	1.54	15
Crassostrea virginica	Eastern Oyster	Juvenile	<1.15			<1.15	1.15			16
Stenotomus chrysops	Scup	Juvenile	1.25			1.25	1.25			17
Americamysis bahia	Mysid	Juvenile	1.27	1.5	1.18	1.27	1.27	1.50	1.18	18
Paralichthys dentatus	Summer Flounder	Juvenile	1.32	1.57	1.19	1.32	1.32	1.57	1.19	19
Pleuronectes americanus	Winter Flounder	Juvenile	1.38	1.65	1.20	1.38	1.38	1.65	1.20	20
Morone saxatilis	Striped Bass	Juvenile	1.58	1.95	1.23	1.58	1.58	1.95	1.23	21
Syngnathus fuscus	Pipe Fish	Juvenile	1.63	1.9	1.17	1.63	1.63	1.90	1.17	22

[a] SMAVs (Species Mean Acute Values) and GMAVs (Genus Mean Acute Values) are all geometric mean values (Stephen *et al.*, 1985)

[b] Ranked according to LC50 GMAV values

Final Acute Value =	1.64 mg/L
Mean LC5/LC50 Ration =	1.38 mg/L
CMC = 1.64 mg/L x 1.38 =	2.27 mg/L

Application of the Marine Criteria Approach

The final marine DO criteria for the Virginian Province are summarized in **Figure 3**. Below the survival level (CMC=2.3 mg/L), DO does not meet protective goals and designated uses are not maintained. At DO levels above the CCC growth level (4.8 mg/L) unacceptable effects from exposure to low DO levels are not expected and aquatic life and its uses are adequately protected. Evaluation of DO levels between the survival and chronic protection levels is based on the comparison between the FRC and measured cumulative DO exposure durations.

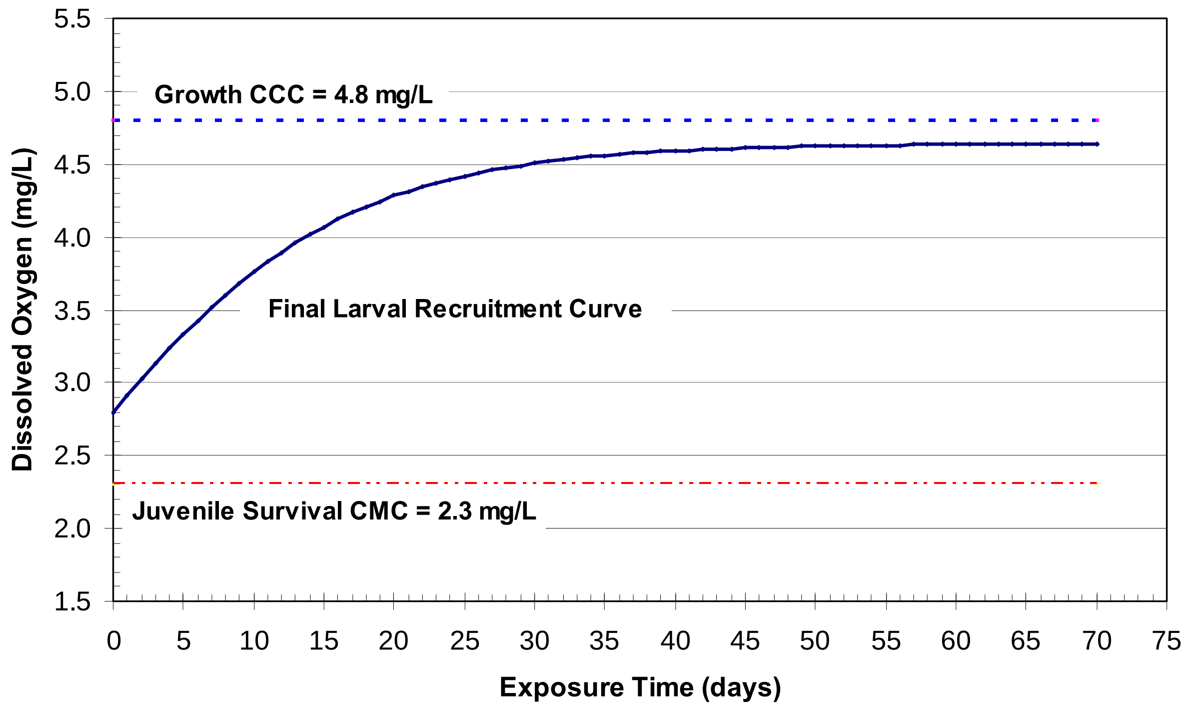

Figure 3. **Plot of the final Virginian Province DO criteria for marine animals continuously exposed to low dissolved oxygen.**

Application of the EPA Virginian Province Approach to the LSJR

The FDEP and SJWMD have evaluated the Virginian Province approach for deriving DO criteria for possible application in Florida's marine waters where the existing criteria may not be appropriate. Because the EPA's recommended approach for the Virginian Province is based on very conservative assumptions for northern cooler waters, it can be concluded that application of a similar approach to derive DO criteria for Florida's marine waters would provide a very conservative level of protection for aquatic life. In addition, many of the species used to derive the Virginian Province criteria are also known to occur in Florida waters including the LSJR with the species present in Florida waters generally bracketing the range of DO sensitivities seen in the entire complement of species used in EPA (2000). Therefore, the approach utilized by EPA to derive DO criteria for marine waters of the Virginian Province (EPA 2000) was used as the basis for the derivation of Site Specific DO Criteria that are protective of aquatic life in the saltwater portions of the Lower St. Johns River. While EPA's Virginian Province methodology provides the basis for the proposed SSAC for DO in the LSJR, the approach was modified slightly to take into account Florida's existing Class III marine criteria and existing conditions in the LSJR. The deviations from the EPA approach in developing the SSAC for DO in the LSJR are described below with a discussion regarding how the changes affect the level of protection afforded by the SSAC.

Based on the DO data collected from 1996 through 2001, only 0.2% of the daily average DO values measured at the Acosta Bridge site were below the current 4.0 mg/L minimum concentration in Florida's current marine DO criteria. Similarly, downstream at the Dames Point site less than approximately 2% of the daily average DO measurements were below 4.0 mg/L. While using the CMC (criterion minimum concentration) of 2.3 mg/L specified in the EPA Virginian Province for the LSJR would likely protect aquatic life from the acute effects of exposure to low DO levels, a CMC of 2.3 mg/L would allow minimum DO levels in the LSJR to be degraded from current conditions. Therefore, it is recommended that a CMC or minimum criterion of 4.0 mg/L be utilized for the LSJR instead of the 2.3 mg/L value recommended by EPA. By increasing the CMC to 4.0 mg/L, the level of protection afforded by the proposed SSAC would also be increased beyond that provided by the EPA recommended approach and is consistent with Florida's existing DO criteria for marine waters.

In addition, it is recommended that EPA's recommended CCC (criterion continuous concentration) of 4.8 mg/L be adjusted upward to 5.0 mg/L. In deriving the CCC, EPA "adjusted" the total number of species (i.e., "n") from the 11 species for which growth response data were available to the 22 species for which acute response data were available. Recalculating the CCC based on an "n" of 11, a value of approximately 5 mg/L is obtained. Additionally, the use of a 5.0 mg/L CCC instead of EPA's recommended 4.8 mg/L is consistent with the State's existing criteria and would provide a basis for requiring permitted discharges to continue to comply with 5.0 mg/L discharge limits currently in place. The use of 5.0 mg/L as the CCC would also afford a slightly increased level of protection compared to EPA's recommended value of 4.8 mg/L.

In the DO range between the CMC (4.0 mg/L) and the CCC (5.0 mg/L) the allowable duration within a portion of this range would be defined by the EPA's recommended Final Recruitment Curve (FRC) (EPA 2000 as shown in **Figure 3**). However, EPA's FRC plateaus at approximately 4.6 mg/L leaving the effect of exposure to DO concentrations in the interval between 4.6 mg/L and the CCC of 5.0 mg/L difficult to interpret. Since the EPA's FRC is based on the larval recruitment/survival of sensitive species, an additional component could be added to consider the **larval growth** response of sensitive species to interpret the effect of exposure to DO levels between the FRC and the CCC.

The proposed SSAC for DO in the LSJR utilizes the dose-response relationship between DO and growth of the most sensitive species identified by EPA (EPA 2000). In the documentation of the derivation of the DO criteria for the Virginian Province (EPA 2000), *Homarus americanus* (American lobster) is identified as the most sensitive species to low DO levels. As discussed previously, since species known to inhabit Florida waters generally bracket the range of sensitivities to low DO levels, it is not unreasonable to use data for the American lobster to represent an equally sensitive species that could potentially exist in the LSJR for which data does not exist. The use of the response of the American lobster in southern waters is also consistent with EPA guidance (EPA 2000). Additionally, using the single most sensitive species to develop the larval growth component of the SSAC would be very conservative and yield a criterion that is highly protective of all aquatic life.

As shown in **Figure 4,** using the data provided by EPA in the derivation of the Virginian Province DO criteria (EPA 2000), the lobster dose-response curve is approximated by a linear function:

$$\mathbf{G_{fr} = -0.231 * [DO] + 1.381} \qquad \textbf{(equation 1)}$$

where $\mathbf{G_{fr}}$ is the fractional reduction in growth rate below that of controls and **[DO]** is the dissolved oxygen concentration in mg/L. Using this function to determine the degree of growth reduction associated with a given **[DO]**, the impact on growth of a given duration of exposure to a range of concentration in DO can be estimated by another function:

$$\mathbf{R_{ygp} = T_e * G_{fr} / T_g} \qquad \textbf{(equation 2)}$$

where $\mathbf{R_{ygp}}$ is the fractional reduction of the year's larval and juvenile growth potential for the most sensitive species, $\mathbf{T_e}$ is the days of exposure within a specified range in concentration of dissolved oxygen, and $\mathbf{T_g}$ is the number of days within the year when larval and juvenile growth primarily occurs.

If equation 1 is then substituted for $\mathbf{G_{fr}}$ in equation 2 and equation 2 is then solved for $\mathbf{T_e}$, the resulting equation becomes:

$$\mathbf{T_e = -\frac{T_g * R_{ygp}}{0.231 * [DO] + 1.381}} \qquad \textbf{(equation 3)}$$

A value of 0.05 can be inserted for $\mathbf{R_{ygp}}$ to specify that no more than a 5% reduction in growth across the larval population on an annual basis is acceptable. Using a $\mathbf{R_{ygp}}$ value of 0.05 is consistent with acceptable level of impairment used by EPA in the derivation of the Virginian Province DO criteria. The annual number of days in which larval and juvenile growth of sensitive species can be expected to occur can be estimated using growth information available for sensitive species indigenous to the LSJR. The available information (Vernberg and Piyatirattivorakul, 1998; Tagatz, 1968) indicates that significant growth is inhibited at temperatures below 15°C and increases markedly between 15 and 20°C. Using the mid-point of this range, significant growth of the sensitive species in the LSJR can be considered to occur at temperatures of 17.5°C and above. Further, using the USGS monitoring data collected at the Acosta Bridge and Dames Point sites in the LSJR between 1996 and 2001, the annual number of days in which the water temperature is at or above 17.5 °C ranged from 261 to 291 with an average of 275 days being at or above 17.5°C.

Inserting the values of 0.05 for $\mathbf{R_{ygp}}$ and 275 for $\mathbf{T_g}$ into equation 3, the equation becomes:

$$\mathbf{Te = -\frac{13.75}{0.231 * [DO] + 1.381}} \qquad \textbf{(equation 4)}$$

The growth function described by equation 4 is plotted for exposure durations from 20 to 70 days in **Figure 5** along with a graphic representation of the other components (i.e., CCC, CMC, and FRC) of the proposed DO SSAC for the LSJR. The larval growth function intersects the larval population survival function (i.e., EPA's FRC) at a DO concentration of approximately 4.6 mg/L. This indicates that the larval population survival function would apply at DO concentrations between the CMC of 4.0 mg/L and 4.6 mg/L while the added growth function based on the lobster would apply over the DO range from 4.6 mg/L to the CCC of 5.0 mg/L. Utilizing a combination of the larval population survival function (EPA's FRC) and the larval growth function in this manner, the proposed SSAC for the LSJR provides protection to both larval population recruitment/survival as well as larval growth.

By comparing EPA's DO criteria for the Virginian Province depicted in **Figure 3** with the components of the proposed DO SSAC for the LSJR derived using a slightly modified application of EPA approach as illustrated in **Figure 5**, it is clear that each component of the proposed DO SSAC affords an equal or in most cases a greater level of protection to the aquatic life in the LSJR compared to EPA's criteria for the Virginian Province. Therefore, the proposed SSAC is expected to provide more than adequate level of protection to all aquatic life in the LSJR from exposure to low DO levels.

Derivation of the Proposed SSAC for DO in the LSJR

In accordance with EPA recommendations for the Virginian Province (EPA 2000), the DO range between the CMC of 4.0 mg/L and CCC of 5.0 mg/L would be divided into intervals corresponding to the approximate accuracy of the instrumentation used to make the measurements. For the proposed LSJR SSAC, intervals from 4.0 to 4.2 mg/L; 4.2 to 4.4 mg/L; 4.4 to 4.6 mg/L; 4.6 to 4.8 mg/L; and 4.8 to 5.0 mg/L based on the applicable portions of the larval population recruitment/ survival function (i.e., EPA's FRC) and the larval growth function.

The applicable larval population recruitment/survival function, and the larval growth function shown in **Figure 5** can then be used to derive the acceptable exposure durations for each interval. Using the center point of each interval the maximum allowable cumulative duration of DO levels within the 4.0 to 4.2 mg/L; 4.2 to 4.4 mg/L; and 4.4 to 4.6 mg/L intervals would be 16, 21, and 30 days, respectively, based on the final larval recruitment curve. Likewise, the maximum allowable cumulative duration of DO levels within the 4.6 to 4.8 mg/L and 4.8 to 5.0 mg/L intervals would be 47 and 55 days, respectively, based on the larval growth curve.

Since the biological effect of low DO exposure is cumulative across the DO intervals, the fractional exposures within each range would be summed as proposed by EPA (2000). The SSAC would be achieved if the sum of the fractional exposures was less than 1. Based on the proposed SSAC for the LSJR, the sum of the fractional exposures between 4.0 and 5.0 mg/L can be expressed as:

$$\left(\begin{array}{c}\textbf{Total Fractional}\\ \textbf{Exposure}\end{array}\right) = \frac{\begin{array}{c}\textbf{Days between}\\ \textbf{4.0 - < 4.2 mg/L}\end{array}}{\textbf{16 day Max}} + \frac{\begin{array}{c}\textbf{Days between}\\ \textbf{4.2 - < 4.4 mg/L}\end{array}}{\textbf{21 day Max}} + \frac{\begin{array}{c}\textbf{Days between}\\ \textbf{4.4 - < 4.6 mg/L}\end{array}}{\textbf{30 day Max}} + \frac{\begin{array}{c}\textbf{Days between}\\ \textbf{4.6 - < 4.8 mg/L}\end{array}}{\textbf{47 day Max}} + \frac{\begin{array}{c}\textbf{Days between}\\ \textbf{4.8 - < 5.0 mg/L}\end{array}}{\textbf{55 day Max}}$$

where the number of days within each interval is based on the daily average DO concentration.

For example, a year with the durations of DO levels for the intervals between 4.0 and 5.0 mg/L as shown in **Table 3**, the Total Fractional Exposure can be expressed as:

$$\textbf{Total Fractional Exposure} = \frac{1}{16} + \frac{4}{21} + \frac{7}{30} + \frac{9}{47} + \frac{12}{55} = 0.896$$

Because the sum of the fractional exposures in this case is less than 1 (i.e., 0.896), the proposed SSAC would be achieved assuming the 4.0 mg/L minimum was not exceeded.

DO Interval (mg/L)	Example, Measured Interval Duration (days/year)	Maximum Interval Exposure Duration (days/year) [a]	Fractional Interval Exposure [b]
4.0 - <4.2 mg/L	1	16	0.063
4.2 - <4.4 mg/L	4	21	0.190
4.4 - <4.6 mg/L	7	30	0.233
4.6 - <4.8 mg/L	9	47	0.191
4.8 – <5.0 mg/L	12	55	0.218
Total Fractional Exposure			**0.896**

[a] Maximum exposure durations for intervals between 4.0 and 4.6 mg/L were determined from EPA Final Recruitment Curve and for intervals between 4.6 and 5.0 mg/L maximum exposure durations were determined from the larval growth curve (see Figure 5).

[b] Fractional interval exposure is the measured interval duration divided by the maximum exposure duration for that interval.

Final Proposed SSAC for DO in the LSJR

From the information provided above, the proposed SSAC for DO in the LSJR would be comprised of two parts. The first part of the proposed SSAC is a minimum DO concentration of 4.0 mg/L. In addition, the Total Fractional Exposure to DO levels in the 4.0 to 5.0 mg/L range must also be at or below 1.0 for each annual evaluation period as determined by the equation:

$$\left(\begin{matrix}\textbf{Total Fractional}\\ \textbf{Exposure}\end{matrix}\right) = \frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.0 - < 4.2 mg/L}\end{matrix}}{\textbf{16 day Max}} + \frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.2 - < 4.4 mg/L}\end{matrix}}{\textbf{21 day Max}} + \frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.4 - < 4.6 mg/L}\end{matrix}}{\textbf{30 day Max}} + \frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.6 - < 4.8 mg/L}\end{matrix}}{\textbf{47 day Max}} + \frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.8 - < 5.0 mg/L}\end{matrix}}{\textbf{55 day Max}}$$

where the number of days within each interval is based on the daily average DO concentration.

Therefore, the proposed SSAC for DO in the LSJR would be a minimum concentration of 4.0 mg/L and a Total Fractional Exposure in the range of 4.0 to 5.0 mg/L of 1.0 or less as determined by the equation above. The proposed SSAC would be utilized to assess the ambient DO status of the waters in the LSJR. It is anticipated that permitted discharges would continue to be required to achieve a DO concentration equal to or above the 5.0 mg/L CCC indicated in **Figure 5.**

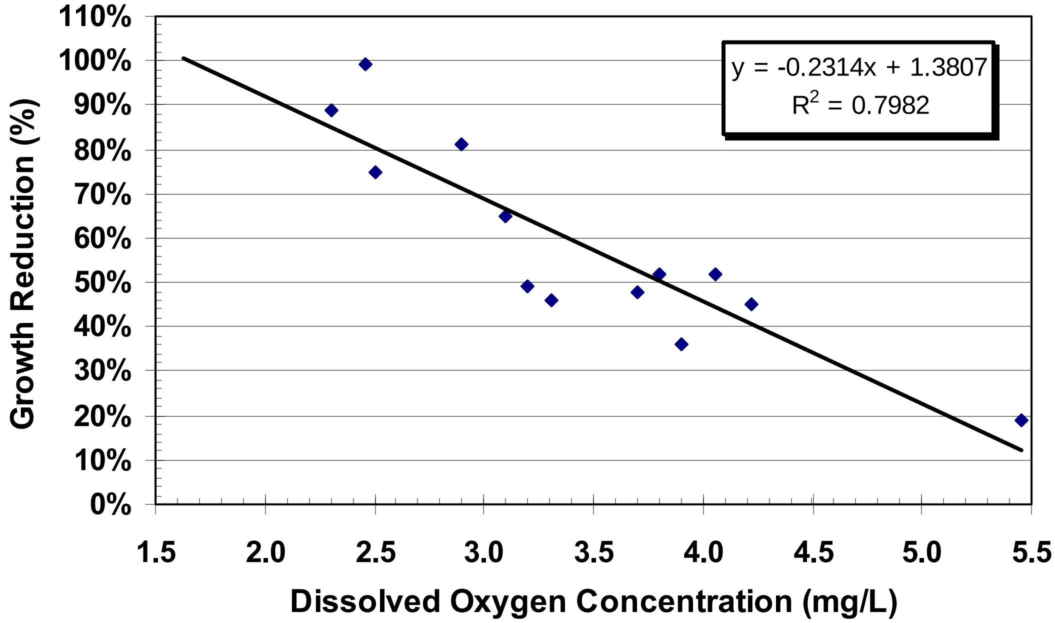

Figure 4. **Growth response curve for the American lobster (*Homarus americanus*) exposed to various continuous low DO concentrations. Graph reproduced from EPA 2000.**

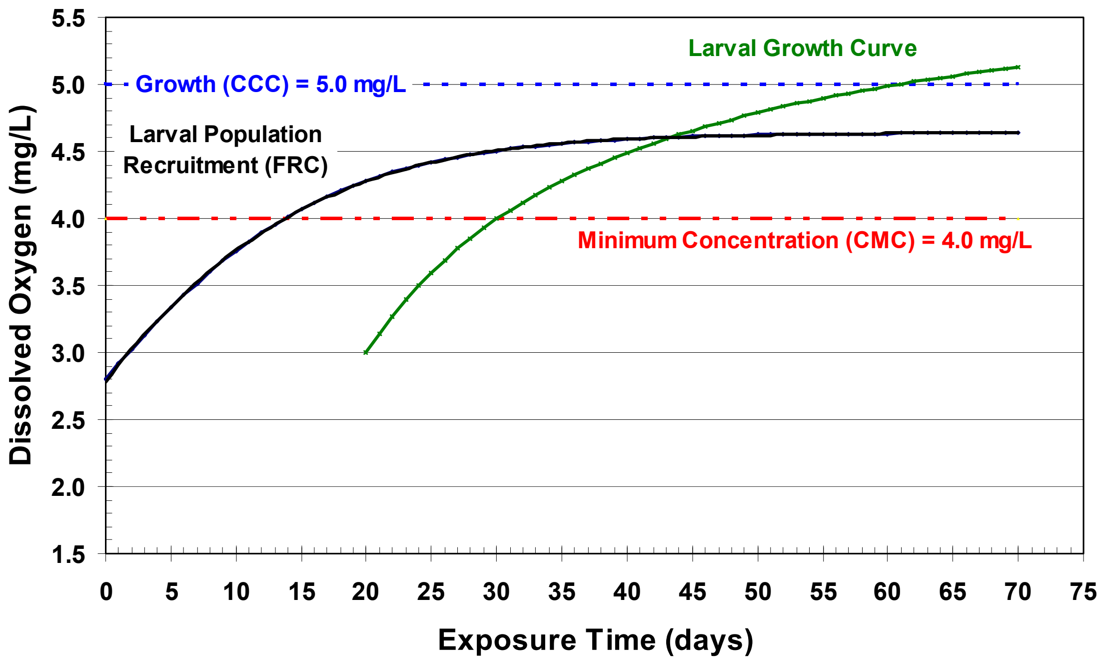

Figure 5. **Plot of the various components of the proposed SSAC for DO in the LSJR**

Literature Cited

CSA, Inc. 1993. Fish Assemblages Inhabiting an Oligohaline Segment of the Lower St. Johns River, Florida. St. Johns River Water Management District Special Publication SJ93-SP11. 75 pp. DeMott, W.R. and F.

Florida Marine Research Institute. 2002. Fisheries Independent Monitoring Program 2001, Annual Data Summary Report. Florida Marine Research Institute, St. Petersburg, Florida.

Frydenborg R. 2005. Personal Communication. Florida Department of Enviromental Protection, Bureau of Laboratories, Tallahassee, FL.

Hendrickson J, EF Lowe, D Dobberhuhl, P Sucsy, D Campbell. 2003. Characteristics of Accelerated Eutrophication in the Lower St. Johns River Estuary and Recommended Targets to Achieve Water Quality Goals for the Fulfillment of TMDL and PLRG Objectives. St. Johns Rivers Water Management District, Palatka, FL.

Stephan CE, Mount DI, Hansen DJ, Gentile GH, Chapman GA, Brungs WA. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. National Technical Information Service Publication No.: PB85-227049.

Tagatz, M.E., 1968. Biology of the Blue crab, *Callinectes sapidus* Rathburn, in the St. Johns River, Florida. Fishery Bullentin, 67(1):17:33.

Thursby GB. 2003. National Saltwater Criteria for Dissolved Oxygen: Potential Addenda to Virginian Province Saltwater Criteria for Warmer and Colder Waters. Environmental Protection Agency, Office of Research and Development, Narragansett, RI. AED-03-113.

U.S. EPA. 2000. Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hattaras. Environmental Protection Agency, Office of Water, Washington D.C. PA-822-R-00-012.

Vernberg, J. and S. Piyatirattivorakul, 1998. Effects of salinity and temperature on the bioenergetics of adult stages of the grass shrimp (*Palaemonetes pugio* Holthuis) from the north inlet estuary, South Carolinia. Estuarties, 21(1): 176-193.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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ATLANTA, GEORGIA 30303-8960

OCT 1 0 2006

Ms. Mimi Drew, Director
Water Resource Management
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Dear Ms. Drew:

The U.S. Environmental Protection Agency (EPA) has completed its review of the Site Specific Alternative Criteria (SSAC) for Dissolved Oxygen (DO) in the Lower St. Johns River, Florida Administrative Code 62-302.800(5). This site specific revision to Florida's existing DO criterion was adopted by the Florida Environmental Regulation Commission on May 25, 2006, and submitted to EPA by letter dated June 30, 2005, from Gregory M. Munson, General Counsel of the Florida Department of Environmental Protection, to James I. Palmer, Jr., Regional Administrator. Mr. Munson also certified that the revisions were duly adopted as water quality standards pursuant to state law. The SSAC will become effective for Clean Water Act (CWA) purposes upon approval by EPA.

The revision establishes a SSAC for dissolved oxygen for the Class III marine portion of the lower St. Johns River and its tributaries between Julington Creek and the mouth of the river. Specifically, the SSAC retains the existing minimum concentration of 4 mg/L of dissolved oxygen and replaces the existing 5 mg/L daily average concentration with an annual total fractional exposure (TFE) index of 1.0 that is not to be exceeded. This TFE is established at a level that protects both larval recruitment and growth for aquatic organisms. EPA's *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras* (EPA-822-R-00-012) served as the initial basis for the formulation of this SSAC.

In January 2001, EPA, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service signed a memorandum of agreement (MOA) which governs the exercise of EPA's authorities under Sections 303(c), 304(a), and 402 of the Clean Water Act in relation to EPA's obligations under Section 7 of the Endangered Species Act. This MOA addresses EPA's review and approval of State-adopted water quality criteria for the circumstances of the revisions to Florida's water quality criteria for aquatic life.

EPA's decision to approve the SSAC for DO in the Lower St. Johns River is subject to the results of the national consultation under Section 7 of the Endangered Species Act with the U.S. Fish and Wildlife Service. By approving the SSAC, "subject to the results of the national consultation," EPA retains its discretion to take appropriate

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action if the consultation identifies deficiencies in the standards requiring remedial action by EPA. EPA will notify the State if remedial action is required.

In summary, this SSAC is consistent with the requirements of the Clean Water Act and 40 CFR Part 131, and I am approving this revision to Florida water quality standards. If you have questions, please contact me at 404-562-9345 or have a member of your staff contact Joel Hansel at 404-562-9274.

Sincerely,

James D. Giattina, Director
Water Management Division

Appendix M: Determination of Nitrogen and Phosphorus Nonpoint Loads for Urban Stormwater Jurisdictions

Determination of Nitrogen and Phosphorus Non-Point Source Loads for Urban Stormwater Jurisdictions of the Lower St. Johns River Basin

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Lower St. Johns River Basin Program

Courtney Hart, GIS Analyst
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August 2007

Determination of Nitrogen and Phosphorus Non-Point Source Loads for Urban Stormwater Jurisdictions of the Lower St. Johns River Basin

Purpose

- To allocate urban stormwater load reductions to responsible parties
- To partition urban stormwater into loads emanating from old urban areas developed prior to the requirement of stormwater BMPs, and new urban area loads, a necessary distinction for establishing TMDL formula level 2 and level 3 reductions
- To establish a relative value on which to base trading pollution reductions to other point and non-point entities.
- To determine the spatial characteristics of urban area load reductions for verification of the revised TMDL

Background

This effort represents the third revision of the calculation of urban stormwater/nonpoint source loads for the lower St. Johns River Basin. The first iteration calculated loads only for major governmental entities (whole counties or municipalities with phase I or II NPDES stormwater permits). This calculation was later revised to distinguish MS4 areas within counties. However, this second analysis was incomplete, as it failed to account for urban area loads outside of designated MS4 areas.

This third revision represents the most complete examination of urban stormwater loads from the lower St. Johns River Basin and their categorization with regard to NPDES stormwater permitting authority and the TMDL. Under the TMDL, allowable loadings are allocated between point source loads which are expressed as part of the wasteload allocation(WLA) and nonpoint loads which are part of the load allocations (LA). Although stormwater discharges traditionally are considered to be nonpoint sources of pollution, certain urban stormwater discharges legally are considered to be point sources since they are covered by a NPDES MS4 stormwater permit. These urban stormwater point sources are placed under the WLA side of the TMDL equation. All other loads are placed under the LA category, including natural background loads, atmospheric deposition, augmented nonpoint source loads that occur from agriculture, forestry, and urban development outside of MS4 areas. The finer-scale sub-division of loads under this analysis expands the number or responsible urban stormwater entities contributing to the river's marine reach from eight to sixteen. Together with the freshwater reach loads that are now included in this analysis, there are thirty-seven entities for which urban stormwater loads and TMDL level 2 reductions have been identified.

This urban stormwater load assessment also benefits from more comprehensive GIS land use/land cover data on which to base projected 2008 nutrient loads. In earlier calculations, future loads were estimated from DOT traffic analysis zone population

Table 1. Urban Stormwater Jurisdictions and Areas for the Marine and Freshwater Contributing Basins of the LSJR

Jurisdiction	WLA	LA	Total Area (Acres)
Marine Reach Contributing Area			
Duval County Marine	X		377,458
Clay Marine UA	X		31,421
St. Johns County Marine UA	X		13,841
Jacksonville Beach	X		4,652
NAS Jacksonville	X		3,843
Mayport NS	X		2,822
Orange Park	X		2,308
Marine Reach WLA Sub-total			**436,345**
Clay Marine Non-UA		X	191,873
Camp Blanding		X	54,929
St. Johns County Marine Non-UA		X	33,334
Penney Farms		X	894
Marine Reach LA Subtotal			**281,029**
Freshwater Reach Contributing Area			
Green Cove Springs	X		3,848
Clay County Fresh UA	X		1,940
Freshwater Reach WLA Sub-total			**5,788**
Putnam County Fresh Non-UA		X	217,472
St Johns County Fresh Non-UA		X	178,548
Clay County Fresh Non-UA		X	54,179
Flagler County Fresh Non-UA		X	4,759
Palatka		X	4,447
Welaka		X	425
Hastings		X	421
Pomona Park		X	219
Freshwater Reach LA Sub-total			**460,470**

[1] UA = Urbanized Area based on 2000 Census data for NPDES Phase II applicability

projections, which were then converted by a regression model to urbanized area. Due to the recent availability of 2004 land use/land cover data, this analysis forecasts 2008 urban area through a regression model utilizing four land cover data sets from 1989 through 2004.

Determination of NPDES MS4 Status and 1984 and 2008 Urban Areas

Based on guidance provided by staff at FDEP regarding the determination of responsibilities for urban stormwater under the NPDES program, a GIS coverage was created by combining the boundaries of governmental entities (counties, municipalities, and military installations), established MS4 boundaries, and 2000 census urbanized areas (areas identified with urban stormwater permit requirements under phase II). The resulting coverage relegated the entire area of the LSJR basin into one of 37 mutually-exclusive areas that were NPDES Phase I, NPDES Phase II, or non-NPDES stormwater responsibility. A number of these areas were then re-combined based upon guidance from MS4 permit holders. Most notable among these subsumed areas was the placement of Cecil Field and the Mayport Fuel Depot into the Duval MS4, the combining of the St. Johns County Julington Creek Plantation and Ponte Vedra into one St. Johns UA category, and the placement of the East Palatka area under the Putnam County jurisdiction. The final list contained 21 areas (Table 1; Figure 1). This report does not address the individual entities adding nutrient load to the Crescent Lake Basin, and this contributing watershed is considered to have a single allocation. Also, karst areas within the LSJR basin in eastern Alachua county and western Clay county with no surface water connections to the St. Johns River are excluded from the allocation process.

Successive years of land use/land cover data were overlain on these 37 areas to examine growth trends for the purpose of hindcasting and forecasting the 1984 urban areas (areas presumed to have been developed without stormwater runoff BMPs) and the 2008 urban area (starting point for load allocations). Figure 2 provides an example of how this calculation was performed for the Jacksonville Phase I area. The calculated 1984 and 2008 urbanized areas within each of the jurisdictional entities are listed in Table 2. Urban areas were defined in the land use/land cover data as the sum of low, medium and high density residential, low and high intensity commercial, and industrial classes.

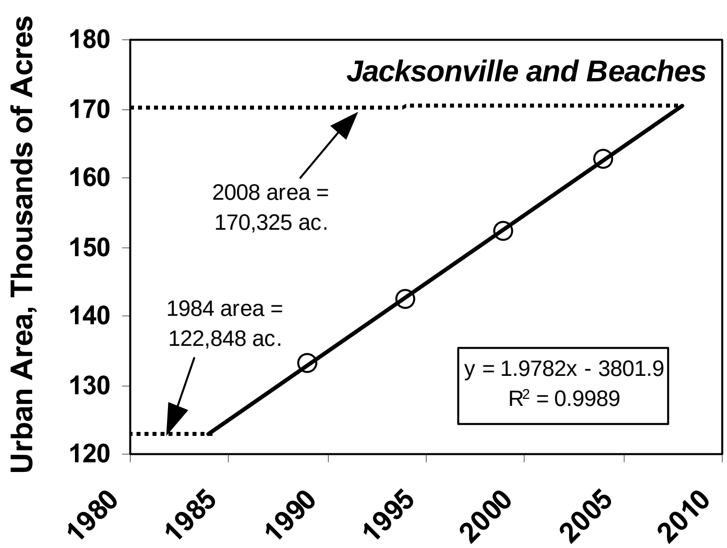


Figure 2. Example of urban area load extrapolation to 1984 and 2008 for the Jacksonville and Beaches MS4 area.

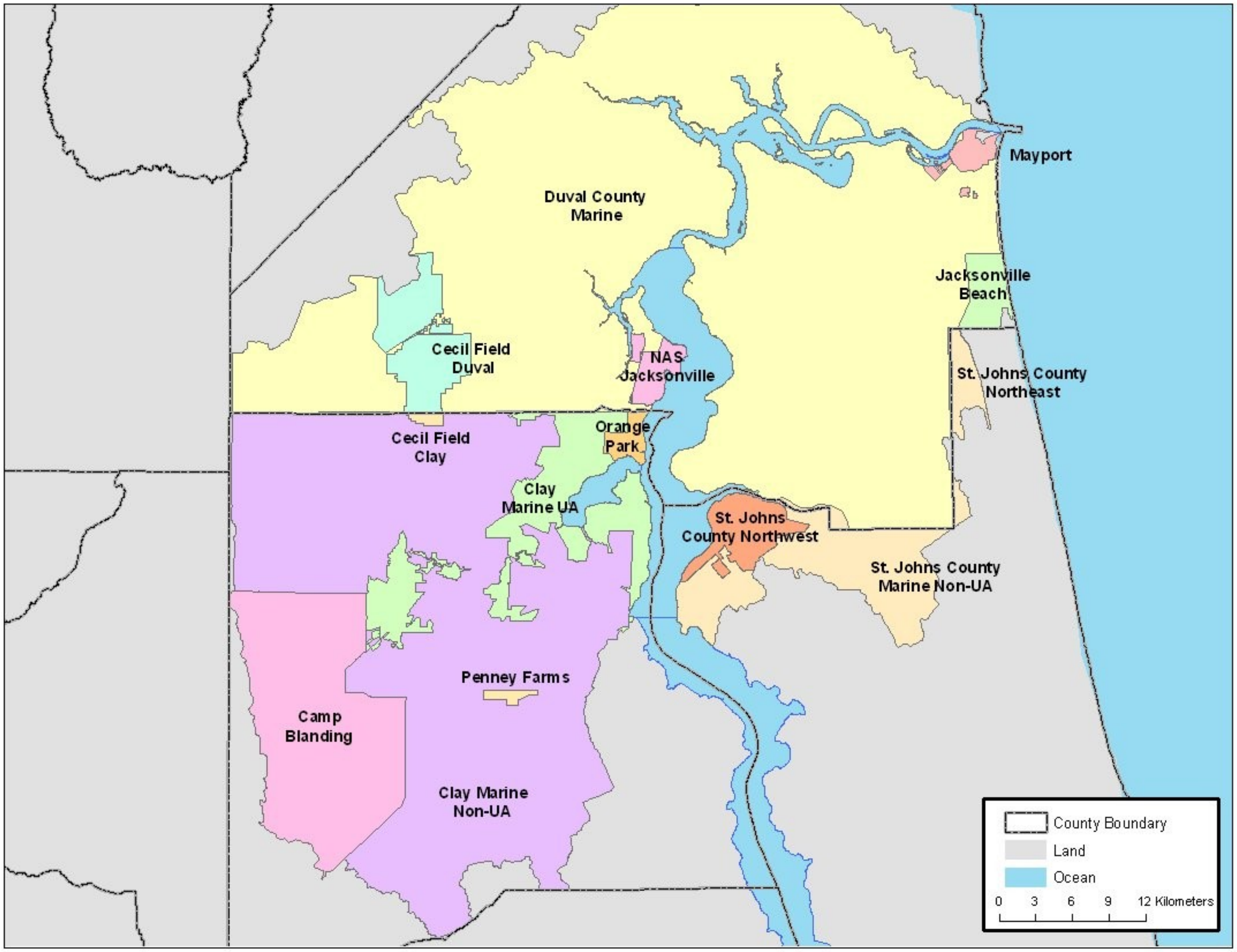


Figure 1. Urban Stormwater Jurisdictions Contributing to the Marine Reach of the Lower St. Johns River

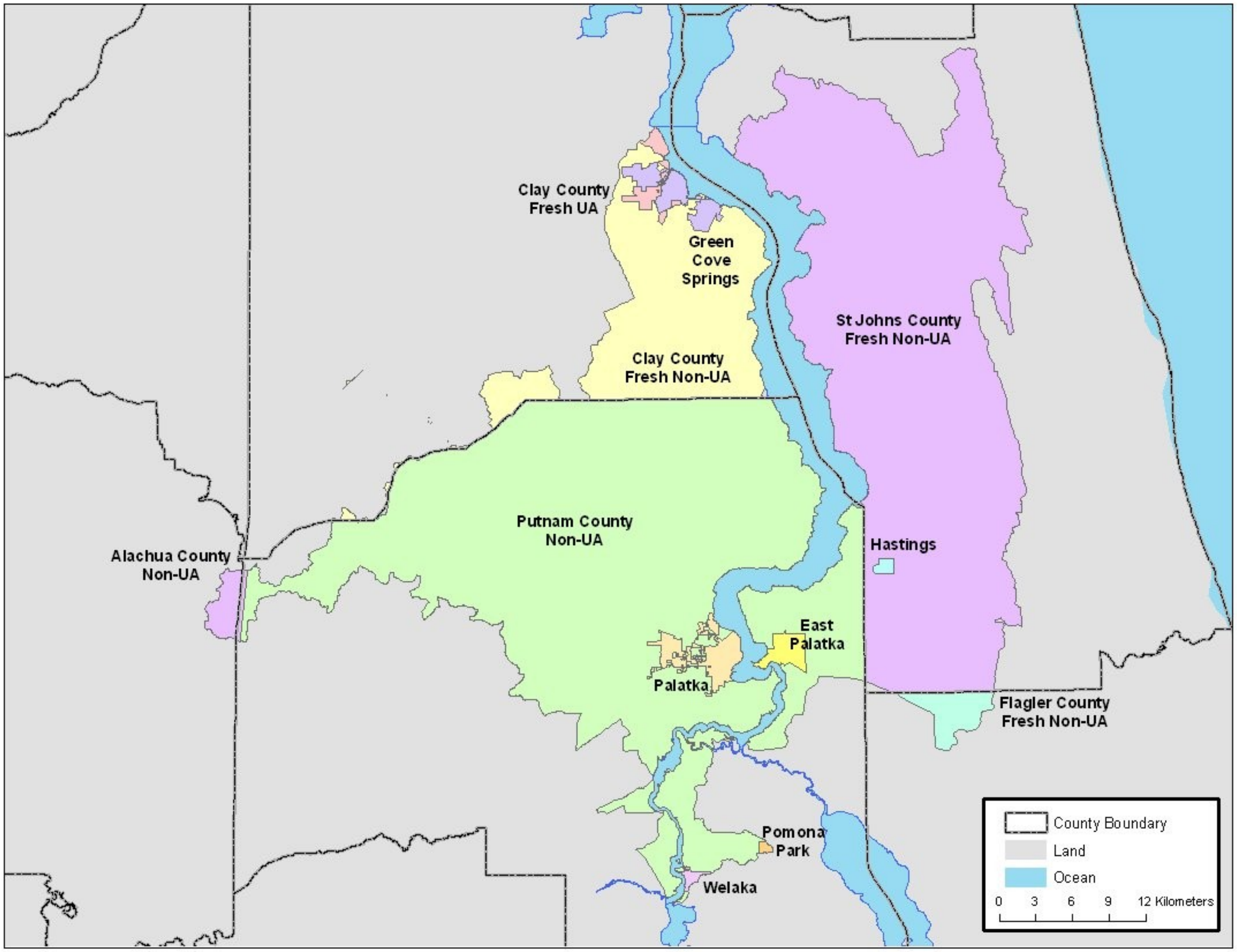


Figure 1. Urban Stormwater Jurisdictions Contributing to the Freshwater Reach of the Lower St. Johns River

Table 2. Estimated 1984 and 2008 Urbanized Areas within Urban Stormwater Entities

Jurisdiction	WLA	LA	Urban Areas, acres[1]						Comments[2,3]
Marine Reach			**1984**	1989	1994	1999	2004	**2008**	
Duval County Marine	X		**125,895**	136099	144622	154536	165417	**173,023**	8.0088*(x/100) - 1539; R2=0.99
Clay Marine UA	X		**15,001**	16375	19371	21253	22138	**24,203**	155.22x - 301883; R2=0.94
St. Johns County Marine UA	X		**4,219**	5338	5827	7084	8617	**9,445**	[4] 22.281x - 43282; R2=0.99 (SJ East); 77.347x - 152947; R2=0.97 (SJ West)
Jacksonville Beach	X		**2,107**	2265	2390	2610	2703	**2,844**	12.443x - 23834; R2=0.98
NAS Jacksonville	X		**2,475**	2476	2311	2367	2482	**2,482**	No clear trend
Mayport NS	X		**1,434**	1434	1313	1305	1387	**1,387**	No clear trend
Orange Park	X		**1,936**	1937	1954	2011	2004	**2,004**	No clear trend
Clay Marine Non-UA		X	**16,860**	16860	16780	17823	20232	**21,395**	139.73x - 271916; R2=0.95
Camp Blanding		X	**3,022**	3022	2404	2407	2674	**2,674**	No clear trend
St. Johns Co. Marine Non-UA		X	**1,112**	1470	1981	2051	2697	**2,912**	30.375x - 59814; R2=0.93
Penney Farms		X	**185**	202	195	228	228	**228**	No clear trend
Freshwater Reach									
Green Cove Springs	X		**2,188**	2188	2247	1965	2041	**2,041**	No clear trend
Clay County Fresh UA	X		**1,152**	1152	1102	1121	1098	**1,098**	No clear trend
Putnam County Fresh Non-UA		X	**20,764**	20213	23466	24319	25925	**27,603**	146.28x - 282829; R2=0.94
St Johns County Fresh Non-UA		X	**4,700**	8380	8832	14670	16237	**18,817**	238.13x - 470547; R2=0.90
Clay County Fresh Non-UA		X	**2,466**	2466	3540	3446	3476	**3,476**	No clear trend
Flagler County Fresh Non-UA		X	**3**	3	2	3	6	**6**	No clear trend
Palatka		X	**3,169**	3169	3044	3009	3050	**3,050**	No clear trend
Welaka		X	**384**	327	311	306	197	**195**	-3.1981x + 6500.6; R2=0.73
Hastings		X	**229**	229	245	239	234	**234**	No clear trend
Pomona Park		X	**65**	65	79	79	29	**29**	No clear trend

[1]Urban areas 1989 - 2004 from GIS Land Use coverages; 1984 and 2008 predicted.
[2]Regression equations based on areas in hectares; x=year
[3]If no clear growth trend, 1989 Urban Area =1984; 2004 Urban area = 2008
[4]Growth flat until 95-99; linear regression under-predicts 1984 and 2008. Trend determined from 1995-2004.

Estimation of Representative Nutrient Concentrations for Urban Areas

The underlying concepts embodied in the non-point source watershed modeling for the TMDL were employed to estimate urban area stormwater loads,. In this model, nutrient load in runoff for an area is calculated as the product of separately determined estimates of concentration and runoff volume. The model relies upon the premise that nutrient concentrations and runoff volume tend to be similar for characteristic land development types, owing to the fact that these land development types and the ensuing activities within them have similar nutrient-generating aspects. These land development types are derived from the Florida Land Use Land Cover classification system, with the lowest level urban delineations in this data layer aggregated into six super-groups of land use (low density residential, medium density residential, high density residential, low intensity commercial, high intensity commercial, and industrial), represented by the level II land uses of Figure 3. Because there are significant climactic, physiographic and developmental (mostly infrastructure related) regional aspects to the propensity for nutrient export in runoff from urban lands, regional data should be used to characterize typical land use-water quality. Harper (1994) has compiled data for studies conducted in Florida, to produce regionally relevant water quality statistics for these land uses.

The land use water quality values used for the LSJR TMDL are fundamentally different than the Harper (1994) in their derivation. While the Harper data are compiled from nitrogen and phosphorus concentrations measured in runoff from small catchments of one predominant land development type (typically tens of acres in size), the LSJR TMDL watershed model values were derived from water quality monitoring data from 30 well-sampled tributaries draining large watersheds (tens to hundreds of square miles) in the LSJR basin. Specific land use water quality concentrations were calculated with multiple regressions relating seasonal flow-weighted concentrations to the fractions of major (level I; Figure 3) watershed land use. In watersheds where only urban development was present, TN and TP coefficients were also determined by extrapolating the fraction of developed area – nutrient concentration regressions to the point of 100 percent watershed land cover, as shown in the example of Figure 5. The resulting LSJR concentrations are lower that the Harper (1994) values (Table 3; Figure 4), presumably because sedimentation, denitrification and assimilation by primary and secondary producers reduces nutrients from their point of mobilization. The LSJR watershed model coefficients were adjusted in this manner to provide the most accurate values of watershed load to the river water quality model, as actual measured data is generally preferred over unsubstantiated literature values when such accuracy is desired (Donigian and Huber, 1991). For urban land use as a whole, the LSJR nitrogen concentrations tend to be 67 percent of the Harper literature data, while phosphorus values are similar (95 percent). The runoff coefficient (RC) values, the fraction of incident rainfall that ultimately ends up in streamflow at a broad temporal scale, tend to be half of the Harper literature values. The departure in RC arises from the very low value for low density residential in the LSJR TMDL model, which was assigned to reflect

Figure 3. Hierarchy of Land Use Classifications Used in the LSJR TMDL Non-point Source Nutrient Load Modeling. Top level land use categories are referred to as "Level I"; Mid-level categories are referred to as "Level II". Bottom boxes of the tree identify the Florida Land Use Land Classification Codes aggregated into the Level II categories.

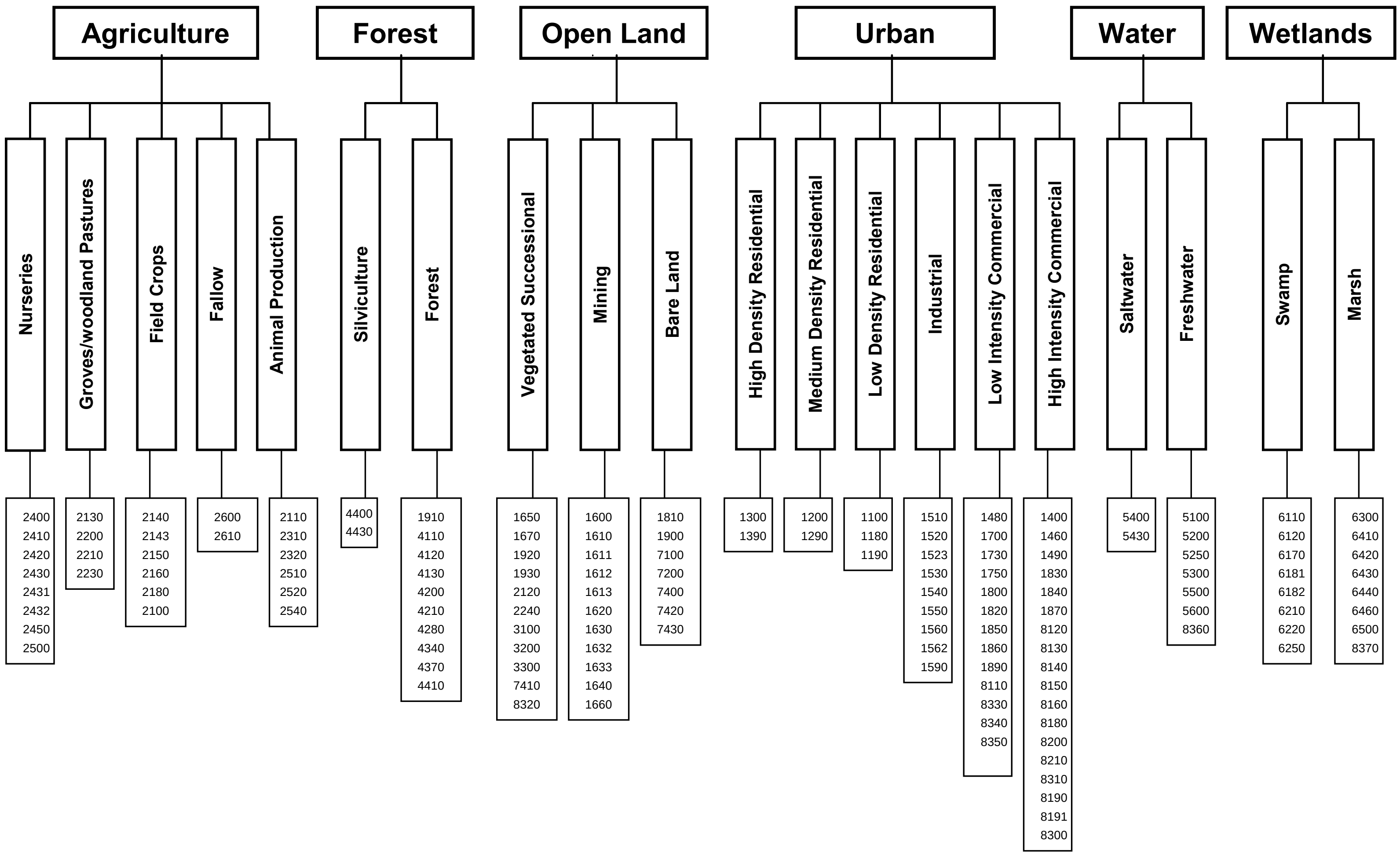


Table 3. Event Mean Concentrations of Total N and P in Runoff for Florida Studies on Small Catchments of Homogeneous Land Use, and Values derived by Regression from Large Watershed Monitoring Data of the LSJR Basin. (*)RC values reflect rural homestead-level development, and were not used in determining the RCs for new development.

	Source	Variable	Low Density Residential	Med. Density Residential	High Density Residential	Low Intensity Commercial	High Inten. Commercial	Industrial
Typical Florida Values, Small Catchment of Homogeneous Land Use	Harper, 1994	N	1.77	2.29	2.42	1.18	2.83	1.79
		P	0.177	0.300	0.490	0.150	0.430	0.310
		RC Avg. Yr	0.268	0.373	0.675	0.837	0.887	0.793
LSJR TMDL Values, Based on Whole Watershed Land Use	Hendrickson and Konwinski, 1998	N	0.80	1.50	1.83	1.20	1.83	1.23
		P	0.080	0.300	0.443	0.240	0.443	0.257
		RC Avg. Yr.	0.123*	0.381	0.406	0.381	0.417	0.381
		RC Dry Yr.	0.090*	0.278	0.296	0.278	0.305	0.278

Figure 4. Comparison of LSJR TMDL and Small Catchment, Homogeneous Land Use N and P Concentrations in Runoff

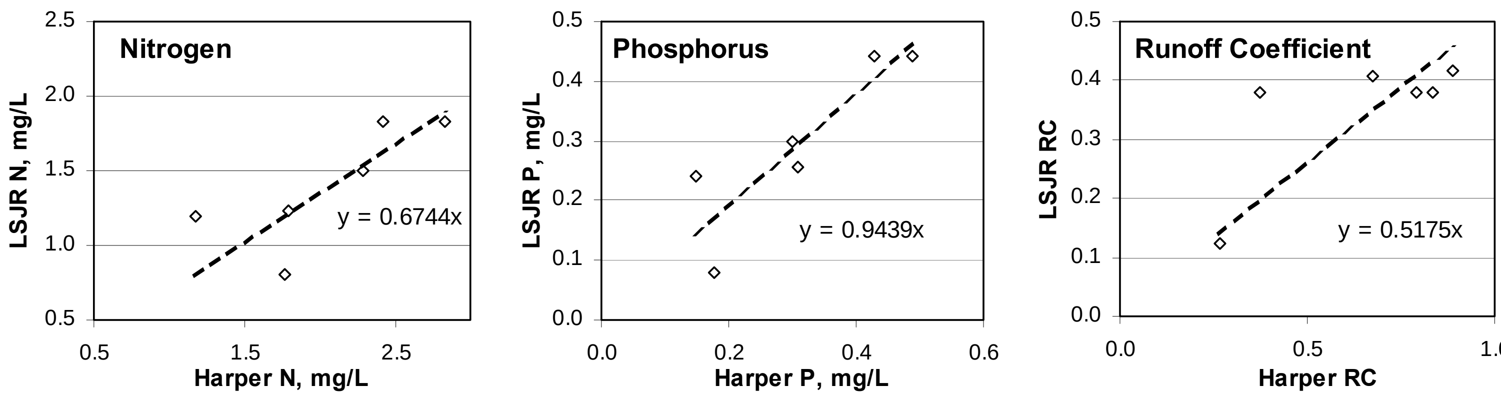
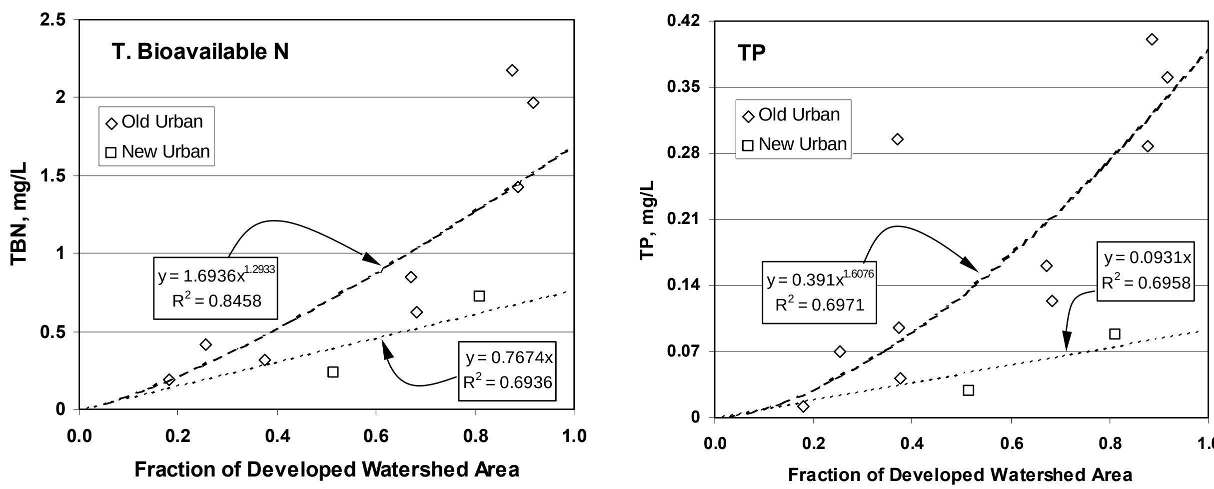


Figure 5. Comparison of Old Urban and New Urban (Post 1984 with Environmental Resource Permit Development Practices) Nitrogen and Phosphorus Concentrations in Runoff



very low development density typical of rural homesteads, and does not reflect the development density assigned to low density residential in the LSJR basin. Due to this large departure from the Harper literature values, this RC value was not used in load calculations for new development.

The LSJR TMDL typical urban area nutrient concentrations are considered to be representative of “old” urban because the data from which they are derived were collected in the early to mid 1990’s from streams draining areas developed prior to 1984, located in the densely developed areas of Jacksonville and northern Clay County. There are several noteworthy characteristics of development subsequent to 1984 that reduce the nutrient concentrations in runoff. The addition of stormwater treatment requirements, impervious area runoff retention, wetland protection, lower overall development density, and the use of sanitary sewer collection instead of septic tanks all are believed to play a role in the lower N and P concentrations observed in post-1984 development. While it would have been possible to model, in a more mechanistic way, typical N and P concentrations representative of newer development by applying literature values on the typical efficiency of stormwater treatment practices, it was felt that this would under-represent the total nutrient load reduction that occurs from the “treatment train” of the additional characteristics listed above. This approach would also not be able to characterize the nature of changes that current stormwater treatment has on the lability of organic nitrogen, a necessary piece of information in subsequent river water quality modeling (a significant portion of organic nitrogen in natural blackwater stream runoff is refractory, or not readily assimilable by algae in time relevant time frames). For these reasons, monitoring from watersheds of only new development was again relied upon to extrapolate to 100 percent model coefficients. Presently, there is a limited amount of data from watersheds dominated by new development, but several sub-watersheds within the large developments of regional impact of Eagle Harbor and Julington Creek Plantation have sufficient data to make preliminary estimates. Using the procedure of extrapolating the developed area of these newly developed residential and commercial developments to 100 percent (Figure 5), a “new” development total bioavailable N (TBN) concentration of around 0.93 mg/L, and TP concentration of around 0.13 mg/L, can be calculated.

Due to the increased amount of impervious surface area in urbanized watersheds, a greater amount of rainfall is directed to runoff, thus increasing the nutrient load. The mean of urban land use RC values used in the TMDL modeling (again representative of older urban areas at a watershed scale) ranged from 0.123 to 0.417, with an average of 0.393 (low density residential omitted). This RC value represents the ratio of runoff to rainfall volume for the watershed scale, long-term average rainfall condition, but in a dry year, the propensity for a rainfall event to generate runoff is reduced, due to soil and vegetation moisture deficits. To account for this in the stormwater source load estimate, the RC was varied based upon a calibration to the ratio of the particular season's rainfall to the long-term rain for that season and for previous seasons, with a factor referred to as the long-term rain ratio. Thus, for the extreme 1999 dry-year case, the urban RC ranged from 0.09 to 0.305, with and overall mean value of 0.287 (low density residential omitted). Insufficient information exists to characterize an RC representative of new urban development at the watershed scale, so this value was estimated by multiplying a hydrologic efficiency of 0.8 for stormwater wet ponds (hydrologic efficiency being the ratio of wet pond exiting volume to that of the total incoming volume; this value is assumed less than 1, as wet pond water volume is lost to evapotranspiration and shallow ground water infiltration) times the aggregate urban land runoff coefficients for average or dry years.

N and P removal Efficiencies for Calculation of TMDL Level 2 Reductions

Nutrient pollutant removal achieved by retrofitted best management practices is dependent upon the particular nutrient form, the treatment system, and the design considerations of the particular system. Even for specific system types, removal efficiencies are highly variable.

Because wet detention if the most commonly applied system for urban stormwater retrofit, published efficiencies for this type of system were used. CDM (2002) provides a range for treatment efficiency for TP of 40 to 50 percent, for TKN of between 20 to 30 percent, and for NO_X of between 30 to 40 percent. Harper (2003) provides equations on the efficiency of wet detention systems based upon residence time. For a 2-week retention time (typical wet pond design target), removal efficiencies were calculated as:

Total N: 8.4126*[Ln(Time, Days)] + 27.25 = 49%
Total P: 8.0847*[Ln(Time, days)] + 44.583 = 66%

Winer (2000) lists nutrient pollution removal efficiencies for stormwater wet ponds of 51% for TP, 66% for soluble P, 33% for TN and 43% for NOX. For calculation of removal efficiencies commensurate with level 2 stormwater retrofit, conservative, low to mid range values have been selected of 30% for TN, and 50% for TP.

Estimation of Urban Area Loads

The Florida Watershed Restoration Act of 1999 directed the Department of Environmental Protection to convene a committee of experts to advise the legislature on the approach to allocating sustainable pollutant loads under the TMDL process. This Allocation Technical Advisory Committee (FDEP, 2001) recommended a stepped process for the reduction of pollutant loads to water bodies. A central concept to this allocation process was that while point sources of pollution throughout the State had instituted accepted technologies to reduce pollutant load, and were operating under permit, most non-point sources of pollution continued unabated. It was the consensus of the committee that reductions in pollutant load should begin first with uncontrolled (non-treated) urban stormwater runoff, prior to the requirement of higher treatment levels from point sources of pollution. Urban stormwater sources were to first institute stormwater management for 45 percent of uncontrolled areas (referred to as level 1), and if this was insufficient, expand area of treatment to 90 percent of uncontrolled areas (level 2). If the level 2 urban stormwater control was insufficient to achieve the TMDL, then point and nonpoint sources shared equal burdens to reduce the remaining excess load.

To apply this allocation guidance to urban stormwater sources of nutrient pollution in the LSJR basin, N and P loads were estimated for:

1. urban areas without stormwater treatment, presumed to be all urban development that occurred prior to the enactment of F.A.C. 40C-4 (Management and Storage of Surface Waters), and later, the general Environmental Resource Permit (F.A.C. 40C-42), as this load would need to be assessed level 1 or level 2 reductions; and
2. urban development with stormwater BMPs, presumed to be new development, or that development that has occurred since 1984, forecast to 2008.

To calculate the untreated urban area loads, the 1989 land use data was aggregated into the six urban subclasses for which typical water quality nutrient concentrations have been determined (Table 2), and loads determined as:

$$(NC_i)*(RC_i)*(RAIN_j)*(AREA_k)$$

Where:

NC_i = the nutrient concentration for land use *i*
RC_i = the runoff coefficient for land use *i*
$RAIN_j$ = the rainfall amount for the year *j*, the average annual condition for the freshwater reach, or the dry year total for the marine reach, and
$AREA_k$ = the area of urban land use *i* for MS4 area *k*.

The urban N and P loads derived from the 1989 land use data were multiplied by the ratio of the 1984 urban area:1989 urban area ratio, with the 1984 urban area predicted by the urban area change over time regressions of Table 2, to provide an estimate of 1984 urban area load.

To estimate the N and P load associated with urban development subsequent to 1984, the formula above was again applied, with the overall urban concentration values of 0.93 mg/L N and 0.13 mg/L P used to represent the aggregate of all urban development categories. Runoff volume was estimated with mean RC values of 0.387 for the average year rain condition, or 0.293 to reflect the dry year condition, with each of these values multiplied by 0.8 to reflect the reduction in runoff by stormwater pond hydraulic efficiency. These single values were used in this load calculation, rather than individual land use category coefficients, as data are not currently available to calculate these watershed scale “new development” rates.

Tables 4 through 7 list the calculated old urban development loads, new urban development loads, total loads and level 2 reductions for both the marine reach and freshwater reach contributing watersheds of the LSJR basin. Old urban area loads are calculated as described above and summed for each of the individual loads of the six urban land development categories, while new urban area loads are determined from the single composite nitrogen and phosphorus concentration and RC values described above. Level 2 load reductions are determined on the old urban area load only, using the 30 percent reduction for nitrogen and 50 percent reduction for phosphorus described above.

Other Considerations

- It should be noted that these calculations concentrate only on the estimation of nitrogen and phosphorus stormwater loads for urban areas, on the distinction of old urban areas that would indicate candidate loads for level 2 reductions, and the changes in this load representative of average rainfall years and the 1999 dry year. Additional TMDL level 3 load reductions are levied upon these urban stormwater jurisdictions through a separate calculation that incorporates point source loads.
- The old urban area loads calculated here should theoretically be greater than the actual loads, as most of these jurisdictions have instituted some levels stormwater retrofit in their older urban areas, extension of sanitary sewer service, street sweeping, etc., that would act to reduce the loads. Credit can be claimed for nutrient load reduction from such projects and activities.
- While stormwater entities have been delineated for the Crescent Lake Basin, the calculations have not been presented on their old and new development loads and reductions, as at this point in the TMDL allocation process the basin is being provided with a single allocation.

Table 4. Calculated *Average Rainfall* Urban Stormwater Source Nitrogen Loads for Jurisdictions of the Marine Reach of the Lower St. Johns River, MT/yr

Marine Reach Jurisdiction	WLA	LA	1984/1989 Urban Area Ratio	Old (1984) Urban Area TN Load, (MT/yr)	New Urban Area TN Load, 1984-2008, (MT/yr)	Total 2008 Projected TN Load, (MT/yr)	Level 2 Reduction (90% Old Urban Retrofit, MT/yr)
Jacksonville, FDOT and Beaches	X		0.93	346.5	74.9	421.5	93.6
Clay Co. Marine w/in UA	X		0.89	28.2	14.4	42.7	7.6
St. Johns Co.	X		0.80	10.4	8.2	18.7	2.8
Jacksonville Beach	X		0.94	7.3	1.1	8.4	2.0
NAS Jacksonville	X		1.00	8.0	0.0	8.1	2.2
Orange Park	X		1.00	5.7	0.1	5.8	1.6
Mayport NS	X		1.00	4.7	0.0	4.7	1.26
Clay Co. Marine non-UA		X	0.95	15.3	7.2	22.5	4.14
Camp Blanding		X	1.00	4.4	3.4	7.9	1.2
SJC remaining marine		X	0.80	1.8	2.2	4.0	0.5
Penney Farms		X	0.94	0.2	0.1	0.3	0.1
TOTAL				**432.5**	**111.6**	**544.6**	**117**

Table 5. Calculated *Dry-Year (1999)* Urban Stormwater Source Nitrogen Loads for Jurisdictions of the Marine Reach of the Lower St. Johns River, MT/yr

Marine Reach Jurisdiction	WLA	LA	1984/1989 Urban Area Ratio	Old (1984) Urban Area TN Load, (MT/yr)	New Urban Area TN Load, 1984-2008, (MT/yr)	Total 2008 Projected TN Load, (MT/yr)	Level 2 Reduction (90% Old Urban Retrofit, MT/yr)
Jacksonville, FDOT and Beaches	X		0.93	206.3	44.4	247.4	55.7
Clay Co. Marine w/in UA	X		0.89	16.7	8.5	25.2	4.5
St. Johns Co.	X		0.80	5.9	4.9	10.5	1.6
Jacksonville Beach	X		0.94	4.3	0.7	5.0	1.2
NAS Jacksonville	X		1.00	4.8	0.0	4.8	1.3
Orange Park	X		1.00	3.4	0.1	3.5	0.9
Mayport NS	X		1.00	2.8	0.0	2.8	0.7
Clay Co. Marine non-UA		X	0.95	8.4	4.2	12.1	2.3
Camp Blanding		X	1.00	2.6	2.0	4.7	0.7
SJC remaining marine		X	0.80	1.1	1.3	2.4	0.3
Penney Farms		X	0.94	0.1	0.0	0.2	0.0
TOTAL			**256.4**	**66.1**	**318.6**	**69.2**	**256.4**

Table 6. Calculated *Average Rainfall* Urban Stormwater Source Nitrogen Loads for Jurisdictions of the Freshwater Reach of the Lower St. Johns River, MT/yr

NITROGEN Freshwater Reach Jurisdiction	WLA	LA	1984/1989 Urban Area Ratio	Old (1984) Urban Area TN Load, (MT/yr)	New Urban Area TN Load, 1984-2008, (MT/yr)	Total 2008 Projected TN Load, (MT/yr)	Level 2 Reduction (90% Old Urban Retrofit, MT/yr)
Green Cove Springs	X		1.00	6.96	0.00	6.96	1.88
Clay Co. Fresh w/in UA	X		1.00	2.77	0.00	2.77	0.75
Putnam Co. non-UA		X	1.03	32.78	10.84	43.62	8.85
St. Johns Co. non-UA		X	0.56	4.96	22.25	27.21	1.34
Palatka		X	1.00	9.68	0.00	9.68	2.61
Clay Co. Fresh non-UA		X	1.00	3.99	1.60	5.59	1.08
Welaka		X	1.17	1.17	0.00	1.17	0.32
Hastings		X	1.00	0.62	0.01	0.62	0.17
Alachua Co. non-UA		X	1.00	0.10	0.54	0.64	0.03
Pomona Park		X	1.00	0.11	0.00	0.11	0.03
Flagler Co. Non-UA		X	1.00	0.00	0.01	0.01	0.00

Table 7. Calculated *Average Rainfall* Urban Stormwater Source Phosphorus Loads for Jurisdictions of the Freshwater Reach of the Lower St. Johns River, MT/yr

PHOSPHORUS Freshwater Reach Jurisdiction	WLA	LA	1984/1989 Urban Area Ratio	Old (1984) Urban Area TP Load, (MT/yr)	New Urban Area TP Load, 1984-2008, (MT/yr)	Total 2008 Projected TP Load, (MT/yr)	Level 2 Reduction (90% Old Urban Retrofit, MT/yr)
Green Cove Springs	X		1.00	1.10	0.00	1.10	0.49
Clay Co. Fresh w/in UA	X		1.00	0.40	0.00	0.40	0.18
Putnam Co. non-UA		X	1.03	4.47	1.52	6.00	2.01
St. Johns Co. non-UA		X	0.56	1.51	0.00	1.51	0.68
Palatka		X	1.00	0.62	3.11	3.73	0.28
Clay Co. Fresh non-UA		X	1.00	0.54	0.22	0.77	0.24
Welaka		X	1.17	0.17	0.00	0.17	0.08
Hastings		X	1.00	0.09	0.00	0.09	0.04
Alachua Co. non-UA		X	1.00	0.02	0.00	0.02	0.01
Pomona Park		X	1.00	0.01	0.08	0.08	0.00
Flagler Co. Non-UA		X	1.00	0.00	0.00	0.00	0.00

Literature Cited

CDM, 2002. Literature Review of Stormwater Best Management Practices. Camp, Dresser and McKee. St. Johns River Water Management District Technical Memorandum.

Donigan, A.S. and W.C. Huber. 1991. Modeling of nonpoint source watewr quality in urban and non-urban areas. EPA/600/3-91/039. U.S. Environmental Protection Agency, Office of research and Development, Washington, D.C.

FDEP, 2001. A Report to the Governor and Legislature on the Allocation of Total Maximum Daily Loads in Florida. FDEP Bureau of Watershed Management, Tallahasee, FL.

Harper, H.H. 2003. Evaluation of Alternative Stormwater Regulations for Southwest Florida. Report submitted to Water Enhancement and Restoration Coalition, Inc. Prepared by Environmental Research and Design, Orlando, FL

Harper, H.H. 1994. Stormwater loading rate parameters for central and south Florida. Environmental Research and Design, Inc. Orlando, FL.

Hendrickson, J.C. and J. Konwinski. 1998. Seasonal Nutrient Import-Export Budgets for the Lower St. Johns River, Florida. Report prepared for the Florida Department of Environmental Protection under Contract WM598. 109 PP>

Winer, R. 2000. National Pollutant Removal Performance Database for Stormwater Treatment Practices 2nd Ed. Center for Watershed Protection, Endicott City, MD. prepared for U.S. EPA Office of Science and Technology.

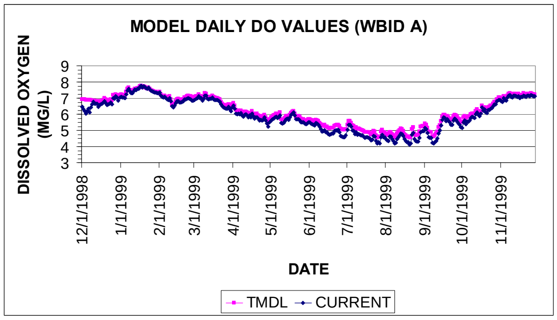
Appendix N: Comparisons Between Existing 1999 Simulation and TMDL Simulation for Marine WBID DO and Freshwater Chlorophyll

Daily average DO and total fractional exposure under the current conditions simulation for 1999 in WBIDs 2213A – 2213D

	WBID Minimum Daily Mean DO				WBID Mean SSAC Dose			
YEAR	A	B	C	D	A	B	C	D
1999	4.13	4.06	4.26	4.39	2.62	2.00	1.59	0.56

Daily average DO and total fractional exposure under the TMDL simulation for 1999 in WBIDS 2213A – 2213D

	WBID Minimum Daily Mean DO				WBID Mean SSAC Dose			
YEAR	A	B	C	D	A	B	C	D
1999	4.52	4.53	4.66	4.8	0.99	0.87	0.42	0.06


MODEL DAILY DO VALUES (WBID A)
DISSOLVED OXYGEN (MG/L)
9
8
7
6
5
4
3
12/1/1998
1/1/1999
2/1/1999
3/1/1999
4/1/1999
5/1/1999
6/1/1999
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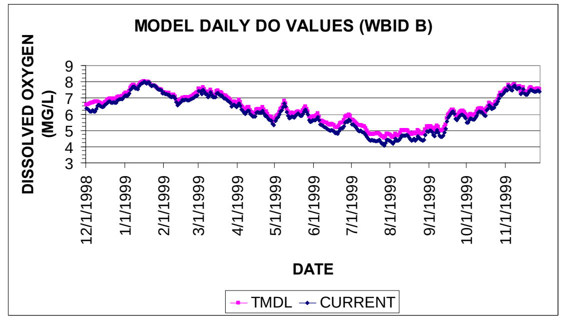
8/1/1999
9/1/1999
10/1/1999
11/1/1999
DATE
TMDL
CURRENT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DISSOLVED OXYGEN (MG/L)
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3
12/1/1998
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4/1/1999
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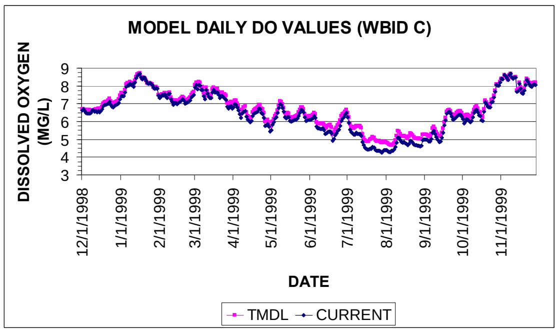
DATE
TMDL
CURRENT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DISSOLVED OXYGEN (MG/L)
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8
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12/1/1998
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2/1/1999
3/1/1999
4/1/1999
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8/1/1999
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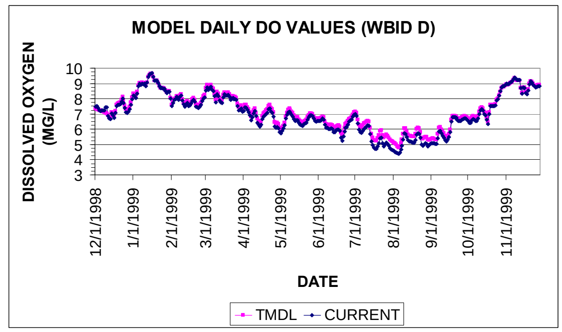
11/1/1999
DATE
TMDL
CURRENT


MODEL DAILY DO VALUES (WBID D)
DISSOLVED OXYGEN (MG/L)
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12/1/1998
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4/1/1999
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DATE
TMDL
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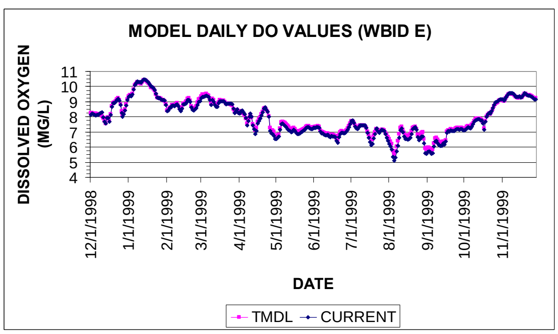
MODEL DAILY DO VALUES (WBID E)
DISSOLVED OXYGEN (MG/L)
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DATE
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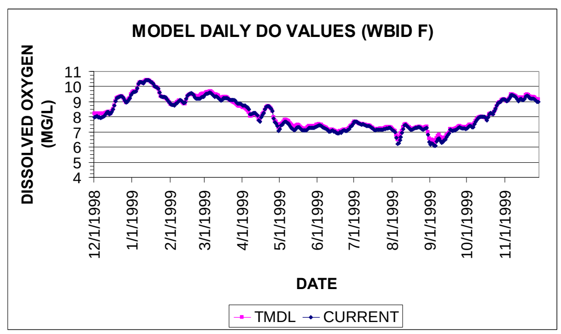
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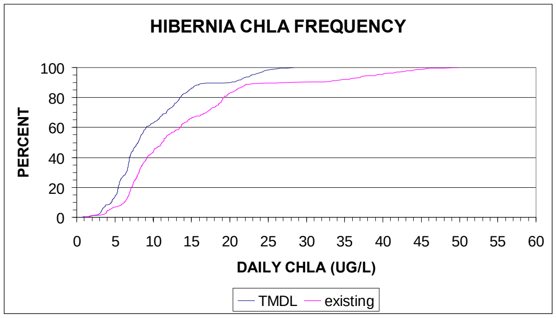
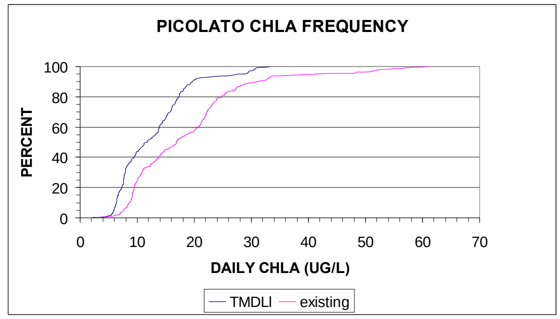
4/1/1999
5/1/1999
6/1/1999
7/1/1999
8/1/1999
9/1/1999
10/1/1999
11/1/1999
DATE
TMDL
CURRENT

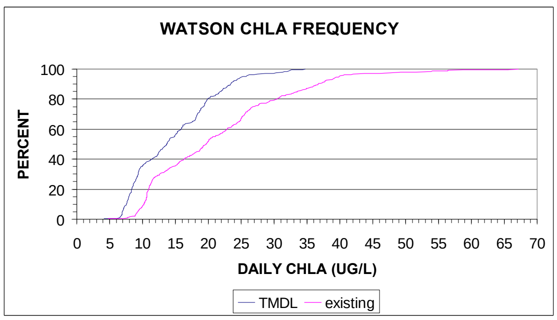
KEY STATISTICS FOR SELECTED FRESHWATER SITES FROM 1999 MODEL YEAR SIMULATIONS

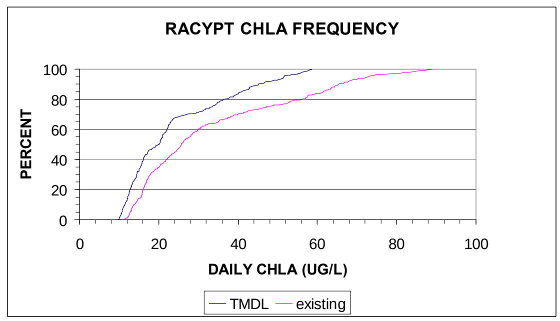
Statistic	Hibernia		Picolata		Racy Pt.		Federal Pt.		Palatka	
	Existing	TMDL	Existing	TMDL	Existing	TMDL	Existing	TMDL	Existing	TMDL
Chla min (ug/L)	0.92	0.84	2.64	2.3	11.4	9.74	11.06	10.6	7.66	9.86
Chla max (ug/L)	49.82	28.46	61.06	33.4	89.24	58.6	88.84	61.42	82.7	61.56
Chla median (ug/L)	11.16	8.01	16.88	11.73	25.68	20.05	28.14	21.92	29.66	25.74
# days Chla > 40 ug/L	16	0	20	0	109	55	122	77	123	68
% of year Chla > 40 ug/L	4.4	0	5.5	0	29.9	15.1	33.4	21.1	33.7	18.6
# Consecutive days Chla > 40 ug/L	10	0	13	0	39	21	53	43	89	31

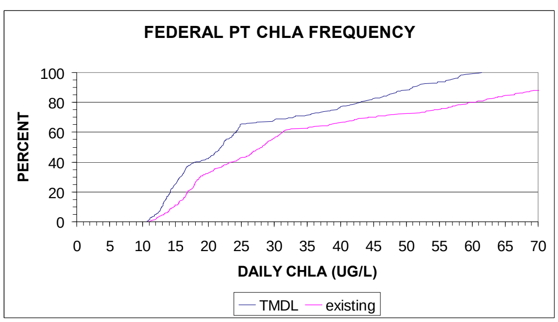
CUMULATIVE FREQUENCY DAILY CHLA PLOTS FOR 1999 BASED ON MODEL SIMULATION OF THE EXISTING AND TMDL SCENARIOS

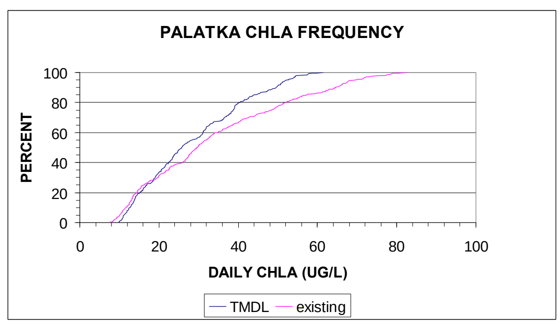






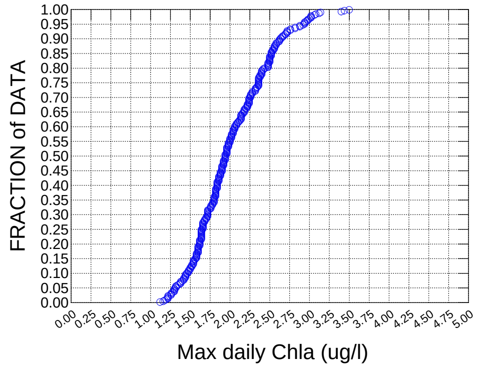






CUMULATIVE FREQUENCY PLOTS FOR DAILY CHLA MAXIMUM FROM THE 1999 TMDL SIMULATION

FULTON



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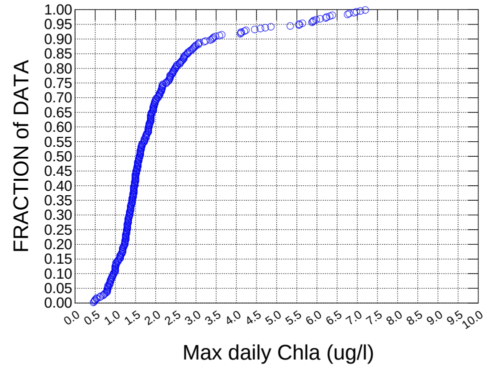

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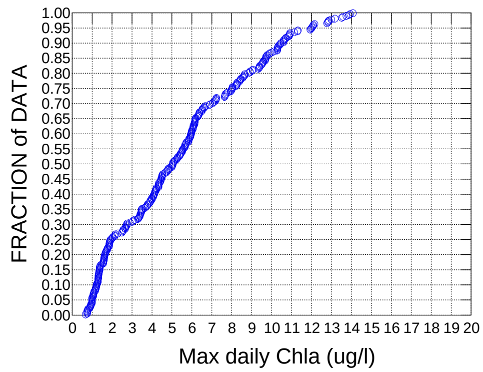

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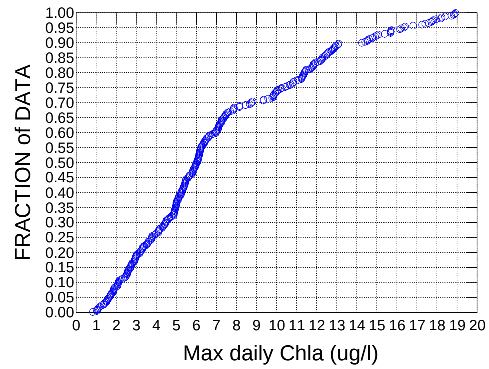

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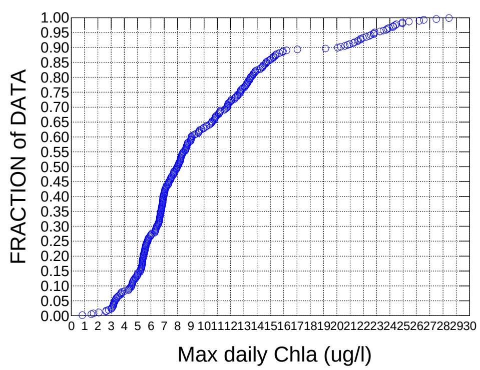

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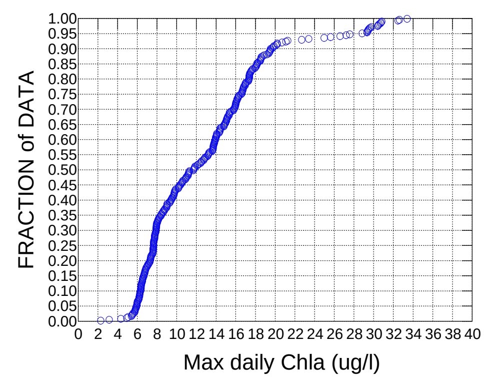

Appendix O: Responsiveness Summary to Public Comments on Draft TMDL following March 2008 Public Meeting

March 05, 2008

Darryl Joiner
Environmental Manager
Water Quality Standards &
Special Projects Program
Florida Department of
Environmental Protection
2600 Blair Stone Road, MS 3560
Tallahassee, FL 32399-2400

RE: Establishment of site specific alternative criteria for dissolved oxygen in the marine portions of the lower St. Johns River and its tributaries.

Dear Mr. Joyner,

The following comments on the establishment of site specific alternative criteria (SSAC) for dissolved oxygen (DO) in the marine portions of the lower St. Johns River (LSJR or River) and its tributaries, proposed by the Florida Department of Environmental Protection (FDEP) are submitted by the St. Johns Riverkeeper.

You may recognize these comments. They're basically the same comments we submitted to the Department over two years ago. Evidently, the DEP didn't consider their merits then, and I don't expect more scrutiny now. I do, however, believe it is important to state that we oppose the entire SSAC travesty, charade, actually. This correspondence will establish standing as we, and others, continue to explore appropriate legal venues in which to continue our legal challenges to the SSAC.
We oppose the establishment of the proposed DO SSAC for the LSJR. Based upon the data we received at the recent SSAC public hearing, the proposed TMDL utilizing the SSAC will allow the discharge of an additional 1 million lbs. of nitrogen per year into the lower St. Johns River beyond what is currently allowed.

The FDEP has failed both scientifically, and administratively, to make the case that the proposed SSAC for the LSJR is warranted or indeed, even appropriate.

Our opposition to the SSCA is based upon the following reasons:

1. **IT IS INAPPROPRIATE TO DEVELOP THE LSJR DO SSAC USING THE ENVIRONMENTAL PROTECTION AGENCY'S (EPA) APPROACH FOR THE VIRGINIAN PROVINCE (VP).**

Our opposition to the methodology FDEP employed to develop the draft SSAC should come as no surprise to the department. Riverkeeper and Clean Water Network questioned the use of the VP guidance in our comments we submitted for the September 30, 2003, Rule Adoption Hearing in Tallahassee for the FDEP nutrient TMDL. (Jerry Brooks was the hearing officer.) At that time we stated, “We question the applicability of this document to the lower St. Johns River ecosystem. If fact, we reject the comparison.” Today, 28 months later, we have not changed our opinion.

The FDEP expects the public to buy into their theory that the LSJR is exactly like the VP, an area bordered by Cape Cod on the north and Cape Hatteras on the south. Using that hypothesis as its basis, the DEP has used the report entitled, *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras* to rationalize lowering DO water quality standards in the LSJR in order to resubmit DEP’s failed, illegal, nutrient TMDL recently rescinded by EPA Region IV. In its rush to lower water quality standards, FDEP has chosen to ignore its own words.

In a March, 2002 report entitled, *Development of Total Maximum Daily Loads and Pollution Load Reduction Goals for the Lower St. Johns River Basin: Plan of Study*, the FDEP, and the St. Johns River Water Management District (SJRWMD), discusses the use of the EPA VP guidance for the LSJR TMDL development. When describing the use of the EPA document to guide the TMDL development, the agencies noted, “…Because it (EPA document)has been developed for the northern adjacent Virginian Province estuaries, which are cooler in temperature and lower in natural levels of organic carbon, it will be used as guidance only in the LSJR TMDL development.” Isn’t it amazing how FDEP’s appraisal of the methodology has changed?

Now, FDEP has done a 180 degree about face and notes, “….because the criteria was based on very conservative assumptions for northern cooler waters, application of the criteria directly to Florida waters would be in fact protective.” What’s the basis of this sunny assessment?

After reviewing the limited data contained in the public notice, it appears the DEP has compared a list of fish species found in the VP and the LSJR, and it has determined that *some* species used to derive the VP criteria, “are known to occur in Florida, including the LSJR." Well, that’s certainly reassuring. Let’s examine the species and their economic importance to the river.

In the 2003 draft TMDL document, the FDEP noted there were five fish species that were found in both the VP and LSJR. Those five are listed in the table below.

SPECIES	COMMON NAME
Syngnathus fuscus	pipe fish
Paralichthus dentatus	summer flounder
Brevoortia spp.	menhaden
Callinectes sapidus	blue crab
Leiostomus xanthurus	Spot

The draft SSAC document now notes 15 species occur in both areas. Regardless of the number, the argument we raised in September, 2003 is still valid.

When one looks at the shared species list, one thing is perfectly clear--very few of them have a commercial value; only summer flounder and blue crab are sought by recreational and/or commercial interests. Although menhaden have commercial value, their inclusion does not increase our confidence in this methodology. Any valid discussion concerning reduction in DO levels, and its potential impacts on fisheries' health, should feature a bias toward protecting commercially viable species, especially in this portion of the river. FDEP's lack of concern about fisheries' health is not limited to pelagic species.

FDEP has made no effort to correlate invertebrate species' occurrence in the VP and LSJR. This omission is telling about FDEP's real motives; much of the research concerning oxygen uptake and nutrient enrichment in coastal areas, including some of the research cited in the original TMDL report, notes the importance of benthic organisms in this relationship.

FDEP has used the VP document and made a mockery of EPA's own guidance. The EPA does not claim the VP is a "one size fits all" methodology. In fact, to the contrary, it warns, "Risk mangers can apply the criteria to other coastal waters if they can scientifically determine that their location-specific *biological, physical, and water quality conditions* are comparable to those of the Virginian Province." There is no data in the public notice that would lead one to believe FDEP made such a determination.

FDEP has failed to follow the EPA's VP guidelines in the proposed SSAC and has ignored the following considerations:

- **Accuracy of monitoring data-** It is not clear from the DRAFT SSAC what monitoring data DEP used and how well hypoxia is captured in these data. The VP approach precautions that existing monitoring programs are not always accurate enough to take advantage of the protective approach.
- **Biological effects**--potential biological effects are difficult to predict. DEP has not provided any information about what the expected range of sensitivity to hypoxia should be for the LSJR. As mentioned above, DEP merely relied on the fact that a few fish species occurred in both systems, and therefore, made the determination the VP guidance is appropriate.
- **Spatial extent**- there is no indication from the existing condition set forth in the draft if there is a hypoxic area and the extent of the hypoxic area.
- **Threatened & endangered species**-Absolutely no mention of whether there is threatened or endangered species in the river. FDEP's selectively omits this issue despite the fact that the EPA specifically addresses it in the VP fact sheet.

Once again, in its rush to support it's ill-conceived, and indefensible, nutrient TMDL for the LSJR, FDEP has used poor, and selectively applied, scientific reasoning to justify weakening DO water quality standards in the lower St. Johns River.

2. THE APPLICATION OF SINGLE DO SSAC FOR THE "LOWER ST. JOHNS RIVER" IS INAPPROPRIATE AND SCIENTIFICALLY INDEFENSIBLE.

In the March, 2002 report entitled, *Development of Total Maximum Daily Loads and Pollution Load Reduction Goals for the Lower St. Johns River Basin: Plan of Study*, the FDEP and the SJRWMD noted:

"The LSJR can be divided into three zones: a predominantly fresh, tidal lake-like zone that extends from the city of Palatka north to the mouth of Julington Creek; an alternatively fresh and marine, oligohaline lake-like zone extending from Julington Creek northward to the Fuller Warren Bridge (I-95) in Jacksonville; and a predominantly marine and much narrower zone downstream from this point to the mouth."

Simply put, the LSJR is really three distinct "ecozones". In effect, one cannot speak about the LSJR as a single biological system. FDEP and SJRWMD recognized this situation and noted, "The change in chemical and hydrologic conditions from freshwater river to ocean results in an aquatic environmental gradient in which few plants or animals can optimally survive and thrive."

Of course, FDEP selectively ignores these differences and contrary to their own words, chooses to establish a "one size fits all" DO SSAC which they apply to the three distinctly different systems.

FDEP and SJRWMD, in further discussions about the zones, noted, "The existence of these three distinct ecozones within the LSJR has important implications for the determination of the nutrient enrichment response continuum." Simply put, nutrients entering these systems react differently. This is particularly critical to the health of the LSJR because the genesis of the marine TMDL evolved from the link between low DO, larval recruitment, maximum acute value, and the growth effects threshold.

Rather than recognize the complexities of the LSJR, FDEP chooses to ignore it and blithely publish a SACC for the LSJR as if it is a homogeneous system. What is particularly damning about FDEP's approach is it is scientifically indefensible, yet they note the proposed SSAC will, "...fully support the propagation of and maintenance of healthy, well-balanced community of fish and wildlife." FDEP's methodology is unconscious able.

3. THE LSJR SSAC FAILS TO COMPLY WITH FLORIDA STATUTE § 62-302.800

Florida's variance procedures for a Site Specific Alternative Criteria (SSAC) are clearly laid out in the Florida Administrative Code Rule 62-302.800. The LSJR Dissolved Oxygen SSAC fails to meet the required procedures.

Florida asserts that the LSJR SSAC was developed in accordance with the procedures set forth in subsection 62-302.800(2). However, this is contrary to what is allowed under the provision. Therefore, FDEP should be prohibited from developing a SSAC under subsection 2.

- From all indications of the DRAFT Site Specific Alternative Dissolve Oxygen Criteria For the Protection of Aquatic Life in the Marine Portions of the Lower St. Johns River (January 9, 2006)("Draft"), the alternative criteria was initiated by the State and not petitioned for by an affected person. Subsection (2) of 62-302.800 only sets forth procedures for adopting an alternative water quality criteria in the situation where an affected person petitioned the State, "In accordance with the procedures set forth below, **affected persons may petition**…." 62-302.800(2). This is to be distinguished from the procedures set forth in subsection (1), which apply "upon petition by an affected person **or upon the initiation of the Department**." 62-302.800(1). Therefore, the procedures in subsection (2) must only be used in situations where an affected person petitioned for the SSAC and not upon FDEP initiation.

- Under the present circumstances the Department is prohibited from relying on subsection 2 for adopting alternative criteria for dissolved oxygen in the LSJR because the procedures set forth in subsection 2 "do not apply to … criteria that apply to: … 7. Dissolved Oxygen." 62-302.500(2) (d). The criterion that FDEP is seeking to get a variance from is the Dissolved Oxygen criteria. Therefore, the procedures set forth in subsection (2) do not apply.

Because FDEP is prohibited from relying on subsection (2) (see reasons set forth above), the only way FDEP can establish an alternate dissolved oxygen criteria under these circumstances is to meet the requirements under 62-302.800(1).

- As a threshold issue, a SSAC under subsection (1) can only be established "when an affirmative demonstration is made that an alternative criteria is more appropriate for a specified portion of water," i.e. a waterbody may not meet the particular water quality criteria specified for its classification due to natural background conditions or man-induced conditions that cannot be controlled or abated. FDEP has not asserted or demonstrated that the natural and man made conditions of the LSJR are such that it is unable to meet the applicable DO criteria. The applicable DO criterion for Florida Class III predominantly marine waters "[s]hall not average less than 5.0[mg/L (milligrams per liter)] in a 24-hour period and shall never be less than 4.0[mg/L]." Without any affirmative demonstration of an inability of the LSJR to meet these requirements, FDEP cannot establish an alternative criterion under subsection (1).

- Even if FDEP could meet the affirmative threshold demonstration under subsection, FDEP has failed to document or provide the documentation requirements. FDEP is required to provide: 1) a description of the physical nature and the water pollution sources affecting the DO in the LSJR; 2) a description of the historical and existing water quality of DO, including at a minimum spatial, seasonal, and diurnal variations; 3) a description of the historical and existing biology, which may be affected by DO; and 4) a discussion of an impacts the alternative DO criteria will have on the designated use and adjoining waters. FDEP has failed to meet any of these requirements. At most FDEP has included a short description of the existing conditions and an incomplete discussion of the potential impact of criteria on designated uses.

Even if FDEP was able to establish alternative DO criteria under subsection (2), DEP has failed to meet the required procedures.

- At the most basic level, the petitioner, (we assume DEP), must demonstrate that the proposed criteria would fully maintain and protect human health, existing uses, and the level of water quality necessary to protect human health and existing and designated beneficial uses.

- Procedurally, under subsection (2) in making the demonstration that the alternative criteria will fully maintain and protect, the Petitioner is required to:

    - Assess aquatic toxicity: there is no indication that FDEP did such an assessment. Additionally, FDEP cannot rely on the Virginia Province alone because translating that approach to another coastal region requires additional information and analysis.
    - Risk assessment: there is no information that has been provided by the Department that suggests such a risk assessment has been completed
    - Information indicating that one or more of the assumptions used in the risk assessment on which the existing criteria is based are inappropriate to the LSJR: once again there is nothing to suggest that a risk assessment has been completed
    - Economic impact statement: there is no information that has been provided by the Department that suggests such a statement has been completed

4. THE LSJR DO SSAC FAILS TO COMPLY WITH THE REQUIREMENTS OF THE CWA AND EPA'S CORRESPONDING GUIDANCE DOCUMENTS

FDEP failed to comply with federal water quality standard (WQS) variance procedures. EPA approves State-adopted variances if "the variance is granted for a specific period of time and must be rejustified upon expiration but at least every 3 years…" Water Quality Standards Handbook, 2nd ed. at 5-12 (1993). Therefore, variances such as a SSAC are required to be time limited and are not intended to allow a waterbody to forgo its designated use. Here, FDEP's intention for the LSJR DO SSAC does not appear to be temporal; rather, FDEP's documentation implies that it intends to implement SSAC for an indefinite period of time, perhaps permanently.

Because EPA requires variance procedures to demonstrate that meeting standards under 40 CFR 131 is unattainable, the state should have to demonstrate that meeting standards under 40 CFR 131 is unattainable before SSAC can be implemented. According to the regulations, states may remove a designated use if the state can demonstrate that attaining the designated use is not feasible because of: naturally occurring pollutant concentrations; low flow conditions or water levels; human caused conditions or sources of pollution that cannot be remedied or would cause more environmental damage to correct; hydrologic modifications; physical conditions related to the natural features of the water body; or controls more stringent would result in substantial and widespread economic and social impact. 40 C.F.R. §131.10 (g) (1-6). FDEP has failed to show any of these conditions exist in order to justify the implementation of SSAC.

As stated above, we believe the proposed DO SSAC is scientifically indefensible, unwarranted, and administratively flawed. The SSAC is nothing more then FDEP's attempt to overturn EPA's recently released nutrient TMDL for the LSJR. We believe the EPA's TMDL is good first step in restoring the lower St. Johns River's health. FDEP's proposed SSAC is a step backward in that effort.

We urge the FDEP to abandon your efforts to increase allowable pollution levels in the St. Johns River. As we stated over two years ago, we will continue to fight to protect the lower St. Johns River.

Thank you for the opportunity to comment.

For the River,

Neil A. Armingeon
St. Johns Riverkeeper

CC: Michael Howle, Esq., St. Johns Riverkeeper
Linda Young, Clean Water Network of Florida

Earlier Department responses to comments on SSAC

HISTORICAL BACKGROUND AND RESPONSE SUMMARY
FOR ESTABLISHMENT OF SITE SPECIFIC ALTERNATIVE CRITERIA
FOR DISSOLVED OXYGEN IN THE LOWER ST. JOHNS RIVER

Historical Background

Rule 62-302.800(2), Florida Administrative Code (FAC), allows for the establishment of Site Specific Alternative Criteria using either the Indicator Species Procedure or other scientifically defensible methods. These SSACs comprise Type II SSACs under Rule 62-302.800, FAC.

The Department and St. Johns River Water Management District (SJRWMD) began looking at dissolved oxygen levels in the lower St. Johns River during the recent basin assessment for this river reach. Initially, the SJRWMD conducted data assessment and modeling to determine appropriate dissolved oxygen levels that were protective of aquatic life. The Department formally initiated rulemaking on December 16, 2005. The Department conducted two public workshops in Jacksonville (January 20, 2006 and April 7, 2006). As a result of further modeling and data analysis, as well as public comments, the proposed site specific alternative criteria were refined.

The proposed rule establishes site specific alternative criteria for dissolved oxygen in the marine portion of the lower St. Johns River from Julington Creek to the mouth of the river. The alternative criteria were developed using the U.S. Environmental Protection Agency's (EPA) draft guidance document, *Ambient Water Quality Criteria for Dissolved Oxygen: Cape Cod to Cape Hatteras*. The criteria are intended to support a healthy aquatic environment and will maintain the designated use of the river.

The proposed criteria are expressed as a minimum concentration of 4.0 mg/L, which is the existing minimum default criterion for Class III marine waters, and a Total Fractional Exposure for each annual evaluation period of not greater than 1.0. The Total Fraction Exposure is defined by the equation:

$$\left(\begin{matrix}\textbf{Total Fractional}\\ \textbf{Exposure}\end{matrix}\right)=\frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.0 - < 4.2 mg/L}\end{matrix}}{\textbf{16 day Max}}+\frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.2 - < 4.4 mg/L}\end{matrix}}{\textbf{21 day Max}}+\frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.4 - < 4.6 mg/L}\end{matrix}}{\textbf{30 day Max}}+\frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.6 - < 4.8 mg/L}\end{matrix}}{\textbf{47 day Max}}+\frac{\begin{matrix}\textbf{Days between}\\ \textbf{4.8 - < 5.0 mg/L}\end{matrix}}{\textbf{55 day Max}}$$

The number of days in an interval is based on the daily average Dissolved Oxygen concentration.

The Total Fractional Exposure utilizes the measured larval recruitment/survival and growth responses of sensitive species to limit the number of days in which the dissolved oxygen can be in each 0.2 mg/L interval between 4.0 and 5.0 mg/L. The Department's analysis, including the derivation of these criteria, is attached. The EPA criteria guidance document is also attached.

Public Comments and Department Response

The Department conducted two public workshops (January 20, 2006 and April 7, 2006, both in Jacksonville, Florida). Public workshop comments from the public included:

1. **The Department is suggesting that the lower St. Johns River is the same as the waters between Cape Cod and Cape Hatteras (i.e., the model is not representative of the lower St. Johns River).**

Response: Many of the species are common to both the Cape Cod to Cape Hatteras area as well as the lower St. Johns River. The model has applicability in the lower St. Johns River.

2. **When calculating the 30-day average, what value(s) are used for daily values?**

Response: The 30-day average was used in the first draft version of the SSAC. The 30-day average is no longer used in the SSAC that was approved by the ERC. (Note: This comment was made after the first public workshop when the 30-day average was proposed for inclusion as part of the SSAC. The SSAC language no longer includes the 30-day average.)

3. **Does the SSAC development mean that Florida cannot meet water quality standards in the lower St. Johns River?**

Response: The SSAC was developed specifically to characterize water quality standards in the lower St. Johns River. It is intended to be fully protective of sensitive aquatic species in their most sensitive life stages. The SSAC is part of Florida's water quality standards.

4. **Is it necessary to demonstrate that water quality standards cannot be met in order to establish a SSAC?**

Response: No, this is not part of the demonstration.

5. **Why were species used that do not occur in the lower St. Johns River?**

Response: The most sensitive species in the EPA study were chosen. Some of these (e.g., American Lobster) do not occur in Florida, yet the Department believes that these sensitive species are representative of the most sensitive organisms in the lower St. Johns River. The Department does not have toxicity data for every species in the river.

6. **The SSAC is an attempt to provide a "cover" for the Department's proposed TMDL.**

Response: The Department disagrees. The SSAC is independent of the TMDL and is intended to be fully protective of aquatic life in the river.

7. Use of the Virginian Province model is an inappropriate surrogate for the lower St. Johns River.

Response: The Department disagrees. Again, the SSAC, based on the EPA model, is intended to be fully protective of aquatic life. Many of the species are common to both the Virginian Province and the lower St. Johns River. One of the principal authors of the EPA Virginian Province model, Dr. Glen Thursby, specifically addressed this question in the document, *National Saltwater Criteria for Dissolved Oxygen: Potential Addenda to Virginian Province Saltwater Criteria for Warmer and Colder Waters* (2003). Dr. Thursby compared two groups of genera, one at 20 degrees C and one at 26 degrees C (representing northern colder waters and southern warmer waters). He concluded that the criterion minimum concentrations (CMCs) for the two groups are "very similar, 2.36 mg/L for the 20C group and 2.26 mg/L for the 26C group." Dr. Thursby also compared populations of three species collected from the Northeast (Rhode Island) and the Southeast (Georgia and Florida). He found that "The exposure-response relationships for each species were similar in northern and southern populations."

8. There are a number of water bodies in Florida that do not naturally meet the default state dissolved oxygen criteria. The SSAC is overly conservative and unduly strict.

Response: The Department agrees that the SSAC is conservative. Most water quality standards are conservative. Nonetheless, the Department believes that a conservative SSAC is necessary to ensure protection of aquatic life in the river, particularly for sensitive species and sensitive life stages.

9. Will establishment of the SSAC solve the impairment problem?

Response: No, the river will still be impaired. Restoration of the river will occur only after the TMDL is implemented with its nutrient load reductions.

10. Is the Total Fractional Exposure based on a calendar year?

Response: Yes, it is based on a calendar year.

11. How will the Clean Water Network's lawsuit against EPA's approval of Florida's Type II SSAC language affect the lower St. Johns River SSAC?

Response: It does not affect approval of the SSAC by the Florida Environmental Regulation Commission (Note: this comment was made at the second workshop which occurred a month prior to EPA's formal approval of the Type II SSAC language. EPA approved the Type II language on May 11, 2006.)

12. Was the SSAC developed specifically for the Department's TMDL using the TMDL as a target?

Response: No, the SSAC was developed independent of any TMDL.

Shortly after the second public workshop, several editorials appeared in newspapers around the state, including the Florida Times Union. The Florida Times Union editorial by Ron Littlepage (attached) contained several erroneous statements that elicited several dozen emails sent to the Department and the Florida Environmental Regulation Commission (emails attached). The Department sent out a fact sheet to emailers in an attempt to correct the erroneous information (Frequently Asked Questions fact sheet attached). At the time the editorial was published, the river had begun experiencing algal blooms. Many of the public were under the mistaken notion that the Department was proposing to allow an additional one million tons of nitrogen into the river beyond what was already allowed. Many emailers took strong exception to this erroneous statement.

Written Correspondence

Several letters were also submitted to the Department (attached). First, comments dated April 28, 2006 from the Clean Water Network (CWN) (also representing St. Johns Riverkeeper and Mid-Atlantic Environmental Law Center) are summarized:

1. **It is inappropriate to develop a SSAC for Dissolved Oxygen in the lower St. Johns River using the Environmental Protection Agency's (EPA) approach for the Virginian Province (VP).**

Response: The Department consulted informally with one of the principal authors of the EPA study, Dr. Glen Thursby, in developing the SSAC for the lower St. Johns River. This issue was addressed in the report by Dr. Thursby, titled *National Saltwater Criteria for Dissolved Oxygen: Potential Addenda to Virginian Province Saltwater Criteria for Warmer and Colder Waters* (2003). There has been no evidence presented that the SSAC is NOT protective of aquatic life in the lower St. Johns River. The CWN states that they reject "FDEP's theory that the St. Johns River is exactly like the VP…" The Department has never claimed that the St. Johns River is *exactly* like the VP. Nonetheless, the methodology has application in the lower St. Johns River.

The CWN further compares fish species common to both the VP and the lower St. Johns River, noting that "very few of them have a commercial value". The CWN also asserts that "Any valid discussion concerning reduction in DO levels, and its potential impacts on fisheries' health, should feature a bias toward protecting commercially viable species, especially in this portion of the river." The Department disagrees with this statement. The Department selected the most sensitive species in the EPA model in an attempt to be most protective of *all* species, not just the commercial species. Both commercial and non-commercial species are protected under the SSAC.

The CWN states:

> FDEP has used the VP document and made a mockery of EPA's own guidance. The EPA does not claim the VP is a "one size fits all" methodology. In fact, to the contrary, it warns, "Risk mangers (sic) can apply the criteria to other coastal waters if they can scientifically determine that their location-specific biological, physical, and water quality conditions are comparable to the Virginian Province." There is no data in the recent public notice that would lead one to believe FDEP made such a determination.

The Department agrees that the VP is not a "one size fits all" methodology. The Department, however, did conduct a comparison of the VP and the lower St. Johns

River. Furthermore, the Department consulted with the author of the EPA methodology to ensure that it was appropriate for the lower St. Johns River.

The CWN then states:

> FDEP has failed to follow the EPA's VP guidelines in the proposed SSAC and has ignored the following considerations:
>
> - Accuracy of monitoring data – The only monitoring data DEP used was from two real time monitors near Jacksonville. It is not clear from the DRAFT SSAC how well hypoxia is captured in these data. The VP approach precautions that existing monitoring programs are not always accurate enough to take advantage of the protective approach.
> - Biological effects – potential biological effects are difficult to predict. DEP has not provided any information about what the expected range of sensitivity to hypoxia should be for the LSJR. As mentioned above, DEP merely relied on the fact that a few fish species occurred in both systems, and therefore, made the determination the VP guidance is appropriate.
> - Spatial extent – there is no indication from the existing condition set forth in the draft if there is a hypoxic area and the extent of the hypoxic area.
> - Threatened and endangered species – Absolutely no mention of whether there is threatened or endangered species in the river. FDEP's (sic) selectively omits this issue despite the fact that the EPA specifically addresses it in the VP fact sheet.

The Department used all the monitoring data available. While it is true that there are currently only two continuous monitoring stations in the LSJR, the Department is pursuing the establishment of additional continuous monitoring stations. Regarding hypoxia, the Department has already established that the LSJR is impaired for nutrients and experiences algal blooms. Implementation of a TMDL is intended, in part, to eliminate hypoxic episodes. The SSAC is not intended to maintain depressed levels of dissolved oxygen. On the contrary, the SSAC is intended to protect all aquatic species in the marine portions of the river, including the most sensitive species.

The Department looked at the potential occurrence of threatened and endangered species in the river. There are two gill-breathing species that may occur in the LSJR: Smalltooth Sawfish (*Pristis pectinata*) and Shortnose Sturgeon (*Acipenser brevirostrum*). Both species have a wide range of occurrence along the Atlantic seaboard and are both Federally listed as endangered. Both species have suffered historically from over-harvesting and habitat loss. Sturgeon studies (Jenkins et al. 1994; Secor & Niklitschek 2001; Campbell & Goodman 2003) have indicated that sturgeon are sensitive to low dissolved oxygen levels. However, these studies have shown that sturgeon mortality occurs at dissolved oxygen levels below 3.5 mg/L. The Campbell and Goodman (2003) study looked specifically at low dissolved oxygen level toxicity on juvenile Shortnose Sturgeon. Between 22 degrees C and 26 degrees C, they found a geometric mean LC50 of 2.27 mg/L, while a higher temperature (29 degrees C) resulted in an LC50 of 3.1 mg/L. The Department's SSAC has a minimum level set at 4.0 mg/L.

2. **The application of a *single* SSAC for dissolved oxygen, applicable to the whole of the "Lower St. Johns River", is inappropriate and scientifically**

indefensible.

Response: Contrary to what the CWN states, the Department's SSAC only applies to the marine portions of the LSJR. The freshwater/saltwater interface moves in response to tides, river flows, droughts, and other factors. The SSAC does not apply to the freshwater portion of the river. The Department's SSAC replaces the statewide default dissolved oxygen criterion of a 4.0 mg/L minimum and a daily average of 5.0 mg/L due to site specific characteristics, replacing it instead with a 4.0 mg/L minimum and a Total Fractional Exposure between 4.0 mg/L and 5.0 mg/L. The Department finds this approach fully appropriate and scientifically defensible and disagrees with CWN's statement.

3. **The proposed SSAC for dissolved oxygen requires real time water quality data that does not currently exist.**

Response: There are presently two continuous sampling stations in the LSJR. One of these stations is located in the portion of the river that has exhibited problems with DO in the past. The Department believes that these sampling stations will provide sufficient DO data to ensure protection of the LSJR. The Department is working on establishing additional continuous monitoring stations in the LSJR.

The CWN asks a number of questions in this section of their letter: (1) How will the exposure estimates be computed if DO values are not available? (2) How many additional monitoring sites will be required? (3) Where will additional sites be located? (4) Who will maintain these sites? (5) Will DEP staff compute the fractional exposures on a daily basis? (6) What happens when the fractional exposures exceed one? (7) Will discharges to the LSJR be halted?

The Department expects that there will be sufficient DO values to ensure compliance with the SSAC. There will be no additional requirement for monitoring sites, although the Department is working toward the establishment of additional sites. Additional sites will provide a more robust data set, but are not essential toward determining compliance. Any additional sites will most likely be maintained either by FDEP or the St. Johns River Water Management District. The Department will compute the fractional exposures on a daily basis (per calendar year) to ensure compliance with state water quality standards. If the SSAC is exceeded, the Department will take appropriate action to ensure compliance. This could potentially include revision of the TMDL for nutrients.

4. **The FDEP has failed to demonstrate that alternative criteria are even warranted for the lower St. Johns River.**

Response: The Department has noted that a continuous DO level of 5.0 mg/L is potentially unlikely during the hot summer months under certain conditions. The SSAC is warranted. It is protective of aquatic life.

5. **Although the FDEP has attempted to amend section 62-302.800 of the Florida Administrative Code to permit the agency to develop site specific alternative criteria for DO, the amendments should be considered effective until FDEP has obtained necessary formal approval from the EPA.**

Response: This comment is now moot. In a letter dated May 11, 2006, EPA formally approved changes to Florida's water quality standards that now allow for the development of a Type II SSAC for dissolved oxygen.

6. **Like the initial SSAC for the St. Johns River, the amended SSAC similarly fails to comply with section 62-302.800 of the Florida Administrative Code.**

Response: CWN maintains that the Department is precluded from initiating rulemaking itself to establish a Type II SSAC. This is an erroneous assertion. The Department can initiate rulemaking to amend any of its rules, following established procedures in the Florida Administrative Procedures Act (Chapter 120, Florida Statutes). The Department has followed all appropriate rulemaking steps in accordance with state law.

7. **The SSAC for dissolved oxygen in the lower St. Johns River fails to meet the relevant EPA standards and guidelines for variances from state water quality standards for (sic).**

Response: The CWN mistakenly believes that Florida's SSACs constitute Federal variances. The SSAC developed for the LSJR is fully consistent with Federal Site Specific Criteria. These criteria are not variances as described under the EPA's *Water Quality Standards Handbook*.

The Department received written correspondence, dated April 13, 2006, from the Jacksonville Electric Authority (JEA). JEA's comments are summarized:

1. **JEA believes that the SSAC is overly conservative. They believe that "the fundamental site-specific reason for adopting a DO SSAC for the Lower St. Johns River is that the state-side standard is substantially more stringent than needed to fully protect its designated uses." JEA notes that the SSAC may be "substantially more stringent than necessary".**

Response: The Department agrees that the SSAC is conservative, but that conservatism is needed in order to fully protect aquatic life in all its life stages.

2. **JEA notes an absence of "a description of the historical and existing biology, including variations, which may be affected by the parameter of concern." JEA requests that the report be "strengthened by incorporating background information on status and trends in the indigenous biological communities, and their relationship (if any) to fluctuations in DO in the Lower St. Johns River".**

Response: As JEA mentioned in their comments, 15 of the 23 species used in EPA's VP DO assessment occur in the LSJR. The river is currently impaired. The current status and trends in the river are not indicative of a healthy riverine system. The Department believes that the SSAC will fully protect aquatic life and the river's designated use.

3. **JEA believes that the use of a default minimum of 4.0 mg/L is arbitrary. JEA asks why 4.0 mg/L was chosen for the Criterion Minimum Concentration (CMC) instead of a criterion developed using a scientific methodology, noting, in particular, that the CMC developed by EPA for the Virginian Province is 2.3 mg/L.**

Response: The Department believes that the default minimum of 4.0 mg/L is necessary. For example, studies on sturgeon have shown adverse effects at DO levels of 3.5 mg/L and below. The SSAC is intended to be fully protective of all sensitive aquatic life and life stages.

4. **JEA objects to the use of a species (American Lobster, *Homarus americanus*) not found in Florida. They propose that a species of mud crab be substituted instead.**

Response: The Department deliberately chose the most sensitive species in the EPA study. The Department believes that there are species with similar needs and requirements in the LSJR and that the American Lobster is an appropriate substitute in the absence of more data.

5. **JEA strongly recommends "that the Department take into account how the proposed rule would affect the Total Maximum Daily Load (TMDL) of nutrients that the river could accommodate, and provide a clear discussion of the economic impacts that the rule might have, to the extent that the TMDL needed to comply with it would be more stringent than the TMDL the Department adopted for the river in 2003."**

Response: The SSAC was developed independent of any TMDL. The SSAC was developed to be fully protective of the most sensitive aquatic life and the most sensitive aquatic life stages. It is inappropriate to use a TMDL to develop a SSAC.

References

Campbell, J.G., and L.R. Goodman. 2003. *Acute sensitivity of juvenile shortnose sturgeon to low dissolved oxygen concentrations.* Draft report for Gulf Ecology Division, National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1994. Tolerance of shortnose sturgeon, Acipenser brevirostrum, juveniles to different salinity and dissolved oxygen concentrations. *Proc. Annu. Conf. Southeast. Assoc. Game Fish Comm.*

Secor, D.H., and E.J. Niklitschek. March 29, 2001. *Hypoxia and sturgeons.* Report to the Chesapeake Bay Program Dissolved Oxygen Criteria Team.

Thursby, G.B. October 7, 2003. *National saltwater criteria for dissolved oxygen: Potential addenda to Virginian Province saltwater criteria for warmer and colder waters.* AED-03-113, USEPA.

U.S. Environmental Protection Agency. 2000. *Ambient aquatic life water quality criteria for dissolved oxygen (saltwater): Cape Cod to Cape Hatteras.* PA-822-R-00-012.

Attachments

1. Revisions to Rule 62-302.800, F.A.C.
2. *Site Specific Alternative Dissolved Oxygen Criterion to Protect Aquatic Life in the Marine Portions of the Lower St. Johns River Technical Support Document* (Department and SJRWMD, April 28, 2006).
3. *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras* (U.S. Environmental Protection Agency, Office of Water, PA-822-R-00-012, 2000).
4. *National Saltwater Criteria for Dissolved Oxygen: Potential Addenda to Virginian Province Saltwater Criteria for Warmer and Colder Waters* (U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, AED-03-113, 2003).
5. Editorial by Ron Littlepage, *Florida Times Union*, May 12, 2006.
6. Emails sent to the Department and Environmental Regulation Commission.
7. Summary of major issues raised in emails from the public (Department, May 17, 2006).
8. Lower St. Johns River TMDL/SSAC Frequently Asked Questions (Department, May 2006).
9. *Florida Times Union* Editorial Board Questions and Department Response (Department and SJRWMD, June 16, 2006).
10. Written correspondence sent to the Department.

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