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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration

CENTRAL DISTRICT • INDIAN RIVER LAGOON BASIN

TMDL Report

Nutrient and Dissolved Oxygen TMDLs for the Indian River Lagoon and Banana River Lagoon

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Acknowledgments

This TMDL report was developed based on the Pollutant Load Reduction Goal (PLRG) for seagrass restoration in the Indian River Lagoon (IRL) and Banana River Lagoon, created by the St. Johns River Water Management District (SJRWMD), and the Total Maximum Daily Loads (TMDLs) for the Northern and Central IRL and Banana River Lagoon, developed by the U.S. Environmental Protection Agency (EPA). We would like to sincerely thank Joel Steward (SJRWMD) and Whitney Green (SJRWMD), who developed the seagrass PLRG, Dr. Margret Lasi, who provided great helps on the atmospheric deposition data, and Elizabeth Belk (EPA) and Dan Scheidt (EPA), who developed the nutrient TMDLs for some of the lagoon segments included in this report. They offered many valuable comments and suggestions to help in the understanding of these lagoon systems, explained many modeling details, and also provided a large amount of information and data needed to generate the TMDLs.

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Total Maximum Daily Load Program

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

Identification of Impaired Surface Waters Rule

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STORET Program

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

2008 305(b) Report

http://www.dep.state.fl.us/water/docs/2008_Integrated_Report.pdf

Criteria for Surface Water Quality Classifications

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

Basin Status Reports and Water Quality Assessment Reports

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

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

http://www.epa.gov/region4/water/tmdl/florida/

National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the nutrient and dissolved oxygen (DO) Total Maximum Daily Loads (TMDLs) for the Indian River Lagoon (IRL) and Banana River Lagoon, within the larger IRL Basin. These waters were verified as impaired due to excessive amounts of phosphorus and nitrogen in the system, based on evidence of a decrease in seagrass distribution provided by the St. Johns River Water Management District (SJRWMD) and low DO, as verified through water quality assessments. These waters were added to the Verified List of impaired waters for the IRL Basin by Secretarial Order on December 12, 2007. The purpose of these TMDLs is to establish the allowable loadings of phosphorus and nitrogen to the IRL and Banana River Lagoon that would restore these waterbodies such that they meet their applicable water quality criteria for nutrients and DO.

1.2 Identification of Waterbody

The IRL Basin is a 156-mile-long estuary located on Florida's east coast. There are six coastal Florida counties in the natural IRL watershed: from north to south, these are Volusia, Brevard, Indian River, St. Lucie, Martin, and Palm Beach Counties. The IRL watershed described in this TMDL report includes only part of the larger IRL Basin, which starts just south of Ponce De Leon Inlet in the north, covers the southeastern corner of Volusia County and eastern portions of Brevard and Indian River Counties, and ends just north of the Fort Pierce Inlet. The majority of the basin area is located between Interstate Highway 95 (I-95) and the central portion of Florida's Atlantic coastline (**Figure 1.1**). The basin is well-developed, with close to 30 percent of the nonwater areas occupied by urban and built-up land. It contains about 20 municipalities and townships, including New Smyrna Beach, Titusville, Cocoa Beach, Melbourne, Palm Bay, and Vero Beach.

The three interconnected lagoons in the IRL Basin are commonly referred to as Mosquito Lagoon, IRL, and Banana River Lagoon. Circulation in these lagoons is influenced by winds, freshwater inflows from tributaries, and tidal exchange via direct connections to the Atlantic Ocean. Other than stream inflows, freshwater inflows also come from direct overland runoff, drainage canals, ground water seepage, and rainfall directly on to the surface of these lagoons.

The Mosquito and Banana River Lagoon systems have relatively small stream inflows of fresh water and poor flushing. Mosquito Lagoon has one inlet, Ponce De Leon, and the Banana River Lagoon has an intermittent navigational connection to the ocean via Port Canaveral. The IRL has comparatively larger stream inflows, particularly in its central and southern regions, but it is also poorly flushed, especially in its northern half. There is some improvement in flushing in the southern half because of the presence of four oceanic inlets: Sebastian, Ft. Pierce, St. Lucie, and Jupiter.

The entire IRL system is a nationally renowned aquatic ecosystem that supports tremendous biodiversity and also provides recreational and commercial fishing resources. It was designated in the 1987 Surface Water Improvement and Management (SWIM) Act as a priority waterbody

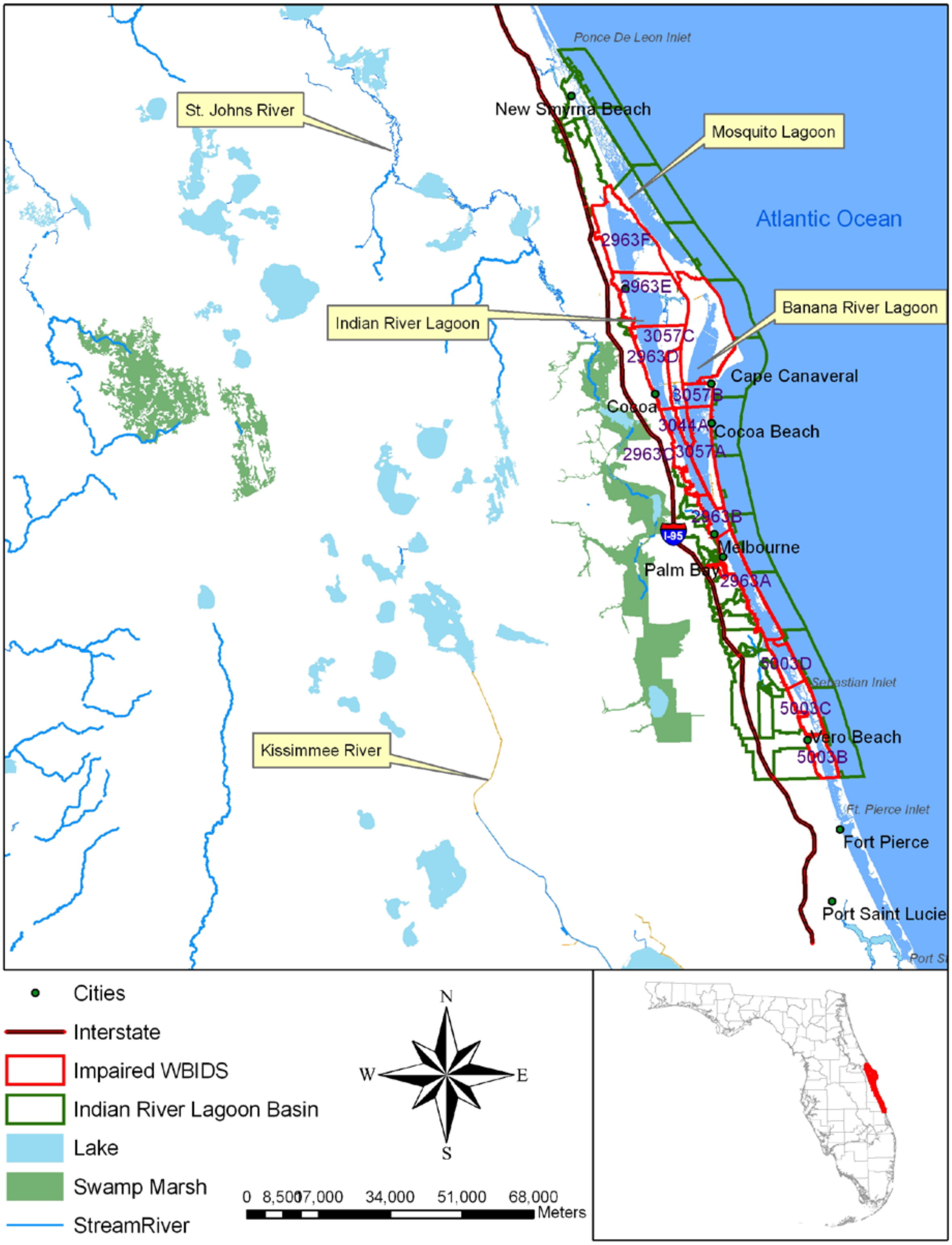

Figure 1.1. Location of the IRL Basin

in need of restoration and special protection. Major problems included the loss of or alteration of 75 percent of the lagoon's salt marsh and mangrove wetlands, excessive freshwater discharges into the central lagoon due to drainage improvements in coastal watersheds and the diversion of floodwaters from the St. Johns River floodplain, and discharges of pollutant-laden wastewater and stormwater into the lagoon. Excessive fresh water degraded hard clam habitat and seagrass coverage densities. Pollutants in discharges exacerbated turbidity levels and promoted algal growth, contributing to the destruction of seagrass beds.

In 1991, the IRL became a part of the National Estuary Program (NEP). Efforts under the IRL Program at the SJRWMD focus on improving water and sediment quality to restore or enhance seagrass and on rehabilitating impacted wetlands to recover as many of their natural functions as possible (http://www.sjrwmd.com/programs/indianriverlagoon.html).

For assessment purposes, the Department has divided the IRL Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. This TMDL report addresses nutrient and DO impairments in the WBIDs that are parts of the main stem of the IRL and Banana River Lagoon. **Table 1.1** summarizes the WBIDs covered in this TMDL report and the parameters of concern for each segment.

Table 1.1. WBIDs and Parameters Addressed in This TMDL Report

WBID	Waterbody Name	Parameters of Concern
3044A	Newfound Harbor	Nutrients (Seagrass)
3057A	Banana River below Mathers	Nutrients (Seagrass)
3057B	Banana River above 520 Causeway	Nutrients (Seagrass)
3057C	Banana River above Barge Canal	Nutrients (Seagrass)
2963A	Indian River above Sebastian Inlet	Nutrients (Seagrass)
2963B	Indian River above Melbourne Causeway	Nutrients (Seagrass), Nutrients (Chlorophyll *a* [Chla])
2963C	Indian River above Melbourne Causeway	Nutrients (Seagrass)
2963D	Indian River above 520 Causeway	Nutrients (Seagrass) and DO
2963E	Indian River above NASA Causeway	Nutrients (Seagrass)
2963F	Indian River above M. Brewer	Nutrients (Seagrass), Nutrients (Chla), and DO
5003 B	South Indian River	Nutrients (Seagrass)
5003C	South Indian River	Nutrients (Seagrass)
5003D	South Indian River	Nutrients (Seagrass)

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the Florida Watershed Restoration Act (FWRA).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards, and provide important water quality restoration goals that will guide restoration activities.

The U.S. Environmental Protection Agency (EPA) finalized a nutrient and DO TMDL report for the IRL and Banana River Lagoon in 2007. The report addressed the lagoon segments that were on the EPA's 1998 303(d) list of impaired waters, which only covers portions of the main stems of the IRL and Banana River Lagoon. The EPA report also covers the nutrient and DO impairments in several tributaries that discharge into the IRL, and was based on the nutrient targets developed to protect seagrass communities in the main stems of these lagoon systems.

In contrast, the nutrient and DO TMDLs in this TMDL report address only the nutrient and DO impairments for the main stems of the IRL and Banana River Lagoon. No tributaries are included because the Department believes that the nutrient targets for protecting the tributaries may be different from those established for protecting the main stem segments. Therefore, the Department will publish tributary nutrient and DO TMDLs in a separate report in the near future.

In addition, because the entire main stem of the Banana River Lagoon and all the IRL main stem segments north of the southern boundary of Indian River County were listed as impaired for nutrients on the Department's Verified List, this TMDL report covers all these main stem segments, instead of just those on the EPA's 1998 303(d) list. The implementation of the TMDLs will apply to the watershed that drains to all these lagoon segments.

In addition to these differences, the final TMDLs in this report also include load estimations for direct atmospheric deposition that were not included in the EPA's 2007 TMDL report, as well as wasteload allocations (WLAs) for two more point source dischargers that were not in the EPA report.

This TMDL report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, to reduce the amount of nutrients that caused the verified impairment of the IRL and Banana River Lagoon. These activities will depend heavily on the active participation of the SJRWMD, local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the Clean Water Act requires states to submit to the EPA a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant source in each of these impaired waters on a schedule. The Department has developed these lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin is also required by the Florida Watershed Restoration Act (FWRA, Subsection 403.067[4], Florida Statutes [F.S.]), and the list is amended annually to include updates for each basin statewide.

Florida's 1998 303(d) list included 16 waterbodies in the IRL Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006. The list of waters for which impairments have been verified using the methodology in the IWR is referred to as the Verified List.

2.2 Information on Verified Impairment

As defined in the IWR, the primary assessment index for estuary nutrient condition is chla concentration. An estuary can be listed for nutrient impairment if, during the verified period of an assessment (1999 through 2006 for the IRL Basin), its annual average chla concentration exceeds the 11 micrograms per liter (µg/L) threshold in any given year, or the 5-year rolling historical minimum annual average concentration by more than 50 percent in 2 consecutive years. Based on these thresholds, the majority of the WBIDs in the IRL and Banana River Lagoon were assessed as not impaired for nutrients.

However, the IWR also allows the use of information other than chla concentrations to verify nutrient-based impairment, including algal blooms, excessive macrophyte growth, a decrease in the distribution (either in density or areal coverage) of seagrasses or other submerged aquatic vegetation, changes in algal species richness, and excessive diel oxygen swings. The verification of the nutrient impairment for the main stem segments of the IRL and Banana River Lagoon (**Table 1.1**) was primarily based on the information provided by the SJRWMD that seagrass coverages in these lagoon segments were depressed compared with the seagrass target depth limit (**Figure 2.1**).

Results from several studies have indicated that phosphorus and nitrogen loadings into the IRL system are among the major factors controlling seagrass coverage. For example, Steward and Green (2005) established that seagrass depth-limit depression in the IRL was mainly caused by elevated light attenuation. Studies by Gallegos (1994) and Steward et al. (2003) indicated that total suspended solids (TSS), water color, and chla concentration were the major factors

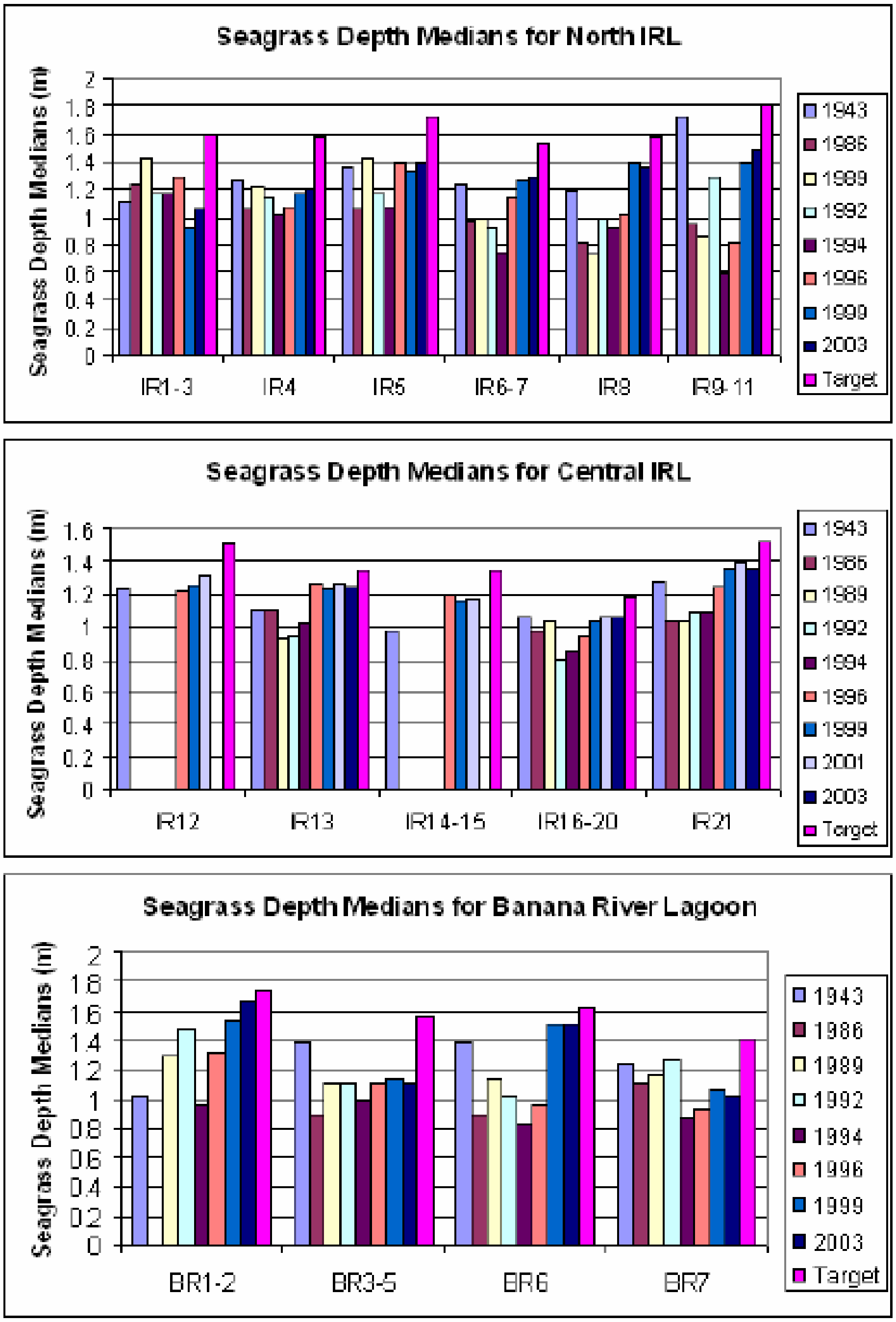

Figure 2.1. Seagrass Depth Medians for Lagoon Segments Compared with Full-Restoration Targets: IR1–IR21 Represent IRL Segments, and BR1–BR7 Represent Banana River Segments. These Segments Were Delineated by the SJRWMD (EPA 2007).

attenuating light in the lagoon. Hanisak (2001) showed a strong correlation between chla and total phosphorus (TP) concentrations in the lagoon, suggesting that phosphorus is one of the major causative pollutants for the elevated chla concentrations. In addition, Hanisak's studies showed a strong negative correlation between nutrient concentrations in the lagoon and salinity, suggesting that the watershed might be the major source of nutrients in the lagoon.

That study was followed by the work of Steward and Green (2006, 2007), which revealed significant correlations between watershed nutrient loadings (TP and total nitrogen [TN]) and seagrass depth limits. Trefry and Feng (1991) and Phlips et al. (2002) conducted other studies that linked the imbalance of lagoon aquatic communities to watershed nutrient inputs. All these studies indicated that nutrients play an important role in controlling seagrass abundance and that the majority of these nutrients were contributed by the watershed of the lagoon system.

Several segments of the IRL and Banana River Lagoon were also listed for nutrient impairment based on elevated chla concentrations and low DO. **Table 2.1** lists the nutrient information for WBID 2963B (Indian River above Melbourne Causeway) and WBID 2963F (Indian River above M. Brewer). **Table 2.2** lists data related to the DO impairment for WBID 2963D (Indian River above 520 Causeway) and WBID 2963F (Indian River above M. Brewer).

Based on **Table 2.1,** WBID 2963B was listed for nutrient impairment based on the observation that annual average chla concentrations in 2001, 2002, and 2005 exceeded the assessment threshold of 11 µg/L. WBID 2963F was listed for nutrient impairment because the annual average chla concentrations exceeded the assessment threshold of 11 µg/L from 1999 through 2002, and in 2004 and 2005. The median TN/TP ratios for both segments fell between 10 and 30, suggesting that the phytoplankton communities in these water segments are co-limited by phosphorus and nitrogen.

In addition, WBID 2963D and 2963F were verified for DO impairment based on observations that 770 out of 4,603 samples in WBID 2963D, and 237 out of 952 samples in WBID 2963F, were lower than the 5.0 milligrams per liter (mg/L) assessment threshold. TN concentrations higher than the 1.0 mg/L assessment threshold were observed for both WBIDs, suggesting that elevated nitrogen was the causative pollutant for low DO in these WBIDs (**Table 2.2**).

Table 2.1. Summary of Nutrient Data in the Verified Period for WBIDs 2963B and 2963F

WBID	Parameter	Summary of Observation
2963B (Indian River above Melbourne Causeway)	Exceedance of annual chla concentration (11 µg/L)	Exceeded in 2001, 2002, and 2005
	Range of chla concentration (µg/L)	1.2–61.5
	Median chla concentration (µg/L)	7.2
	Range of TN concentration (mg/L)	0.53–2.70
	Median TN concentration (mg/L)	1.14
	Range of TP concentration (mg/L)	0.02–0.25
	Median of TP concentration (mg/L)	0.058
	Median TN/TP ratio	22.7
	Limiting nutrient(s)	Nitrogen and phosphorus co-limited
2963F (Indian River above M. Brewer)	Exceedance of annual chla concentration (11 µg/L)	Exceeded in 1999–2002 and 2004–05
	Range of chla concentration (µg/L)	1.0–285.0
	Median of chla concentration (µg/L)	5.4
	Range of TN concentration (mg/L)	0.33–4.82
	Median of TN concentration (mg/L)	1.32
	Range of TP concentration (mg/L)	0.01–0.81
	Median of TP concentration (mg/L)	0.04
	Median TN/TP ratio	26
	Limiting nutrient(s)	Nitrogen and phosphorus co-limited

Table 2.2. Summary of DO Monitoring Data in the Verified Period for WBIDs 2963D and 2963F

WBID	Parameter	Summary of Observation
2963D (Indian River above 520 Causeway)	Total number of samples	4,603
	IWR-required number of exceedances for the Verified List	552
	Number of observed exceedances	770
	Number of observed nonexceedances	3,833
	Number of seasons during which samples were collected	4
	Highest DO observation (mg/L)	14.1
	Lowest DO observation (mg/L)	0.0
	Median DO observation (mg/L)	6.4
	Mean DO observation (mg/L)	6.3
	Median value for biochemical oxygen demand (BOD) observations (mg/L)	No BOD measurements
	Median value for 363 TN observations (mg/L)	1.40
	Median value for 738 TP observations (mg/L)	0.04
	Possible causative pollutant by IWR	Nitrogen
	FINAL ASSESSMENT	**Impaired**
2963F (Indian River above M. Brewer)	Total number of samples	952
	IWR-required number of exceedances for the Verified List	114
	Number of observed exceedances	237
	Number of observed nonexceedances	715
	Number of seasons during which samples were collected	4
	Highest DO observation (mg/L)	11.9
	Lowest DO observation (mg/L)	0.1
	Median DO observation (mg/L)	5.9
	Mean DO observation (mg/L)	5.6
	Median value for 18 BOD observations (mg/L)	2.1
	Median value for 339 TN observations (mg/L)	1.32
	Median value for 343 TP observations (mg/L)	0.05
	Possible causative pollutant by IWR	Nitrogen
	FINAL ASSESSMENT	**Impaired**

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

The following WBIDs listed in **Table 1.1** are Class II waterbodies, with a designated use of shellfish propagation or harvesting:

- *WBID 2963A (Indian River above Sebastian Inlet);*
- *WBID 2963C (Indian River above Melbourne Causeway);*
- *WBID 2963F (Indian River above M. Brewer), 5003B (South Indian River); and*
- *WBID 5003D (South Indian River).*

The remaining WBIDs in the table are all Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife:

- *WBID 3044A (Newfound Harbor);*
- *WBID 3057A (Banana River below Mathers);*
- *WBID 3057B (Banana River above 520 Causeway);*
- *WBID 3057C (Banana River above Barge Canal);*
- *WBID 2963B (Indian River above Melbourne Causeway);*
- *WBID 2963D (Indian River above 520 Causeway);*
- *WBID 2963E (Indian River above NASA Causeway); and*
- *WBID 5003C (South Indian River).*

These TMDLs address both Class II and Class III water quality criteria for nutrients and DO, as applicable.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 Interpretation of Narrative Nutrient Criterion

Florida's nutrient criterion is narrative only—i.e., nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. A threshold commonly used for assessing the nutrient impairment in estuaries is the annual average chla concentration of 11 µg/L, which is defined in the IWR (Chapter 62-303, F.A.C.). The IWR also allows the use of other information indicating an imbalance in flora or fauna due to nutrient enrichment, including, but not limited to, algal blooms, excessive macrophyte growth, a decrease in the distribution (either in density or areal coverage) of seagrasses or other submerged aquatic vegetation, changes in algal species richness, and excessive diel oxygen swings.

As discussed in Chapter 2, most segments along the main stems of the IRL and Banana River Lagoon were not verified for nutrient impairment using the chla threshold. The verified impairments were based on a comparison of the existing seagrass depth limits with the seagrass full-restoration targets (Steward and Green 2006). As both TP and TN are identified as important factors that influence seagrass distribution in these systems (Trefry and Feng 1991, Gallegos 1994, Hanisak 2001, Phlips et al. 2002, Steward et al. 2003), this TMDL establishes TP and TN targets to achieve the goal of seagrass restoration.

3.2.1.1 Establishing Nutrient Loading Targets for the IRL and Banana River Lagoon

Nutrient targets for the IRL and Banana River Lagoon for this TMDL report were based on the pollutant load reduction goal (PLRG) developed by the SJRWMD (Steward and Green 2006). These nutrient targets were established through a three-step process, as follows:

1. Establishing the seagrass full-restoration target

The spatial variability of the IRL and Banana River Lagoon is well-documented. Therefore, different seagrass restoration targets for different parts of the lagoon systems should be considered. Historically, the lagoon system was divided into three sublagoons—North IRL, Central IRL, and Banana River Lagoon—based on the unique hydraulic characteristics of each part of the system. According to Christian (2004) and Steward and Green (2007), the entire Central IRL lies within 28 kilometers of either the Sebastian Inlet or Ft. Pierce Inlet, and is much closer to the inlets than the North IRL and Banana River Lagoon. Consequently, the average flushing rate in the Central IRL is 10 times higher than in the North IRL and 15 times higher than in the Banana River Lagoon. **Figure 3.1** shows the location of the three sublagoons.

To appropriately address seagrass distribution in different parts of the lagoon system, the three sublagoons were further divided into segments (**Figure 3.1**). These segments were initially created based on the location of 13 causeway bridges that span the IRL and Banana River Lagoon system (Virnstein et al. 2003), resulting in 21 preliminary segments.

A detailed principle component analysis indicated that salinity and turbidity variations explained most differences between these segments. Follow-up cluster and Kriging analyses regrouped the segments based on similarities in salinity and turbidity and created a 15-segment delineation (Sigua et al. 1996). Seagrass targets and, in turn, nutrient targets were based on segment-specific seagrass depth limits, and the relationship between seagrass depth limits and model-simulated TN and TP loadings (**Figure 3.1**).

As elevated light attenuation is one of the major factors influencing the maximum water depth to which seagrass can grow (Steward et al. 2005), and this in turn determines the total area of seagrass distribution in a lagoon system, seagrass distribution depth limit was used as an index in assessing the extent of seagrass distribution. Seagrass depth-limit data were obtained by comparing historical seagrass maps with the lagoon bathymetry established by Coastal Planning and Engineering, Inc., in 1996. Seagrass maps from 1943, 1986, 1989, 1992, 1994, 1996, and 1999 were used for this analysis.

Depth measurements closest to a segment's seagrass deep-edge boundary were selected using a set of rules that captured only the appropriate bathymetric data and excluded other data that could create erroneous depth limits (e.g., near or within dredged areas and the shallow edges of seagrass beds [Steward et al. 2005]). No sea-level rise correction was applied in this analysis because previous studies (Trefry et al. 1990, Martin et al. 2004) indicated that the change in bottom elevation of the lagoon system resulting from sedimentation generally balances out the sea-level rise.

The seagrass depth-limit target for the lagoon was established based on the union of all the seagrass maps available from 1943 through 1999 (Steward et al. 2005). The deep-edge boundary delineating this unified coverage was considered the maximum depth limit that seagrass distribution can reach under the full-restoration condition. The final depth-limit targets were established by allowing a 10 percent departure (shallower) from the full-restoration depth-limit targets because the State Surface Water Quality Standard (Chapter 62-302, F.A.C.) allows a decrease of depth of the compensation point by no more than 10 percent from the natural background condition. The median value of the depth-limit targets for each lagoon segment was used for the analysis to establish the nutrient targets for the lagoon system. **Table 3.1** summarizes the ranges of seagrass depth-limit targets in the three sublagoon segments.

Table 3.1. Range of Seagrass Median Depth-Limit Targets for the Three Sublagoons

Sublagoon	Median Seagrass Depth Target (meters)
North IRL	1.5 – 1.8
Central IRL	1.2 – 1.7
Banana River Lagoon	1.4 – 1.8

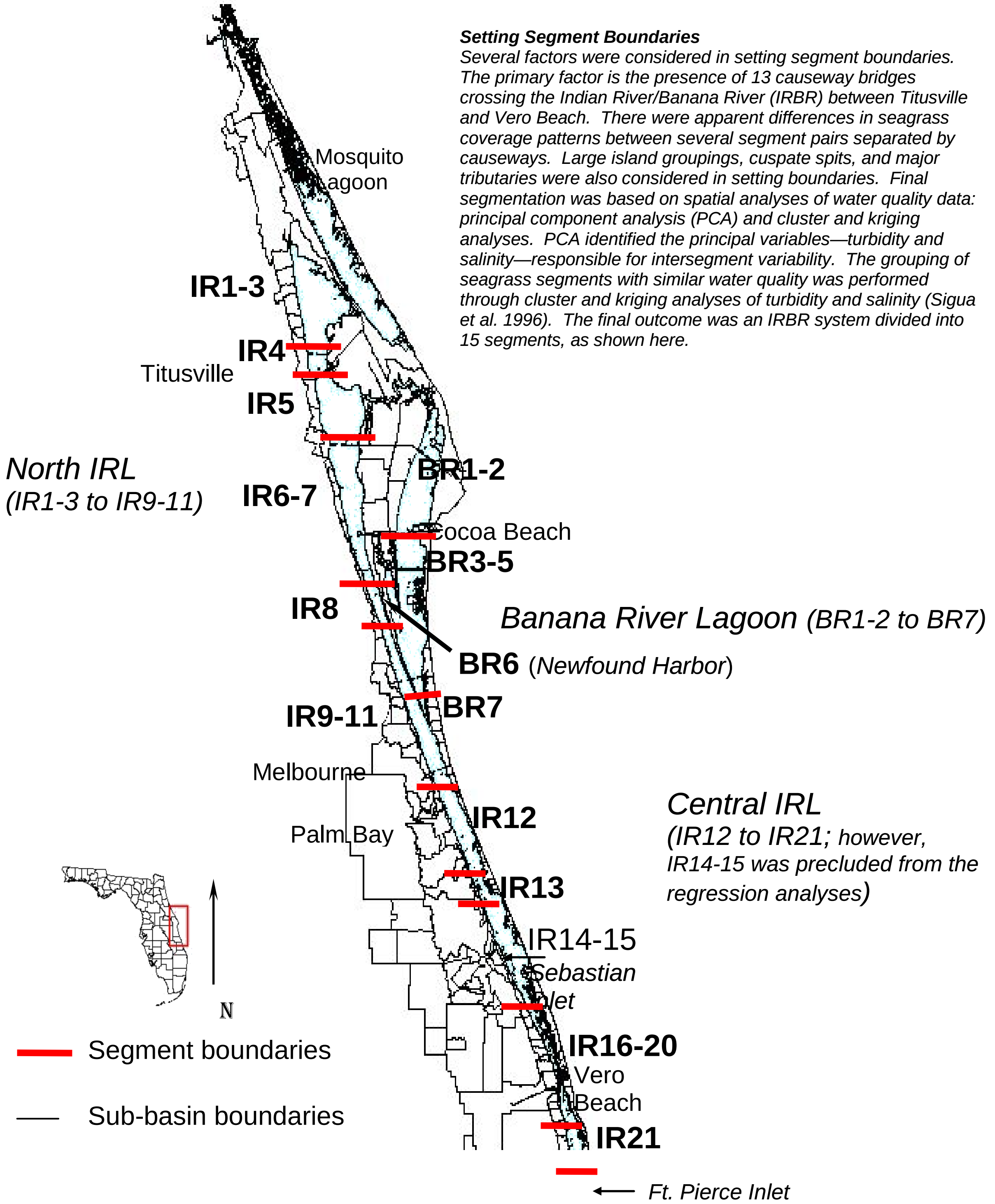

Figure 3.1. Location of the North IRL, Central IRL, and Banana River Lagoon, and Further Segmentation of the IRL and Banana River Lagoon Systems (Steward and Green 2006)

(2) Establishing the relationship between seagrass depth limit and TN and TP loadings from point and nonpoint sources

Nutrient targets for the IRL and Banana River Lagoon systems were established based on the seagrass depth-limit targets and correlations between seagrass depth limits and TN and TP loadings from point and nonpoint sources. TN and TP loadings were the sums of nonpoint and point source loadings. For those segments that had no point source contributors, nonpoint source loadings represented the total loadings.

The SJRWMD simulated nonpoint source loadings using the Pollutant Load Screening Model (PLSM) and the Hydrological Simulation Program–Fortran (HSPF) Model. For model calibration purposes, the HSPF Model used 1995 land use data. The calibration of the PLSM was mostly based on 2000 land use data, while 1990 land use data were used to calibrate the model against observed data collected for Turkey Creek/C-1 Canal during the same period. These models were built based on the SJRWMD's 1995 land use information and calibrated against observed gaging data for hydrology in four IRL tributaries: Crane Creek, C-1 Canal of Turkey Creek, South Prong of the Sebastian River, and Briar Creek (Green and Steward 2003, CDM 2003, Adkins et al. 2004). These tributaries were selected because they represent the variety of land uses in the IRL watershed.

To simulate nonpoint source loadings for a given year, the rainfall of the year and land use information closest to the year under analysis were substituted into the calibrated models. For example, to simulate the pollutant loads for 1943, land use information for 1943 was substituted into the calibrated models, and pollutant loadings for the year were simulated using the 1943 rainfall data. Before March 2000, rainfall data were taken from established National Oceanic and Atmospheric Administration (NOAA) National Weather Service stations and were supplemented with data from the SJRWMD's hydrological/ meteorological network. After March 2000, rainfall data were derived from Doppler radar.

During the model calibration, stormwater treatment was accounted for by applying loading reduction factors to developments constructed after Florida's stormwater treatment rules went into effect in 1984. Aerial photo-interpreted land use maps, circa 1989, were used as a baseline for determining treated versus nontreated developments. Model-simulated nutrient loads were comparable to the measured loads for the 4 tributaries listed above, slightly overpredicting TN and TP loadings (by about 0.7 percent and 7 percent, respectively) (Green and Steward 2003).[1]

For lagoon segments that receive point source discharges, TN and TP loadings from point sources were added to the total loadings that these segments receive. This TMDL includes 16 point sources that discharge into the IRL and Banana River Lagoon. **Table 4.1** lists the facilities and the lagoon segments into which they discharge. Annual loads from these facilities were calculated based on flow and concentration measurements retrieved from the Department's Permit Compliance System Database.

The following data transformations were conducted before conducting the regression analyses:

(a) Typically, TN and TP concentrations in receiving waters are determined by the loading intensity (areal loading) instead of total loading from drainage basins.

[1] Detailed descriptions of the PLSM, HSPF Model, and model calibration can be obtained from *Development of a nonpoint source pollution load screening model* (Mundy and Bergman 1998), *HSPF Version 12 user manual* (Bicknell et al. 2004), and specific model setups by Green and Steward (2003).

Therefore, before the regression analyses were conducted, the total nutrient loadings from the drainage area of each lagoon segment were converted to areal loadings.

(b) It has been established that the relationship between nutrient loadings and seagrass depth is not linear (Steward and Green 2006, Davies-Colley et al. 1993, Gallegos and Kenworthy 1996); therefore, the areal nutrient loadings were log-transformed before the regression analysis.

(c) Seagrass depth limits for the years used to create the regression equation were established as percent departures from the seagrass depth-limit target.

To conduct the regression analysis, loading estimates for nonpoint sources and point sources, and the data on seagrass depth limit, should all be available within the same year. The years that met all these requirements were 1943, 1996, 1999, and 2001. Nutrient loading data for point sources were not available for 1943, but given the limited land use and population in that year, it was assumed that point source discharges into the IRL and Banana River Lagoon were insignificant compared with nonpoint source loading.

According to the SJRWMD, these semi-log regression analyses utilized data from all segments except Sebastian Inlet (IR14-15), which was excluded because its hydraulic flushing rate (measured in days) far exceeds the rates of the other segments (measured in months). The higher flushing rate significantly reduces the impact of pollutant loads on seagrass coverage, in contrast to the apparent impact observed elsewhere in the IRL and Banana River Lagoon. Pollutant load versus seagrass depth-limit regression equations were developed lagoonwide, as well as for each of the sublagoon systems. Nutrient loading estimates from both the HSPF Model and the PLSM were evaluated during the regression analyses.

In most cases, loading estimates from the PLSM produced stronger correlations with the seagrass depth limit than the loading estimates from the HSPF Model, except for TP for the North IRL sublagoon segments. Therefore, the regression equation for TP for the North IRL sublagoon was developed based on HSPF TP loading estimates, while both the lagoonwide and other sublagoon regression equations were developed based on loading estimates from the PLSM (Steward and Green 2006, 2007).

(3) Establishing TN and TP targets based on a -10 percent deviation (shoreward) from the seagrass full-restoration targets and the relationship between seagrass depth limit and nutrient loadings.

After the nutrient loadings–seagrass depth-limit regression equations were established, target nutrient loadings for the entire IRL and Banana River Lagoon, and for all the sublagoon systems, were estimated by substituting the target seagrass depth limit (a -10 percent departure from the full-restoration condition) into the regression equations. To avoid underestimating the nutrient loadings by simply back-transforming the log-transformed loading rates, according to the SJRWMD (Steward and Green 2006) a nonparametric method described by Duan (1983) was used to back-calculate the target areal loading.

Table 3.2 shows the target nutrient loadings for nonpoint and point surface water sources for the entire lagoon system, as well as for the sublagoon systems. The table also shows the models used for estimating the nutrient loadings from nonpoint sources, the regression coefficient for each regression, and the probability at which these regression models are statistically significant.

According to the SJRWMD (Steward and Green 2006) and based on **Table 3.2**, the sublagoon analyses generally yielded stronger correlation statistics than the lagoonwide analysis. Also, in contrast to a lagoonwide analysis, a sublagoon analysis should generate more realistic loading targets because it better reflects land use and rainfall characteristics specific to the sublagoon drainage areas. Consequently, is the SJRWMD recommends favoring the sublagoon loading limits over the lagoonwide loading limits in the establishment of loading targets or TMDLs.

Two WBIDs covered by this TMDL report—WBID 2963B (Indian River above Melbourne Causeway) and WBID 2963F (Indian River above Melbourne Brewer)—also had verified impairments for chla. The majority of the WBIDs included in this TMDL are listed for nutrient impairments due to seagrass growth depression even when they were not impaired for chla, suggesting that the nutrient targets established to address seagrass distribution are more stringent than the nutrient targets set up to address chla concentration. It is therefore expected that, once the nutrient targets established for protecting seagrass are achieved, the chla concentration of these WBIDs should also be controlled.

Table 3.2. Nutrient Loading Targets for Surface Water Nonpoint and Point Sources Lagoonwide, and for the Three Sublagoon Systems (Steward and Green 2006)

Lagoonwide (IRL and Banana River Lagoon combined; excludes Sebastian Segment IR14-15)		
PLSM Regressions	**TN target loading (pounds per acre per year [lbs/ac/yr])**	**TP target loading (lbs/ac/yr)**
Years included in the analyses: 1943, 1996, 1999, and 2001 data	3.34 $R^2 = 0.49$, $p < 0.001$	0.546 $R^2 = 0.53$, $p < 0.001$
North IRL		
PLSM Regressions	**TN target loading (lbs/ac/yr)**	**TP target loading (lbs/ac/yr)**
Years included in the analyses: 1943, 1996, and 1999 data	2.88 $R^2 = 0.43$, $p = 0.006$	
HSPF Regressions		
Years included in the analyses: 1943, 1996, and 1999 data		0.368 $R^2 = 0.47$, $p = 0.003$
Central IRL (excludes Sebastian Segment IR14-15)		
PLSM Regressions	**TN target loading (lbs/ac/yr)**	**TP target loading (lbs/ac/yr)**
Years included in the analyses: 1996, 1999, and 2001 data	2.90 $R^2 = 0.87$, $p<0.001$	0.574 $R^2 = 0.65$, $p = 0.001$
Banana River Lagoon		
PLSM Regressions	**TN target loading (lbs/ac/yr)**	**TP target loading (lbs/ac/yr)**
Years included in the analyses: 1943, 1996, and 1999 data	2.18 $R^2 = 0.74$, $p = 0.001$	0.374 $R^2 = 0.72$, $p = 0.001$

3.2.2 Applicable Water Quality Standard for DO Concentration

Florida's Surface Water Quality Standards require that the DO concentration for Class II and III marine waters "shall not average less than 5.0 mg/L in a 24-hour period and shall never be less than 4.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained" (Chapter 62-302, F.A.C.).

Multiple environmental factors control DO concentrations in the IRL. Theoretically, the DO concentration in a given waterbody can be influenced by temperature, salinity, flow, water depth, photosynthesis, respiration, sediment oxygen demand (SOD), the oxidation of organic carbon or inorganic reductants, and low DO ground water input. Typically, low DO concentrations were observed in the lagoon during the summer months (May to September). Occasional DO concentrations lower than 5.0 mg/L were also observed in other months, but with a much lower frequency. While temperature is an important factor responsible for changes in DO, saturation DO concentrations under the typical summer water temperature (28^0C) and salinity (above 3 percent) should still be higher than 6.0 mg/L, as long as no other chemical and biochemical processes are involved (Clescerl et al. 1999). Therefore, DO concentrations lower than 4.0 mg/L in the IRL most likely result from factors other than temperature and salinity.

For example, low DO ground water input can be an important cause of low DO in many freshwater systems. In the IRL Basin, however, ground water input may not be important in the total water budget because of the existence of a confining layer for the Floridan aquifer (Martin et al. 2004). Therefore, the low DO concentration observed in the lagoon could be caused by processes influenced by nutrients, such as elevated respiration due to the excessive populations of both primary producers and grazers at various levels of the food chain, or SOD.

Excessive amounts of nutrient loading into the lagoon can cause low DO in many different ways. As the chla concentrations in most WBIDs assessed by the Department did not exceed the 11 µg/L threshold, the excessive growth of phytoplankton may not be a major process through which nutrients can influence DO concentrations in the lagoon system. Based on a study by Hanisak (2001) in the IRL, the primary productivity of seagrass and epiphytes was much greater (around 15 to 30 times) than that of phytoplankton and benthic microalgae. His analysis showed that the mean areal productivity (grams of carbon fixed by seagrass per square meter per hour [g C m^{-2} h^{-1}]) was 0.76 for seagrass, 1.01 for epiphytes, 0.03 for phytoplankton, and 0.05 for benthic microalgae. Therefore, seagrasses and their epiphytes accounted for 96 percent of the carbon fixed (41 and 55 percent, for seagrass and epiphytes, respectively).

Nutrients in the water column can stimulate the growth of epiphytes. The excessive growth of epiphytic algae on the leaf surface of seagrasses can shield light and cause light limitation (Wetzel 2001). Studies have shown that seagrasses typically have a high respiratory demand to support a large nonphotosynthetic biomass (e.g., roots, rhizomes) (Fourqurean and Zieman 1991). They must regularly oxygenate their root zones to compensate for anoxic sediment. If excessive epiphyton growth causes light limitation of seagrasses and therefore limits their photosynthetic capability, seagrasses produce less organic carbon and DO, which in turn results in less oxygen being transported to the root tissue. Low DO availability at the root zone may cause seagrasses to rely more on the fermentation pathway to obtain their energy, which may then stimulate the accumulation of sulfate in sediment. This, in turn, will stimulate the respiration of seagrasses and consume more oxygen.

The excessive growth of epiphytes may also cause the accumulation of organic materials from these algae. In addition, the decomposition of these algal materials will consume oxygen in the water. Studies have also shown that a significant amount of dissolved organic carbon can be released by epiphyton, which stimulates the growth of bacteria. The respiration of these bacteria further decreases the oxygen concentration in the water column. Therefore, controlling nutrient loading from a watershed restrains excessive epiphyton growth, stimulates seagrass growth, and improves the structure of the seagrass community, which in turn improves DO concentrations in the lagoon.

However, whether the control of nutrient loading from the watershed will ensure that DO concentrations in the lagoon never drop bellow 4.0 mg/L is uncertain. As discussed previously, seagrasses also respire and consume oxygen. Studies have shown that the growth of seagrass may produce a habitat that slows down the water flow and increases the sedimentation of particulate materials from the water column, trapping organic materials in the seagrass bed. This decreases the DO concentration by decreasing the reaeration rate, and also increases DO consumption in seagrass beds by stimulating the growth of bacteria using the accumulated organic materials.

The net productivity of seagrass also decreases as the colonization of seagrass proceeds. Barron et al. (2004) showed that gross primary production from *Cymodocea nodosa* increased from 7 to 49.3 millimoles of carbon being fixed by seagrass per square meter per day (mmol C m^{-2} d^{-1}) during the initial stages of colonization and then decreased to 20 mmol C m^{-2} d^{-1} when the biomass was in excess of 6 moles (mol C m^{-2}). At the same time, community respiration increased with seagrass colonization, leading to a shift from net autotrophy in the unvegetated sediment community to net heterotrophy after *C. nodosa* colonization. The increase in net heterotrophy with seagrass colonization was reflected in the development of reducing conditions in the sediment.

The seasonal variation of photosynthetic and nonphotosynthetic tissue may also influence seagrass respiration and, in turn, DO concentrations. Kennish et al. (2007) found that the mean above-ground biomass of *Zostera marina* (eelgrass) in Barnegat Bay–Little Egg Harbor peaked during August and September (mean = 13.77 g dry weight per square meter [wt m^{-2}]). In contrast, the mean below-ground biomass was at a maximum from June to July (51.54 g dry wt m^{-2}). The unsynchronization of the biomass of photosynthetic and nonphotosynthetic seagrass tissue can also lead to respiration rates that are higher than oxygen production from photosynthesis during certain times of the year.

Based on the above analyses, even after nutrient loading is controlled and the seagrass restoration target is achieved in the lagoon, whether DO concentration will never be lower than the 5.0 mg/L criteria cannot be determined based on the available information. More data need to be collected regarding the relationship between seagrass communities and DO concentration in the IRL to address the natural DO condition. However, it is reasonable to expect that, when the seagrass full-restoration target is achieved, the impact of excessive nutrients from human sources on DO concentrations in the lagoon should be alleviated, and DO concentrations should be those typically associated with a healthy seagrass community and provide healthy habitat for fish and other aquatic organisms.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

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

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA’s 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 A** for background information on the federal and state stormwater programs).

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

4.2 Potential Sources of Pollutants in the IRL and Banana River Lagoon Watersheds

4.2.1 Point Sources

4.2.1.1 Wastewater Point Sources

Forty-one NPDES-permitted facilities were identified in the IRL Basin. Nineteen of these are concrete batch plants that typically receive generic permits, which require that the facilities meet certain treatment requirements, but have no requirements for routine monitoring. Untreated discharges from these facilities may be high in turbidity and may also change the pH of receiving waters, but they are generally not considered major sources of nutrients.

The remaining facilities, which are either industrial or domestic wastewater facilities, do not contribute significant amounts of nutrients to the IRL and Banana River Lagoon, even if they are NPDES-permitted facilities:

*(1) Three facilities—the **New Smyrna Beach Water Reclamation Facility** (WRF) (FL0172090), **Edgewater WWTF** (FL0021431), and **Brevard County Utilities Department (BCUD)/South Central Regional WWTF** (FL0102679)—are domestic wastewater facilities. Although they are located in the IRL Basin, they do not discharge into the IRL and Banana River Lagoon systems. The New Smyrna Beach WRF and Edgewater WWTF discharge into Mosquito Lagoon. The BCUD/South Central Regional WWTF discharges to the St. Johns River. Therefore, these facilities are not considered contributors to the IRL and Banana River Lagoon in this TMDL.*

*(2) The **Vero Beach Municipal Power Plant** (FL0002984) is located at 100 17th Street, Vero Beach (Latitude 27^{0}37$^{'}$52$^{''}$, Longitude 80^{0}22$^{'}$33$^{''}$). The power plant has 5 power-generating units. Units #1, #2, and #3 use a total of 181 million gallons per day (MGD) (Maximum Daily Flow) of water from the Indian River as once-through cooling water, which is discharged back to the Indian River via outfalls D-011, D-012, and D-013. As discharges from these outfalls are recycling Indian River waters, the discharges are not considered an addition of extra nutrients to the Indian River. Cooling water for the Unit #4 cooling tower is treated wastewater effluent from the Vero Beach Wastewater Treatment Plant (WWTP). Boiler blowdown is discharged to the WWTP but not to the Indian River. There is no discharge from Unit #5 to the Indian River. Therefore, the Vero Beach Municipal Power Plant is not considered a source of nutrients in this TMDL.*

*(3) The **Cape Canaveral Air Force Station (CCAFS) Regional WWTF** (FL0102920) is located at Scrub Jay Road, CCAFS (Latitude 28^{0}29$^{'}$44$^{''}$, Longitude 80^{0}35$^{'}$3$^{''}$). The facility has a 0.8-MGD annual average flow capacity. This discharge is completely reused, and no discharge to a water of the state is allowed from the facility. The facility was granted an NPDES permit because it accepts a small amount of treated hazardous waste, and federal regulations regarding hazardous wastes require a facility to hold an NPDES permit to accept hazardous wastes. The facility was therefore not considered a significant nutrient contributor in this TMDL.*

*(4) The **Titusville Osprey WRF** (FL0103268) is located at 1105 Buffalo Road, Titusville. The facility has a 2.75-MGD annual average daily flow (AADF) permitted capacity slow-rate public access, consisting of on-site irrigation at the plant and the irrigation of residential lawns, parks, playgrounds, cemeteries, golf courses, highway medians, and other landscape areas. A certain portion of the reclaimed water for golf course irrigation is stored in stormwater retention ponds located on each golf course. These ponds intermittently discharge stormwater to adjacent drainage features, which ultimately discharge to the Indian River.*

However, as stated in the Department's Program Guidance Memo (DOM-96-01, 1996) regarding reuse activities and NPDES permitting for golf course lakes, as long as a given golf course lake that takes reclaimed water can still hold the first 0.5 inch or 1.0 inch (depending on the area) of runoff from the tributary watershed based on Chapter 62-25, F.A.C., and the water quality condition of the reclaimed water meets the requirement of Chapter 62-610, F.A.C. (secondary treatment, high-level disinfection, and 5.0 mg/L TSS), any discharges from the lake to waters of the state likely will consist primarily of

> *stormwater. Therefore, the discharge from the facility is implicitly considered in this TMDL as part of the nonpoint source loadings through stormwater. No WLA is assigned to the facility.*
>
> *In addition to the discharge to golf course lakes, the facility also has an existing 2.75-MGD maximum monthly flow permitted wet-weather backup discharge to the Blue Heron Water Reclamation Facility, which has an existing 4.0-MGD annual average discharge flow. The reclaimed water from the Titusville WRF will be blended with the reclaimed water from the Blue Heron WRF and discharged through a constructed wetland system to Addison Canal and then to the St. Johns River. Based on this information, the Titusville WRF is not considered a major nutrient contributor to the IRL system.*

Table 4.1 lists all the NPDES-permitted facilities that are considered significant contributors of nutrients into the IRL and Banana River Lagoon, and the lagoon segments that they discharge into**. Figure 4.1** shows the location of these facilities. **Tables 4.2** and **4.3** show long-term average annual loads for TN and TP, respectively, from these facilities during the six-year period from 2000 through 2005.

The 6-year long-term annual TN loadings from these wastewater facilities ranged from none to more than 13,000 lbs/yr. The facilities that discharged the highest amount of TN to the IRL include the Cocoa Beach WRF (FL0021105), which discharged about 13,652 lbs of TN per year, and the Vero Beach WWTF (FL0021661), which discharged about 12,993 lbs of TN per year. Other significant TN dischargers include the Melbourne Reverse Osmosis (RO) WWTF (FL0043443) and Cocoa WRF Facility (FL0021521), which discharged about 6,558 and 6148 lbs/yr of TN, respectively, from 2000 to 2005.

The 6-year long-term annual TP loadings from these facilities follow a similar pattern to that of TN. TP loadings ranged from none to about 2,622 lbs/yr. The two facilities that discharged the highest amount of TP are, again, the Cocoa Beach WRF, which discharged about 2,622 lbs of TP per year, and the Vero Beach WWTF, which discharged about 1,064 lbs of TP per year. Other significant TP dischargers include the Cocoa WRF and Vero Beach RO WTF (FL0042544), which discharged about 575 and 536 lbs/yr of TP, respectively, from 2001 to 2005.

Long-term annual average nutrient loads from several facilities could not be calculated, even though these facilities are listed in **Table 4.2**. This was either because a given facility did not have a TN and TP monitoring requirement between 2000 and 2005, or because the facility did not discharge a significant quantity of TN and/or TP into the IRL during the period of calculation. For example, the Cape Canaveral Power Plant (FL0001472), located in the city of Cocoa, has several effluent points into the IRL, including two once-through cooling water (OTCW) outfalls and one auxiliary equipment cooling water (AECW) outfall, that use the water from the IRL. The IRL water is used primarily as cooling water. No significant amount of TN and TP is added to the water, which is discharged back to the IRL. The cooling water is therefore not considered a major source of TN and TP to the lagoon.

The facility also has three stormwater outfalls from an equipment area, a fuel oil storage tank area, and a nonequipment area. These stormwater discharges were routed to a runoff disposal

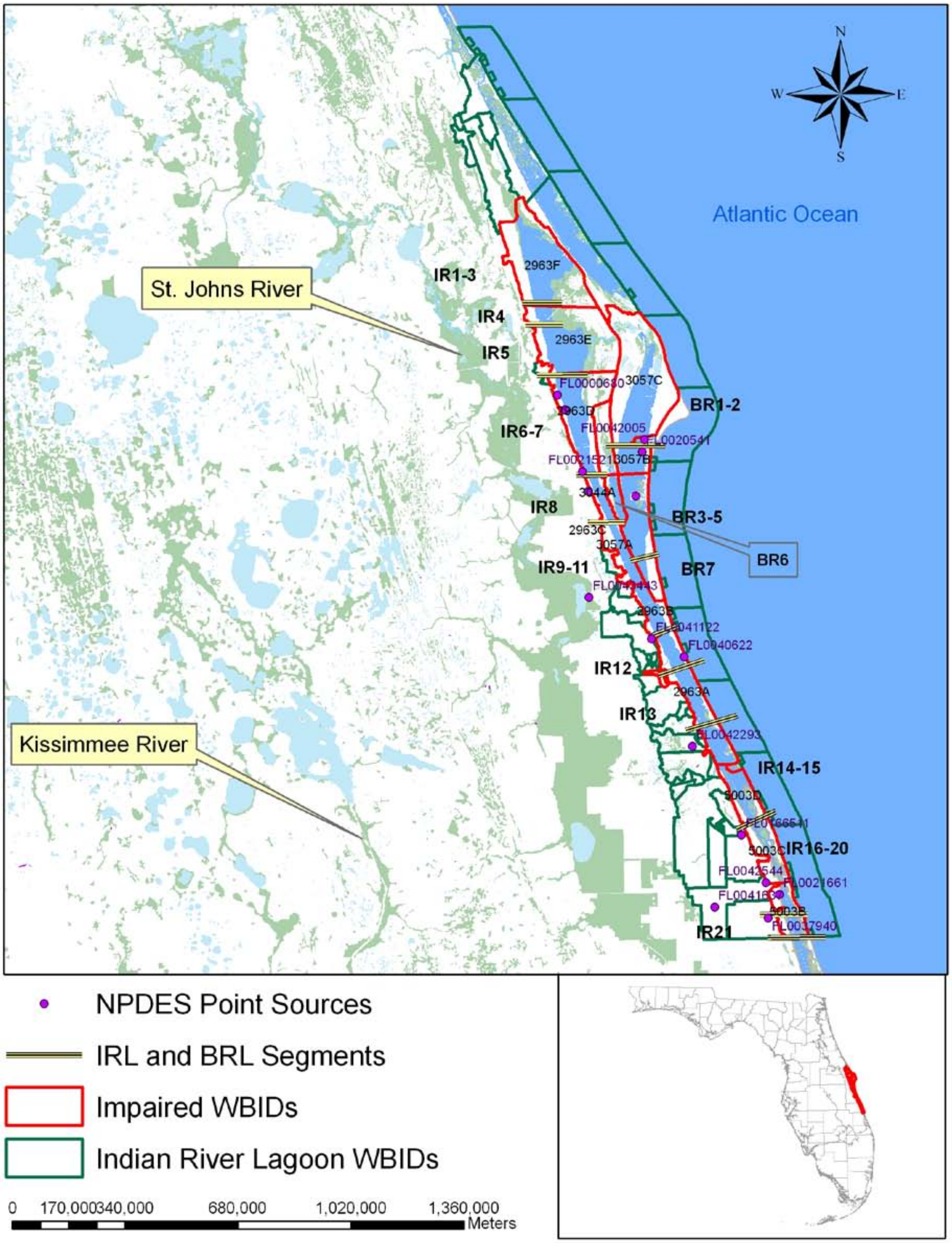

Figure 4.1. NPDES-Permitted Facilities Located in the IRL and Banana River Lagoon Watersheds

Table 4.1. Point Source Facilities that Discharge into the IRL and Banana River Lagoon

NPDES Permit Number	Facility Name	Facility Type	City, County	Impacted Segment
FL0021521	Cocoa/J. Sellers WWTP	Domestic WWTP	Cocoa, Brevard	IR6-7
FL0001473	Florida Power & Light (FPL) Cape Canaveral Power Plant	Power Plant with RO	Cocoa, Brevard	IR6-7
FL0042005	Morton Salt	Industrial Wastewater	Cape Canaveral, Brevard	BR1-2
FL0020541	City of Cape Canaveral	Domestic WWTP	Cape Canaveral, Brevard	BR3-5
FL0021105	City of Cocoa Beach	Domestic WWTP	Cocoa Beach, Brevard	BR3-5
FL0000680	Reliant Energy Indian River	Power Plant	Titusville, Brevard	IR6-7
FL0021571	City of Rockledge WWTP	Domestic WWTP	Rockledge, Brevard	IR8
FL0043443	Melbourne RO WTF	RO	Melbourne, Brevard	IR9-11
FL0040622	Brevard County Utilities Department (BCUD)/ South Beaches	Domestic WWTP	Melbourne, Brevard	IR12
FL0041122	Melbourne/Grant St. WWTP	Domestic WWTP	Melbourne, Brevard	IR12
FL0042293	Barefoot Bay WWTP	Domestic WWTP	Barefoot Bay, Brevard	IR14-15
FL0021661	City of Vero Beach WWTP	Domestic WWTP	Vero Beach, Indian River	IR16-20
FL0042544	Vero Beach RO WTF	RO	Vero Beach, Indian River	IR16-20
FL0166511	Indian River County Utilities Department (IRCUD)/ Hobart RO WTF	RO	Vero Beach, Indian River	IR16-20
FL0041637	IRCUD/West Regional	Domestic WWTP	Vero Beach, Indian River	IR16-20
FL0037940	IRCUD/South RO WTF	RO	Vero Beach, Indian River	IR16-20

Table 4.2. Long-Term Annual Average TN Loadings from NPDES-Permitted Facilities (2000–05)

NPDES Permit Number	Facility Name	Long-Term Annual Mean TN (mg/L)	Long-Term Annual Mean Discharge (million gallons/yr)	Long-Term Annual Mean TN Loading (lbs/yr)
FL0021521	Cocoa/J. Sellers WWTP	5.78	128	6,148
FL0001473	FPL Cape Canaveral Power Plant	N/A	N/A	N/A
FL0042005	Morton Salt	2.74	21	492
FL0020541	City of Cape Canaveral	1.05	169	1475
FL0021105	City of Cocoa Beach	6.27	238	13,652
FL0000680	Reliant Energy Indian River	N/A	8	N/A
FL0021571	City of Rockledge WWTP	N/A	0	N/A
FL0043443	Melbourne RO WTF	2.43	323	6,558
FL0040622	BCUD/South Beaches	8.09	6.1	415
FL0041122	Melbourne/Grant St. WWTP	10.78	0.45	44
FL0042293	Barefoot Bay WWTP	2.29	6.0	123
FL0021661	City of Vero Beach WWTP	11.85	131	12,993
FL0042544	Vero Beach RO WTF	2.39	121	2,419
FL0166511	IRCUD/Hobart RO WTF	1.90	134	2,123
FL0041637	IRCUD/West Regional	0.73	235	1,422
FL0037940	IRCUD/South RO WTF	1.51	300	3,795

N/A – Discharge data are not available or the load cannot be calculated for the reasons described in this section.

Table 4.3. Long-Term Annual Average TP Loadings from NPDES-Permitted Facilities (2000–05)

NPDES Permit Number	Facility Name	Long-Term Annual Mean TP (mg/L)	Long-Term Annual Mean Discharge (million gallons/yr)	Long-Term Annual Mean TP Loading (lbs/yr)
FL0021521	Cocoa/J. Sellers WWTP	0.54	128	575
FL0001473	FPL Cape Canaveral Power Plant	N/A	N/A	N/A
FL0042005	Morton Salt	0.57	21	103
FL0020541	City of Cape Canaveral	0.11	169	161
FL0021105	City of Cocoa Beach	1.32	238	2,622
FL0000680	Reliant Energy Indian River	0.20*	8*	12*
FL0021571	City of Rockledge WWTP	N/A	0	N/A
FL0043443	Melbourne RO WTF	0.04	323	96
FL0040622	BCUD/South Beaches	1.50	6.1	77
FL0041122	Melbourne, Grant St. WWTP	0.45	0.45	2
FL0042293	Barefoot Bay WWTP	0.35	6.0	19
FL0021661	City of Vero Beach WWTP	1.06	131	1,064
FL0042544	Vero Beach RO WTF	0.34	121	536
FL0166511	IRCUD/Hobart RO WTF	0.04	142	45
FL0041637	IRCUD/West Regional	0.04	235	84
FL0037940	IRCUD/South RO WTF	0.04	300	103

N/A – Discharge data are not available or the load cannot be calculated for the reasons described in this section.

area. The disposal area only overflows under heavy rainfall and was therefore not considered a major source of TN to the lagoon. Before the facility renewed its permit in 2005, it used treated ground water for the boiler and blowdown. The reject from the treated ground water was discharged directly to the IRL. As nutrients were not considered a major issue for the reject discharge at the time, no TN and TP discharge limits were applied to the discharge.

When the permit was renewed in 2005, the facility started to use treated wastewater as source water for the boiler and blowdown. TN and TP discharge loading limits were applied to the reject discharge of the treated wastewater (annual average daily loads of 7 lbs/day for TN and 0.4 lbs/day for TP). However, as the TN and TP loading limits established for the reject discharge are annual loading limits, and the facility did not start to collect TN and TP samples until 2006, no 5-year long-term annual average TN and TP loadings could be calculated for the facility for the period from 2001 to 2005.

The vast majority of the discharge from the Reliant Energy Indian River Power Plant (maximum daily average of 820 MGD) was OTCW from the IRL. No extra TN and TP loadings were added to the lagoon through the cooling water. The only other surface water discharges from the plant are boiler blowdown (maximum monthly average 0.297 MGD) and nonindustrial stormwater (roof runoff), which are also directed to the discharge canal (no discharge limit). As the facility adds trisodium phosphate and disodium phosphate into the boiler blowdown to control pH, the permit requires the facility to monitor the TP concentrations of the boiler blowdown discharge on a monthly basis. **Table 4.4** shows the TP concentrations in this discharge from January 2000 through October 2007.

Because the facility started to use a new method to control pH in February 2003, the TP concentration of the boiler blowdown discharge was dramatically decreased compared with the TP concentration before February 2003. To represent the existing condition of the facility, a five-year long-term average TP loading from the facility was calculated based on data from 2003 through 2007. No significant amount of TN was added into the discharge from the Reliant Energy plant.

The Rockledge WWTF (FL0021571), located in the city of Rockledge, Brevard County, has a permitted average daily flow (ADF) of 4.5 MGD discharged to the IRL. However, this discharge is limited to a period not to exceed 7 days during the Mechanical Integrity Testing of the facility's underground injection well, which is conducted once every 5 years. In other times, the 4.5-MGD ADF is directed to a permitted underground injection well system. The facility also has a 1.6-MGD AADF reuse system, which irrigates a reuse service area around the facility. As necessary, wet-weather flows from the reuse system are discharged to the underground injection well. From 2001 through 2005, there was no discharge from the facility.

All the above facilities discharged a total of about 48,695 lbs of TN and 4,716 lbs of TP into the IRL and Banana River Lagoon per year.

Table 4.4. TP Concentration of the Boiler Blowdown Discharge for the Reliant Energy Indian River Power Plant

Date	Flow (MGD)	TP (mg/L)	Date	Flow (MGD)	TP (mg/L)
1/31/2000	0.018	1.88	9/30/2003	0.058	0.311
2/29/2000	0.052	1.49	10/31/2003	0.023	0.161
3/31/2000	0.011	1.8	11/30/2003	0.01	0.098
4/30/2000	0.048	2.1	12/31/2003	0.017	0.067
5/31/2000	0.051	3	1/31/2004	0.03	0.04
6/30/2000	0.083	26.1	2/29/2004	0.021	0.03
7/31/2000	0.132	7.74	3/31/2004	0.03	0.04
8/31/2000	0.131	2.5	4/30/2004	0.029	0.045
9/30/2000	0.165	1	5/31/2004	0.03	0.04
10/31/2000	0.049	1.2	6/30/2004	0.029	0.05
11/30/2000	0.041	0.9	7/31/2004	0.037	0.09
12/31/2000	0.048	2	8/31/2004	0.038	0.05
1/31/2001	0.033	1.3	9/30/2004	0.049	0.075
2/28/2001	0.036	1.1	10/31/2004	0.039	0.071
3/31/2001	0.039	1.1	11/30/2004	0.008	0.09
4/30/2001	0.044	1.6	12/31/2004	0.02	0.05
5/31/2001	0.07	1.5	1/31/2005	0.014	0.085
6/30/2001	0.091	1.3	2/28/2005	0.016	0.04
7/31/2001	0.107	2.2	3/31/2005	0.02	0.028
8/31/2001	0.09	0.32	4/30/2005	0.02	0.05
9/30/2001	0.088	0.67	5/31/2005	0.024	0.07
10/31/2001	0.067	N/A	6/30/2005	0.004	0.063
11/30/2001	0.041	N/A	7/31/2005	0.016	0.05
12/31/2001	0.025	N/A	8/31/2005	0.019	0.045
1/31/2002	0.047	3.1	9/30/2005	0.068	0.085
2/28/2002	0.038	3	10/31/2005	0.001	0.05
3/31/2002	0.032	1.81	11/30/2005	0.0003	0.04
4/30/2002	0.047	1.56	12/31/2005	0.006	0.06
5/31/2002	0.031	2.66	2/28/2006	0.004	0.07
6/30/2002	0.031	2.62	3/31/2006	0.007	0.06
7/31/2002	0.014	1.9	4/30/2006	0.012	0.08
8/31/2002	0.059	1.11	5/31/2006	0.005	0.09
9/30/2002	0.028	1.11	6/30/2006	0.005	0.1
10/31/2002	0.029	1.61	7/31/2006	0.008	0.15
11/30/2002	0.023	1.29	8/31/2006	0.046	0.06
12/31/2002	0.022	3.66	9/30/2006	0.007	0.09
1/31/2003	0.027	2.77	10/31/2006	0.005	0.11
2/28/2003	0.018	0.84	11/30/2006	0.008	0.09
3/31/2003	0.051	0.89	12/31/2006	0.008	0.09
4/30/2003	0.037	0.49	1/31/2007	0.001	0.05
5/31/2003	0.027	0.053	2/28/2007	0.001	0.05

Date	Flow (MGD)	TP (mg/L)	Date	Flow (MGD)	TP (mg/L)
6/30/2003	0.032	0.082	4/30/2007	0.001	0.05
7/31/2003	0.054	0.067	9/30/2007	0.021	0.05
8/31/2003	0.077	0.088	10/31/2007	0.025	0.07

N/A – No monitoring data are available.

4.2.1.2 Municipal Separate Storm Sewer System Permittees

Like other nonpoint sources of pollution, urban stormwater discharges are associated with land uses and human activities, and are driven by rainfall and runoff processes leading to the intermittent discharge of pollutants in response to storms. The 1987 amendments to the Clean Water Act designated certain stormwater discharges from urbanized areas as point sources requiring NPDES stormwater permits. In October 2000, the EPA authorized the Department to implement the NPDES Stormwater Program in all areas of Florida, except for Indian tribal lands. The Department's authority to administer the NPDES Program is set forth in Section 403.0885, F.S. The three major components of the NPDES stormwater regulations are as follows:

(1) ***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.*

(2) ***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 contamination of stormwater.*

(2) ***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 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 state Stormwater Rule in late 1981. The Stormwater Rule is a technology-based program that relies on the implementation of best management practices (BMPs) designed to achieve a specific level of treatment (i.e., performance standards), as set forth in Chapter 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 five water management districts, although the Department continues to do the permitting for specified 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, which brings 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.

Table 4.5 lists the counties, cities, and townships with MS4 permits influenced by TMDLs in the IRL and Banana River Lagoon watersheds.

Table 4.5. MS4 Permittees Affected by TMDLs in the IRL and Banana River Lagoon Watersheds

MS4 Permit Phase	Permit Name	Permit Number	County
II	FDOT District 4	FLR04E083	None
II	FDOT District 5	FLR04E024	None
II	Brevard County	FLR04E052	Brevard
II	City of Titusville	FLR04E079	Brevard
II	City of Cape Canaveral	FLR04E003	Brevard
II	City of Cocoa	FLR04E032	Brevard
II	City of Cocoa Beach	FLR04E062	Brevard
II	Town of Rockledge	FLR04E047	Brevard
II	City of Satellite Beach	FLR04E072	Brevard
II	Patrick Air Force Base	FLR04E074	Brevard
II	City of Indian Harbor Beach	FLR04E026	Brevard
II	Town of Indialantic	FLR04E030	Brevard
II	City of Melbourne	FLR04E027	Brevard
II	Town of Melbourne Beach	FLR04E041	Brevard
II	City of West Melbourne	FLR04E028	Brevard
II	City of Palm Bay	FLR04E077	Brevard
II	Town of Malabar	FLR04E050	Brevard
II	Indian River County	FLR04E068	Indian River
II	City of Sebastian	FLR04E124	Indian River
II	Town of Indian River Shores	FLR04E009	Indian River
II	City of Vero Beach	FLR04E010	Indian River
II	St. Lucie County	FLR04E029	St. Lucie
II	City of Fort Pierce	FLR04E065	St. Lucie

4.2.2 Nonpoint Sources

Other than the TN and TP loadings from NPDES-permitted point sources, the majority of the nutrient loadings are primarily generated from nonpoint sources in the watershed. Major nonpoint sources may include, but are not limited to, loadings through surface runoff, ground water, and atmospheric deposition directly onto the surface of the lagoon system. Based on stepwise regression analyses conducted by the SJRWMD, the atmospheric sources of nutrients do not significantly affect the relationship between watershed nutrient loadings and seagrass depth distributions at $\alpha = 0.15$ (Steward and Green 2006). Therefore, the atmospheric nutrient loadings were not included in the loading versus depth-limit regression analyses. However, as these loadings are part of the total nutrient budgets that these lagoons receive, they were calculated in this TMDL report and added to both the existing total nutrient loadings and TMDLs.

Ground water input from the Floridan aquifer does not represent a significant portion of the total water budget for the IRL system (Martin et al. 2004). Depending on the season, input from the surficial aquifer to the lagoon could be important. Nutrient contributions from the surficial aquifer were implicitly included in the SJRWMD's model simulations as part of the budget for watershed flow and nutrient loadings.

As discussed in Chapter 3, the SJRWMD used both the PLSM and HSPF Model to simulate TN and TP loadings from the watershed. This TMDL is based on the watershed loadings simulated by these models. The PLSM, a GIS-based stormwater runoff model, was originally developed as a tool to assist the SJRWMD in watershed planning. The SJRWMD assessed its reliability in estimating annual nutrient loads to determine PLRGs for the IRL (Steward and Green 2006).

The PLSM generates pollutant loads from multiple, spatially distributed inputs such as land use, soil types, hydrologic boundaries, rainfall, runoff coefficients, event mean concentrations (EMCs), and BMPs. In assessing the model's reliability in predicting nutrient pollutant loads, the PLSM was calibrated for runoff volume, TN, TP, and TSS to flow and loading estimates based on measured data in four IRL drainage basins: Crane Creek, C-1 Canal of Turkey Creek, South Prong of Sebastian River, and Briar Creek (Green and Steward 2003). The SJRWMD study concluded that PLSM loads predicted reasonably well the measured flow, and the TN, TP, and TSS loadings derived from measured concentrations and flow. **Figure 4.2** shows the combined runoff volume and TN, TP, and TSS loadings for the four creeks, as simulated by PLSM, versus measured runoff volume and TN, TP, and TSS loadings in these creeks.

For comparison purposes, the SJRWMD also developed an HSPF Model to simulate the TN and TP loadings from the IRL. HSPF (Bicknell et al. 2004), developed and maintained by Aqua Terra and the EPA, is a comprehensive package that can be used to develop a combined watershed and receiving water model. It can simulate various species of nitrogen and phosphorus, chla, BOD, coliform bacteria, metals, and DO concentrations in receiving waters. The model has three major modules, as follows, that simulate pollutant loadings from the watershed and in-water transport of the pollutants and their effects on chla and DO concentrations:

- *The PERLND Module performs a detailed analysis of surface and subsurface flow for pervious land areas based on the Stanford Watershed Model. Water quality calculations for sediment in pervious land runoff can include sediment detachment during rainfall events and reattachment during dry periods, with the potential for washoff during runoff events. For other water quality constituents, runoff water quality can be determined using buildup-washoff algorithms, "potency factor" (e.g.,* *factors relating constituent washoff to sediment washoff), or a combination of both.*

- *The IMPLND Module analyzes surface processes only and uses buildup-washoff algorithms to determine runoff quality.*
- *The RCHRES Module is used to simulate flow routing and water quality in receiving waters, which are assumed to be one-dimensional. Receiving water constituents can interact with suspended and bed sediments through soil-water partitioning. The HSPF Model can incorporate "special actions" that utilize user-specified algorithms to account for occurrences such as opening/closing of water control structures to maintain seasonal water stages or other processes beyond the normal scope of the model code.*

Based on SJRWMD studies, both loading models provide comparable annual loading estimates for the IRL and Banana River Lagoon systems (Green and Steward 2003). The major purpose of watershed TN and TP simulations is to find the relationship between pollutant loadings and seagrass depth limit. There were differences between the PLSM and HSPF results: one or the other provided a stronger regression outcome for a given sublagoon or pollutant; therefore the stronger of the two sets of regressions, based on correlation and significance statistics (R^2 and p values), was selected to determine the final loading.

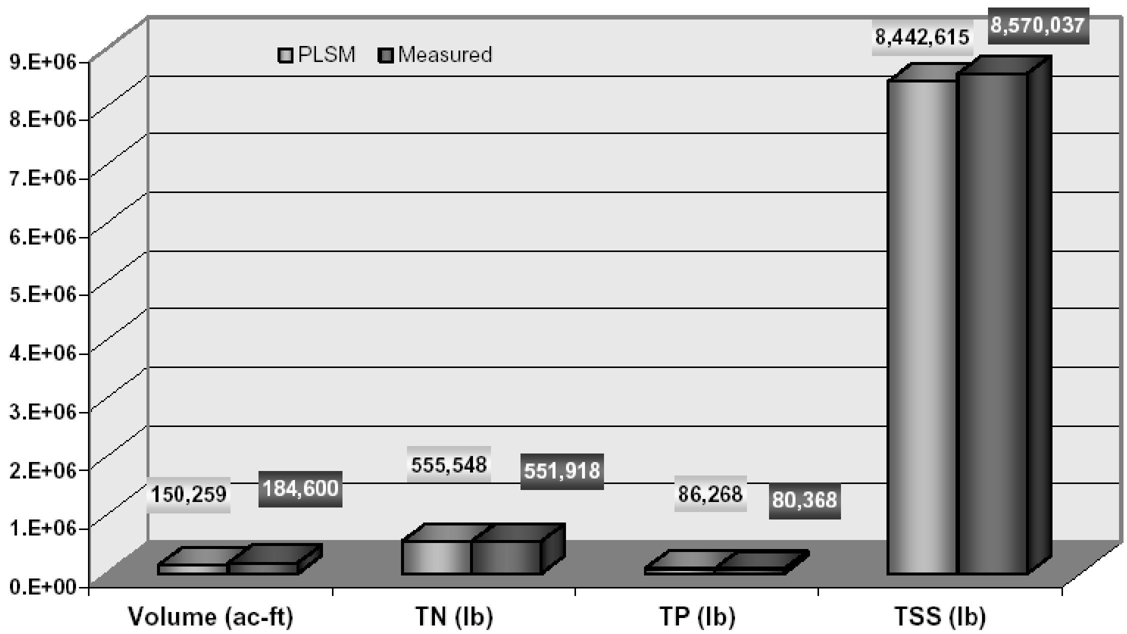

Figure 4.2. PLSM Estimated Versus Measured Loads for Four Creeks in the IRL Watershed (Green and Steward 2003)

In the PLRG analysis, the PLSM loads generally produced better regression statistics than the HSPF loads. However, the HSPF-estimated loads for TP produced a better set of regression statistics for the North IRL and thus dictated the annual TP loading for that sublagoon (Steward and Green 2006, 2007).

4.2.2.1 Land Uses

No matter what model was used for watershed loading simulation, land use patterns in the IRL and Banana River Lagoon watersheds are among the most important factors influencing pollutant loadings. Land use patterns influence the imperviousness of the watershed and determine the amount of runoff that can be produced in a given watershed area. These patterns also determine the concentrations of pollutants in the runoff produced in a given area and therefore determine the amount of a given pollutant that can be produced per acre of drainage basin. Knowing the land use distribution in the watershed is therefore very important in simulating the pollutant watershed loading.

Table 4.6 summarizes the land use patterns in the watersheds that drain into each lagoon segment in all the three sublagoon areas: North IRL, Central Central IRL, and Banana River Lagoon. The land use summary was conducted based on Level 1 land use in the Florida Land Use, Cover, and Forms Classification System (FLUCCS 1984). This analysis used the SJRWMD's 2000 land use GIS coverage. It should be noted that the surface areas of lagoons are not considered part of the watersheds and therefore are not included in the water land use areas in **Table 4.6**. **Table 4.7** shows the percent distribution of each land use in each watershed.

Table 4.6. Land Use Distribution (in acres) in the IRL and Banana River Lagoon Watersheds

Sublagoon	Lagoon Segment	Urban and Built-Up	Low-Density Residential	Medium-Density Residential	High-Density Residential	Agriculture	Rangeland	Upland Forest	Water	Wetland	Barren Land	Transportation, Communication, and Utilities	Subtotal
North IRL	IR1-3	247	1,894	570	137	7,129	6,120	6,533	494	27,776	545	564	52,009
	IR4	351	264	66	384	274	68	199	5	334	36	246	2,227
	IR5	2,312	150	479	1,115	662	6,621	2,024	349	18,428	465	749	33,353
	IR6-7	1,297	1,679	1,862	982	3,407	1,666	1,240	830	7,928	90	911	21,892
	IR8	550	505	694	238	88	178	185	50	132	15	109	2,744
	IR9-11	4,028	1,106	4,667	3,593	175	1,178	1,624	848	1,477	84	1,131	19,910
	Subtotal	**8,784**	**5,597**	**8,338**	**6,449**	**11,735**	**15,831**	**11,805**	**2,576**	**56,074**	**1,234**	**3,710**	**132,135**
Central IRL	IR12	14,466	3,899	23,071	2,730	8,461	6,799	7,102	1,641	4,626	932	2,394	76,121
	IR13A	37	248	126	78	5	549	565	19	142	2	48	1,820
	IR13B	561	1,941	820	113	808	3,455	4,832	530	3,413	69	298	16,840
	IR14	5,046	5,261	5,508	1,383	41,810	18,161	19,289	2,357	16,024	1,032	1,294	117,156
	IR15	559	128	419	192	606	151	542	122	728	44	43	3,533
	IR16-20	6,540	4,383	9,155	3,160	24,439	3,963	6,084	1,393	3,833	682	2,140	65,773
	IR21	145	84	527	241	28	106	378	65	737	8	37	2,358
	Subtotal	**27,355**	**15,944**	**39,626**	**7,897**	**76,157**	**33,184**	**38,793**	**6,127**	**29,503**	**2,768**	**6,255**	**283,609**
Banana River Lagoon	BR1-2	3,880	139	0.0	0.1	105	9,148	9,281	2,036	7,846	188	473	33,095
	BR3-5	2,633	102	1,182	1,433	8	356	278	217	1,047	38	300	7,593
	BR6	720	110	802	1,244	108	156	186	1,153	1,602	39	194	6,314
	BR7	592	88	2,433	601	11	262	73	243	13	34	71	4,420
	Subtotal	**7,825**	**439**	**4,416**	**3,278**	**231**	**9,921**	**9,818**	**3,649**	**10,507**	**299**	**1,038**	**51,423**
Total		**43,965**	**21,980**	**52,380**	**17,624**	**88,124**	**58,936**	**60,416**	**12,352**	**96,085**	**4,301**	**11,003**	**467,167**

Table 4.7. Percent Land Use Distribution in the IRL and Banana River Lagoon Watersheds

Sublagoon	Lagoon Segment	Urban and Built-Up	Low-Density Residential	Medium-Density Residential	High-Density Residential	Agriculture	Rangeland	Upland Forest	Water	Wetland	Barren Land	Transportation, Communication, and Utilities	Subtotal
North IRL	IR1-3	0.5%	3.6%	1.1%	0.3%	13.7%	11.8%	12.6%	0.9%	53.4%	1.0%	1.1%	100.0%
	IR4	15.7%	11.9%	3.0%	17.3%	12.3%	3.0%	8.9%	0.2%	15.0%	1.6%	11.0%	100.0%
	IR5	6.9%	0.4%	1.4%	3.3%	2.0%	19.9%	6.1%	1.0%	55.3%	1.4%	2.2%	100.0%
	IR6-7	5.9%	7.7%	8.5%	4.5%	15.6%	7.6%	5.7%	3.8%	36.2%	0.4%	4.2%	100.0%
	IR8	20.0%	18.4%	25.3%	8.7%	3.2%	6.5%	6.7%	1.8%	4.8%	0.6%	4.0%	100.0%
	IR9-11	20.2%	5.6%	23.4%	18.0%	0.9%	5.9%	8.2%	4.3%	7.4%	0.4%	5.7%	100.0%
	Subtotal	**6.6%**	**4.2%**	**6.3%**	**4.9%**	**8.9%**	**12.0%**	**8.9%**	**1.9%**	**42.4%**	**0.9%**	**2.8%**	**100.0%**
Central IRL	IR12	19.0%	5.1%	30.3%	3.6%	11.1%	8.9%	9.3%	2.2%	6.1%	1.2%	3.1%	100.0%
	IR13A	2.1%	13.6%	6.9%	4.3%	0.3%	30.2%	31.0%	1.1%	7.8%	0.1%	2.6%	100.0%
	IR13B	3.3%	11.5%	4.9%	0.7%	4.8%	20.5%	28.7%	3.1%	20.3%	0.4%	1.8%	100.0%
	IR14	4.3%	4.5%	4.7%	1.2%	35.7%	15.5%	16.5%	2.0%	13.7%	0.9%	1.1%	100.0%
	IR15	15.8%	3.6%	11.9%	5.4%	17.1%	4.3%	15.3%	3.4%	20.6%	1.2%	1.2%	100.0%
	IR16-20	9.9%	6.7%	13.9%	4.8%	37.2%	6.0%	9.3%	2.1%	5.8%	1.0%	3.3%	100.0%
	IR21	6.2%	3.5%	22.4%	10.2%	1.2%	4.5%	16.1%	2.8%	31.3%	0.3%	1.6%	100.0%
	Subtotal	**9.6%**	**5.6%**	**14.0%**	**2.8%**	**26.9%**	**11.7%**	**13.7%**	**2.2%**	**10.4%**	**1.0%**	**2.2%**	**100.0%**
Banana River Lagoon	BR1-2	12.4%	0.4%	0.0%	0.0%	0.3%	29.2%	29.6%	0.9%	25.0%	0.6%	1.5%	100.0%
	BR3-5	34.9%	1.4%	15.7%	19.0%	0.1%	4.7%	3.7%	2.1%	13.9%	0.5%	4.0%	100.0%
	BR6	12.1%	1.9%	13.4%	20.9%	1.8%	2.6%	3.1%	13.5%	26.8%	0.6%	3.3%	100.0%
	BR7	13.4%	2.0%	55.0%	13.6%	0.2%	5.9%	1.7%	5.5%	0.3%	0.8%	1.6%	100.0%
	Subtotal	**15.9%**	**0.9%**	**9.0%**	**6.7%**	**0.5%**	**20.1%**	**19.9%**	**3.0%**	**21.3%**	**0.6%**	**2.1%**	**100.0%**
Total		**9.5%**	**4.7%**	**11.3%**	**3.8%**	**19.0%**	**12.7%**	**13.0%**	**2.2%**	**20.7%**	**0.9%**	**2.4%**	**100.0%**

Based on **Table 4.6**, the IRL and Banana River Lagoon watersheds cover a total of about 467,167 acres (not including lagoon surface areas). There are about 132,135 acres, 283,609 acres, and 51,423 acres in the watersheds of the North IRL, Central IRL, and Banana River Lagoon, respectively. At the lagoonwide scale, urban areas—including low-, medium-, and high-density residential; transportation, communication, and utilities; and other urban and built-up land uses—comprise about 146,953 acres, or about 31 percent of the total drainage area. These areas account for 25, 34, and 35 percent of the drainage areas in the North IRL, Central IRL, and Banana River Lagoon, respectively. In addition to these human land use areas, agricultural lands are important in the Central IRL, accounting for about 27 percent of its watershed area. Agricultural lands account for about 9 percent and 0.4 percent of the total drainage areas in the North IRL and Banana River Lagoon watersheds, respectively.

The dominant natural land use in the watersheds of these sublagoons is wetlands, which total about 96,085 acres and account for about 21 percent of the total drainage area. Upland forest and rangeland each account for about 13 percent of the total drainage areas to these lagoons. Percent drainage basin dominated by wetlands is highest in the North IRL watershed, at about 42 percent, followed by the Banana River Lagoon watershed, at about 21 percent. The highest percent drainage areas dominated by upland forests, about 20 percent, are observed in the Banana River Lagoon watershed. This is followed by 14 percent of upland forest areas in the Central IRL watershed and 9 percent in the North IRL watershed.

Percent drainage basin occupied by rangelands accounts for about 12, 12, and 20 percent, in the North IRL, Central IRL, and Banana River Lagoon watersheds, respectively. Water surface areas other than the lagoon surface areas are relatively insignificant, occupying only 2 to 3 percent of the drainage areas in all three watersheds.

The highest percent human land use dominance appears in the Central IRL watershed, accounting for 61 percent of the drainage area. Human land uses occupy 34 to 35 percent of the North IRL and Banana River Lagoon watersheds, respectively. **Figures 4.3**, **4.4**, and **4.5** show the spatial distribution of Level 1 land uses in the IRL and Banana River Lagoon watersheds.

4.2.2.2 Nonpoint Source TN and TP Loadings from the Watersheds Draining into the IRL and Banana River Lagoon

Existing nonpoint source TN and TP loadings from most watersheds that drain into the IRL and Banana River Lagoon were simulated using the PLSM and were mostly based on 2000 land use and 30-year mean annual rainfall. Level 3 land use classification was used in conducting the actual PLSM simulation. TP loadings into North IRL segments were simulated using the HSPF Model because there was a better correlation between watershed HSPF TP loading simulates and seagrass depth limits than between PLSM TP loading simulates and seagrass depth limits. As the HSPF Model was used to simulate continuous watershed loading on a daily basis, daily rainfall data for the 9 years between 1995 and 2003 were used in place of long-term annual average rainfall.

Other than land use information, other model inputs required by the PLSM to simulate watershed TN and TP loadings include drainage basin boundary, hydrologic soil groups, annual rainfall, land use and hydrologic soil specific runoff coefficients, and the EMCs of TN and TP associated with different land uses. **Figure 4.6** shows the drainage basin delineation provided

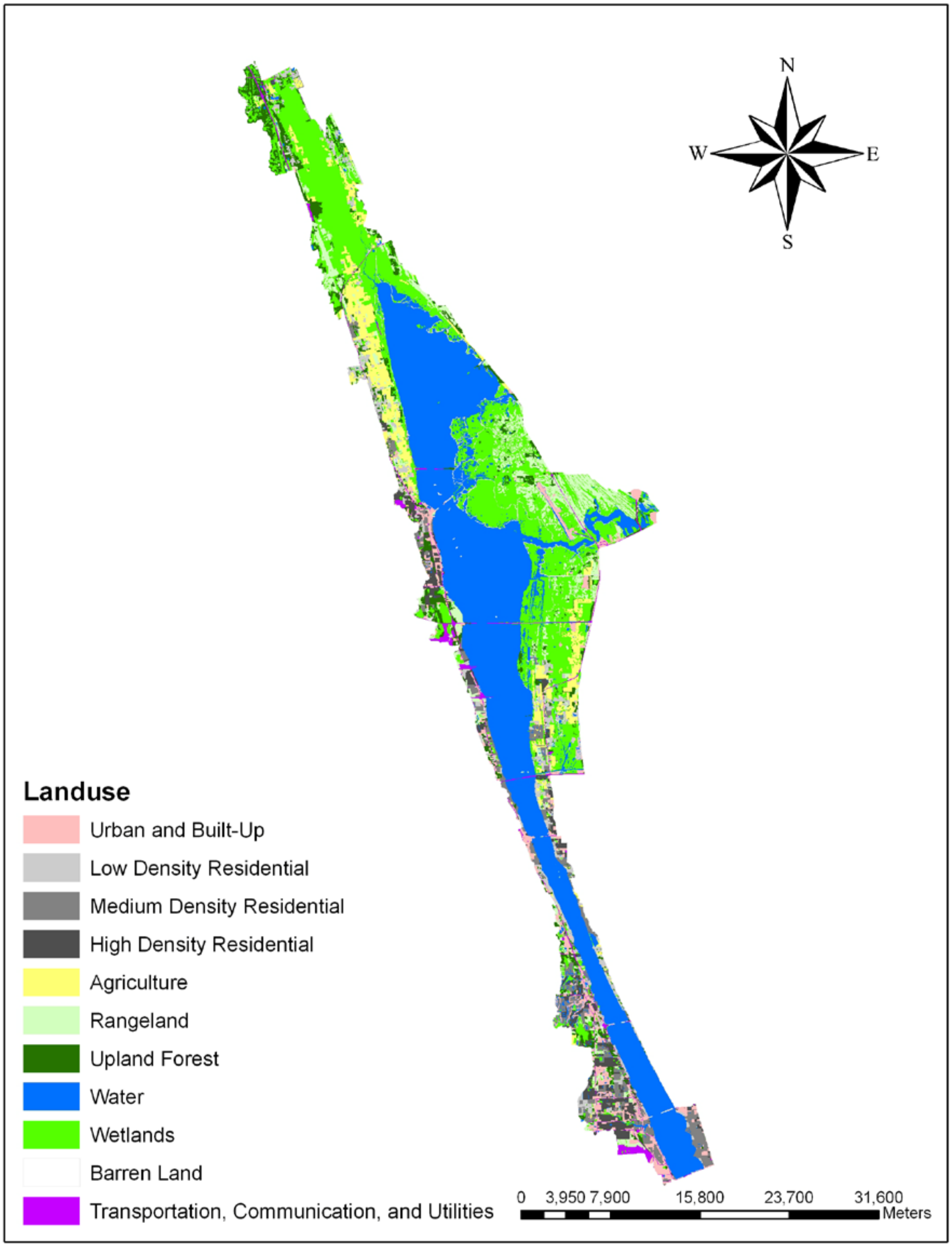

Figure 4.3. Major Land Uses in the North IRL Watershed

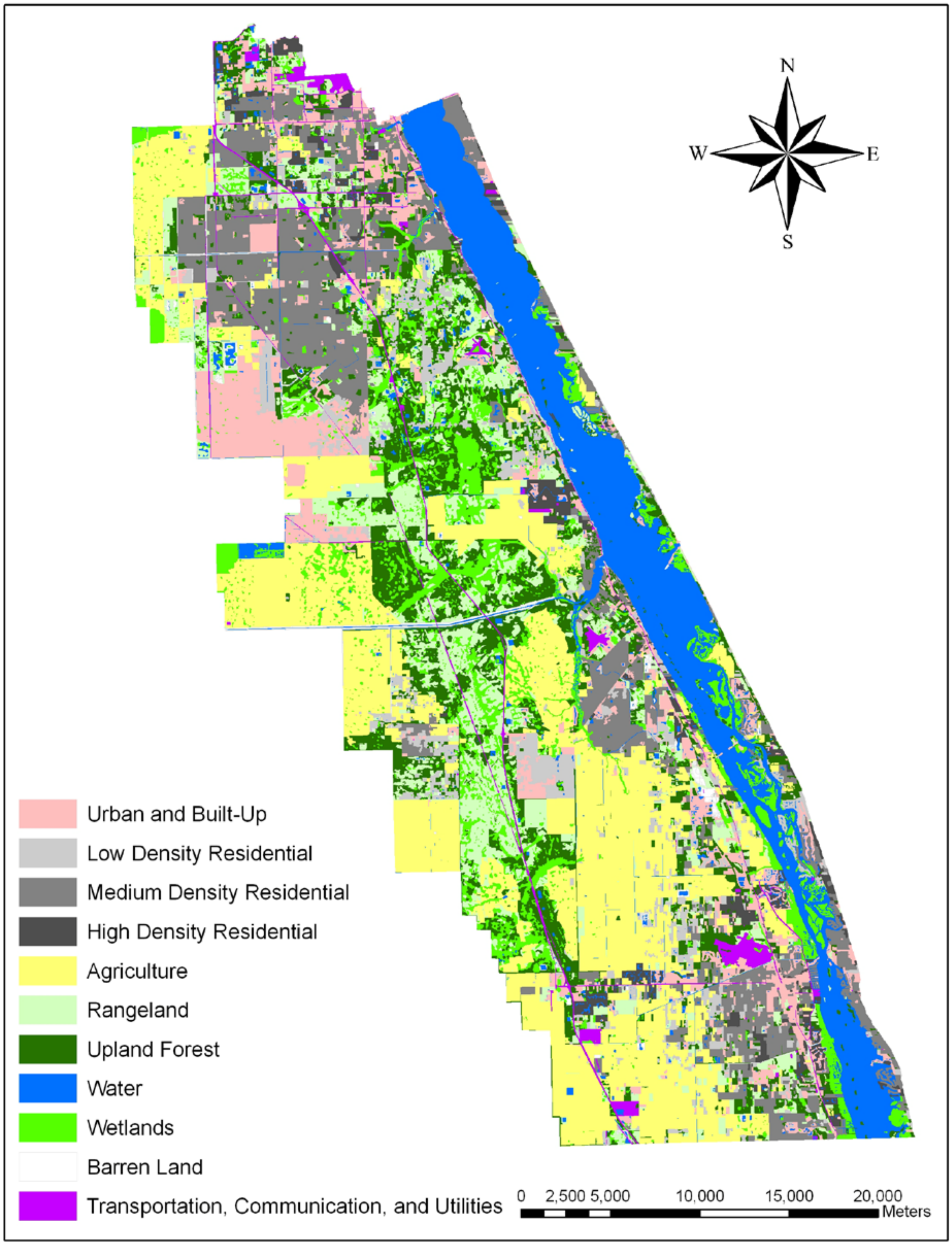

Figure 4.4. Major Land Uses in the Central IRL Watershed

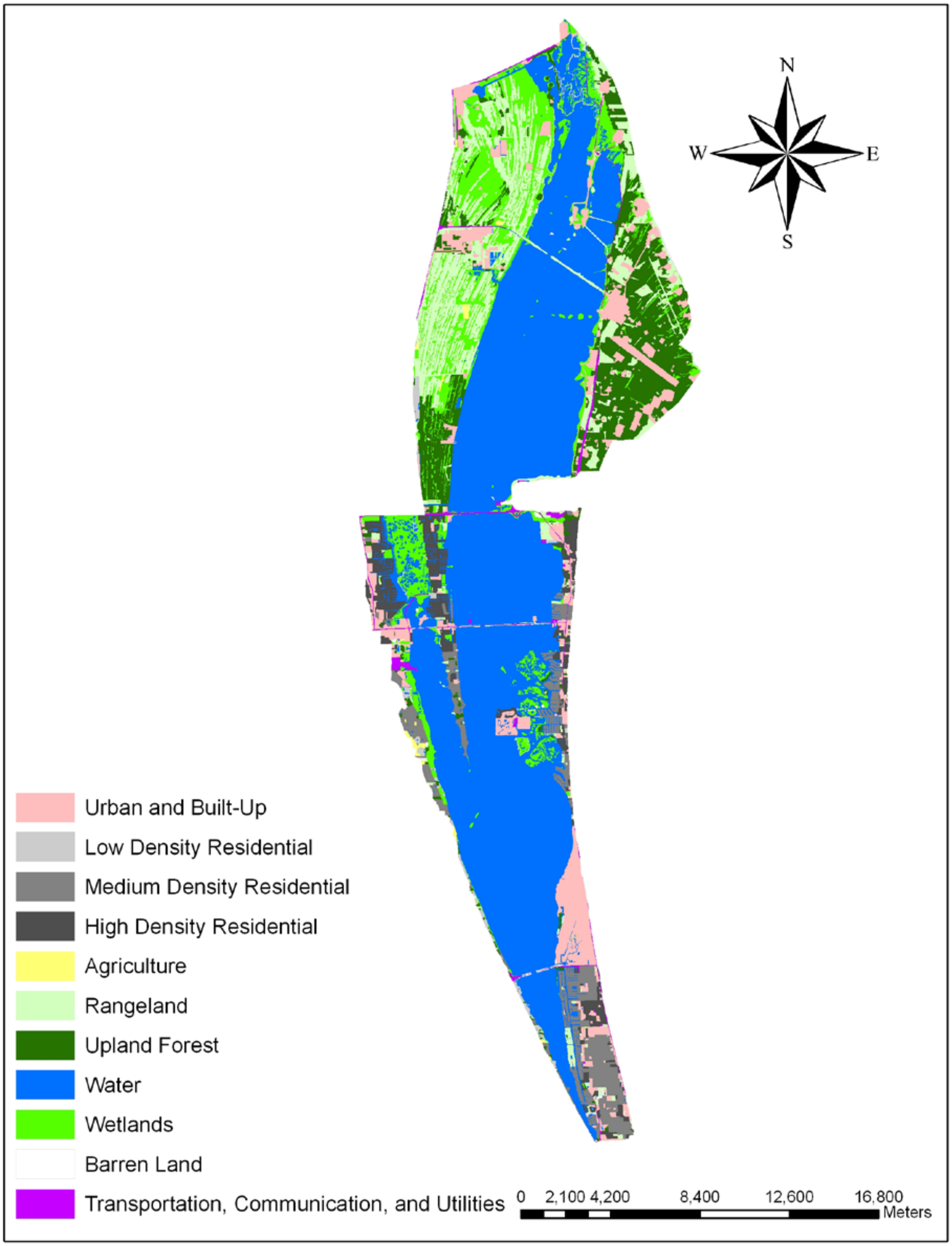

Figure 4.5. Major Land Uses in the Banana River Lagoon Watershed

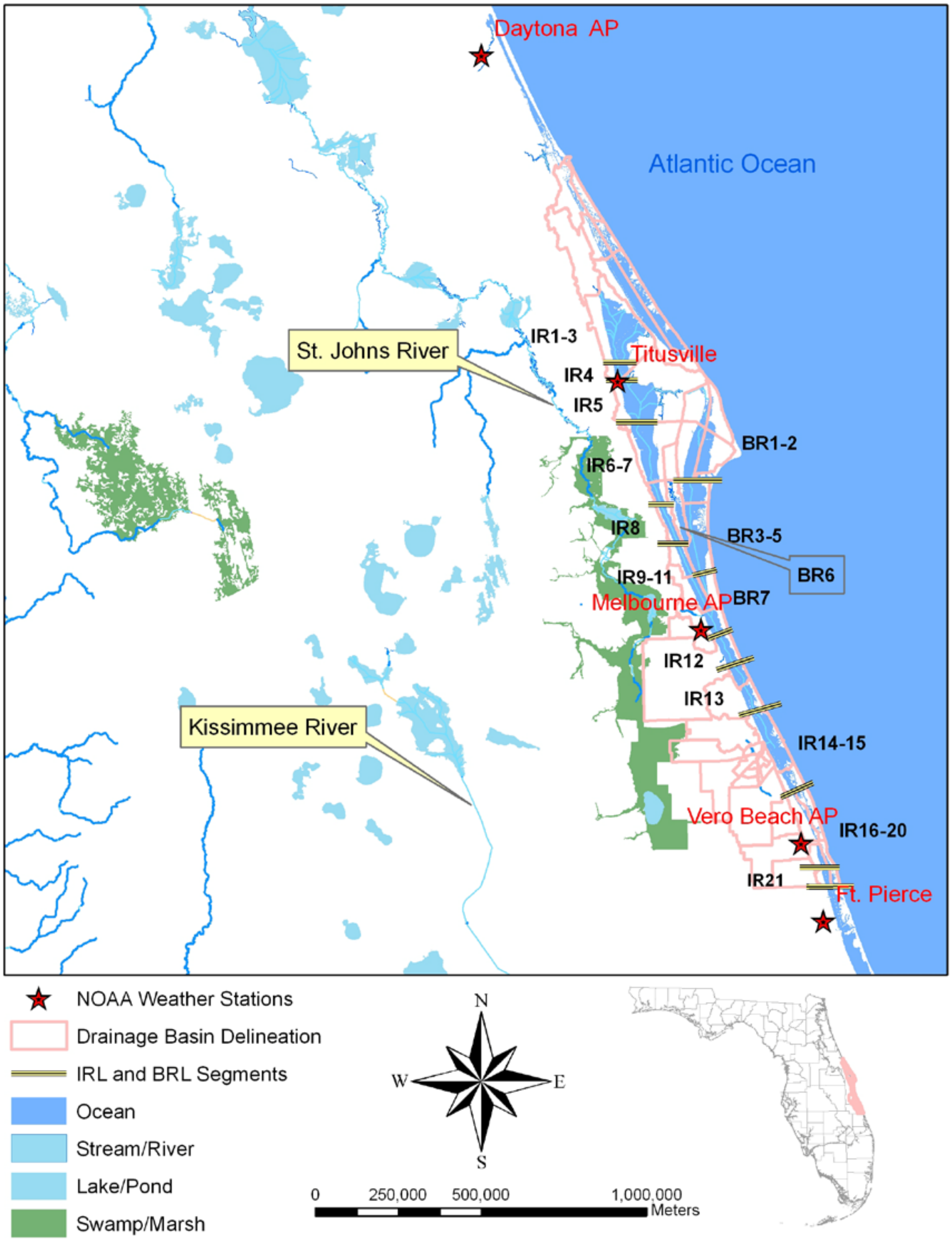

Figure 4.6. IRL and Banana River Lagoon Watershed Delineation and Locations of National Weather Service Stations

by the SJRWMD. Detailed runoff coefficients for different land use–hydrologic soil combinations and the EMCs of TN and TP associated with different land use categories used in the PLSM simulation can be found in **Appendix A** of the EPA's seagrass nutrient and DO TMDL report (2007).

The 30-year long-term annual rainfall from five National Weather Service rain gages in the watershed (Daytona Beach International Airport, Titusville, Melbourne International Airport, Vero Beach Airport, and Fort Pierce) were used in simulating TN and TP watershed loadings for the existing condition. **Figure 4.6** shows the locations of these weather stations.

Table 4.8 lists the long-term annual average rainfall and the annual rainfall for each individual year from 2000 through 2005 at each of the five weather stations. The actual rainfall amounts used for simulating the TN and TP loadings from the drainage area discharge into a specific lagoon segment were calculated as the average annual rainfall of the nearby weather stations using the Thiessen Polygon method. As shown in the table, the annual rainfall from these stations from 2000 through 2005 ranged from 34.8 to 69.9 inches. The average 30-year long-term annual average from 1975 to 2005 was about 53.1 inches. The period used to develop the nonpoint load and derive the WLA for the NPDES facilities includes a reasonable range of dry and wet years.

Table 4.8. Annual Rainfall (inches) (2000–05) and 30-Year Long-Term Annual Average Rainfall (1975–2005) at Five National Weather Service Stations Used in the Development of This TMDL (EPA 2007)

Year	Daytona Beach International Airport	Titusville	Melbourne International Airport	Vero Beach Airport	Fort Pierce
2000	49.6	56.85	61.66	58.73	63.11
2001	40.47	34.76	43.25	46.14	39.42
2002	53.31	59.32	65.92	50.6	60.62
2003	69.91	58.57	56.94	54.88	44.19
2004	47.87	47.72	40.54	46.07	53.26
2005	65.51	61.65	61.6	61.22	58.06
30-Year Mean	**51.18**	**53.84**	**50.73**	**55.79**	**54.04**

Note: Rainfall totals were calculated from April to the following March to correspond with the modeling and seagrass mapping year used by the SJRWMD.

Table 4.9 lists the nonpoint source loadings of TN and TP from the IRL and Banana River Lagoon watersheds estimated using the above information and models. Per-acre pollutant loading represents the intensity at which a given pollutant is discharged from a given land use area. **Table 4.10** provides per-acre nonpoint source TN and TP loadings in the watersheds discharging to different IRL and Banana River Lagoon segments.

Total nonpoint source TN and TP loadings are 2,661,593 and 457,495 lbs/yr, respectively, which translate into about 5.7 lbs/ac/yr of TN and 1.0 lbs/ac/yr of TP. Sublagoonwide per-acre TN loadings are 4.4, 6.3, and 5.6 lbs/ac/yr for the North IRL, Central IRL, and Banana River

Table 4.9. Nonpoint Source Loadings of TN and TP from the IRL and Banana River Lagoon Watersheds

Sublagoon	Lagoon Segment	TN (lbs/yr)	TP (lbs/yr)
North IRL	IR1-3	134,968	13,901
	IR4	20,743	4,435
	IR5	125,855	20,377
	IR6-7	115,901	18,618
	IR8	24,288	4,418
	IR9-11	154,658	31,758
	Subtotal	**576,413**	**93,507**
Central IRL	IR12	508,473	81,661
	IR13	62,789	7,743
	IR14-15	728,453	121,192
	IR16-20	484,025	96,052
	IR21	12,323	2,359
	Subtotal	**1,796,063**	**309,007**
Banana River Lagoon	BR1-2	127,782	20,660
	BR3-5	73,704	17,044
	BR6	46,213	9,724
	BR7	41,418	7,553
	Subtotal	**289,117**	**54,981**
Total Loading		**2,661,593**	**457,495**

Lagoon, respectively, and lagoonwide per-acre TP loadings are 0.7, 1.1, and 1.0 lbs/ac/yr, respectively.

In addition, of the total TN loadings (including point sources and nonpoint sources) into the 3 sublagoons, point source TN loadings account for 2.2, 1.3, and 5.1 percent in the North IRL, Central IRL, and Banana River Lagoon, respectively. Point source TP loadings account for about 0.7, 0.6, and 5.0 percent of total TP loadings (including point sources and nonpoint sources) into the North IRL, Central IRL, and Banana River Lagoon, respectively. Nonpoint sources are the dominant source of TN and TP loadings in the IRL and Banana River Lagoon.

4.2.2.3 TN and TP Loadings from Atmospheric Deposition Directly onto the Surface of the IRL and Banana River Lagoon

As discussed in **Section 4.2.2**, although no significant correlation was observed between seagrass depth limit and nutrient loads through atmospheric deposition directly onto the lagoon surface, atmospheric deposition does contribute to the nutrient loadings to the IRL and Banana River Lagoon. Therefore, nutrient loadings through atmospheric deposition are calculated in this TMDL report and added to the existing loadings and TMDLs.

Table 4.11 lists the surface areas and watershed areas of all the lagoon segments (Steward et al. 2005). Of the total areas of these lagoon segments, from 8 to 73 percent are lagoon surface

Table 4.10. Per-Acre Nonpoint Source Loadings of TN and TP from the IRL and Banana River Lagoon Watersheds

Sublagoons	Lagoon Segment	TN (lbs/yr)	TP (lbs/yr)	Basin Area (acres)	Per-Acre TN Load (lbs/ac/yr)	Per-Acre TP Load (lbs/ac/yr)
North IRL	IR1-3	134,968	13,901	52,009	2.6	0.3
	IR4	20,743	4,435	2,227	9.3	2.0
	IR5	125,855	20,377	33,353	3.8	0.6
	IR6-7	115,901	18,618	21,892	5.3	0.9
	IR8	24,288	4,418	2,744	8.9	1.6
	IR9-11	154,658	31,758	19,910	7.8	1.6
	Subtotal	**576,413**	**93,507**	**132,135**	**4.4**	**0.7**
Central IRL	IR12	508,473	81,661	76,121	6.7	1.1
	IR13	62,789	7,743	18,661	3.4	0.4
	IR14-15	728,453	121,192	120,698	6.0	1.0
	IR16-20	484,025	96,052	65,773	7.4	1.5
	IR21	12,323	2,359	2,358	5.2	1.0
	Subtotal	**1,796,063**	**309,007**	**283,609**	**6.3**	**1.1**
Banana River Lagoon	BR1-2	127,782	20,660	33,095	3.9	0.6
	BR3-5	73,704	17,044	7,593	9.7	2.2
	BR6	46,213	9,724	6,314	7.3	1.5
	BR7	41,418	7,553	4,420	9.4	1.7
	Subtotal	**288,625**	**54,878**	**51,423**	**5.6**	**1.1**
Total		**2,661,593**	**457,495**	**467,167**	**5.7**	**1.0**

areas. Overall, the surface areas of the IRL and Banana River Lagoon account for about 25 percent of the lagoon and watershed areas.

The SJRWMD provided the bulk TN and TP atmospheric deposition rates used in this TMDL report (J.W. Steward, M. Lasi, and W.C. Green, personal communication). These rates were estimated based on data collected from an atmospheric deposition site (IRL 141) located at Sebastian Inlet between 2001 through 2006. Site IRL 141 belongs to the Clear Air Status and Trends Network (CASTNET), which has been sponsored by the EPA since 2006. Between 2001 and 2006, the SJRWMD maintained the site (Rogers 2007).

Typically, CASTNET sites only collect dry deposition data. However, at Site IRL 141, the SJRWMD maintains a wet deposition collector, which collects the wet deposition data using a protocol similar to that used by the National Atmospheric Deposition Program (NADP). The bulk deposition rates for TN and TP used in this TMDL were the sum of the CASTNET dry deposition rate and the NADP-style wet deposition rate. Because the CASTNET sites typically do not measure ammonia gas and organic nitrogen, the dry deposition data were adjusted for ammonia and organic nitrogen with a multiplication factor of 1.25, based on published literature (Poor et al. 2001, Russel et al. 2003, Barna et al. 2008). Areal wet deposition rate is related to rainfall.

Table 4.11. Surface Areas of the IRL and Banana River Lagoon Segments

Sublagoon	Lagoon Segment	Lagoon Surface (Acres)	Segment Drainage Area (Acres)	Total Segment Area (Acres)	% Lagoon Surface Area in Total Segment Area
North IRL	IR1-3	21,763	52,009	73,772	29%
	IR4	2,367	2,227	4,594	51%
	IR5	16,556	33,353	49,909	32%
	IR6-7	16,042	21,892	37,934	42%
	IR8	3,803	2,744	6,547	58%
	IR9-11	12,209	19,910	32,119	38%
Central IRL	IR12	8,566	76,121	84,687	10%
	IR13	3,645	18,660	22,305	16%
	IR14-15	13,865	120,689	134,554	10%
	IR16-20	6,010	65,773	71,783	8%
	IR21	2,545	2,358	4,903	52%
Banana River Lagoon	BR1-2	18,755	33,095	51,850	36%
	BR3-5	21,338	7,593	28.931	73%
	BR6	3,872	6,314	10,186	40%
	BR7	1,905	4,420	6,325	31%
Total		**153,241**	**467,158**	**620,399**	**25%**

Because the SJRWMD used long-term average annual rainfall for the period from 1975 to 2005 to simulate long-term average annual TN and TP loadings from the watershed, the average annual areal wet deposition rates estimated based on 2001 through 2006 data were adjusted with the long-term average annual rainfall (1975 to 2005). The long-term average annual rainfall values applied to the North IRL, Central IRL, and Banana River Lagoon are 53.2, 53.3, and 50.6 inches per year, respectively (J.W. Steward, M. Lasi, and W.C. Green, personal communication).

Total atmospheric TN and TP loadings depositing directly onto the lagoon surface were calculated by multiplying the areal atmospheric deposition rates by the surface area of each lagoon segment. **Table 4.12** lists the total TN and TP atmospheric loads to the IRL and Banana River Lagoon segments. **Tables 4.13a** and **4.13b** show the total nonpoint source TN and TP loadings from both watershed runoff and atmospheric direct deposition.

The total nonpoint source TN annual load to the IRL and Banana River Lagoon is about 3,280,163 lbs/yr. Total TN annual load to each lagoon segment ranges from 22,738 to 785,187 lbs/yr (**Table 4.13a**). The overall percent TN annual load resulting from direct atmospheric deposition to the surface of the lagoon system is about 19 percent. Depending on the percent lagoon surface area in the total area and the land use patterns of each lagoon segment, the percent TN load from direct atmospheric deposition ranges from 5 percent (IR16-20) to 53 percent (BR3-5). TN loadings through direct atmospheric deposition represent a significant portion of the TN loadings received by the IRL and Banana River Lagoon.

Table 4.12. Atmospheric TN and TP Loadings Depositing Directly onto the Surface of the IRL and Banana River Lagoon Segments

Sublagoon	Lagoon Segment	Lagoon Surface (acres)	TN Areal Deposition Rate (lbs/ac/yr)	TP Areal Deposition Rate (lbs/ac/yr)	Annual TN Atmospheric Load (lbs/yr)	Annual TP Atmospheric Load (lbs/yr)
North IRL	IR1-3	21,763	4.09	0.093	88,898	2,013
	IR4	2.367	4.09	0.093	9,670	219
	IR5	16,556	4.09	0.093	67,630	1,532
	IR6-7	16,042	4.09	0.093	65,531	1,484
	IR8	3,803	4.09	0.093	15,535	352
	IR9-11	12,209	4.09	0.093	49,875	1,129
Central IRL	IR12	8,566	4.09	0.093	35,051	794
	IR13	3,645	4.09	0.093	14,915	338
	IR14-15	13,865	4.09	0.093	56,734	1,285
	IR16-20	6,010	4.09	0.093	24,591	557
	IR21	2,545	4.09	0.093	10,415	236
Banana River Lagoon	BR1-2	18,755	3.92	0.093	73,486	1,649
	BR3-5	21,338	3.92	0.088	83,604	1,876
	BR6	3,872	3.92	0.088	15,172	340
	BR7	1,905	3.92	0.088	7,465	168
Total		**153,241**			**618,570**	**13,972**

Table 4.13a. Total Nonpoint Source TN Loads (lbs/yr) to the IRL and Banana River Lagoon Segments

Sublagoon	Lagoon Segment	Atmospheric Deposition Load	Drainage Basin Load	Total Nonpoint Source Load	% Atmospheric Loads in the Total Nonpoint Source Load
North IRL	IR1-3	88,898	134,968	223,866	40%
	IR4	9,670	20,743	30,413	32%
	IR5	67,630	125,855	193,485	35%
	IR6-7	65,531	115,901	181,432	36%
	IR8	15,535	24,288	39,823	39%
	IR9-11	49,875	154,658	204,533	24%
Central IRL	IR12	35,051	508,473	543,524	6%
	IR13	14,915	62,789	77,704	19%
	IR14-15	56,734	728,453	785,187	7%
	IR16-20	24,591	484,025	508,616	5%
	IR21	10,415	12,323	22,738	46%
Banana River Lagoon	BR1-2	73,486	127,782	201,268	37%
	BR3-5	83,604	73,704	157,308	53%
	BR6	15,172	46,213	61,385	25%
	BR7	7,465	41,418	48,883	15%
Total		**618,570**	**2,661,593**	**3,280,163**	**19%**

Table 4.13b. Total Nonpoint Source TP Loads (lbs/yr) to the IRL and Banana River Lagoon Segments

Sublagoon	Lagoon Segment	Atmospheric Deposition Load	Drainage Basin Load	Total Nonpoint Source Load	% Atmospheric Loads in the Total Nonpoint Source Load
North IRL	IR1-3	2,013	13,901	15,914	13%
	IR4	219	4,435	4,654	5%
	IR5	1,532	20,377	21,909	7%
	IR6-7	1,484	18,618	20,102	7%
	IR8	352	4,418	4,770	7%
	IR9-11	1,129	31,758	32,887	3%
Central IRL	IR12	794	81,661	82,455	1%
	IR13	338	7,743	8,081	4%
	IR14-15	1,285	121,192	122,477	1%
	IR16-20	557	96,052	96,609	1%
	IR21	236	2,359	2,595	9%
Banana River Lagoon	BR1-2	1,649	20,660	22,309	7%
	BR3-5	1,876	17,044	18,920	10%
	BR6	340	9,724	10,064	3%
	BR7	168	7,553	7,721	2%
Total		**13,972**	**457,495**	**471,467**	**3%**

The total nonpoint source TP annual load to the IRL and Banana River Lagoon is about 471,467 lbs/yr. The total TP annual load to each lagoon segment ranges from 2,595 to 122,477 lbs/yr (**Table 4.13b**). The overall percent TP annual load from direct atmospheric deposition to the surface of the lagoon system is about 3 percent, which is lower than the percent TN contributed by atmospheric direct deposition (19 percent).

Depending on the percent lagoon surface area in the total area and the land use patterns of each lagoon segment, the percent TP load from direct atmospheric deposition ranges from 1 percent (IR12, IR14-15, and IR16-20) to 13 percent (IR1-3). Compared with the total nonpoint source TP loading into the IRL and Banana River Lagoon, TP loading through direct atmospheric deposition represent a relatively small portion of the total load.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Overall Approach

As discussed in Chapter 3, once the target seagrass depth limit was established, the loading targets for TN and TP, or the TN and TP assimilative capacity of the IRL and Banana River Lagoon, were established through the following steps:

(1) Nonpoint source TN and TP loadings were estimated using the PLSM (TP for the North IRL was based on the HSPF Model) for 1943, 1996, 1999, and 2001 based on land use distribution and rainfall corresponding to these years. Total loadings from each segment for each year were calculated as the sum of point source and nonpoint source loadings. There were no 1942–43 point source data, and so only runoff load estimates were used for that year. The SJRWMD believed that any point source loading from 1942 to 1943 should be relatively negligible and would have no significant bearing on the regression results.

(2) Total TN and TP loadings were converted to per-acre loading for each lagoon segment and these loadings were log-transformed.

(3) Log-transformed TN and TP loadings were regressed against the percent deviation of seagrass depth limits in1943, 1996, 1999, and 2001; and target log TN and TP loadings were established at -10 percent deviation (shallower) of the seagrass depth limit from the full-restoration target.

(4) The target log TN and TP loadings were then back-transformed to a target per-acre TN and TP loading using the nonparametric method described by Duan (1983).

Table 3.2 lists the areal loading for TN and TP for the three sublagoons. Based on the per-acre TN and TP loading targets and the acreages of the drainage areas discharging to different lagoon segments, total drainage area TN and TP loading targets (lbs/yr) were developed for different segments. It should be noted that the TN and TP loadings from point sources were included in the total drainage area loadings when conducting the seagrass depth limit versus loading regression analysis. Therefore, the target allowable loads derived for the drainage basin based on the regression also include point source contributions. It is important to note that the TMDLs presented in this report focus on reducing the TN and TP loadings from the drainage basins, and that loadings from atmospheric deposition are considered part of the allowable loads that will not be changed from the existing condition. The final allowable loads (TMDL) are calculated as the sum of the allowable drainage basin loads (including point source loads, surface runoff load, and ground water loads), and the direct atmospheric loads.

Table 5.1 lists the final allowable loads. It also includes the existing total TN and TP loadings for these segments, which include the drainage basin loadings, point source loadings, loadings from direct atmospheric deposition and loadings from ground water, and the percent reductions of TN and TP loadings required to achieve the target loadings.

The total TN and TP loadings discharged into impaired WBIDs were also calculated, based on the corresponding spatial relationship between the SJRWMD's IRL and Banana River Lagoon segmentation and the Department's WBID delineation. **Table 5.2** lists the impaired WBIDs and their corresponding IRL and Banana River Lagoon segments. Because segment boundaries do not always match up with WBID boundaries, the aggregation of WBIDs and segments was conducted to capture comparable watersheds. **Table 5.2** also shows the existing TN and TP loadings and target TN and TP loadings into the impaired WBIDs, and the required TN and TP load reductions to achieve the target loads. **Figure 5.1** shows the spatial relationship between WBID boundaries and the SJRWMD's segment boundaries.

Table 5.1. TN and TP Existing and Target Loadings and Load Reductions Required to Achieve the Target Loadings

	TN			TP		
	Existing Loading (lbs/yr)	**Target Loading (lbs/yr)**	**Required Reduction (lbs/yr; %)**	**Existing Loading (lbs/yr)**	**Target Loading (lbs/yr)**	**Required Reduction (lbs/yr; %)**
North IRL						
North IRL (total)	**886,257**	**687,044**	**199,213 (22%)**	**100,919**	**56,550**	**44,369 (44%)**
IR1-3	223,866	177,220	46,646 (21%)	15,914	9,320	6,594 (41%)
IR4	30,413	23,244	7,169 (24%)	4,654	2,550	2,104 (45%)
IR5	193,485	149,988	43,497 (22%)	21,909	12,243	9,666 (44%)
IR6-7	187,580	147,524	40,056 (21%)	20,689	11,845	8,844 (43%)
IR8	39,823	31,429	8,394 (21%)	4,770	2,674	2,096 (44%)
IR9-11	211,091	157,640	53,451 (25%)	32,983	17,918	15,065 (46%)
Central IRL						
Central IRL (total)	**1,961,103**	**962,988**	**998,115 (51%)**	**314,148**	**165,193**	**148,955 (47%)**
IR12	543,983	261,412	282,571 (52%)	82534	43,170	39,364 (48%)
IR13	77,704	42,811	34,893 (45%)	8,081	4,348	3,733 (46%)
IR14-15	785,310	380,491	404,819 (52%)	122,496	64,076	58,420 (48%)
IR16-20	531,368	262,384	268,984 (51%)	98,442	52,141	46,301 (47%)
IR21	22,738	15,890	6,848 (30%)	2,595	1,458	1,137 (44%)
Banana River Lagoon						
Banana River Lagoon (total)	**484,462**	**291,755**	**192,707 (40%)**	**61,900**	**23,253**	**38,647 (62%)**
BR1-2	201,760	116,314	85,446 (42%)	22,412	7,825	14,587 (65%)
BR3-5	172,435	123,434	49,001 (28%)	21,703	9,755	11,948 (55%)
BR6	61,385	30,661	30,724 (50%)	10,064	3,247	6,817 (68%)
BR7	48,883	21,347	27,536 (56%)	7,721	2,426	5,295 (69%)

Table 5.2. TN and TP Existing and Target Loadings to Impaired WBIDs and Load Reductions Required To Achieve the Target Loadings

WBID	Segment	TN			TP		
		Existing Loading (lbs/yr)	Target Loading (lbs/yr)	Required Reduction (lbs/yr; %)	Existing Loading (lbs/yr)	Target Loading (lbs/yr)	Required Reduction (lbs/yr; %)
North IRL							
North IRL (total)		**886,257**	**687,044**	**199,213 (22%)**	**100,919**	**56,550**	**44,369 (44%)**
2963F	IR1-3	223,866	177,220	46,646 (21%)	15,914	9,320	6,594 (41%)
2963E	IR4+IR5	223,898	173,232	50,666 (23%)	26,563	14,793	11,770 (44%)
2963D	IR6-7	187,580	147,524	40,056 (21%)	20,689	11,845	8,844 (43%)
2963B+2963C	IR8+IR9-11	250,913	189,068	61,845 (25%)	37,753	20,592	17,161 (45%)
Central IRL							
Central IRL (total)		**1,961,103**	**962,988**	**998,115 (51%)**	**314,148**	**165,193**	**148, 955 (47%)**
5003D+2963A	IR12+IR13+ IR14-15	1,406,998	684,715	722,283 (51%)	213,111	111,594	101,517 (48%)
5003B+5003C	IR16-20+ IR21	554,105	278,273	275,832 (50%)	101,037	53,599	47,438 (47%)
Banana River Lagoon							
Banana River Lagoon (total)		**484,462**	**291,755**	**192,707 (40%)**	**61,900**	**23,253**	**38,647 (62%)**
3057C	BR1-2	201,760	116,314	85,446 (42%)	22,412	7,825	14,587 (65%)
3057A+3057B	BR3-5+BR 7	221,317	144,780	76,537 (35%)	29,424	12,181	17,243 (59%)
3044A	BR6	61,385	30,661	30,724 (50%)	10,064	3,247	6,817 (68%)

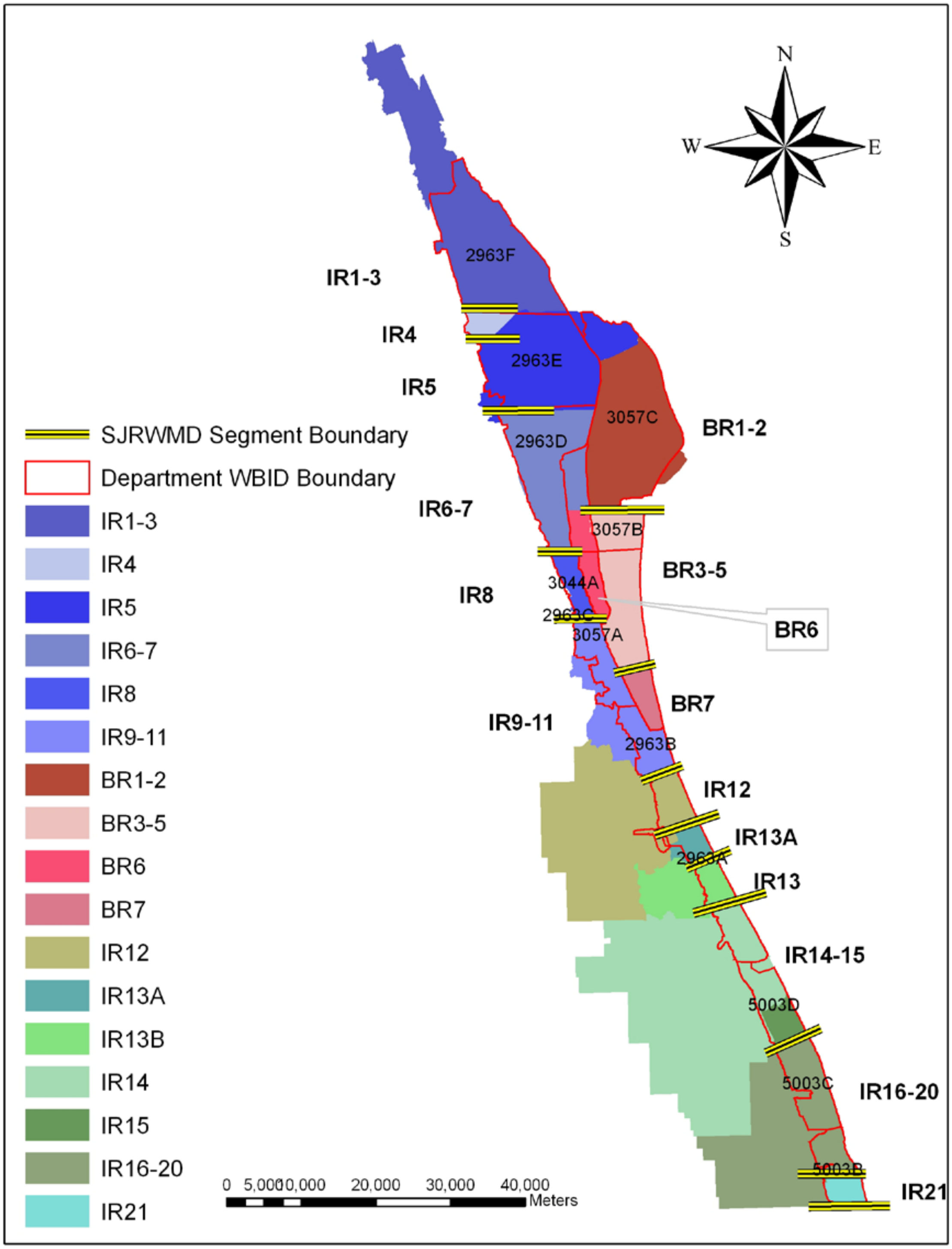

Figure 5.1. Spatial Relationship Between the Department's WBID Boundaries and the SJRWMD's Segment Boundaries

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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

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

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

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

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

WLAs for stormwater discharges are typically expressed as percent reduction because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish the loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the "maximum extent practical" through the implementation of BMPs.

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. TMDLs for the main stem segments of the IRL and Banana River Lagoon are expressed in terms of lbs/yr, lbs/day, and percent reduction of TN and TP, and represent the long-term average TN and TP loadings that these IRL and Banana River Lagoon segments can assimilate and maintain balanced aquatic flora and fauna (**Tables 6.1a** and **6.1b**). It should be noted that the expression of the TMDL on a mass-per-day basis is for informational purposes only. The implementation of these TMDLs should be carried out using an annual time scale.

Based on a recent EPA memorandum (2006), daily loads of TN and TP from point and nonpoint sources were also calculated (**Tables 6.2a** and **6.2b**). These daily loads were calculated by dividing the annual loads by 365 days/yr and are only provided in this report for informational purposes. The implementation of the TMDLs covered in this TMDL report should be carried out using an annual time scale.

Table 6.1a. TN TMDL Components for Nutrient-Impaired WBIDs of the IRL and Banana River Lagoon Main Stem

WBID	Parameter	TMDL (lbs/yr)	WLA_{NPDES} wastewater (lbs/yr)	WLA_{NPDES} Stormwater *	LA (lbs/yr)	MOS
2963F	TN	177,220	N/A	35%	177,220	Implicit
2963E	TN	173,232	N/A	35%	173,232	Implicit
2963D	TN	147,524	8,111	36%	139,413	Implicit
2963B+2963C	TN	189,068	9,200	36%	179,868	Implicit
5003D+2963A	TN	684,715	831	56%	683,884	Implicit
5003B+5003C	TN	278,273	25,391	56%	252,882	Implicit
3057C	TN	116,314	1,214	67%	115,100	Implicit
3057A+3057B	TN	144,780	6,173	59%	138,607	Implicit
3044A	TN	30,661	N/A	66%	30,661	Implicit

N/A – Not applicable.
* The required percent reduction for $WLA_{NPDES\ Stormwater}$ was considered the same as the required percent reduction for nonpoint source loading (**Table 6.3**). Refer to the discussion in **Section 6.3.2** for details.

Table 6.1b. TP TMDL Components for Nutrient-Impaired WBIDs of the IRL and Banana River Lagoon Main Stem

WBID	Parameter	TMDL (lbs/yr)	WLA_{NPDES} wastewater (lbs/yr)	WLA_{NPDES} Stormwater	LA (lbs/yr)	MOS
2963F	TP	9,320	N/A	47%	9,320	Implicit
2963E	TP	14,793	N/A	47%	14,793	Implicit
2963D	TP	11,845	1,609	53%	10,236	Implicit
2963B+2963C	TP	20,592	225	48%	20,367	Implicit
5003D+2963A	TP	111,594	122	48%	111,472	Implicit
5003B+5003C	TP	53,599	1,949	48%	51,650	Implicit
3057C	TP	7,825	302	72%	7,523	Implicit
3057A+3057B	TP	12,181	1221	64%	10,960	Implicit
3044A	TP	3,247	N/A	70%	3,247	Implicit

N/A – Not applicable.
* The required percent reduction for $WLA_{NPDES\ Stormwater}$ was considered the same as the required percent reduction for nonpoint source loading (**Table 6.3**). Refer to the discussion in **Section 6.3.2** for details.

Table 6.2a. TN TMDL Daily Loads for Nutrient-Impaired WBIDs of the IRL and Banana River Lagoon Main Stem

WBID	Parameter	TMDL (lbs/day)	WLA_{NPDES} wastewater (lbs/day)	WLA_{NPDES} Stormwater	LA (lbs/day)	MOS
2963F	TN	486	N/A	35%	486	Implicit
2963E	TN	475	N/A	35%	475	Implicit
2963D	TN	404	22**	36%	382	Implicit
2963B+2963C	TN	518	25**	36%	493	Implicit
5003D+2963A	TN	1,876	2**	56%	1,874	Implicit
5003B+5003C	TN	762	70**	56%	692	Implicit
3057C	TN	319	3**	67%	316	Implicit
3057A+3057B	TN	397	17**	59%	380	Implicit
3044A	TN	84	N/A	66%	84	Implicit

N/A – Not applicable.
** Daily WLAs were calculated by dividing the annual loads by 365 days. In reality, daily WLAs for different facilities have different applicable time scales. The daily WLAs at different time scales are not directly addable. The daily WLAs in this table are only for informational purposes. **Section 6.3.1** contains a detailed WLA for each facility and the applicable time scale.

Table 6.2b. TP TMDL Daily Loads for Nutrient-Impaired WBIDs of the IRL and Banana River Lagoon Main Stem

WBID	Parameter	TMDL (lbs/day)	WLA_{NPDES} wastewater (lbs/day)	WLA_{NPDES} Stormwater	LA (lbs/day)	MOS
2963F	TP	26	N/A	47%	26	Implicit
2963E	TP	41	N/A	47%	41	Implicit
2963D	TP	32	4.4**	53%	28	Implicit
2963B+2963C	TP	56	0.6**	48%	56	Implicit
5003D+2963A	TP	306	0.3**	48%	305	Implicit
5003B+5003C	TP	147	5.3**	48%	142	Implicit
3057C	TP	21	0.8**	72%	21	Implicit
3057A+3057B	TP	33	3.3**	64%	30	Implicit
3044A	TP	9	N/A	70%	9	Implicit

N/A in this table means not applicable.
** Daily WLAs were calculated by dividing the annual loads by 365 days. In reality, daily WLAs for different facilities have different applicable time scales. Daily WLAs at different time scales are not directly addable. The daily WLAs in this table are only for informational purposes. **Section 6.3.1** contains a detailed WLA for each facility and the applicable time scale.

6.2 Load Allocation

As discussed in Chapter 4, the vast majority of TN and TP loadings in the IRL and Banana River Lagoon watersheds come from nonpoint sources. Point source discharges typically account for less than 5 percent of the total watershed load. Major sources of nonpoint nutrient loadings include watershed runoff, ground water input, and direct atmospheric deposition onto the lagoon surface.

Based on **Tables 6.1a** and **6.1b**, the total allowable LAs for TN for the impaired WBIDs range from 30,661 lbs/yr for WBID 3044A (Newfound Harbor), to 683,884 lbs/yr for WBIDs 5003D and 2963A (South Indian River and Indian River above Sebastian Inlet, respectively). For TP, the LAs range from 3,247 lbs/yr for WBID 3044A (Newfound Harbor), to about 111,472 lbs/yr for WBIDs 5003D and 2963A (South Indian River and Indian River above Sebastian Inlet, respectively).

Assuming that atmospheric direct deposition will remain the same for the existing and target conditions, to achieve the allowable LAs listed in **Tables 6.1a** and **6.1b**, TN and TP loadings from watershed nonpoint sources need to be reduced as follows:

(1) The required percent reductions for WBIDs located in the North IRL—WBID 2963F (Indian River above Melbourne Brewer), WBID 2963E (Indian River above NASA Causeway), WBID 2963D (Indian River above 520 Causeway), WBID 2963B (Indian River above Melbourne Causeway), and WBID 2963C (Indian River above Melbourne Causeway)—range from 35 to 36 percent for TN and 47 to 53 percent for TP loadings.

(2) For the WBIDs located in the Central IRL—which include several South IRL segments (WBIDs 5003B, 5003D, and 5003E) and WBID 2963A (Indian River above Sebastian Inlet)—the required percent load reductions are 56 percent for TN and about 48 percent for TP.

(3) For the WBIDs located in the Banana River Lagoon—WBID 3057C (Banana River above Barge Canal), WBID 3057A (Banana River below Mathers), WBID 3057B (Banana River above 520 Causeway), and WBID 3044A (Newfound Harbor)—the required percent reductions range from 56 to 67 percent for TN, and 64 to 72 percent for TP.

As the focus of this TMDL is to reduce the nutrient loadings from the lagoon watershed, and the seagrass depth-limit and nutrient load relationship was derived only based on the watershed loading, the percent load reductions needed to achieve the restoration target (**Tables 6.1a** and **6.1b**) were calculated only based on the nonpoint source loading from the watershed. **Table 6.3a** lists the existing and total allowable nonpoint source TN and TP loadings from the watershed without including the loadings from direct atmospheric deposition in the calculation. The table also shows the percent reductions that need to be applied to the nonpoint drainage basin load to achieve the restoration target.

On the other hand, the needed percent reductions can also be calculated based on the total nonpoint source loadings, which include loading from atmospheric direct deposition. **Table 6.3b** lists the existing nonpoint source TN and TP loadings, the nonpoint source TMDLs for TN and TP, and the percent reduction required to achieve the TMDL targets when atmospheric direct deposition onto the lagoon surface is considered. As **Table 6.3b** shows, calculating the needed percent reduction by including direct atmospheric deposition results in lower needed percent reductions. In this TMDL, the percent reduction focuses on the watershed load reduction, which requires a higher percent nutrient reduction. This approach adds to the MOS.

Table 6.3a. Required Percent Reductions of TN and TP Loads, by WBID, To Achieve Restoration Targets (Excluding Atmospheric Deposition)

WBID	TN			TP		
	Existing Nonpoint Load (lbs/yr)	LA (lbs/yr)	% Reduction	Existing Nonpoint Load (lbs/yr)	LA (lbs/yr)	% Reduction
2963F	134,968	88,322	35%	13,901	7,307	47%
2963E	146,598	95,932	35%	24,812	13,042	47%
2963D	115,901	73,882	36%	18,618	8,752	53%
2963B+2963C	178,946	114,459	36%	36,176	18,886	48%
5003D+2963A	1299,715	577,183	56%	210,596	109,055	48%
5003B+5003C	496,348	217,877	56%	98,411	50,857	48%
3057C	127,782	41,614	67%	20,660	5,874	72%
3057A+3057B	115,122	47,539	59%	24,597	8,916	64%
3044A	46,213	15,489	66%	9,724	2,907	70%

Table 6.3b. Required Percent Reductions of TN and TP Loads, by WBID, To Achieve Nonpoint Source Loading Targets (Including Atmospheric Deposition)

WBID	TN			TP		
	Existing Nonpoint Load (lbs/yr)	LA (lbs/yr)	% Reduction	Existing Nonpoint Load (lbs/yr)	LA (lbs/yr)	% Reduction
2963F	223,866	177,220	21%	15,914	9,320	41%
2963E	223,898	173,232	23%	26,563	14,793	44%
2963D	181,432	139,413	23%	20,102	10,236	49%
2963B+2963C	244,355	179,868	26%	37,657	20,367	46%
5003D+2963A	1,406,416	683,884	51%	213,013	111,472	48%
5003B+5003C	531,353	252,882	52%	99,204	51,650	48%
3057C	201,268	115,100	43%	22,309	7,523	66%
3057A+3057B	206,190	138,607	33%	26,641	10,960	59%
3044A	61,385	30,661	50%	10,064	3,247	68%

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

As discussed in Chapter 4, 16 NPDES-permitted wastewater facilities are considered significant TN and TP contributors to the IRL and Banana River Lagoon watersheds (**Table 4.1**). WLAs for each facility were developed considering their current permit limits, the quality and frequency of their actual discharge, and the assimilative capacity of the receiving waters. For each NPDES facility, monthly discharge volume and TN and TP concentration data were retrieved directly from the Discharge Monitoring Reports submitted to the Department. Annual TN and TP loads were calculated for 2001 through 2005. The arithmetic mean and the 95th percentile of these annual loads were also calculated.

Tables 6.4a and **6.4b** provide TN and TP values, respectively, for these facilities. These average annual loads and the 95th percentile of the annual loads were compared with permitted loads and discharge concentrations for each facility. Those facilities that already achieve advanced wastewater treatment (AWT) nutrient concentrations (3 mg/L for TN and 1 mg/L for TP) and/or discharge infrequently were allocated annual TN and TP loads equivalent to the 95th percentile of their discharged nutrient loads for 2001 to 2005. For facilities that do not meet the AWT concentration requirements and discharge a relatively large quantity of nutrients into the lagoon system, the long-term average annual TN and/or TP loads are assigned as the facilities' WLA.

Based on a recent EPA memorandum (2006), daily loads of TN and TP from point sources should be calculated. In this TMDL report, daily WLAs for facilities that have whole-year daily discharge are calculated as annual loads divided by 365 days. The daily WLAs for facilities that are only allowed to discharge over limited periods less than 365 days are calculated as annual loads divided by the allowable numbers of discharge days. These daily loads are only applicable to those allowable discharge days. It should be noted that the daily loads presented in this report are for informational purposes only. The implementation of these TMDLs and WLAs will be based on an annual time scale. The WLAs are assigned to the identified facilities as follows:

(1) ***Cocoa/J. Sellers WRF (FL0021521):*** *The facility has a 4.5-MGD average daily flow permitted discharge to the IRL at Segment IR6-7. The permit allows a surface discharge from the facility for no more than 91 days (or the equivalent of 2,184 hours) per year. The rest of the time, the treated wastewater is directed to a 4.5-MGD AADF permitted capacity slow-rate public access system consisting of on-site irrigation and decorative ponds, irrigation of residential lawns, parks, playgrounds, cemeteries, golf driving ranges, highway medians, and other landscape areas within the Reuse Service Area. The anticipated reuse demand from these areas is about 5.98-MGD AADF.*

Through the years, the facility has made great efforts to reduce its nutrient loadings into the IRL. Other than the land application of treated wastewater, it also has taken steps to decrease discharge nutrient concentrations. The

Table 6.4a. Permitted Annual TN Limits, Discharges, and WLAs for Facilities and TMDLs for Each Lagoon Segment

Lagoon Segment	NPDES Facility	2000–05 Flow Weighted Concentration TN (mg/L)[1]	Annual Average Load 2001–05 TN (lbs/yr)[2]	95^{th} Percentile Annual Load TN (lbs/yr)[3]	Permit Concentration TN (mg/L)[4]	Permit Flow Equiv. (MGD)[5]	Permit Annual Load TN (lbs/yr)[6]	TMDL TN (lbs/yr)[7]	WLA TN (lbs/yr)[8]
North IRL									
IRL1-3	N/A							177,220	
IR4	N/A							23,244	
IR5	N/A							149,988	
IR6-7	FL0021521 Cocoa/ J. Sellers	5.78	5,556	8,932	12	1.125	41,007	147,524	5,556
IR6-7	FL0001473 Cape Canaveral PP	N/A	N/A	N/A	N/A	N/A	2,555		2,555
IR6-7	FL0000680 Reliant Energy Indian River	N/A	N/A	N/A	N/A	0.297	N/A		N/A
IR8	FL0021571 Rockledge	N/A	0	0	12	0.062	2,253	31,429	30
IR9-11	FL0043443 Melbourne RO	2.43	6,585	9,170	3	1.250	11,422	157,640	9,170
Central IRL									
IR12	FL0040622 BCUD/South Beaches	8.09	62	173	12	0.123	4,506	261,412	173
IR12	FL0041122 Melbourne/Grant Street	10.78	53	182	20	0.068	2,503		182
IR13	N/A							42,811	
IR14-15	FL0042293 Barefoot Bay	2.29	148	476	3	0.188	1,709	380,491	476
IR16-20	FL0021661 Vero Beach	11.85	12,173	24,794	20	0.740	45,063	262,384	12,173
IR16-20	FL0042544 Vero Beach RO	2.39	2,438	2,985	4	0.5	6,092		2,985
IR16-20	FL0166511 IRCUD/Hobart RO	1.90	2,221	2,759	3	0.750	6,853		2,759
IR16-20	FL0041637 IRCUD/ West Regional	0.73	1,397	2,838	1	4.0	12,184		2,838
IR16-20	FL0037940 IRCUD/ South County RO	1.51	3,752	4,636	3	1.5	13,707		4,636
IR21	N/A							15,890	

Lagoon Segment	NPDES Facility	2000–05 Flow Weighted Concentration TN (mg/L)[1]	Annual Average Load 2001–05 TN (lbs/yr)[2]	95th Percentile Annual Load TN (lbs/yr)[3]	Permit Concentration TN (mg/L)[4]	Permit Flow Equiv. (MGD)[5]	Permit Annual Load TN (lbs/yr)[6]	TMDL TN (lbs/yr)[7]	WLA TN (lbs/yr)[8]
Banana River Lagoon									
BR1-2	FL0042005 Morton Salt	2.74	571	1214	N/A	0.084	N/A	116,314	1,214
BR3-5	FL0020541 Cape Canaveral	1.05	1,342	2,151	3	1.8	16,448	123,434	2,151
BR3-5	FL0021105 Cocoa Beach	6.27	12,476	18,446	12	1.5	54,676		4,022
BR6	N/A							30,661	
BR7	N/A							21,347	

Notes:

1. Average flow-weighted nutrient concentration in the discharge summarized from monthly data reported to the Department by the facility. The 2000–05 period corresponds to the modeling period used by the SJRWMD for TMDL development.
2. Average annual nutrient load discharged by the facility from 2001–05. Loads are calculated from monthly discharge and monthly effluent nutrient concentration, as reported by the facility to the Department, with unit conversion factors. Annual loads are calculated from April to the following March to correspond with the modeling year used by the SJRWMD. The average annual load is the average of the five annual loads. The five-year period corresponds to the five-year cycle of an NPDES permit.
3. The calculated 95th percentile of the discharge's 5 annual nutrient loads.
4. The effluent nutrient concentration limit in the facility's NPDES permit. Provided for reference only; not used in WLA calculations.
5. The permitted annual flow equivalent in the NPDES permit issued by the Department. Some facilities are permitted to discharge only 60 or 91 days during the rainy season. The flow and number of discharge days allowed in the permit are multiplied along with conversion factors to calculate an annual flow equivalent. Provided so intermittent discharge facility flow can be compared with continuous discharge facilities. Provided for reference only; not used in WLA calculations.
6. The annual load allowed by the facility's NPDES permit calculated by multiplying the permit discharge flow, the permit effluent nutrient concentration, and conversion factors. Provided for reference only; not used in WLA calculations.
7. The proposed TMDL (all point and nonpoint sources) for that lagoon segment calculated by the SJRWMD modeling approach (Steward and Green 2006), plus direct atmospheric deposition.
8. Proposed WLA for all point sources in that lagoon segment. **Section 6.3.1** describes the basis for specific allocations in more detail.
9. N/A represents the condition that a given lagoon segment does not have a point source discharger or, for a given facility, no permit limit for TN, TP, and/or flow.

Table 6.4b. Permitted Annual TP Limits, Discharges, and WLAs for Facilities and TMDLs for Each Lagoon Segment

Lagoon Segment	NPDES Facility	2000-2005 Flow Weighted Concentration TP (mg/L)[1]	Annual Average Load 2001–05 TP (lbs/yr)[2]	95th Percentile Annual Load TP (lbs/yr)[3]	Permit Concentration TP (mg/L)[4]	Permit Flow Equiv. (MGD)[5]	Permit Annual Load TP (lbs/yr)[6]	TMDL TP (lbs/yr)[7]	WLA TP (lbs/yr)[8]
North IRL									
IRL1-3	N/A							9,320	
IR4	N/A							2,550	
IR5	N/A							12,243	
IR6-7	FL0021521 Cocoa/J. Sellers	0.54	578	1,423	4.0	1.125	13,669	11,845	1,423
IR6-7	FL0001473 Cape Canaveral PP	N/A					146		146
IR6-7	FL0000680 Reliant Energy Indian River	0.20	12	40	N/A	0.297	N/A		40
IR8	FL0021571 Rockledge	N/A	0	0	4.0	0.062	751	2,674	30
IR9-11	FL0043443 Melbourne RO	0.04	101	195	1.0	1.25	3,807	17,918	195
Central IRL									
IR12	FL0040622 BCUD/ South Beaches	1.50	13	36	4.0	0.123	1,502	43,170	36
IR12	FL0041122 Melbourne// Grant Street	0.45	2	8	1.0	0.068	125		8
IR13	N/A							4,348	
IR14-15	FL0042293 Barefoot Bay	0.35	22	78	1.0	0.188	570	64,076	78
IR16-20	FL0021661 Vero Beach	1.06	916	1,411	6.0	0.740	13,518	52,141	916
IR16-20	FL0042544 Vero Beach RO	0.34	340	487	4.0	0.5	6,092		487
IR16-20	FL0166511 IRCUD/Hobart RO	0.04	45	96	1.0	0.750	2,284		96
IR16-20	FL0041637	0.04	81	159	0.1	4.0	1,218		159

Lagoon Segment	NPDES Facility	2000-2005 Flow Weighted Concentration TP (mg/L)[1]	Annual Average Load 2001–05 TP (lbs/yr)[2]	95th Percentile Annual Load TP (lbs/yr)[3]	Permit Concentration TP (mg/L)[4]	Permit Flow Equiv. (MGD)[5]	Permit Annual Load TP (lbs/yr)[6]	TMDL TP (lbs/yr)[7]	WLA TP (lbs/yr)[8]
	IRCUD/West Regional								
IR16-20	FL0037940 IRCUD/South County RO	0.04	112	291	1.0	1.5	4,569		291
IR21	N/A							1,458	
Banana River Lagoon									
BR1-2	FL0042005 Morton Salt	0.57	103	302	N/A	0.084	N/A	7,825	302
BR3-5	FL0020541 Cape Canaveral	0.11	112	158	0.5	1.8	2,741	9,755	158
BR3-5	FL0021105 Cocoa Beach	1.32	2,291	3,599	4.0	1.5	18,226		1,063
BR6	N/A							3,247	
BR7	N/A							2,426	

1. Average flow-weighted nutrient concentration in the discharge summarized from monthly data reported to the Department by the facility. The 2000–05 period corresponds to the modeling period used by the SJRWMD for TMDL development.
2. Average annual nutrient load discharged by the facility, 2001–05. Loads are calculated from monthly discharge and monthly effluent nutrient concentration as reported by the facility to the Department, with unit conversion factors. Annual loads are calculated from April to the following March to correspond with the modeling year used by the SJRWMD. The average annual load is the average of the five annual loads. The five-year period corresponds to the five-year cycle of an NPDES permit.
3. The calculated 95th percentile of the discharge's five annual nutrient loads.
4. The effluent nutrient concentration limit in the facility's NPDES permit. Provided for reference only; not used in WLA calculations.
5. The permitted annual flow equivalent in the NPDES permit issued by the Department. Some facilities are permitted to discharge only 60 or 91 days during the rainy season. The flow and number of discharge days allowed in the permit are multiplied along with conversion factors to calculate an annual flow equivalent. Provided so intermittent discharge facility flow can be compared with continuous discharge facilities. Provided for reference only; not used in WLA calculations.
6. The annual load allowed by the facility's NPDES permit calculated by multiplying the permit discharge flow, the permit effluent nutrient concentration, and conversion factors. Provided for reference only; not used in WLA calculations.
7. The proposed TMDL (all point and nonpoint sources) for that lagoon segment calculated by the SJRWMD modeling approach (Steward and Green 2006), plus direct atmospheric deposition.
8. Proposed WLA for all point sources in that lagoon segment. **Section 6.3.1** describes the basis for specific allocations in more detail.
9. N/A in the table represents the condition that a given lagoon segment does not have a point source discharger or, for a given facility, no permit limit for TN, TP, and/or flow.

existing long-term average TP concentration of the surface discharge is about 0.57 mg/L, which is significantly lower than the concentration observed before the 1990s and meets the AWT requirement. Therefore, the 95th percentile TP annual discharge load for 2001 through 2005, which is 1,423 lbs/yr, is assigned to the facility as its annual TP WLA.

The long-term TN concentration of the discharge is 5.78 mg/L, which is also significantly lower than the historical discharge concentration, but does not meet the AWT concentration requirement. Considering that the 95th percentile of the annual TN discharge rate from the facility is about 8,932 lbs/yr for the period from 2001 through 2005 (more than 10 percent of the total allowable TN load for Segment IR6-7 [81,993 lbs/yr]), assigning the 95th percentile annual TN load to the facility for its WLA was not considered sufficiently protective for the IRL. Therefore, the long-term average annual TN load for 2001 through 2005, which is 5,556 lbs/yr, is assigned to the facility as its annual TN WLA. The corresponding daily WLAs for TP and TN are 15.6 and 61.1 lbs/day, respectively, applicable to no more than 91 days in a given year.

*(2) **Reliant Energy Indian River Power Plant (FL0000680):** The vast majority of the discharge from the facility (maximum daily average of 820 MGD) into Segment IR6-7 is OTCW from the IRL. No extra TN and TP loadings are added through the recycled lagoon water. The only other surface water discharge from the plant is boiler blowdown, which has a maximum monthly average limit of 0.297 MGD. The facility adds trisodium phosphate and disodium phosphate into the boiler blowdown to control pH. Therefore, a WLA of TP loading to the facility is needed.*

For the past 5 years, the long-term average TP concentration from the facility's surface discharge has been about 0.20 mg/L, which meets the AWT concentration requirement. Therefore, the 95th percentile of the existing TP discharge load, which is 40 lbs/yr, is assigned to the facility as its annual WLA. The corresponding daily TP WLA is 0.1 lbs/day. As the facility does not discharge extra TN loading into the IRL, no WLA for TN is assigned to the facility.

*(3) **Melbourne RO WWTF (FL0043443):** The facility provides potable water to the city of Melbourne. It has a 1.25-MGD permitted design flow discharged to the Eau Gallie River, which in turn discharges into IRL Segment IR9-11. The surface discharge contains concentrated ground water constituents (brine) and TN and TP. The facility's existing long-term discharge TN and TP concentrations are 2.43 and 0.04 mg/L, respectively, which meet the AWT requirements for both TN and TP. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 9,170 lbs/yr for TN and 195 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 25.1 and 0.5 lbs/day, respectively.*

*(4) **BCUD/South Beaches WWTF (FL0040622):** The facility has an 8.0-MGD ADF discharge permit. Treated wastewater is injected into an underground injection well system most of the time. The facility's wastewater permit only allows surface discharges of the same ADF discharge limit for 5 days in a 5-year permit*

cycle when the mechanical integrity test is conducted for the underground injection well system. From 2001 through 2005, the 95th percentile TN and TP discharge rates were about 173 and 36 lbs/yr, respectively. Compared with the total allowable TN load of 226,361 lbs/yr and TP load of 42,376 lbs/yr for the segment, the TN and TP loads from the facility are considered insignificant. Therefore, even though the long-term discharge TN and TP concentrations of the facility are 8.09 and 1.50 mg/L, respectively, which are higher than the AWT levels, the 95th percentile TN and TP discharges for the 2001–05 period, which are 173 and 36 lbs/yr, respectively, are assigned to the facility as its TN and TP annual WLAs. The corresponding daily WLAs for TN and TP are 34.6 and 7.2 lbs/day, respectively, applicable only to the 5-day mechanical integrity test in a given permit cycle.

(5) ***Melbourne/Grant Street WWTF (FL0041122):*** *The 5.5-MGD AADF permitted capacity for treated wastewater is either disposed of in a Class I underground injection well or directed to a public access reuse system. The surface discharge to Crane Creek, which in turn discharges into IRL Segment IR12, is only allowed for a 5-day period in a 5-year permit cycle during the mechanical integrity test of the underground injection well. The long-term average TN and TP concentrations for the surface discharge from the facility are 10.78 and 0.45 mg/L, respectively. Although the TN discharge concentration does not meet the AWT concentration requirement, the 95th percentile of the annual TN discharge rate is about 182 lbs/yr for 2001 through 2005, which is considered insignificant compared with the segment's total allowable TN load (226,361 lbs/yr). Therefore, the 95th percentile TN and TP annual discharge loads for the period from 2001 through 2005, which are 182 lbs/yr for TN and 8 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 36.4 and 1.6 lbs/day, respectively, applicable only to the 5-day mechanical integrity test in a given permit cycle.*

(6) ***Barefoot Bay Advanced WWTF (FL0042293):*** *The majority of treated wastewater from the facility is used for irrigating golf courses, sod farms, and citrus groves at or near the Barefoot Bay Mobile Home Community. The intermittent wet-weather discharge is only allowed for less than 91 days (or the equivalent of 2,184 hours) per year, and the average daily discharge rate during that period should not exceed 0.75 MGD. The long-term average TN and TP discharge concentrations for the facility are 2.29 and 0.35 mg/L, respectively, which both meet the AWT concentration requirements. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 476 lbs/yr for TN and 78 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 5.2 and 0.9 lbs/day, respectively, applicable to no more than 91 days for each year.*

(7) ***Vero Beach WWTF (FL0021661):*** *The majority of the treated wastewater from the facility is directed to a slow-rate public access reuse system that is used to irrigate recreation areas, residential lawns, golf courses, urban landscapes, and road medians in the Reuse Service Area. The wet-weather intermittent discharge to the IRL at Segment IR16-20 is only allowed for no more than 60 days (or the equivalent 1,440 hours) per year, and the average daily discharge during the period should not exceed 0.740 MGD. The long-term average TN and TP concentrations for the discharge are 11.85 and 1.06 mg/L, respectively,*

which exceed the AWT concentration requirements. Considering that the 95th percentile TN and TP loadings for the facility from 2001 through 2005 are 24,794 and 1,411 lbs/yr, respectively, which are significant, the long-term average annual discharge loads of TN and TP from 2001 through 2005, which are 12,173 lbs/yr for TN and 916 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 202.9 and 15.3 lbs/day, respectively, applicable to no more than 60 days in each year.

*(8) **Vero Beach RO–Potable Water Treatment Plant (FL0042544):** The facility has a 0.5-MGD permitted surface water discharge for its ground water concentrate (brine) to the Indian River Farm Control District Main Canal, which in turn discharges to the IRL at Segment IR16-20. The long-term average TN and TP discharge concentrations for the facility are 2.39 and 0.34 mg/L, respectively, which meet both the TN and TP AWT concentration requirements. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 2,985 lbs/yr for TN and 487 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 8.2 and 1.3 lbs/day, respectively, applicable for the entire year.*

*(9) **IRCUD/Hobart Park Demineralization Concentration Discharge (FL0166511):** The facility has a 0.75-MGD permitted capacity discharge to the IRL at Segment IR16-20 for its ground water concentration (brine). The long-term average TN and TP discharge concentrations for the facility are 1.90 and 0.04 mg/L, respectively, which meet both the TN and TP AWT concentration requirements. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 2,759 lbs/yr for TN and 96 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 7.6 and 0.3 lbs/day, respectively, applicable for the entire year.*

*(10) **IRCUD/West Regional WWTF (FL0041637):** The facility has a 4.0-MGD permitted discharge capacity to the Vero Beach Main Canal, which in turn discharges to the IRL at Segment IR16-20. The long-term average TN and TP discharge concentrations are 0.73 and 0.04 mg/L, respectively, which meet both the TN and TP AWT concentration requirements. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 2,838 lbs/yr for TN and 159 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 7.8 and 0.4 lbs/day, respectively, applicable for the entire year.*

*(11) **IRCUD/South County RO–Potable Water Treatment Plant (FL0037940):** The facility has a 1.2-MGD permitted average daily discharge capacity to the Indian River County South Relief Canal, which in turn discharges to the IRL at Segment IR16-20. The long-term average TN and TP discharge concentrations are 1.51 and 0.04 mg/L, respectively, which meet both the TN and TP AWT concentration requirements. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 4,636 lbs/yr for TN and 291 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs for TN and TP are 12.7 and 0.8 lbs/day, respectively, applicable for the entire year.*

(12) ***Morton Salt Industrial Wastewater Treatment and Disposal System (FL0042005):*** *The facility, located in Port Canaveral, has a 0.084-MGD average daily flow process wastewater discharge to a turning basin, which is connected to the Banana River Lagoon at Segment BR1-2 through a boat lock. The long-term average TN and TP discharge concentrations for the facility are 2.74 and 0.57 mg/L, respectively, which meet both the TN and TP AWT concentration requirement. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 1,214 lbs/yr for TN and 302 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs of TN and TP are 3.3 and 0.8 lbs/day, respectively, applicable for the entire year.*

(13) ***Cape Canaveral WRF (FL0020541):*** *The facility has a 1.80-MGD AADF permitted discharge to the Banana River at Segment BR3-5. The long-term average TN and TP discharge concentrations are 1.05 and 0.11 mg/L, respectively, which meet both the TN and TP AWT concentration requirements. Therefore, the 95th percentile TN and TP annual discharge loads for 2001 through 2005, which are 2,151 lbs/yr for TN and 158 lbs/yr for TP, are assigned to the facility as its annual WLAs. The corresponding daily WLAs of TN and TP are 5.9 and 0.4 lbs/day, respectively, applicable for the entire year.*

WLAs are assigned to the following facilities using methods that are different from the one described above:

(1) The ***Rockledge WWTP (FL0021571)*** *is known to discharge a very small load of TN and TP (about 10 lbs/yr of TN and TP) only when it performs mechanical integrity testing. The last time Rockledge had a discharge during this testing was in 1996–97. The facility is allocated limits of 30 lbs/yr for both TN and TP as its annual WLAs, an amount sufficient for this purpose. The corresponding daily WLAs for TN and TP are both 6.0 lbs/day, applicable to the 5-day mechanical integrity test in any given permit cycle.*

(2) The ***Cape Canaveral Power Plant (FL0001473)*** *is allocated its currently permitted loads for TN and TP (146 lbs/yr TP and 2555 lbs/yr TN); as no TN and TP permit limits were applied to the surface discharge of the facility before 2005, no monitoring data can be used to calculate long-term statistics for TN and TP discharge loadings from the facility. The current permit limits for the facility are annual average daily loads of 7 lbs/day for TN and 0.4 lbs/day for TP, which corresponds to 2,555 lbs/yr for TN and 146 lbs/yr for TP. As the percentages of TN and TP contributions from the facility are fairly low in the total TN and TP loadings to the lagoon segment, even when the facility discharges at its current permit level (3 percent for TN and 1 percent for TP), the facility's permit TN and TP loadings are used as the WLAs in this TMDL.*

(3) As discussed above, the ***Cape Canaveral WWTP (FL0020541)*** *is allocated the 95th percentile of its annual load as a maximum limit because it has low effluent concentrations and loads (0.11 mg/L and 161 lbs/yr for TP, and 1.05 mg/L and 1475 lbs/yr for TN). However, the Cocoa Beach WWTP (FL00211005), which discharges to the same lagoon segment as the Cape Canaveral WWTP, has much higher effluent concentrations (6.3 mg/L TN and 1.3 mg/L TP) and much higher loads (13,652 lbs/yr of TN and 2,622 lbs/yr of TP). After reserving the*

allocation for Cape Canaveral, Cocoa Beach was allocated annual load limits for TN and TP that result in 15 percent of the TMDL for Segment BR3-5 being allocated for point sources, with the other 85 percent allocated for nonpoint sources.

Tables 6.3a and **6.3b** summarize the WLAs of TN and TP, respectively, assigned to each facility. Although the loads currently contributed by NPDES-permitted facilities are generally a small fraction of the total annual external load of nutrients to the lagoon, most facilities have permit limits that are much higher than their current discharges. In some cases, the difference is tenfold, twentyfold, or even a hundredfold. If all of these facilities were to discharge at their present permit limits, their contribution would become much more significant and could offset gains made by reducing nonpoint sources. This is especially true of Segment BR3-5. In fact, the present permits for the two facilities in BR3-5 exceed the entire TMDL, including the nonpoint source allocation for this lagoon segment.

It should be noted that, for those domestic wastewater facilities whose discharges are influenced by the rainfall condition—for example, inflow and infiltration (I&I) issues for a domestic wastewater treatment plant, and reduced irrigation demand for a public access reuse system—wastewater permitting is primarily based on the long-term average rainfall condition. In implementing these TMDLs, the Department will take into consideration rainfall conditions that are above the long-term average.

6.3.2 NPDES Stormwater Discharges

Because no information was available to the Department at the time this analysis was conducted regarding the boundaries and locations of all the NPDES stormwater dischargers, the exact stormwater TN and TP loadings from MS4 areas were not explicitly estimated. The wasteload allocations for each of the MS4s are the same percent TN and TP reductions required for the LA assigned to the nonpoint sources in the river segments that belong to each county and municipality. **Table 4.5** lists the MS4 permits that will be influenced by the TMDLs covered in this report. 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 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL. 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.

The IRL TMDLs were developed using an implicit MOS. The sublagoon targets for TN and TP are set to achieve within -10 percent of the maximum seagrass depths documented in each segment of the IRL between 1943 and 1999. Except for TN in the Central IRL, these TMDLs are similar to the loading estimates for 1943, when human alteration of the watershed was fairly minimal. The estimated TP load for the Central IRL in 1943 is higher than its target. However, an implicit MOS is provided by the presence of Sebastian Inlet, which did not exist in 1943, but today provides flushing to the Central IRL sublagoon, lessening the impact of pollutant loads. In addition, estimating the needed percent reduction by focusing on the loadings from the watershed resulted in a higher needed percent reduction than including the atmospheric deposition into the calculation, which also adds to the MOS.

6.5 Recommendations for Further Studies

TMDLs for the IRL and Banana River Lagoon segments covered in this report are developed based on the correlation between watershed loading and seagrass depth limit. Nutrient targets are developed as loading targets. No nutrient concentration targets are explicitly developed in this TMDL, although the per-acre nutrient loadings from the watershed imply the nutrient concentrations from the watershed. The SJRWMD is currently working on defining concentration targets for the estuarine segments of the IRL. These targets include TN and TP, as well as other parameters, and are being developed from the median concentrations observed where seagrass depth limits are within the -10 percent departure (shoreward) from their full-restoration levels.

The project is still in progress, but it suggests TN concentrations of 0.98 mg/L based on 12-month medians, or 1.0 mg/L based on 18-month medians. For TP, the 12-month median is 0.05 mg/L, and the 18-month median is 0.06 mg/L (Steward and Green 2006). Having target nutrient concentrations for these waters can facilitate evaluating the effectiveness of nutrient removal in the watershed, because it is easier to measure nutrient concentrations than to directly measure the nutrient loadings from the watershed.

In addition to directly measuring the TN and TP concentrations in the lagoon segments that have already achieved seagrass depth limits, studies on the processes that influence nutrient dynamics in these lagoon segments will be instrumental in interpreting nutrient concentrations in these waters. For example, if a low nutrient concentration is observed, it is important to understand whether it means a high uptake rate from periphyton or low nutrient watershed loading.

Another issue that deserves further study is the dynamics of DO concentrations in the lagoon. For now, how the recovery of seagrasses will influence DO concentrations in the lagoon is not completely understood. Studies have shown that certain developmental stages of seagrass communities and at certain seasons, seagrasses may show net DO consumption instead of DO enrichment. That is why this TMDL only addresses the DO depression resulting from human activities that are pollutant related, but it is not feasible to identify the expected DO target after the full restoration of seagrass targets is achieved in these waters. An improved understanding of how seagrass influences DO concentrations in these lagoon waters will help to answer this question.

Understanding how pollutant sources other than human land uses influence nutrient loadings into the lagoon system will facilitate the implementation of these TMDLs. The TN and TP loadings from the IRL and Banana River Lagoon watersheds were estimated primarily based on land use and soil type. Especially for urban areas, watershed loadings estimated using this method are lumped loadings that may include many potential sources, such as septic tanks, sewer line leakage, residential fertilization, the reuse of treated wastewater, etc. Contributions from these sources were not quantified explicitly in this TMDL report due to the lack of local data. However, during the TMDL implementation stage, information regarding the load contribution from each individual source will be evaluated.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

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

- *Appropriate load reduction allocations among the affected parties;*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDL;*
- *Timetables for implementation;*
- *Confirmed and potential funding mechanisms;*
- *Any applicable signed agreement(s);*
- *Local ordinances defining actions to be taken or prohibited;*
- *Any applicable local water quality standards, permits, or load limitation agreements;*
- *Milestones for implementation and water quality improvement; and*
- *Implementation tracking, water quality monitoring, and follow-up measures.*

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

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

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

Chapter 62-40, F.A.C., also requires the water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG had been developed for Newnans Lake when this report was published.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and the master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria. 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 NPDES and the state's stormwater/environmental resource permitting programs is that the NPDES Program covers both new and existing discharges, while the state's program focuses on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. 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.

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