St. Lucie River Watershed Protection Plan

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ST. LUCIE RIVER WATERSHED PROTECTION PLAN
ACRONYM LIST

%	percent
ac-ft	acre-feet
AFSIRS	Agricultural Field Scale Irrigation Requirements Simulation
ASR	Aquifer Storage and Recovery
AWSF	Alternative Water Storage Facility
BMP	best management practice
BOD_5	5-day biological oxygen demand
C&SF	Central and Southern Florida
CBASE	Current Base
CERP	Comprehensive Everglades Restoration Project
cfs	cubic foot per second
CH3D	Curvilinear Hydrodynamics 3-Dimensional
CRWPP	Caloosahatchee River Watershed Protection Plan
CWA	Clean Water Act
DO	dissolved oxygen
USDOI	US Department of the Interior
DTKN	Dissolved Total Keldahl Nitrogen
EFDC	Environmental Fluid Dynamics Code
EIS	Environmental Impact Statement
USEPA	US Environmental Protection Agency
ERP	Environmental Resource Permit
ET	evapotranspiration
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FLUCCS	Florida Land Use, Cover, and Forms Classification System
F.S.	Florida Statutes
USFWS	US Fish and Wildlife Service
IRL	Indian River Lagoon

IRL-S PIR	Indian River Lagoon – South Final Integrated Project Implementation Report and Environmental Impact Statement
km^2	square kilometers
lb/ac/yr	pounds per acre per year
LOER	Lake Okeechobee and Estuary Recovery
LOFT	Lake Okeechobee Fast Track
LOPA	Lake Okeechobee Protection Act
LORSS	Lake Okeechobee Regulation Schedule Study
LOSA	Lake Okeechobee Service Area
LOWPP	Lake Okeechobee Watershed Protection Plan
LOP2TP	Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan
LOWSM	Lake Okeechobee Water Shortage Management
MFL	Minimum Flows and Levels Program
mi^2	square miles
MM	management measure
MS4	Municipal Separate Storm Sewer Systems
mt/yr	metric tons per year
mtons	metric tons
N	nitrogen
NEEPP	Northern Everglades and Estuaries Protection Program
NERSM	Northern Everglades Regional Simulation Model
NGVD	National Geodetic Vertical Datum
NPDES	National Pollution Discharge Elimination System
USNRCS	US Natural Resources Conservation Service
NSM	Natural System Model
O&M	Operation and Maintenance
OPTI	Reservoir Optimization Model
P	phosphorus
PD&E	Process Development and Engineering
PIR	Project Implementation Report
POR	period of record
ppb	parts per billion

ppm	parts per million
ppt	parts per thousand
R&WQMP	Research and Water Quality Monitoring Program
RECOVER	Restoration Coordination and Verification
RSM	Regional Simulation Model
RWPPB	River Watershed Protection Plan Base
RWQMP	Research and Water Quality Monitoring Program
SAV	submerged aquatic vegetation
SFER	South Florida Environmental Report
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SJRWMD	St. John's River Water Management District
SLRWPP	St. Lucie River Watershed Protection Plan
SLT	St. Lucie Tributary Monitoring Program
STA	Stormwater Treatment Area
SWIM	Surface Water Improvement and Management
TMDL	Total Maximum Daily Load
TN	total nitrogen
TOC	Total Organic Carbon
TP	total phosphorus
TSS	total suspended solids
UF/IFAS	University of Florida Institute of Food and Agriculture Sciences
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
VEC	Valued Ecosystem Component
WaSh	Watershed Hydrology and Water Quality Model
WCA	Water Conservation Area
WRAC	Water Resources Advisory Commission
WRDA	Water Resources Development Act
WSE	Water Supply/Environmental Regulation Schedule
WWF	World Wildlife Fund

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CHAPTER 1

TECHNICAL OVERVIEW

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The Northern Everglades and Estuaries Protection Program requires the development of the St. Lucie and Caloosahatchee River Watershed Protection Plans by January 1, 2009. In response, the St. Lucie River Watershed Protection Plan was developed by the South Florida Water Management District in coordination with the Florida Department of Environmental Protection and the Florida Department of Agriculture and Consumer Services – and with extensive input from stakeholders throughout its development. Subject to ratification by the Florida Legislature, the Preferred Plan builds upon existing and planned programs and projects, and successfully consolidates many previous St. Lucie River watershed restoration efforts into a broader, Northern Everglades-focused approach.

1.0 TECHNICAL OVERVIEW

Passed by the Florida Legislature and signed into law by Governor Charlie Crist in 2007, the landmark Northern Everglades and Estuaries Protection Program promotes a comprehensive, interconnected watershed approach to protecting Lake Okeechobee, and the Caloosahatchee and St. Lucie Rivers and Estuaries. By expanding the Lake Okeechobee Protection Act, the Florida Legislature recognized the importance and connectivity of the entire ecosystem – from the Kissimmee Chain of Lakes south to Florida Bay.

The primary goal of the legislation is to restore and protect surface water resources by addressing not only the water quality but also the quantity, timing, and distribution of water to the natural system. State agencies are working in partnership with those local governments whose economy and quality of life depend on the health of Lake Okeechobee and the coastal estuaries to develop and implement comprehensive plans to restore and protect these waterbodies.

The Northern Everglades and Estuaries Protection Program legislation requires development of watershed protection plans for the three northern everglades watersheds: (1) the St. Lucie River watershed; (2) the Caloosahatchee River watershed; and (3) the Lake Okeechobee watershed. The three main components of the watershed protection plans required under the Northern Everglades and Estuaries Protection Program legislation include: (1) a Construction Project, which identifies water quality and storage projects to improve hydrology, water quality, and aquatic habitats within the watershed; (2) a Watershed Pollutant Control Program that is a multi-faceted approach to reducing pollutant loads by improving the management of pollutant sources within the watersheds; and (3) a Watershed Research and Water Quality Monitoring Program to monitor progress of the programs and the health of the estuaries.

These Protection Plans represent a comprehensive watershed-based approach to restoration that builds upon existing efforts. Therefore, one of the first steps in the planning process was to inventory existing and planned programs and projects (e.g., Comprehensive Everglades Restoration Plan Indian River Lagoon-South project) and determine the cumulative benefit provided by those projects. The cumulative benefit was then compared to the program objectives to determine if gaps still existed and whether additional projects or programs would be necessary to achieve the program objectives. A Preferred Plan was selected that best achieved the program objectives. However, achievement of the Preferred Plan benefits is contingent upon implementation of those existing and planned programs and projects that were incorporated.

This chapter represents the technical overview of the St. Lucie River Watershed Protection Plan. The Construction Project is provided in Chapter 6 of this document, the St. Lucie River Watershed Pollutant Control Program is included as Chapter 7 of this document and the St. Lucie River Watershed Research and Water Quality Monitoring Plan is attached as Appendix E and summarized in Chapter 8 of this document. Chapter 9 of this document represents the Preferred Plan of the St. Lucie River Watershed Protection Plan. Chapter 10 contains references from each of the earlier chapters.

1.1 St. Lucie River Watershed

The St. Lucie River watershed drains into the St. Lucie Estuary and includes much of Martin and St. Lucie Counties, and a small portion of Okeechobee County at the northwest corner. **Figure 1-1** shows the St. Lucie River Watershed Protection Plan study area with the following sub-watersheds that drain directly into the St. Lucie Estuary:

1. South Fork Sub-Watershed
2. C-44 and S-153 Sub-Watershed
3. 4-5-6 Sub-Watershed
4. C-23 Sub-Watershed
5. C-24 Sub-Watershed
6. North Fork Sub-Watershed
7. South Coastal Sub-Watershed

Basin 1 watershed discharges directly into the Indian River Lagoon, while the C-25 and C-25 East watersheds typically drain into the IRL, but in some cases, excess water from the C-25 sub-watershed can be discharged into the C-24 watershed by way of the G-81 control structure. When this occurs, the C-25 sub-watershed is considered part of the St. Lucie River watershed and these discharges are accounted for in the discharge volumes from the C-24 watershed.

1.2 Problems, Objectives, and Constraints

The quality of water entering the St. Lucie Estuary directly affects the health of the system. Evaluating water quality and quantity can determine long-term trends and the state of this estuary. Historical drainage patterns within the St. Lucie River watershed have been highly altered since pre-drainage times. Loss of natural habitat from riverfront and coastal development, increased urban development, construction of drainage canals, and agricultural activities have affected the timing, quantity, quality, and distribution of runoff to the estuary. Wet season flows have increased due to additional runoff from land clearing and impervious areas; and dry season flows have decreased due to increased water supply demand for agricultural and urban development.

Problems, objectives, and constraints associated with the St. Lucie River Watershed Protection Plan are summarized in **Table 1-1**.

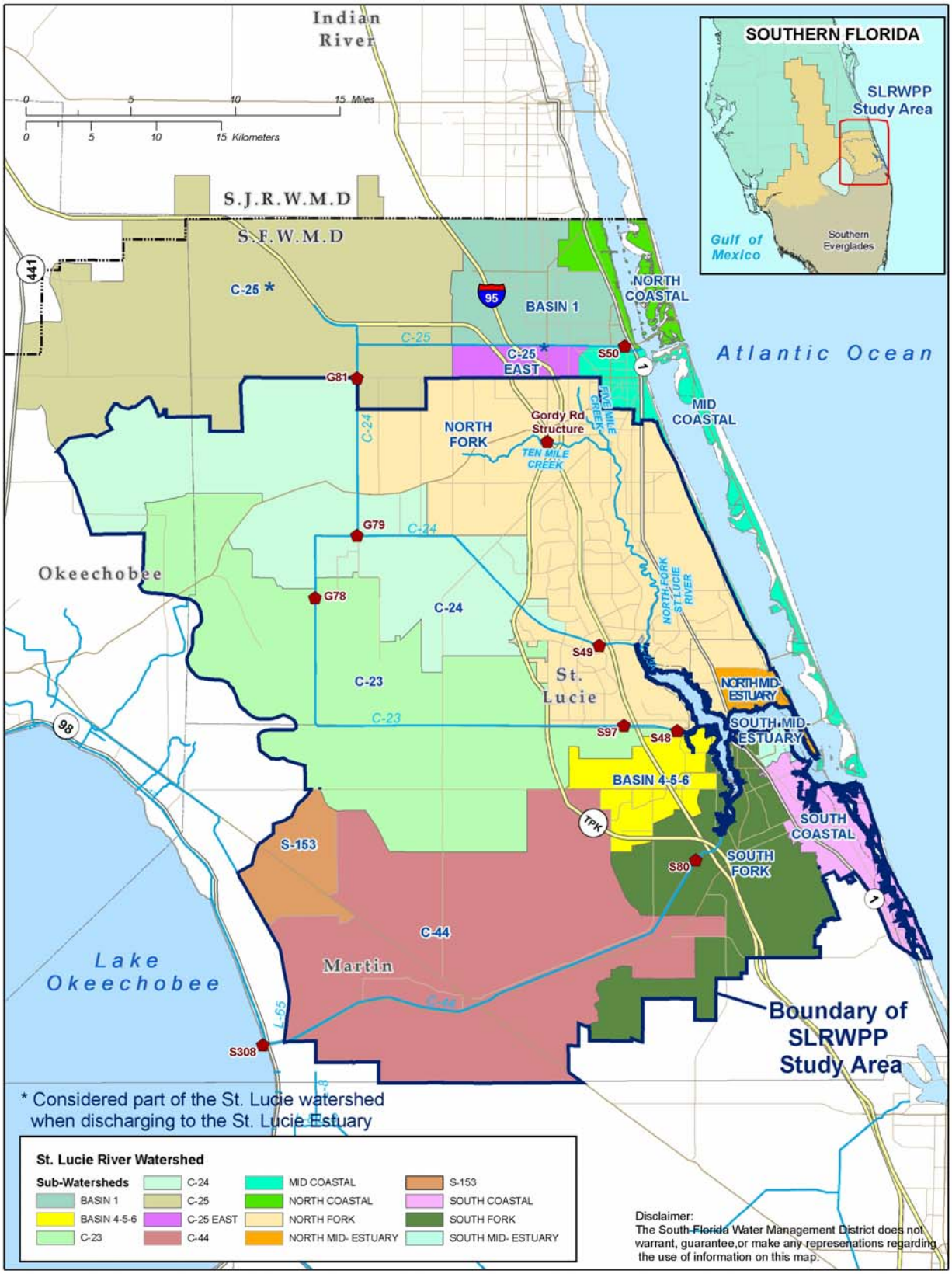

Figure 1-1. The St. Lucie River Watershed Protection Plan Study Area

Table 1-1. Problems, Objectives, and Constraints

Problems	Objectives	Constraints
• Excess discharges resulting from watershed runoff excess nutrient loads to St. Lucie Estuary • Undesirable low flows to the St. Lucie Estuary Muck accumulation in St. Lucie Estuary	• Meet Total Maximum Daily Loads • Manage watershed discharges to meet desirable salinity ranges for estuary • Reduce pollutant loads by improving management of pollutant sources in watershed • Establish Research and Water Quality Monitoring Program sufficient to implement the program and projects	• Maintain existing levels of flood protection • Maintain water supply for affected water user basins • Maintain minimum flows and levels

1.3 Public Process for Plan Development

A concerted effort was made during the St. Lucie River Watershed Protection Plan planning process to involve all appropriate and relevant agencies, and to keep the public and stakeholders informed about the project. A public outreach initiative was developed and implemented throughout the planning process, which focused on interagency coordination, public involvement and stakeholder notification, and internal management and communication. Specific objectives of this initiative included the following:

- Develop and implement an approach that would reach all stakeholders;
- Integrate the public outreach efforts with all other aspects of the planning process;
- Take advantage of other ongoing public efforts being conducted by the South Florida Water Management District and collaborating agencies as part of other St. Lucie Estuary restoration programs;
- Increase public awareness of the overall goals and objectives of the Northern Everglades and Estuaries Protection Program;
- Inform the public and receive input regarding the project goals, objectives, progress, issues, and findings; and
- Improve the substantive quality of program and project-level decisions as a result of public participation.

The draft St. Lucie River Watershed Protection Plan was released for public comment in October 2008. Public, stakeholders, and agencies were invited to review and provide comments on the draft St. Lucie River Watershed Protection Plan. Comments received over the 4-week public comment period were considered during the finalization of the St. Lucie River Watershed Protection Plan.

Input from other agencies was solicited through informal interaction and during stakeholder and interagency meetings such as:

- The St. Lucie River Watershed Protection Plan Working Team;
- The St. Lucie River Research and Water Quality Monitoring Plan Working Team;
- The Water Resources Advisory Commission;
- The Water Resources Advisory Commission, Lake Okeechobee Committee;
- The Ten County Coalition;
- Governing Board Meetings; and
- The Northern Everglades Interagency Meeting.

1.4 Construction Project

The Construction Project includes identification of water quality and storage projects (known as management measures) to improve hydrology, water quality, and aquatic habitats within the watershed. The management measures were used to formulate alternatives that were evaluated for water storage benefits and total nitrogen and total phosphorus loading reductions. The preferred alternative maximizes water quality and quantity benefits. The following sections summarize the main components of the construction project.

1.4.1 Construction Project Water Quantity and Quality Evaluation Methods

Water quantity was evaluated by a water budget analysis using the Northern Everglades Regional Simulation Model, based upon a simulation period of 1970 to 2005. The water storage of each management measure was estimated based upon the best available information. There are two water quantity base conditions in the St. Lucie River Watershed Protection Plan: the Current Base (CBASE) condition and the River Watershed Protection Plan Base condition.

The CBASE condition includes the following assumptions:

- Represents the conditions as they existed in the Northern Everglades watershed in 2005;
- Assumes there are no Comprehensive Everglades Restoration projects or Lake Okeechobee Watershed Protection Plan Phase 2 Technical Plan projects in place;
- Lake Okeechobee releases to the estuary and Water Conservation Area are based on the existing Water Supply/Environmental regulation schedule.

The River Watershed Protection Plan Base condition assumes base condition of 2015 and the following projects are in place:

- Full Kissimmee River Restoration including Kissimmee River Headwaters Revitalization project;
- All Acceler8 projects (e.g., C-43 Reservoir, C-44 Reservoir/Stormwater Treatment Area);
- Authorized MODWATERS and C-111 projects;

- Northern Everglades Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan; and
- The Ten Mile Creek Reservoir and the C-44 Reservoir located in the St. Lucie River watershed.

Tracking water quality benefits (total nitrogen and total phosphorus load reductions) involved a spreadsheet created in Excel®, which was used as an accounting tool to track load reductions of total phosphorus and total nitrogen. The current load from the St. Lucie River watershed to the St. Lucie Estuary was based on a period of record from 1995 to 2005. Phosphorus and nitrogen reductions for each management measure were estimated based upon the best available information. These reductions were totaled for each alternative and imported into the spreadsheet; they represent the anticipated total phosphorus and total nitrogen load reductions and remaining loads to the St. Lucie Estuary upon implementation of the alternatives. A very conservative approach was taken when quantifying water quantity and water quality benefits anticipated from individual management measures. For example, the performance assigned to the management measures was always the lowest anticipated. Furthermore, many water quality benefits for many management measures were not quantified due to insufficient information or the nature of the project was not conducive to quantifying the benefits, so these anticipated benefits were not captured in the water quality spreadsheet.

1.4.2 Construction Project Formulation

Each alternative was evaluated for nitrogen load removal, phosphorus load removal, and water quantity performance. The alternatives were formulated with input from the working team and all results were presented to the working team. Four alternatives were formulated for the St. Lucie River Watershed Protection Plan by combining management measures to meet the planning objectives. The objectives of each alternative are listed below.

Alternative 1—Common elements are current, ongoing, and planned projects that were incorporated into all subsequent alternatives. All management measures that were also part of the Central and Southern Florida Project Indian River Lagoon South Plan Final Project Implementation Report and Environmental Impact Statement recommended projects, and all source control management measures are included in Alternative 1.

Alternative 2—Maximizes water storage capacity. As discussed in the water quantity section below, Alternative 1 maximized the water storage goal in the St. Lucie Estuary watershed; therefore, no additional management measures were included in Alternative 2, and Alternative 2 mirrors Alternative 1.

Alternative 3—Maximize phosphorus and nitrogen nutrient load reductions. It builds upon Alternatives 1 and 2 with the addition of 12 new water quality management measures.

Alternative 4—Optimizes both water storage capacity and phosphorus and nitrogen nutrient load reductions. The coordinating agencies evaluated the

potential for incorporating additional management measures into Alternative 4 for further storage and load reductions, however, no additional management measures were identified. The working team concluded that Alternative 3 optimizes storage and load reductions; therefore, Alternative 4 mirrors Alternative 3. Alternative 4 is the preferred alternative.

Based on the results of the water quantity and quality analyses, Alternative 4 was identified as the plan that best met the legislative goals and is referred to as the Preferred St. Lucie River Watershed Protection Plan or the Preferred Plan from this point forward. The following sections discuss the results of the analyses and the benefits anticipated from implementation of the Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan and the River Watershed Protection Plans.

1.4.3 Water Quantity Evaluation and Results

The total storage for the Preferred Plan is approximately 200,000 acre-feet. This includes the Indian River Lagoon South C-44 Reservoir, C23/24 Reservoirs, and Natural Lands Storage, as well as the Ten Mile Creek Critical Project. Based on modeling results, this 200,000 acre-feet per year of storage in the St. Lucie watershed provided significant water quantity improvement. Furthermore, this watershed storage is in addition to the approximately 900,000 acre-feet per year of storage that was identified in the Lake Okeechobee Phase Two Technical Plan to manage Lake Okeechobee flows.

An objective of the St. Lucie River Watershed Protection Plan is to reduce the frequency and duration of harmful freshwater releases into the St. Lucie Estuary. There are two performance measures for evaluating the plan alternatives with respect to preferred flows for the estuary, the High Discharge Criteria and the Salinity Envelope Criteria. The High Discharge Criteria evaluates occurrences of mean monthly flows between 2,000 and 3,000 cubic feet per second and greater than 3,000 cubic feet per second. The Salinity Envelope Criteria establishes the target for desirable salinity ranges in the estuary and considers both quantity and duration of discharges. In addition, an Oyster Stress Model was utilized to assess reductions in oyster mortality resulting from improvements in the flow and salinity regimes in the estuary.

The water quantity results for the Preferred Plan are summarized below.

High Flows

- **Flows between 2,000 and 3,000 cubic feet per second**—The Preferred Plan (Alternative 4) reduces occurrences of flows between 2,000 and 3,000 cubic feet per second to 25. The ecological target is 21 occurrences; therefore, the Preferred Plan only exceeds the target by 4 events. This is a 75 percent improvement over current conditions.
- **Flows greater than 3,000 cubic feet per second—**The Preferred Plan reduces occurrences of flows greater than 3,000 cubic feet per second to 17. The ecological target is 6 occurrences; therefore, the Preferred Plan exceeds the target by 11 events. This is a 50 percent improvement over current conditions.

Low Flows

- **Flows less than 350 cubic feet per second**—The Preferred Plan results in improved low flow performance. However low flow is not a significant issue for the St. Lucie Estuary, as the low flow target is typically achieved through groundwater flows.

Ecological Assessment

- **Oyster Health—**The Preferred Plan showed a 45 percent improvement in the number of years with oyster mortality as compared to current conditions.
- **Detrimental Flows—**Overall, the Preferred Plan reduced the number of months with detrimental high flow events to 9.7 percent.

1.4.4 Water Quality Evaluation and Results

The current load from the St. Lucie River watershed to the St. Lucie Estuary is:

- 1,296 metric tons per year of total nitrogen; and
- 276 metric tons per year of total phosphorus.

Nutrient Total Maximum Daily Loads are currently under development by Florida Department of Environmental Protection for the St. Lucie River watershed. The interim goal utilized in this planning process was to maximize nutrient load reductions. The team also considered estimated natural background concentrations of total phosphorus and total nitrogen as developed by the Restoration Coordination and Verification Program for the Comprehensive Everglades Restoration Program (2005) as a water quality indicator. The estimated natural background concentrations were 81 parts per billion for total phosphorus and 0.72 parts per million for total nitrogen. Based on the Indian River Lagoon—South Final Integrated Project Implementation Report and Environmental Impact Statement, 81 parts per billion total phosphorus is expected when annual loading from the watershed is at or below 110 metric tons and 0.72 parts per million total nitrogen is expected when the annual loading from the watershed is reduced by 30 percent (665.4 metric tons per year), that is, when the annual loading is at or below 1,552.7 metric tons for total nitrogen.

The Preferred Plan achieved a total load reduction of 55 percent for total nitrogen and 56 percent for total phosphorus, as shown in **Table 1-2**. These results reflect the "big picture" benefits provided by implementation of the Lake Okeechobee Phase 2 Technical Plan and the St. Lucie River Watershed Preferred Plan. The load reductions to the estuary achieved by each plan are also included in **Table 1-2**. It should be noted that the total load reduction of 55 percent for nitrogen has resulted in a remaining load and concentration of 1,009 metric tons and 0.94 parts per million, respectively, which are well below the natural background levels summarized above. On the other hand, the total load reduction of 56 percent for phosphorus has resulted in a remaining load and concentration of 164 metric tons and 153 parts per billion, respectively. Remaining total phosphorus concentrations are higher than the natural background concentrations, although to a much lesser extent than under current conditions. Currently, phosphorus concentrations in the estuary are primarily resulting from excessively high phosphorus levels throughout the watershed. Therefore, the major focus of management measures implemented for nutrient reductions in the watershed is phosphorus treatment,

especially in the C-23 and C-24 sub-watersheds, which are major contributors of high phosphorus levels. Total phosphorus and total nitrogen loading performance will be revisited once Florida Department of Environmental Protection adopts nutrient Total Maximum Daily Loads and provides specific loading rates, compliance locations, and compliance methodology.

Table 1-2. Load Reductions Achieved by the Preferred Plan for Total Nitrogen and Total Phosphorus

	Total Nitrogen	**Total Phosphorus**
Total Load Reduction[1]	55%	56%
Watershed Load Reduction[2]	40%	46%
Lake Okeechobee Load Reduction[3]	70%	68%
Resulting Load	1,009 metric tons	164 metric tons
Resulting Concentration	0.94 parts per million	153 parts per billion

[1]Total load reduction from Lake Okeechobee and St. Lucie River watershed compared to Current Base condition
[2] Load reductions only from the St. Lucie River watershed compared to River Watershed Protection Plan Base condition
[3] Load reductions only from the Lake Okeechobee compared to Current Base condition

Additional analyses were conducted to estimate nutrient load reductions by sub-watershed. **Figure 1-2** shows the load reductions (in percent) for total nitrogen whereas load reduction for total phosphorus is represented in **Figure 1-3**. During the plan formulation process, hot spots contributing high nutrient loads were identified within the watershed and management measures were developed to address this problem. For example, C-23 and C-24 sub-watersheds were identified as having disproportionately high annual phosphorus loads to the St. Lucie Estuary when compared to the volume of water discharged from these watersheds; therefore, they were targeted for water quality management measures. The most significant reduction for total nitrogen occurs in the C-23 sub-watershed, where loading is reduced more than 50 percent. This is followed by the C-24 and C-44 sub-watersheds as shown in **Figure 1-2**. On the other hand, more than 50 percent load reductions for total phosphorus are achieved for C-23, C-24 and C-44 sub-watersheds as a result of the Preferred Plan, as represented in **Figure 1-3**.

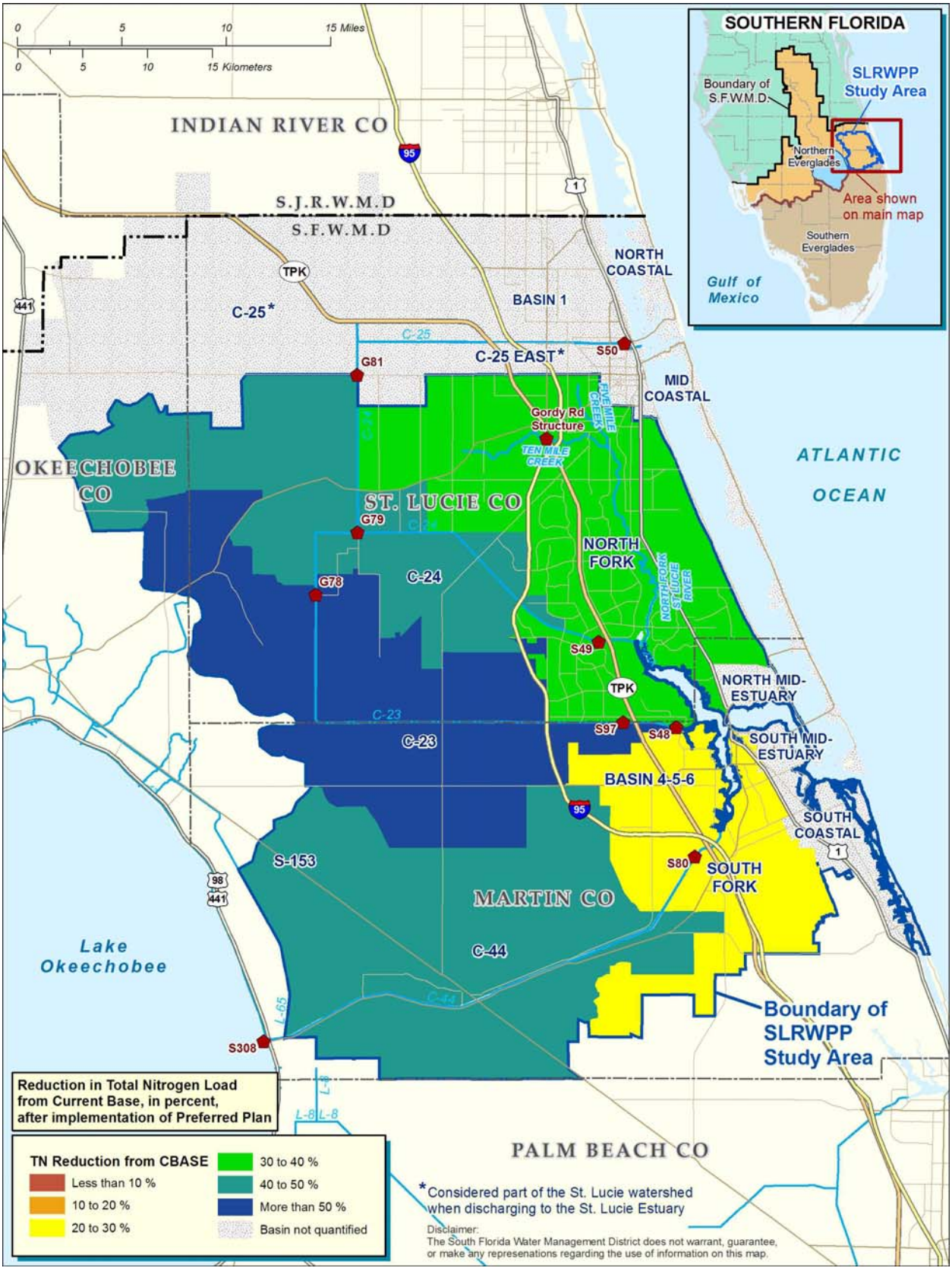

Figure 1-2. Load Reductions (percent) for Total Nitrogen by Sub-watershed

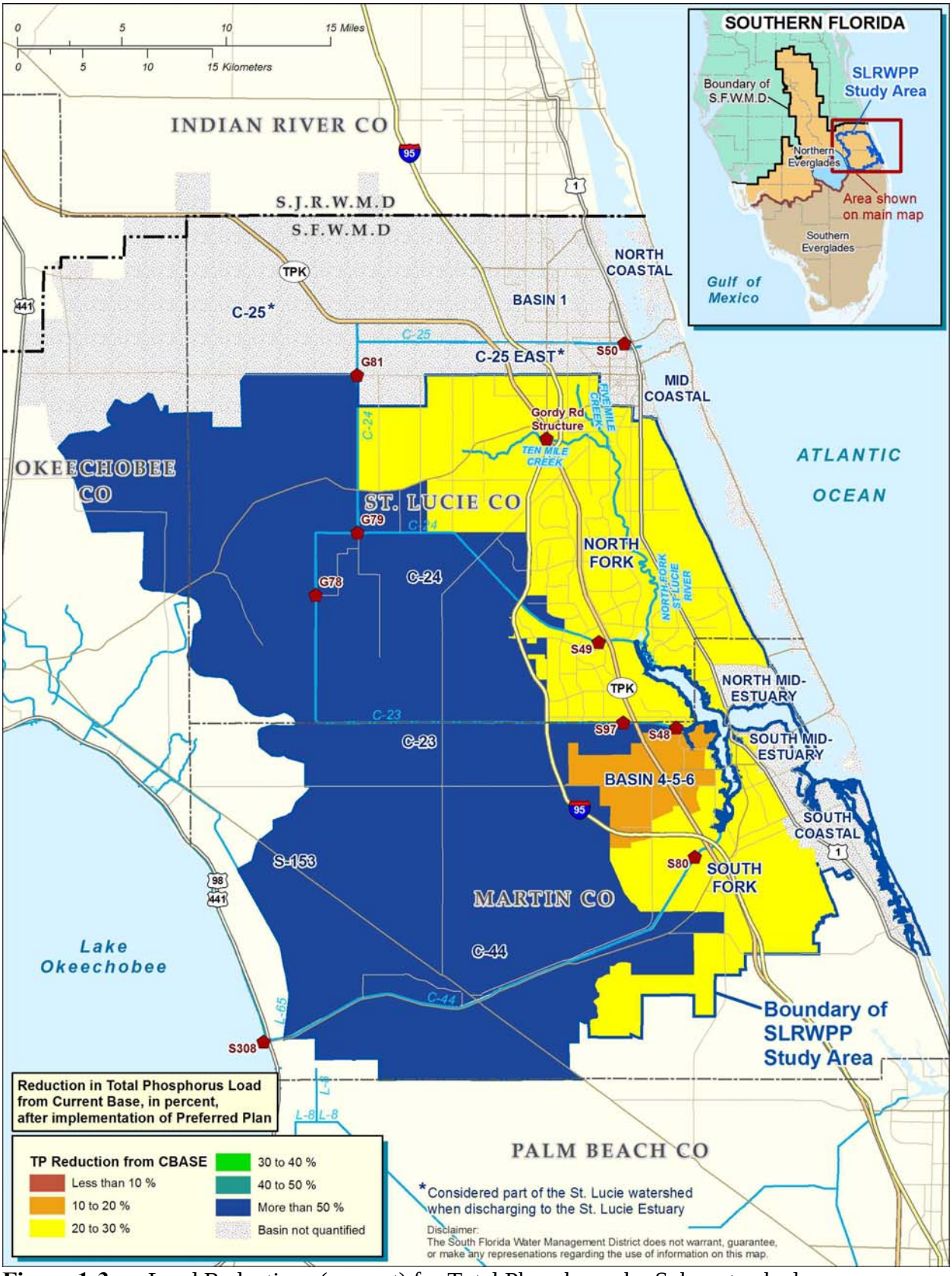

Figure 1-3. Load Reductions (percent) for Total Phosphorus by Sub-watershed

1.5 Pollutant Control Program

Pollutant source control is integral to the success of any water resource protection or restoration program. Therefore, full implementation of a comprehensive source control program was included in all alternatives and is considered the foundation upon which the construction project is built. Source control programs in the St. Lucie River watershed are evolving and expanding through cooperative and complementary efforts by Florida Department of Environmental Protection, Florida Department of Agriculture and Consumer Service, and South Florida Water Management District. The St. Lucie River Watershed Pollutant Control Program is designed to be a multi-faceted approach to reducing pollutant loads that includes improving the management of pollutant sources within the watershed through implementation of regulations and best management practices, and development and implementation of improved best management practices focusing on nitrogen and phosphorus. The Pollutant Control Program includes agricultural best management practices implemented by Florida Department of Agriculture and Consumer Service, Florida Department of Environmental Protection pollutant source control programs, and South Florida Water Management District's regulatory source control programs, which are summarized below.

Florida Department of Agriculture and Consumer Service nutrient source control programs include Agricultural Best Management Practice Programs, the Animal Manure Application Rule, and the Urban Turf Fertilizer Rule. Florida Department of Agriculture and Consumer Service develops, adopts, and implements agricultural best management practices to reduce water quality impacts from agricultural discharges and enhance water conservation. The Animal Manure Application Rule was initiated in February 2008 to control the land application of animal wastes in the St. Lucie River watershed. The proposed rule includes minimum application setbacks from wetlands and all surface waters. The statewide Urban Turf Fertilizer Rule was adopted by Florida Department of Agriculture and Consumer Service in August 2007. The rule limits the phosphorus and nitrogen content in fertilizers for urban turf and lawns, thereby reducing the amount of phosphorus and nitrogen applied in urban areas and limiting the amount of those compounds reaching Florida's water resources.

Florida Department of Environmental Protection Pollutant Source Control Programs include initiatives to improve existing stormwater and wastewater infrastructure, implementation of pollutant reduction plans for municipal stormwater management systems, land development regulations to promote proper stormwater treatment, enhancement to existing regulations for the management of domestic wastewater residuals within the watershed, coordination with applicable authorities on septage disposal to ensure that nutrient loadings are considered, and administering the National Pollution Discharge Elimination System permit program.

South Florida Water Management District regulatory programs in the St. Lucie River watershed include the Environmental Resource Permit Program and the 40E-61 Regulatory Nutrient Source Control Program. In March 2008, the South Florida Water Management District initiated rule development for an Environmental Resource Permit basin rule with specific supplemental criteria designed to result in no increase in total runoff volume from new development that discharges ultimately to Lake Okeechobee and/or the Caloosahatchee or St. Lucie Estuaries. The 40E-61 regulatory source control program was adopted in 1989 as a result of the Lake Okeechobee Surface Water Improvement and Management Plan to provide a regulatory source

control program specifically for phosphorus. The Northern Everglades and Estuaries Protection Program legislation expanded the program boundary to the St. Lucie River watershed and to also include nitrogen. The program applies to new and existing activities with the goal of reducing nutrients in offsite discharges.

1.6 Research and Water Quality Monitoring Plan

The South Florida Water Management District developed the Research and Water Quality Monitoring Plan in cooperation with the coordinating agencies, local governments, and other stakeholders. The objective of the Research and Water Quality Monitoring Plan is to increase the ability to identify robust, scientifically based solutions to the water quality and water quantity issues in the St. Lucie Estuary and allow for more accurate predictions for responding to ecological changes. The recommended monitoring plan has been formulated to fulfill the goals and reporting requirements of the St. Lucie River Watershed Protection Plan and to support adaptive management. It builds upon the existing monitoring, research, and modeling efforts, and makes recommendations/modifications to these efforts to better achieve and assess the goals and targets of the St. Lucie River Watershed Protection Plan.

1.6.1 Monitoring

Existing monitoring in the St. Lucie River watershed includes water quality and flow monitoring. Monitoring efforts are also being undertaken within the St. Lucie Estuary including salinity monitoring and aquatic habitat monitoring (oysters and submerged aquatic vegetation (i.e. seagrasses). A brief description of these monitoring efforts is provided in the following subsections.

1.6.1.1 Watershed Monitoring

Flow Monitoring Program—The existing flow monitoring is conducted at major water control structures and along the major tributaries of the North Fork and South Fork basins. In general, existing program focuses on surface water flows from the western sub-watersheds and Lake Okeechobee.

Water Quality Monitoring Programs—Two programs, both conducted by the South Florida Water Management District, currently monitor water quality in the St. Lucie Estuary watershed. The Water Quality Monitoring Network monitors at major water control structures, while the St. Lucie Tributary Program monitors smaller tributaries.

1.6.1.2 Estuary Monitoring

Salinity Monitoring—The long-term tide and salinity monitoring network in the St. Lucie Estuary was established in 1997. All tide and salinity monitoring stations take water level, temperature and conductivity measurements at 15-minute intervals. The measurements of temperature and conductivity were taken at two depths to detect stratification in the water column.

Water Quality Monitoring—This program was established in 1990 to detect long-term spatial and temporal trends in the St. Lucie Estuary. Data were collected bi-weekly from July 1992 through December 1996 and monthly from January 1997 until present.

Bacteria Monitoring—Currently, the St. Lucie County and the Martin County Health Department monitor fecal coliform and Enterococci bacteria in the St. Lucie Estuary to protect human health. Port St. Lucie monitors 15 stations in the North Fork on a monthly basis, while Martin County monitors a station near SE03 on a weekly basis.

Seagrass Monitoring—Seagrass monitoring is performed semi-annually to collect long-term data to assist with determining the health of seagrass in the lagoon and monthly to collect short-term (five-year) data to help document seasonal changes and associated macro-algae.

Oyster Monitoring—A long-term monitoring program of Eastern oysters (*Crassostrea virginica*) was established in 2004 that emphasizes spatial and size distribution patterns of adult oysters, distribution and frequency patterns of oyster diseases, reproduction and recruitment, and juvenile oyster growth and survival. This effort includes mapping the existing distribution of oyster reefs and the mean density of living oysters on each oyster bed.

Assessment of existing monitoring efforts outlined above suggested that current monitoring programs are adequate in meeting objectives of the Preferred Plan. It is recommended that the existing flow, salinity, water quality, aquatic habitat, and bacteria monitoring programs continue. Three new water quality parameters are recommended to be added to the current suite. Recommendations also included optimization of the existing watershed network. In addition, the research and water quality monitoring plan recognizes that a District-sponsored source control monitoring program, to measure the success of the collective Source Control Program (South Florida Water Management District, Florida Department of Environmental Protection and Florida Department of Agriculture and Consumer Service) at the sub-watershed level, is under development and may refine the existing St. Lucie tributary monitoring program. At the sub-watershed level monitoring activities associated with the program will assess the collective success of pollutant source control best management practices, compliance with pollution reduction targets, and the need for additional best management practices or optimization of existing best management practices. At the local level, this monitoring will identify priority areas of water quality concern and provide data to enhance performance of downstream treatment facilities. This program also will provide data that can be used in adaptive management as well as modeling and tracking of progress towards Total Maximum Daily Loads.

1.6.2 Research

Research projects are intended to reduce or eliminate key uncertainties related to the Total Maximum Daily Load and flow and salinity envelopes, and optimize operational protocols. The three research projects in the Research and Water Quality Monitoring Plan are as follows:

Estuarine Nutrient Budget—This project will construct nutrient budgets of nitrogen and phosphorus for the St. Lucie Estuary. Results of this project can be used to support water quality modeling efforts, which will reduce uncertainties related to the Total Maximum Daily Load and increase the capability to predict effects of various management measures, including best management practices.

Dissolved Oxygen Dynamics—This project will identify the factors causing the dissolved oxygen impairment in the St. Lucie Estuary. Understanding of dissolved oxygen dynamics will also help to identify impacts from the pollutant loads to estuarine ecosystems. This

project supports the River Watershed Protection Plan goal of achieving the Total Maximum Daily Load for the St. Lucie Estuary and improving dissolved oxygen conditions in the St. Lucie Estuary.

Low Salinity Zone—This project examines the effects of freshwater discharges on the production of fish larvae and utilization of the low salinity zones in the North and South Forks of the St. Lucie Estuary as a nursery area. Results of this study will be used to refine the salinity envelope and to provide environmental guidelines for delivery of fresh water to the North and South Forks of the St. Lucie Estuary.

1.6.3 Modeling

Numerous models have been developed or are currently under development for use in the St. Lucie River watershed as summarized in **Table 1-3**. An assessment of existing models and their ability to meet future modeling needs was conducted and a set of modeling recommendations was developed.

Table 1-3. Summary of Models Used or in Development in the St. Lucie River Watershed

Watershed Water Quality and Hydrology	Estuary Water Quality and Hydrology	Estuarine Ecology
Watershed Hydrology and Water Quality Model (WaSH)	St. Lucie Estuary 2-D Hydrodynamic Model	Oyster Salinity Stress Model
Northern Everglades Regional Simulation Model (NERSM)	St. Lucie 3-D Hydrodynamic and Water Quality Model	
Reservoir Optimization Model (OPTI)		

An integrated modeling framework combining the resource-based Valued Ecosystem Component approach and linked watershed and estuarine models is proposed to meet water management objectives for coastal ecosystems protection and restoration (South Florida Water Management District, 2008). Specifically, the watershed model estimates the quantity, timing, and quality of freshwater inflow to the estuary. The estuarine hydrodynamic, sediment transport and water quality models, in turn, simulate the estuarine conditions in terms of salinity, water quality, and sediment transport. Finally, the ecological models simulate the responses of estuarine resources and processes to the estuarine conditions.

1.7 St. Lucie River Watershed Protection Plan Preferred Plan

The preferred St. Lucie River Watershed Protection Plan combines the preferred construction project, pollutant control program, and research and water quality monitoring program into a comprehensive restoration program that best meets the legislative goals. The two major goals of the Northern Everglades and Estuaries Protection Program legislation are to achieve nutrient load reductions consistent with adopted Total Maximum Daily Loads and to provide additional storage capacity in order to better manage Lake Okeechobee stages and to reduce the magnitude and frequency of harmful freshwater releases to the estuaries while meeting other water related needs.

The preferred St. Lucie River Watershed Protection Plan:

- Provides significant nutrient load reductions and decreases in damaging discharges to the estuary;
- Builds upon existing and planned programs and projects;
- Minimizes real estate acquisition requirements by promoting involvement of private landowners as partners in the restoration program (best management practices, Florida Ranchlands Environmental Services Project, alternative water storage projects) and emphasizing the use of state-owned lands; and
- Emphasizes cost-effective local features and includes select regional projects to complement and build upon those local features.

The Preferred Plan includes the Indian River Lagoon - South Final Integrated Project Implementation Report and Environmental Impact Statement projects, best management practices and regulatory programs, additional regional phosphorus treatment in the C-23/24 basin, and local water quality/quantity projects. In summary, the Preferred Plan provides approximately 200,000 acre-feet of storage per year from the Indian River Lagoon - South Final Integrated Project Implementation Report and Environmental Impact Statement projects, the Ten Mile Creek Reservoir/Stormwater Treatment Area, and Alternative Water Storage Facilities. It also provides a 55 percent reduction of total nitrogen and a 56 percent reduction of total phosphorus from current conditions. Total phosphorus and total nitrogen loading performance will be revisited once Florida Department of Environmental Protection adopts nutrient Total Maximum Daily Loads and provides specific loading rates, compliance locations, and compliance methodology. As required by the legislation, the Preferred Plan avoids impacts to other water-related needs of the region and actually improves water supply by reducing the frequency of irrigation demands not met and the frequency and volume of Lake Okeechobee Service Area cutbacks.

Benefits of the St. Lucie River Watershed Protection Plan include:

- Implementation of best management practices on 297,442 acres of agricultural lands;
- Implementation of best management practices on 83,861 acres of urban lands;
- Completing Environmental Resource Permit and 40E-61 Regulatory Nutrient Source Control Program rule revisions;
- Construction of approximately 11,800 acres of reservoirs and over 8,500 acres of Stormwater Treatment Areas;
- The potential for reducing total phosphorus and total nitrogen loads to the St. Lucie Estuary by 209 metric tons (55 percent) and 1,210 metric tons (56 percent), respectively;
- Restoring approximately 95,000 acres of wetlands and natural areas within the St. Lucie River watershed;
- Providing approximately 200,000 acre-feet of water storage within the St. Lucie River watershed; and

- Removing approximately 250,000 cubic yards of silty muck sediment from Manatee Pocket in the St. Lucie Estuary, thereby improving water quality.

The Preferred Plan will be implemented in multiple phases. Phase I includes projects that are currently initiated or will be initiated by 2012. Phase II projects includes projects that will be initiated between 2013 and2018. The Long Term Implementation Phase includes projects that will be initiated beyond 2018. Projects that are anticipated to be initiated or completed by 2012 are included in Phase I and are summarized **Table 1-4**.

Table 1-4. Phase I Projects

		Initiated	Completed
Construction Project	Alternative Water Storage Facilities- Indiantown Citrus Growers Association Phase I and II		√
	Florida Ranchlands and Environmental Services Projects (Alderman-Deloney complete)	√	√
	CERP-IRL South: C-44 Reservoir/STA	√	
	CERP-IRL South: Allapattah Complex- Natural Storage and Water Quality Area	√	
	Alternative Water Storage Facilities-Indiantown Citrus Growers Association- Phase III, Dupuis, Waste Management St Lucie Site, Caulkins	√	
	Hybrid Wetland Treatment Technology Pilot Project	√	
	Local-Stormwater Projects (e.g., retention/detention ponds, treatment wetlands, conveyance and structural improvements)	√	√
	Local-Wastewater Projects (e.g., sludge disposal management, sewage treatment and disposal systems)		√
	Local-Habitat Restoration (e.g., muck removal, oyster balls)	√	√
	Florida Ranchlands and Environmental Services Projects	√	
	Farm and Ranchland Protection Program Partnership	√	
Pollutant Control Program	Agricultural and Urban Best Management Practices	√	
	Revisions to Regulatory Programs (40E-61 Source Control Regulatory Program, Environmental Resource Permit Basin Rule, Statewide Stormwater Rule)		√
	Comprehensive Planning and Growth Management	√	
Research and Water Quality Monitoring	Monitoring, Research, and Modeling	√	√

Benefits of the SLRWPP Phase I include:

- On going implementation of BMPs on 297,442 acres of agricultural lands by 2015;
- On going implementation of BMPs on 83,861 acres of urban lands;
- Completing Environmental Resource Permit and 40E-61 Regulatory Nutrient Source Control Program rule revisions;
- Completing design and initiating construction of an approximately 3,400 acres reservoir and 4,000 acres of STA;
- Restoring 42,348 acres of wetlands and natural areas within the SLR Watershed
- Providing approximately 50,000 acre-feet of water storage within the SLR Watershed; and

- Removing approximately 250,000 cubic yards of silty muck sediment from Manatee Pocket in the SLR Estuary thereby improving water quality..

1.7.1 Costs

The Preferred Plan captures a wide array of projects and programs; therefore, a variety of implementation and funding strategies will be used to move the Preferred Plan projects forward. Many of these projects are already included in other planning or restoration efforts (e.g., Comprehensive Everglades Restoration Project). This plan assumes that those projects will continue to be implemented through the existing mechanisms or programs as originally intended.

In order to capture the most likely funding scenarios for these projects, several cost categories were identified (as described below). It is recognized that there may be other alternative funding strategies for these projects in addition to those found below. Furthermore, as required by section 373.4595(4), F.S., the coordinating agencies will maximize opportunities for federal and local government cost-sharing programs and opportunities for partnerships with the private sector and local government.

<u>Comprehensive Everglades Restoration Project Costs</u>

- Eligible for up to a 50 percent cost share with the federal government, which may also include local cost share

<u>Non-Comprehensive Everglades Restoration Project Costs</u>

- Paid from state, South Florida Water Management District, and/or local sources

<u>Local Costs</u>

- Costs that will be covered entirely by local government or may be cost shared with local government and state or South Florida Water Management District sources. Five million dollars for the St. Lucie River watershed per year was used for Phase I estimates (covers local projects and Alternative Water Storage Facilities).

To provide a source of state funding for the continued restoration of the South Florida ecosystem, the 2007 Florida Legislature expanded the use of the Save Our Everglades Trust Fund to include Northern Everglades restoration and extended the State of Florida's commitment to Everglades restoration through the year 2020.

Cost estimates with assumptions are provided in **Table 1-5**.

Table 1-5. Comprehensive Everglades Restoration Project, Non-Comprehensive Everglades Restoration Project, and Local Project Cost Estimates.

		CERP	Non-CERP	Local
Construction Project		$504-694 million		$15 million [1/]
Pollutant Control Program	Agricultural		$1.64-2 million [2/]	
	Urban		$393-479 million [3/]	
Research and Water Quality Monitoring			$2.7 million [4/]	

CERP = Comprehensive Everglades Restoration Project

1/ $15 million reflects state's contribution

2/ Assumes 50 percent state contribution for capital costs only; all best management practices implemented by 2015

3/ Includes total capital costs

- No cost share assumptions included, but most costs will be borne by local and state programs and only a fraction of these costs will likely be borne by River Watershed Protection Plan Program
- No phasing assumptions included

4/ Reflects additional monitoring not ongoing monitoring

1.7.2 Plan Refinements and Revisions

The Preferred Plan provides a framework and road map for progressive water quality and quantity improvements to benefit the lake and downstream estuaries. Throughout implementation, it is fully expected that hydrologic and water quality conditions in the watershed will continue to change as land uses in the watershed are modified, and as restoration projects become operational. Performance will be periodically assessed and revisions made as necessary. In addition, the legislation requires annual reports and protection plan updates every 3 years.

Portions of this plan have already been implemented or are in the process of being implemented. More detailed planning and design of other features will begin in 2009 and continue throughout the plan implementation stages. During implementation, the hydrologic and water quality conditions in the St. Lucie River watershed will continue to change as land use changes and individual projects affecting the quality and quantity of water become operational. It is therefore important to have a procedure in place to:

- Provide a process for more detailed planning and design to project implementation;
- Monitor plan performance adequately and appropriately over time;
- Ensure revisions to the plan are made periodically, as necessary, based on evaluation of monitoring data; and
- Progress towards plan goals and objectives is reported to the Legislature, regulatory agencies, and the public on a regular basis.

It is anticipated that this procedure will be borne out through Process Development and Engineering. The recommendations for Process Development and Engineering include model refinement, technology refinement, innovative nutrient control technology, and sub-watershed conceptual planning. Progress of refinements will be made and documented through annual progress reports and the required 3-year plan updates.

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CHAPTER 2

INTRODUCTION

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2.0 INTRODUCTION

The St. Lucie River Watershed Protection Plan (SLRWPP) has been developed in response to the recent state legislation, which authorized the Northern Everglades and Estuaries Protection Program (NEEPP) [Section 373.4595, Florida Statutes (F.S.)]. NEEPP is an expansion of the Lake Okeechobee Protection Act (LOPA) and strengthens protection for the Northern Everglades. It was developed in response to legislative findings that the Lake Okeechobee, Caloosatchee River, and St. Lucie River watersheds are critical water resources of the state that have been and are continuing to be adversely affected from changes to hydrology and water quality. The NEEPP covers the Lake Okeechobee watershed and the watersheds of the St. Lucie and Caloosahatchee Estuaries. The primary intent of the NEEPP is:

"to protect and restore surface water resources and achieve and maintain compliance with water quality standards in the Lake Okeechobee Watershed, the Caloosahatchee River Watershed, and the St. Lucie River Watershed, and downstream receiving waters, through the phased comprehensive, and innovative protection program set forth in this section which includes long-term solutions based upon the total maximum daily loads established in accordance with s.403.067" [373.4595(1)(l), F.S.]."

Two programs are established under the NEEPP legislation: (1). the Lake Okeechobee Protection Program, and (2) the River Watershed Protection Program. Under these programs, the NEEPP legislation requires development of watershed protection plans for the three Northern Everglades watersheds: (1) the St. Lucie River watershed; (2) the Caloosahatchee River watershed; and (3) the Lake Okeechobee watershed. The Lake Okeechobee Watershed Protection Plan (LOWPP), also known as the Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan (LOP2TP), was completed in February of 2008 and can be found at: www.sfwmd.gov/northerneverglades. The three main components of the watershed protection plans required under the legislation include: (1) a construction project; (2) a pollutant control program, and (3) a research and water quality monitoring program. This document represents the SLRWPP. The Construction Project is provided in Chapter 6 of this document, the St. Lucie River Watershed Pollutant Control Program is included as Chapter 7 of this document, and the St. Lucie Research and Water Quality Monitoring Program (SLRWQMP) is attached as Appendix E and summarized in Chapter 8 of this document. Chapter 9 of this document represents the Preferred Plan of the SLRWPP. Chapter 10 contains literature cited throughout the document.

The coordinating agencies include the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (FDEP), and the Florida Department of Agriculture and Consumer Services (FDACS). In cooperation with Martin, St. Lucie, and Lee Counties and affected municipalities, the coordinating agencies developed the SLRWPP and Caloosahatchee River Watershed Protection Plan (CRWPP) throughout late 2007 and 2008, and were required to submit them to the Florida Legislature for ratification by January 1, 2009.

The SLRWPP recommendations included in this document are based on best available information to date. All recommendations are subject to modification as additional data and understanding of the dynamics of the watershed are developed. This approach will allow for

maximum flexibility for implementing proposed and additional management measures through the Process Development and Engineering (PD&E) component of this plan, which provides a roadmap for further refinement of the design of individual plan components and identifies additional measures that, if implemented, will increase certainty of meeting the overall plan objectives. These management measures are intended to achieve the Total Maximum Daily Load (TMDL), salinity envelope, flow regimes, and related restoration goals for the St. Lucie Estuary and watershed. Implementation of these projects is subject to availability of real estate, formation of local and state partnerships, and the potential for meeting multiple State and District water management, water quality, and water supply objectives.

The programs and recommendations described in this plan reflect collective efforts of a working team representing federal, state, regional, and local public and private stakeholders. Consistent with the aforementioned recommendations, the programs and approach described in this plan are based on current data, best available information to date, and best professional judgment. Actual program performance and effectiveness may vary from original goals and performance targets.

2.1 Northern Everglades and Estuaries Protection Program

The Florida legislature established the NEEPP in 2007 (see **Figure 2-1**). It is an expansion of the LOPA in Section 373.4595, F.S., and strengthens protection for the Northern Everglades by incorporating the Caloosahatchee River and St. Lucie River watersheds into NEEPP. It also recognizes the importance and connectivity of the entire Everglades ecosystem. Implementation of this program will include improving the quality, quantity, timing, and distribution of water to the natural system.

The legislative mandate for the NEEPP (Section 373.4595, F.S.) establishes three watershed protection programs: (1) the Lake Okeechobee Watershed Protection Program, (2) the St. Lucie River Watershed Protection Program, and (3) the Caloosahatchee River Watershed Protection Program. Under each of these three watershed protection programs, a specific watershed protection plan is required. Details of these plans are discussed in the following subsections.

2.1.1 Lake Okeechobee Watershed Protection Plan

In 2000, the legislature passed the LOPA, Section 373.4595, F.S. (2000), which established a restoration and protection program for the lake. The intent of the original legislation was to achieve and maintain compliance with State water quality standards in Lake Okeechobee and its tributary waters through a watershed-based, phased, comprehensive and innovative protection program designed to reduce phosphorus (P) loads. This program would implement long-term solutions based upon the Lake's TMDL for P. The LOWPP is required under the Lake Okeechobee Watershed Protection Program and includes two phases: Phase I was developed under the original LOPA and Phase II was developed under the NEEPP.

2.1.1.1 Lake Okeechobee Watershed Protection Plan Phase I

Phase I of the LOWPP was intended to bring some immediate total phosphorus (TP) load reduction to Lake Okeechobee. The project features are designed to improve hydrology and water quality of Lake Okeechobee and downstream receiving waters, consistent with recommendations included in the South Florida Ecosystem Working Group's Lake Okeechobee

Action Plan. Section 528(b)(3) of the Water Resources Development Act (WRDA) of 1996 authorized the identification of critical restoration projects for the South Florida ecosystem. Phase I of the LOWPP included a critical restoration project, which was identified as the Lake Okeechobee Water Retention Phosphorus Removal Critical Project. LOWPP Phase I was delivered to the legislature in 2004 and an update was submitted in February 2007.

2.1.1.2 Lake Okeechobee Watershed Protection Plan Phase II Technical Plan

Phase II of the LOWPP identifies construction projects, along with on-site measures that prevent or reduce pollution at its source such as agricultural and urban best management practices (BMPs), needed to achieve water quality targets for Lake Okeechobee. In addition, it includes other projects for increasing water storage north of Lake Okeechobee to achieve healthier lake levels and reduce harmful discharges to the Caloosahatchee and St. Lucie Estuaries. Phase II was submitted to the legislature in February of 2008.

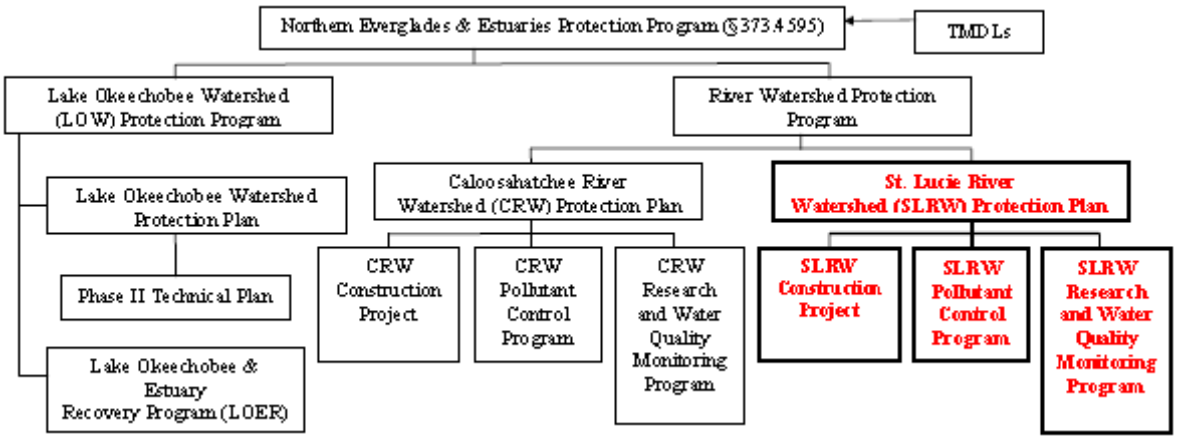

Figure 2-1. Northern Everglades and Estuaries Protection Program Legislative Mandates

2.1.2 St. Lucie River Watershed Protection Plan

The SLRWPP is required by the NEEPP. This document is to be updated every 3 years. As such, the recommendations included in the SLRWPP are based on best available information to date and are subject to modification as additional data and understanding of the dynamics of the St. Lucie River watershed and Lake Okeechobee develop. This will allow maximum flexibility to embrace new technologies, processes and procedures.

The SLRWPP identifies the geographic extent of the watershed and was coordinated as needed with the LOWPP and CRWPP. It provides an implementation schedule for pollutant load reductions consistent with any adopted TMDLs and compliance with applicable water quality standards. The SLRWPP includes three main components: (1) a construction project; (2) a pollutant control program, and (3) a research and water quality monitoring program.

2.1.2.1 Construction Project

The purpose of the SLRWPP Construction Project is to: (1) identify potential water quality and quantity projects within the St. Lucie River watershed and Estuary, (2) formulate alternatives based on the projects identified, and (3) identify a preferred alternative that results in the most benefit to the St. Lucie Estuary. The SLRWPP also identifies available funding sources to implement the projects. To ensure timely implementation, the coordinating agencies will coordinate design, scheduling, and sequencing of project facilities with Martin County, St. Lucie County, and other interested stakeholders and affected local governments.

2.1.2.2 Pollutant Control Program

The St. Lucie River Watershed Pollutant Control Program is designed to be a multi-faceted approach to reducing pollutant loads by improving the management of pollutant sources within the St. Lucie River watershed through: (1) the implementation of regulations; (2) the development and implementation of BMPs; (3) the improvement and restoration of hydrologic function of natural and managed systems; and 4) the utilization of alternative technologies for pollutant reduction, such as cost-effective biologically based, hybrid wetland/chemical and other innovative nutrient control technologies. The coordinating agencies will facilitate the utilization of federal, state and local programs that offer opportunities for water quality treatment, including preservation, restoration, or creation of wetlands on agricultural lands. The Pollutant Control Program is discussed in more detail in Section 7 of this document.

2.1.2.3 Research and Water Quality Monitoring Program

The Research and Water Quality Monitoring Program (RWQMP) will build upon the District's existing research program and is intended to carry out, comply with, or assess the plans, programs, and other responsibilities created by this program. The program will also conduct an assessment of the water volumes and timing from the Lake Okeechobee and St. Lucie River watersheds and their relative contributions to the estuary. The RWQMP is discussed in more detail in Section 8 of this document.

2.1.3 Caloosahatchee River Watershed Protection Plan

The CRWPP was developed under the Caloosahatchee River Watershed Protection Program and in concurrence with the SLRWPP and will also be submitted to the Florida legislature no later than January 1, 2009. The CRWPP comprises the same three components as the SLRWPP: (1) a construction project, (2) a pollutant control program, and (3) a research and water quality monitoring program.

2.2 Purpose and Scope

The purpose of the SLRWPP is to provide an overall strategy for improving quality, quantity, timing, and distribution of water in the St. Lucie Estuary and to re-establish salinity regimes

suitable for the maintenance of healthy, naturally diverse, and well-balanced estuarine ecosystem. The SLRWPP is intended to achieve the following three objectives:

- Minimize the frequency and duration of harmful excess freshwater discharges from the St. Lucie River watershed;
- Maintain minimum flows to the St. Lucie Estuary to prevent undesirable high salinity conditions (Chamberlain and Hayward 1996); and
- Maximize nitrogen (N) and P load reductions to meet TMDLs as they are established for the St. Lucie Estuary.

2.3 Background

The St. Lucie Estuary is located in southeast Florida, in Martin and St. Lucie Counties, and is a major tributary to the Southern Indian River Lagoon. The St. Lucie Estuary is divided into four distinct regions as follows: the North Fork, the South Fork, the middle estuary, and the lower estuary. The North and South Forks are relatively shallow waterbodies that transport fresh water into the middle estuary. The Old South Fork is now part of the Okeechobee Waterway, which was constructed during the 1920s to provide a connection to Lake Okeechobee. The middle estuary is the area between the river forks and is the interface between freshwater and saltwater input. The lower estuary is closest to the inlet and is predominantly salt water, depending on the tides.

The St. Lucie River watershed includes much of Martin and St. Lucie Counties, and a small portion of Okeechobee County at the northwest corner. It encompasses a drainage area of more than 600,000 acres [937 square miles (mi^2) or 2,428 square kilometers (km^2)] and includes areas that drain naturally or are pumped, and the major canals that discharge into the St. Lucie Estuary (C-44, C-23, and C-24).

2.3.1 Historical Conditions

Historical drainage patterns within the St. Lucie River watershed have been highly altered since pre-drainage times. **Figure 2-2** shows the extent of altered flows and wetland loss in the Everglades system, including the St. Lucie River watershed. Continued population growth increased the demands for more land, better flood protection, and consistent water supply. Flood control measures were taken to protect residents by constructing the Herbert Hoover Dike around Lake Okeechobee, as well as ditching and draining to create residential land, cities and agricultural fields.

A high-density drainage conveyance system was created that allowed runoff from the St. Lucie River watershed to enter the major drainage canals (C-44, C-23, C-34 and C-25), which discharge into the St. Lucie Estuary. In the 1920s, a canal (C-44 or St. Lucie Canal) was dredged connecting Lake Okeechobee to the South Fork of the St. Lucie River. This provided a navigable connection between the east and west coasts of Florida and also made the St. Lucie Estuary one of the major outlets for water draining from the Upper Kissimmee and Lake Okeechobee Basins. The St. Lucie Estuary has received discharges from Lake Okeechobee since the completion of the St. Lucie Canal (C-44) in 1924. Also, as part of the drainage effort in the 1930s-1950, the C-23, C-24, and C-25 Canals were constructed. The C-23 drains into the St.

Lucie Estuary at the confluence of the North and South Forks, the C-24 drains into the North Fork, and the C-25 drains into the Indian River Lagoon (IRL). These major hydrologic modifications allowed runoff to quickly exit the St. Lucie River watershed and discharge into the St. Lucie Estuary. Water from the St. Lucie River watershed was no longer detained, evaporated, cleansed, and attenuated in natural wetlands.

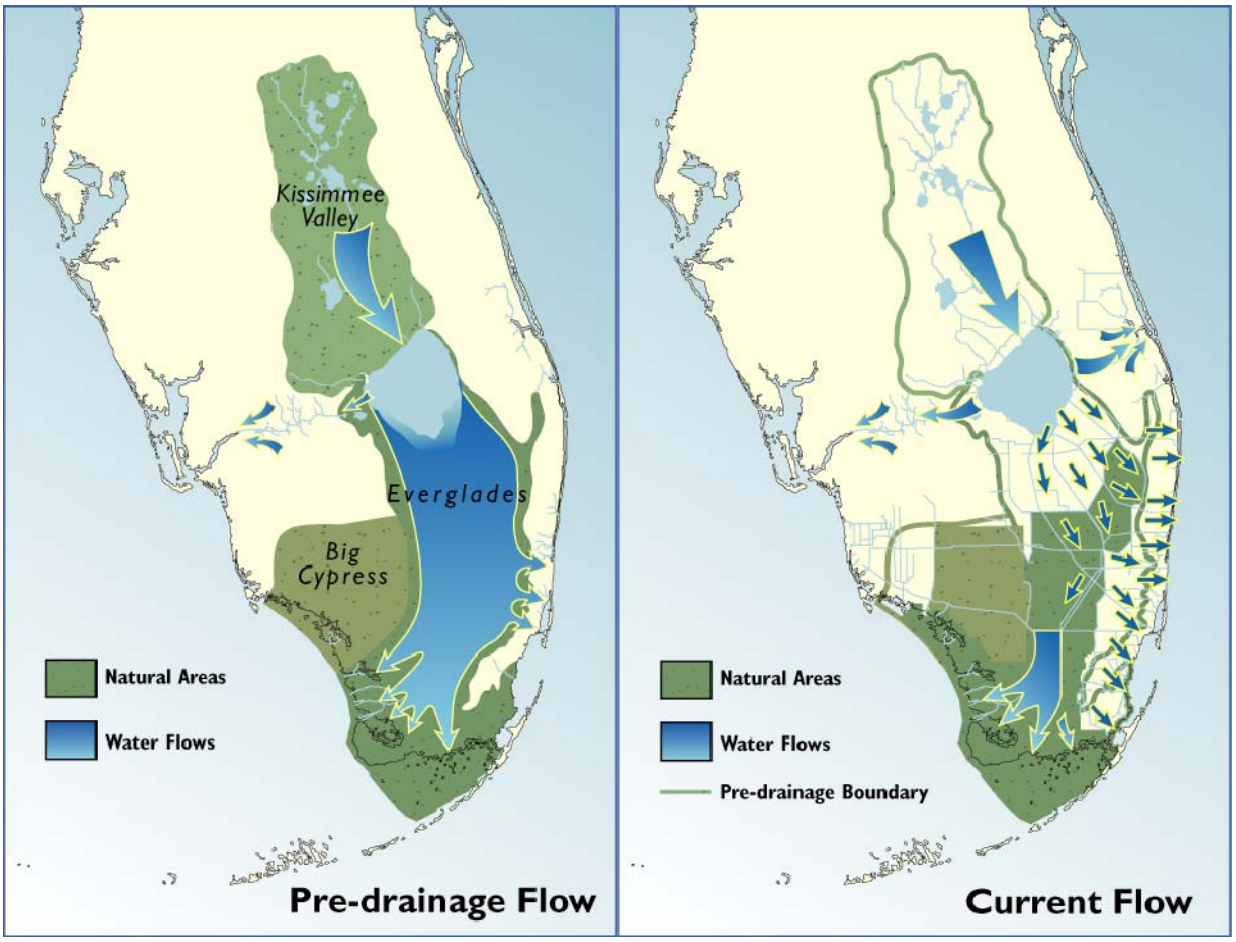

Figure 2-2. Historical vs. Current Everglades Flows

The St. Lucie River watershed drains into the St. Lucie Estuary, which is located east of Lake Okeechobee. Until the late-1800s, the St. Lucie Estuary was a freshwater river that flowed into the IRL, which did not have a permanent connection to the Atlantic Ocean. In 1892, increases in water and transportation demands lead to the creation of a permanent inlet that connected the St. Lucie River and the IRL to the Atlantic Ocean. The inlet, known today as the St. Lucie Inlet, changed the eastern portion of this river network from a freshwater river to a brackish water estuary [U.S. Army Corps of Engineers (USACE) and SFWMD, 2004, p. 2-5, A-21].

2.3.2 Current Conditions

Despite the aforementioned drainage modifications, the St Lucie Estuary is a highly diverse system with a mosaic of habitats including open water, submerged aquatic vegetation, oyster

beds, mangroves, and tidal mud flats. It offers many benefits to the local communities, the local economy, and nature including tourism, recreational and commercial fishing, flood protection, habitat for nesting and foraging wading birds and prey birds including the endangered wood stork (*Mycteria Americana*), juvenile fish habitat essential to commercial fish species, and habitat for the endangered West Indian manatee (*Trichechus manatus*). However, the system's health and benefits are being compromised today.

Three major watershed influences have been identified as affecting the estuary's ecological health: (1) excessive nutrient loading mainly from urban runoff, fertilizers, agricultural operations, and septic systems; (2) freshwater discharges from the St. Lucie River watershed and Lake Okeechobee resulting in undesirable low salinity conditions in the St. Lucie Estuary (Chamberlain and Hayward, 1996); and (3) undesirable low flows to the St. Lucie Estuary resulting in high salinity conditions in the St. Lucie Estuary. These influences have resulted in physical changes to the estuary including changes in salinity and dissolved oxygen content, increased turbidity, and nitrification. Loss of natural habitat from riverfront and coastal development, increased urban development, construction of drainage canals, and agricultural activities have affected the timing, quantity, quality, and distribution of runoff to the estuary. Wet season flows have increased from increased runoff due to land clearing and impervious areas, and dry season flows have decreased due to increased water supply demand for agricultural and urban development (USACE and SFWMD, 2004, p. 3-20).

The resulting biological impacts include habitat loss and degradation, decreased biodiversity, and increased prevalence of marine resource diseases. For example, an increased frequency of algal blooms that deplete oxygen in the water, suffocating fish and plant life, have occurred as a result of increased nutrients. In addition, two key indicator species of estuary health, oysters and aquatic vegetation, have declined in the St. Lucie Estuary. Natural resource specialists agree that the system will continue to decline under the current conditions (USACE, 1999, p. 5-3).

2.4 Study Area

The study area encompasses the St. Lucie Estuary and its watershed, which are shown on **Figure 2-3**. The following subsections provide basic physical characteristics of the estuary and watershed as it exists today.

Land-use types are one of the physical characteristics of the study area discussed. The District uses the Florida Land Use, Cover, and Forms Classification System (FLUCCS) to define land-use types. In the following discussions, it should be noted that natural areas include upland forests, wetlands, barren lands, and open lands. In addition, urban areas includes low, medium, and high density residential, commercial and services, industrial, extractive, institutional, and recreational land-use descriptions.

2.4.1 St. Lucie Estuary

The St. Lucie Estuary is located in southeast Florida, in Martin and St. Lucie Counties, and is a major tributary to the Southern IRL. As previously stated, the St. Lucie Estuary waterbody is divided into four distinct regions as follows: the North Fork and South Fork; the middle estuary, and the lower estuary. The North and South Forks are relatively shallow waterbodies that

transport fresh water into the mid-estuary. The South Fork is now part of the Okeechobee Waterway, which was constructed during the 1920s to provide a connection to Lake Okeechobee. The middle estuary is the area between the river forks and is the mixing zone between fresh and salt water. The lower estuary is the area closest to the St. Lucie Inlet and is predominantly salt water depending on the tides.

As previously discussed in Section 2.1.2, development within the St. Lucie River watershed has altered wet season and dry season water flows to the St. Lucie Estuary and resulted in impacts to the estuary including habitat loss, decreased biodiversity, and increased prevalence of marine resource diseases.

2.4.2 St. Lucie River Watershed

The St. Lucie River watershed includes much of Martin and St. Lucie Counties, and a small portion of Okeechobee County at the northwest corner. It encompasses a drainage area of more than 600,000 acres (937 mi^2 or 2,428 km^2) and includes areas that drain naturally or are pumped, and the major canals that discharge into the St. Lucie Estuary (C-44, C-23, and C-24). A map of land use types, based on the FLUCCS, for the St. Lucie River watershed is shown in **Figure 2-4.** The single largest land use is agricultural citrus, which encompasses 22.6 percent (116,442 acres) of the total watershed. Improved pastures are second, accounting for 20.7 percent of the watershed (106,321 acres), and wetland natural areas are third, accounting for 11.9 percent (61,052 acres). Urban areas are typical of the eastern reaches of the watershed and account for 16.3 percent of the total area (83,861 acres).

Drainage basins within the St. Lucie River watershed are defined by typography and empty into a specific tributary or canal that connects to the St. Lucie Estuary. Basin names typically coincide with the major drainage conveyance within the basin. For example, the C-44 Canal is the major drainage conveyance canal within the C-44 Basin. The St. Lucie River watershed contains sub-watersheds that may consist of one or more basin. The sub-watersheds include the South Fork/Tidal St. Lucie; C-44 and S-153; 4-5-6; C-23; C-24; North Fork, South Coastal, C-25, C-25 East, and sub-watershed 1.

2.4.2.1 4-5-6 Sub-Watershed

The 4-5-6 sub-watershed comprises Basins 4, 5, and 6, which have a total drainage area of approximately 15,055 acres (23.5 mi^2). Basins 4, 5, and 6 are located in northeast Martin County. The predominant land use is residential development (5,552 acres), followed by natural areas (4,052 acres) and pastures (1,468 acres).

The C-23 Canal flows along the northeastern border of Basin 4, before draining into the St. Lucie Estuary. Basin 4 also includes the Bessey Creek and Hidden River tributaries, which flow into Basin 5 during periods of high tide. Basins 4 & 5 are commonly referred to as the Bessey Creek or Hidden River Basins. Basin 6 includes the Danforth Creek Tributary and is otherwise known as the Danforth Creek Basin. The only control structure within Basins 4, 5, and 6 is the S-48 structure (fixed crest weir that controls surface water elevations to prevent saltwater intrusion into local groundwater). The C-23 Canal and S-48 supply water to Basins 4, 5, and 6, remove excess water from the C-23 Basin, and prevent saltwater intrusion into groundwater.

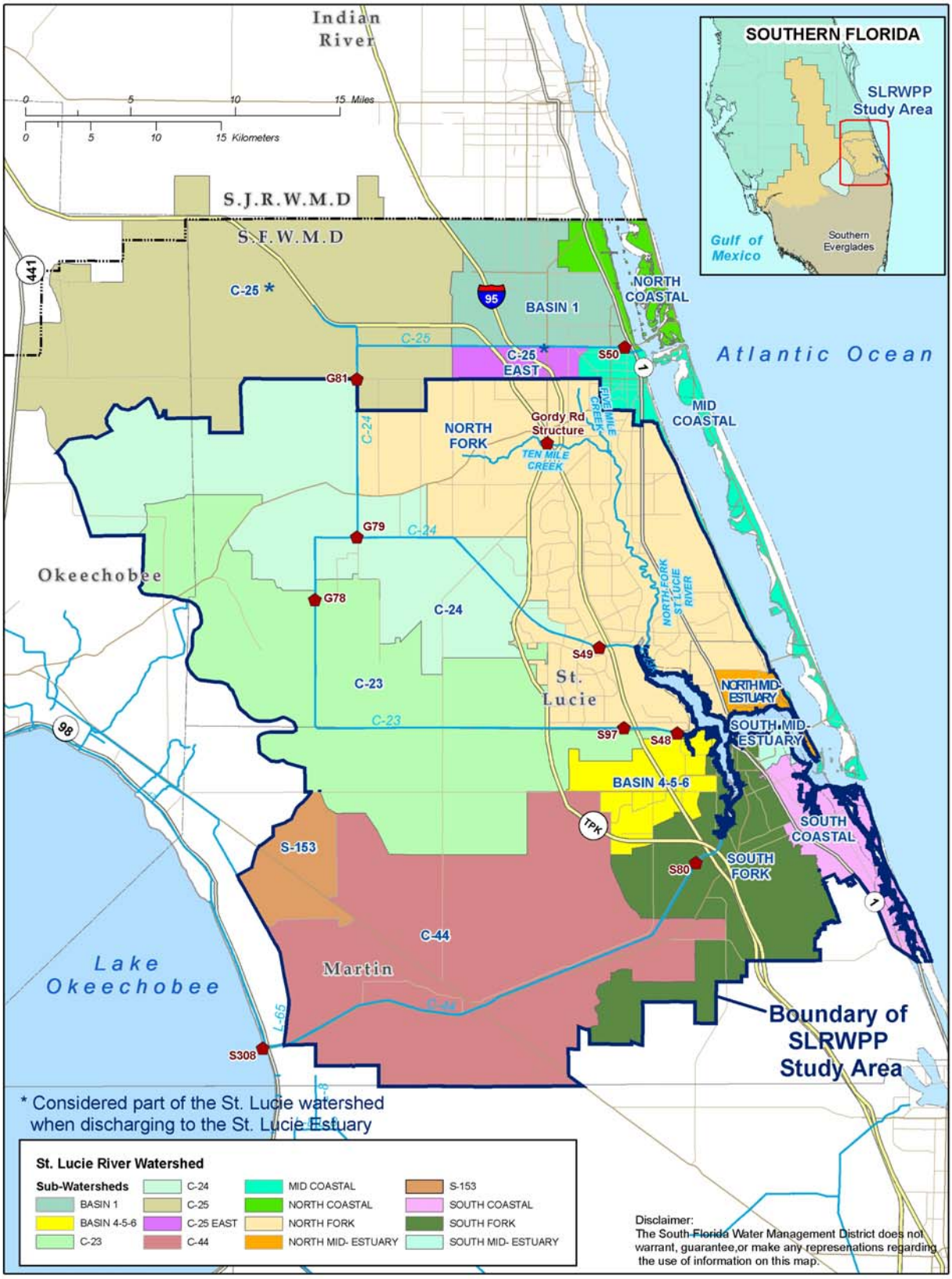

Figure 2-3. St. Lucie River Watershed and Sub-Watershed Boundary Map

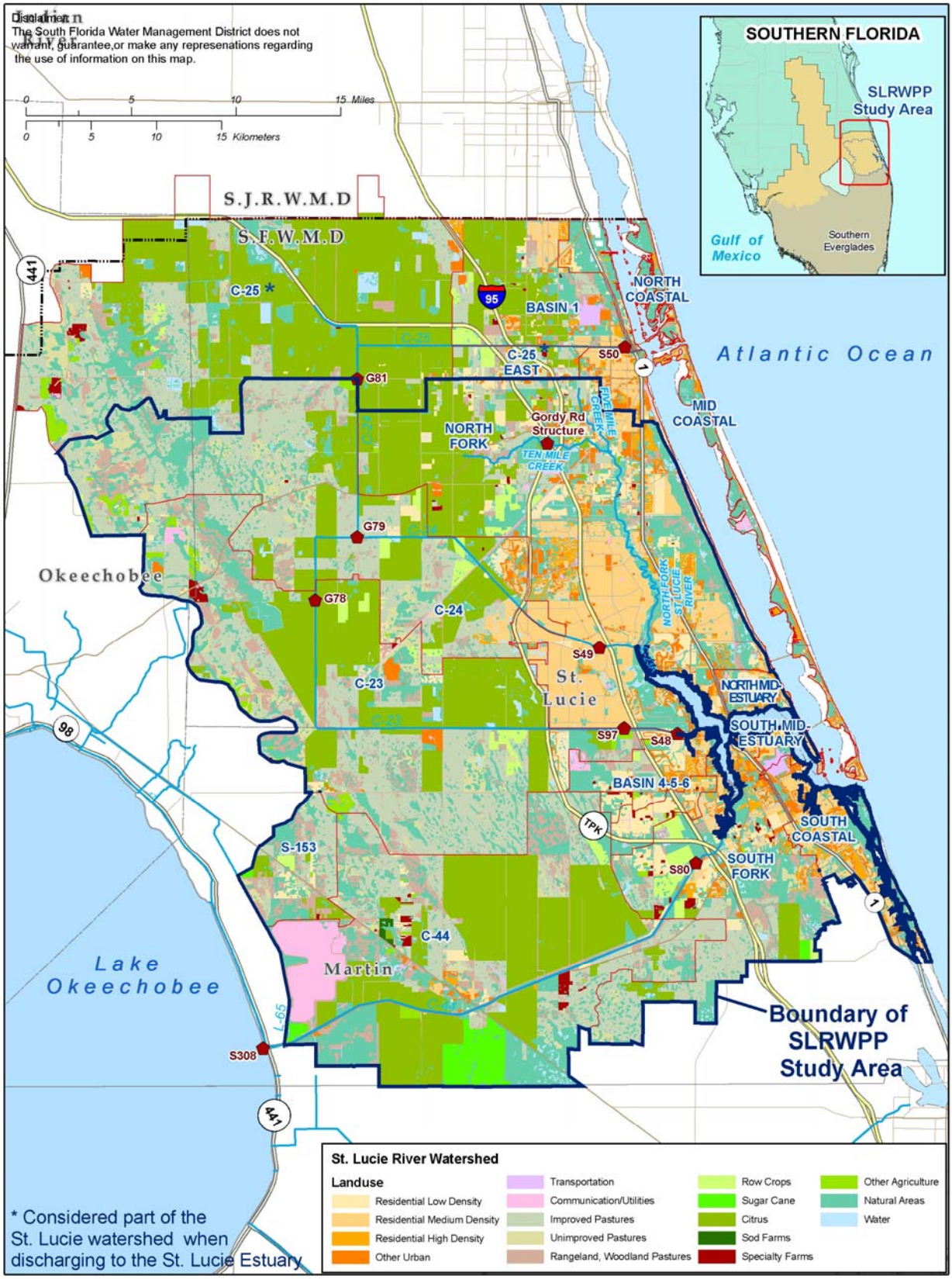

Figure 2-4. Land Use in the St. Lucie River Watershed.

2.4.2.2 South Fork Sub-Watershed

The South Fork sub-watershed (otherwise known as Tidal St. Lucie) includes the South Fork and South Mid-Estuary Basins and has a total drainage area of approximately 49,965 acres (78.1 mi^2). It is located in northeastern Martin County and is east of the C-44 Basin. The South Fork sub-watershed includes the South Fork of the St. Lucie from south of the Roosevelt Bridge, including the City of Stuart, to a portion of the area to the southwest and upstream of the S-80 control structure. Major land uses include natural areas (14,541 acres), pastures (14,410 acres), and urban areas (11,479 acres).

The C-44, a continuation of the C-44 Canal, is the only major drainage canal in the Tidal St. Lucie/South Fork sub-watershed. There are also eight sub-basin tributaries within the South Fork sub-watershed. The only control structure regulating flow in the South Fork Basin is S-80 (a gated spillway operated to restrict upstream and downstream stages and channel velocities to non-damaging levels). The main functions of the C-44 Canal and S-80 are to: (1) accept flows from the C-44 in order to discharge to tidewater by way of the South Fork of the St. Lucie River, (2) to provide a navigable waterway from S-80 to the Intracoastal Waterway, (3) to provide drainage from portions of the South Fork Basin, and (4) to maintain groundwater elevations sufficient to prevent saltwater intrusion. Water can flow northeast along the C-44 Canal, discharging into the South Fork of the St. Lucie River southeast of the City of Stuart, or can flow west to Lake Okeechobee depending on the Lake and canal stages. No lands in the sub-watershed drain to the C-44 upstream of S-80 (SFWMD, 1988a).

2.4.2.3 C-24 Sub-Watershed

The C-24 sub-watershed comprises the C-24 Basin, which has a total drainage area of approximately 87,706 acres (137 mi^2). The majority of the C-24 Basin is located in southwest St. Lucie County, with a small section encroaching into eastern Okeechobee County. Major land uses include pastures (46,904 acres), citrus farms (17,488 acres), and natural areas (13,885 acres).

The major drainage canals in the C-24 Basin include the C-24 Canal and a portion of the C-23 Canal to the south. There are four control structures that regulate flow in the C-24 Basin: S-49 (a gated spillway that controls water surface elevations in C-24 and controls discharges from C-24 to tidewater), G-78 (a gated culvert southwest of the confluence of C-23 and C-24), G-79 (a culvert in the alignment of C-23 at the intersection of C-23 and C-24 that controls flows east and west), and G-81 (a steel sheet-pile dam with a gated weir that functions as a divide between the C-24 and C-25 Basins). The main functions of the canals and control structures in the C-24 Basin include removing excess water from the Basin, supplying water to the Basin, and maintaining a groundwater table elevation west of S-49 to prevent saltwater intrusion into local groundwater. Water in the C-24 Canal can flow north to G-81, where it converges with the C-25 and flows east, or it can flow south to G-79 where it can either continue east and discharge into the North Fork of the St. Lucie River, or flow west and then south to the C-23 Canal (SFWMD, 1988b; USACE and SFWMD, 2004).

2.4.2.4 C-23 Sub-Watershed

The C-23 sub-watershed comprises the C-23 Basin, which has a total drainage area of approximately 112,675 acres (176 mi^2). A majority of the C-23 Basin is located in southwest St. Lucie County and northern Martin County, with a small section encroaching into eastern Okeechobee County. Major land uses include pastures (47,387 acres), agricultural citrus (32,466 acres), and natural areas (20,121 acres).

The C-23 Canal is the main drainage canal in the C-23 Basin. Water flows north to south from the C-24 down to the Martin-St. Lucie County line and heads east discharging into the North Fork of the St. Lucie River. There are three project control structures controlling flow in the C-23 Basin: S-48 (a fixed crest weir located at the outlet of C-23 to the North Fork), S-97 (a gated spillway located at the Florida Turnpike's crossing of C-23), and G-78 (a culvert located 3.6 miles southwest of where C-23 joins C-24). The main functions of the canal and control structures in the C-23 Basin include removing excess water from the Basin, supplying water to the C-23 and occasionally to the C-24 Basins under low-flow conditions, and maintaining a groundwater table elevation west of S-48 adequate to prevent saltwater intrusion into local groundwater. Water in the north-south leg of the C-23 Canal may occasionally be diverted north into the C-24 Basin for water supply and flood protection purposes (SFWMD, 1988a).

2.4.2.5 North Fork Sub-Watershed

The North Fork sub-watershed comprises of the North Fork and North Mid-Estuary Basins, and has a total drainage area of approximately 119,168 acres (186.2 mi^2). It is located in eastern St. Lucie County and northeastern Martin County. Major land uses include urban areas (53,656 acres), natural areas (25,043 acres), and citrus farms (20,678 acres).

The C-23A is a short section of canal in the lower reach of the North Fork of the St. Lucie River that passes discharges from the North Fork and C-24 to the St. Lucie Estuary. Additionally, a short reach of the C-24 Canal extends from one mile west of Florida's Turnpike to the North Fork of the St. Lucie River. There are also 15 sub-basin tributaries within the North Fork Basin. The only control structure regulating flow in the North Fork is S-49 (a gated spillway that controls surface water elevations in C-24 and discharges from C-24 to the North Fork of the St. Lucie River). The short reach of the C-24 Canal that is located in the North Fork Basin has no control structures and is tidally influenced. These canals, along with the S-49 control structure, regulate water levels in the North Fork Basin and also the C-24 Basin (SFWMD, 1988b).

There are fifteen sub-basin tributaries within the North Fork Sub-watershed: Winters Creek, Howard Creek, Elkcam Waterway, Five Mile Creek, Ten Mile Creek (Gordy Road Structure), Britt Creek, PSL Ditches 1-6, C-105, C-106, C-107, C-108 and Hog Pen Ditch. The Ten Mile Creek is the largest sub-basin tributary delivering water to the North Fork of the St. Lucie River. Water releases are regulated through the Gordy Road structure which is controlled by the North St. Lucie Water Control District.

2.4.2.6 C-44 and S-153 Sub-Watershed

The C-44 and S-153 sub-watershed comprises the C-44 and S-153 Basins. It is located in the south-central portion of Martin County and has a total drainage area of approximately 129,719

acres (202.7 mi^2). Land-use types in this sub-watershed are mostly characterized by citrus farms (42,755 acres), pastures (38,810 acres), and natural areas (27,738 acres).

2.4.2.6.1 C-44 Basin

The C-44 Basin has a drainage area of approximately 116,622 acres (182.2 mi^2). The primary conveyance that serves this basin is the C-44 Canal (also known as the St. Lucie Canal) that connects Lake Okeechobee to the South Fork of the St. Lucie River. There are two control structures located in the C-44 Canal: the S-80 gated spillway (also known as the St. Lucie Lock and Spillway) and the S-308 gated spillway (also known as the Port Mayaca Lock and Spillway). The operational goals of this system are to remove excess waters from the C-44 Basin, supply surface water to the C-44 Basin when needed, and maintain groundwater elevations sufficient to prevent saltwater intrusion. The C-44 is also an integral part of the Okeechobee Waterway Navigational Project and, along with the Caloosahatchee River, provides a primary outlet from Lake Okeechobee for flood control. Water surface elevations in the C-44 Basin are regulated by S-80, and regulatory releases from Lake Okeechobee are made by way of S-308 (SFWMD, 1988a; USACE and SFWMD, 2004).

2.4.2.6.2 S-153 Basin

The S-153 Basin alone has a drainage area of approximately 13,097 acres (20.5 mi^2). The L-65 Borrow Canal within the S-153 Basin is part of a continuous borrow canal along the east side of L-64 and L-65 that parallels the Florida East Coast Railway from C-44 to the railway's crossing of State Road 710. The only control structure in the basin is the S-153 gated spillway aligned with the L-65 Borrow Canal at the canal's outlet to C-44, just north of the town of Port Mayaca. The canal and control structure provide flood protection and drainage for the S-153 Basin by discharging excess water into C-44 and regulating surface water elevations. Water supply to the S-153 Basin is from local rainfall (SFWMD, 1988a).

2.4.2.7 South Coastal Sub-Watershed

The South Coastal Sub-watershed has a drainage area of approximately 15,011 acres (23.5 mi^2). It is located in southeastern Martin County and is directly east of the North Fork Basin. Major land uses include urban areas (8580 acres) and natural areas (5047acres).

The northern portion of the South Coastal Sub-watershed drains into the St. Lucie Estuary to the north and the southern portion into Hobe Sound to the south. The northern section includes the St. Lucie Inlet. Sub-basin tributaries located in the South Coastal Basin include East Fork Creek, Manatee Creek tributaries, Crooked Creek tributary, and Willoughby Creek. There are no major canals or control structures in the South Coastal Basin.

This sub-watershed was not included in the modeling effort or the water quality evaluation because there is no discharge or loading data from this sub-watershed.

2.4.2.8 C-25 Sub-Watershed and C-25 East Sub-Watershed

The C-25 and C-25 East sub-watersheds comprise the C-25 and C-25 East Basins, respectively. These sub-watersheds have a combined drainage area of approximately 114,083 acres (178.3 mi^2), with the C-25 contributing 108,004 acres (168.8 mi^2) and the C-25 East Basin contributing 6,079 acres (9.5 mi^2). A majority of these basins are located in northern St. Lucie County, with a small section of the C-25 Basin encroaching into northeastern Okeechobee County. Major land uses in these basins include citrus farms (59,931 acres), pastures (28,591 acres), and natural areas including waterways (20,077 acres). In addition, urban areas along the IRL account for a significant portion of the C-25 East Basin (946 acres).

The major drainage canals in the C-25 and C-25 East Basins include the C-25, C-25 South Leg, and the C-25 Extension. Two other canals that provide flood protection and drainage in the western portion of the C-25 Basin are the Turnpike Canal and the Orange Avenue Borrow Canal. Control structures include G-81 (a steel sheet-pile dam with a gated weir that functions as a divide between the C-24 and C-25 Basins) and S-99 (a gated spillway that controls water surface elevations in the upper reach and discharges in the lower reach of the C-25 Basin). The main functions of these canals and control structures are to remove excess water from the two basins, to supply water to the two basins and occasionally the C-24 Basin, and to maintain groundwater table elevations adequate to prevent saltwater intrusion. Water flows southeast along the C-25 extension and then heads east where it discharges into the tidewater in the Intracoastal Waterway (IRL) west of the Fort Pierce inlet. Excess water may be discharged into the C-24 Basin if needed by way of G-81 (SFWMD, 1988b).

The C-25 and C-25 East sub-watersheds typically drain into the IRL, but in some cases, excess water from the C-25 sub-watershed can be discharged into the C-24 sub-watershed by way of the G-81 control structure. When this occurs, the C-25 sub-watershed is considered part of the St. Lucie River watershed and water discharged into the C-24 from the C-25 are captured in the discharge volumes from the C-24 sub-watershed.

2.4.2.9 Basin 1 Sub-Watershed

The Basin 1 sub-watershed only contains Basin 1, which has a total drainage area of approximately 26,082 acres (40.8 mi^2). Basin 1 is located in northeastern St. Lucie County and is bordered to the west and south by the C-25 and C-25 East Basins, respectively. Major land uses include citrus farms (10,719 acres), natural areas including waterways (5,353 acres), and urban areas (4,859 acres).

The C-25 Canal splits Basin 1 from the C-25 East Basin on the south side. The two control structures located in Basin 1 include S-99 (a gated spillway that controls water surface elevations in the upper reach and discharges in the lower reach of the C-25 Basin) and S-50 (a fixed crest weir that controls discharge to the C-25 East Basin and the IRL west of the Fort Pierce Inlet). The main goals of the canals and control structures of Basin 1 include removing excess water and supplying water to Basin 1, the C-25, and C-25 East Basins, and preventing saltwater intrusion into local groundwater by maintaining adequate water elevations. Water flows east along the south edge of Basin 1 out the IRL. This basin was not included in the modeling effort

because it drains directly into the IRL and does not contribute to discharges into the St. Lucie Estuary.

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CHAPTER 3

PLANNING PROCESS

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3.0 PLANNING PROCESS

A comprehensive and systematic planning process was used to develop the St. Lucie River Watershed Protection Plan (SLRWPP). The planning was conducted by the coordinating agencies, which included staff from the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (FDEP), Florida Department of Agriculture and Consumer Services (FDACS). Planning was performed in consultation with the SLRWPP Working Team which included cooperating agencies (Martin and St. Lucie Counties, affected municipalities), stakeholders, and the interested public. Significant steps in this process included the following:

1. **Characterization of existing conditions** – Existing conditions in the SLRWPP study area were characterized by reviewing available data on previous studies, ongoing projects, and planned initiatives in the St. Lucie River watershed. Current and future planned projects that would either contribute to the achievement of SLRWPP objectives or could be directly integrated into the plan were also identified during this review.

2. **Identification of problems**– Water resource construction projects are generally planned and implemented to solve problems, to meet challenges, and to seize opportunities. In the context of planning, a problem can be thought of as an undesirable condition. Identification of problems gives focus to the planning effort and aids in the development of planning objectives. For the SLRWPP planning process, problems were identified through an interagency brainstorming process and a review of historical documents.

3. **Determination of planning objectives** – Planning objectives are statements of what a plan is attempting to achieve. The objectives communicate to others the intended purpose of the planning process. The SLRWPP planning objectives were developed from the problem and opportunities identified in the working team meetings. Planning objectives were intended to solve the identified problems and take advantage of recognized opportunities.

4. **Identification of planning constraints** – Constraints are restrictions that both define and limit the extent of the planning process and in some context support and inform it. For the SLRWPP planning process, the constraints were identified through a working team brainstorming process concurrent with the identification of problems and opportunities.

5. **Selection of performance measures** – Performance measures and indicators are benchmarks used to guide formulation of alternative plans and evaluate plan performance. For the SLRWPP planning process, performance measures and/or indicators for water quality and quantity were identified consistent with previous and current planning processes.

6. **Identification of management measures** – Management measures (MMs) are the building blocks of alternative plans. A comprehensive list of MMs was prepared and evaluated through the collective input of the St. Lucie River working team (see Chapter 4.0 for a description of the working team). Using predetermined criteria, the MMs were screened to eliminate features or activities that did not contribute to meeting the planning goals and objectives.

7. **Formulation of alternatives** – A set of four alternative plans was formulated by combining individual MMs.

8. **Evaluation of alternatives** – Performance of each individual alternative plan was determined using agreed upon methodologies and modeling applications. Performance measures were then used to evaluate the performance of individual plans to the objectives of the SLRWPP.

9. **SLRWPP Selection -** The plan that best met the legislative goals was selected as the SLRWPP.

10. **SLRWPP Processing** – Planning-level budget estimates, implementation schedule, and an adaptive management plan were developed for the SLRWPP. Funding needs and opportunities were identified.

Routine, periodic Northern Everglades interagency meetings and working team meetings were held to engage the cooperating agencies, stakeholders, and the public throughout the planning process. Through these meetings, public input was sought and incorporated into the decision-making process as appropriate.

3.1 Ongoing Restoration Efforts and Other Relevant Projects

Numerous ongoing or planned projects in the St. Lucie River watershed are aimed at improving water quality, quantity, timing, and distribution. Some of the major projects, which complement and support the SLRWPP goals and objectives, are described in the following sections.

3.1.1 Federal and State Partnership Efforts

Several federal and state projects completed or planned contribute to the goals and objectives of the SLRWPP. These projects and their effects will be seen on a regional scale and include the Ten Mile Creek Water Preserve Area, the Comprehensive Everglades Restoration Plan (CERP), the Indian River Lagoon – South Final Integrated Project Implementation Report and Environmental Impact Statement (IRL-S PIR) and related Feasibility Study, and the Lake Okeechobee Watershed Project.

3.1.1.1 Critical Projects

Section 528(b)(3) of the Water Resources Development Act (WRDA) of 1996 authorized the identification of critical restoration projects for the South Florida ecosystem that will produce independent, immediate, and substantial restoration, preservation, and protection benefits, and will be generally consistent with the conceptual framework described in the Conceptual Plan for the Central and Southern (C&SF) Florida Project Restudy. There is one Critical Restoration Project within the St. Lucie River watershed, which is the Ten Mile Creek Water Preserve Area Critical Project. Details regarding this project are provided below.

3.1.1.1.1 Ten Mile Creek Water Preserve Area Critical Project

The Ten Mile Creek Water Preserve Area Critical Project is located in St. Lucie County at the headwaters of the North Fork of the St. Lucie River along Ten Mile Creek. This project consists of an aboveground reservoir of approximately 550 acres, which will store up to 6,000 acre-feet of water. The project also includes a 100-acre Stormwater Treatment Area (STA) used to treat flows from the reservoir. Initial construction of the project is complete and modifications and improvements to the design are currently under development and review.

3.1.1.2 Comprehensive Everglades Restoration Plan

CERP was authorized in Section 601(h) of the WRDA of 2000 and Sections 373.1501 and 373.1502, Florida Statutes (F.S.), and has been described as the world's largest ecosystem restoration effort. CERP includes more than 60 major project components. The goal of CERP is to capture fresh water that now flows unused to the Atlantic Ocean and the Gulf of Mexico and to redirect it to areas where it can be utilized most effectively to promote restoration of the Everglades ecosystem. The major components of CERP are surface water storage reservoirs, water preservation areas, and management of Lake Okeechobee as an ecological resource. Other major components include improved water deliveries into the estuaries, underground water storage, treatment wetlands, improved water deliveries to the Everglades, removal of barriers to sheet flow, storage of water in existing quarries, reuse of wastewater, pilot projects, improved water conservation, and additional feasibility studies. The CERP projects that have the greatest impact on the St. Lucie Estuary are the IRL-S PIR, the Lake Okeechobee Watershed Project, and Aquifer Storage and Recovery (ASR) Projects, which are discussed in more detail below.

3.1.1.2.1 Indian River Lagoon- South Final Integrated Project Implementation Report and Environmental Impact Statement

In March of 2004, the U.S. Army Corps of Engineers (USACE), in cooperation with the SFWMD, completed a C&SF Project IRL-S PIR. The IRL-S PIR replaces the USACE's Final Feasibility Report of the Indian River Lagoon (IRL) – South published in October 2002, which investigated options to alter the detrimental effects of the flow of surface waters through the existing C&SF canal system to the St. Lucie Estuary and the IRL (USACE and SFWMD, 2004; SFWMD, undated). IRL-S PIR has been authorized in the WRDA of 2007. It documents a plan to restore the southern portion of the IRL and St. Lucie Estuary and its associated watershed. The report also meets the requirements of the WRDA of 2000, which requires completion of a Project Implementation Report (PIR) prior to implementation of a CERP project.

The recommended IRL-S PIR plan consists of five features and/or operational modifications that include: (1) construction of four aboveground freshwater storage reservoirs for water storage; (2) construction of four STAs for excess nutrient removal; (3) acquisition and restoration of natural storage and treatment areas including North Fork floodplain restoration; (4) diversion of existing flows via a canal connection; and (5) muck removal and the creation of artificial habitat to increase habitat quality and quantity (USACE and SFWMD, 2004). IRL-S PIR projects that were considered in this SLRWPP include the C-44 Reservoir and STA, Natural Storage and Water Quality Areas, the C-23/24 Reservoir/STA, North Fork Natural Floodplain Restoration, oyster substrate creation in the St. Lucie Estuary, and muck removal from the St. Lucie Estuary.

C-44 Reservoir and STA

The objectives of the C-44 Reservoir and STA are to capture, store, and treat flood runoff from the C-44 Basin prior to discharge to the St. Lucie Estuary. Implementation of this project is expected to reduce damaging freshwater discharges, decrease nutrient load, and maintain desirable salinity regimes that are expected to occur collectively as a result of Northern Everglades and Estuaries Protection Program (NEEPP) and CERP implementation. This project includes construction of a 3,400-acre reservoir and a 6,300-acre STA in southern Martin County, to be located directly north of the C-44 Canal.

Natural Storage and Water Quality Areas

This project includes the PalMar, Allapattah, and Cypress Creek/Trail Ridge Complexes that total 92,130 acres of drained pasture lands. These lands will be hydrologically restored to provide a variety of benefits including water storage, rehydration, and habitat restoration. The natural areas will provide approximately 30,000 acre-feet of freshwater storage and reduce phosphorus (P) and nitrogen (N) loads through this onsite retention of stormwater. This project will also increase the spatial extent of natural wetlands and upland habitat for wildlife and provide recharge for the surficial aquifer.

C-23/24 Reservoir/Stormwater Treatment Area

This project involves a north reservoir, a south reservoir, and a STA that covers an 11,122-acre area. The total storage capacity of the project is 94,468 acre-feet. The project purpose is to capture and treat local runoff from the C-23 and C-24 Basins, thereby improving the quality, quantity, timing, and distribution of water discharged to the St. Lucie Estuary from these basins.

North Fork Natural Floodplain Restoration

Preserving lands within the North Fork corridor provides environmental benefits to the St. Lucie Estuary such as decreased stormwater runoff and turbidity, and improved wildlife habitat. This project includes acquisition and preservation of approximately 3,100 acres of floodplain and adjacent lands, which will receive an additional 64,500 acre-feet of flow via the northern diversion efforts.

Oyster Substrate Creation

Established oyster reefs provide many ecological benefits, including improvement of water quality. Oysters are a vital species in achieving restoration of the St. Lucie Estuary. They are a key indicator of the health of the system and are also very effective biofilters of fine sediments and nutrients in the water column. Creating additional oyster habitat would provide substrate for oyster larvae to settle, thus increasing the population filtering base. This project would build upon existing efforts to create suitable oyster substrate in the St. Lucie Estuary using natural or man-made conditions (i.e. “oyster balls,” limestone rocks, relict shell bags, etc.).

Muck Removal

Muck from watershed runoff has accumulated in portions of the St. Lucie Estuary and has covered substrate previously suitable for submerged aquatic vegetation (SAV) and oyster communities. This project would remove muck sediment from “hot spots” identified in the St. Lucie Estuary, improving estuarine conditions by exposing this substrate suitable for

colonization by target species, and improving water quality, clarity, and sunlight attenuation, which are especially critical for seagrass colonization and growth.

3.1.1.2.2 Lake Okeechobee Watershed Project

The Lake Okeechobee Watershed Project selected plan includes six structural components and a modification to the existing Lake Istokpoga Regulation Schedule. The components are as follows:

- **Taylor Creek/Nubbin Slough Reservoir** – This 1,984-acre storage facility is located in the S-191 sub-basin and will provide a maximum capacity of 32,000 acre-feet at an average depth of 18 feet. It will receive inflows from and discharge back to Taylor Creek. This reservoir feature will remove approximately 3 to 5 metric tons per year (mt/yr) of total phosphorus (TP) by sediment settling. The location and configuration of this feature matches with that of the Taylor Creek Reservoir being considered under the Lake Okeechobee Fast Track (LOFT) program.
- **Taylor Creek/Nubbin Slough STA** – This 3,975-acre treatment facility is located in the S-135 sub-basin and will treat flows from S-133, S-191, and S-135 sub-basins. This STA is expected to reduce TP loads by 19 mt/yr. The location of this facility overlaps with that of the Lakeside Ranch STA being considered under LOFT.
- **Kissimmee Reservoir** – This storage facility consists of a 10,281-acre aboveground reservoir with a maximum storage capacity of 161,263 acre-feet at 16-feet average depth. The feature is located in the C-41A sub-basin. It will receive flow from and discharge back to the C-38 Canal (Kissimmee River). A secondary discharge structure will also allow for releases to the C-41A Canal.
- **Istokpoga Reservoir** – This 5,416-acre storage facility will be located in the C-40A and C-41A sub-basins and will provide a maximum storage capacity of 79,560 acre-feet at an average depth of 16 feet. It will receive inflow from and discharge back to the C-41A Canal.
- **Istokpoga STA** – This 8,044-acre treatment facility will be located in the L-49 sub-basin. It will receive flow from the C-41 Canal and discharge treated water to Lake Okeechobee. It is expected to reduce TP loads by approximately 29.1 mt/yr.
- **Paradise Run Wetland Restoration** – This 3,730-acre wetland restoration site is located at the ecologically significant confluence (under pre-development conditions) of Paradise Run, oxbows of the Kissimmee River and Lake Okeechobee. Under restored conditions it would have a rain-driven hydrology unless future efforts could link the site to the surface flows from the C-38 or C-41A Canals.
- **Lake Istokpoga Regulation Schedule** – The recommended revised Lake Istokpoga Regulation Schedule is based on an El Niño operating strategy. This operating strategy consists of a combined assessment of existing hydrologic conditions and long-term climatic forecasts at the beginning of each dry season to determine whether normal, wet, or dry year recession rule curves should be used.

3.1.1.3 Lake Okeechobee Regulation Schedule and Herbert Hoover Dike

A regulation schedule is a federally authorized tool used by water managers to manage the water levels in a lake or reservoir. Prior to April 2008, water in Lake Okeechobee was managed in accordance with the Water Supply/Environmental Regulation Schedule (WSE) approved in 2000. On April 28, 2008 the USACE approved the new 2008 Lake Okeechobee Regulation Schedule (USACE, 2008a) and all surface water releases from Lake Okeechobee to the St. Lucie and Caloosahatchee Estuaries after this date will be in accordance with this new schedule.

Water management decisions regarding Lake Okeechobee are highly dependent upon the Herbert Hoover Dike. The Herbert Hoover Dike is an approximately 70-year-old earthen levee that was constructed around the southern portion of Lake Okeechobee for flood control purposes. For decades, the dike has served this purpose; however, it is in need of rehabilitation. Until the rehabilitation is complete, the USACE's goal is to manage Lake Okeechobee water levels between 12.5 and 15.5 feet throughout the year, which is considered a safe range for the dike (USACE, 2008b).

The previous WSE schedule was developed to improve performance of Lake Okeechobee's littoral zone habitat and water supply, without impacting the other lake management objectives. Maintaining these water levels within the lake with the WSE has proven ineffective in meeting these goals. During extreme wet weather events during the 2004 and 2005 hurricane seasons, Lake Okeechobee rose to 17 and 18 feet National Geodetic Vertical Datum (NGVD), and during the current 2-year drought the water level in the lake has dropped to about 10 feet (USACE, 2008b; USACE, 2008c). These levels are not considered within the safe range for the Herbert Hoover Dike as determined by the USACE. Furthermore, the implementation WSE has resulted in ecological impacts to Lake Okeechobee from fluctuating water levels and impacts to the St. Lucie and Caloosahatchee Estuaries from excessive freshwater releases (USACE, 2007).

The Lake Okeechobee Regulation Schedule Study (LORSS) was initiated in late 2005 in order to develop a new water regulation schedule for the lake that would allow operational changes within the existing infrastructure to address these issues. Based solely on current water storage capacity in the system, the operational changes will allow for quicker response and operational flexibility to changing lake conditions and tributary inflows. An additional feature of the new schedule is that it allows for the capability to initiate releases to the Caloosahatchee and St. Lucie Estuaries, and the Water Conservation Areas (WCAs) to the south, at lower levels than under the current schedule. The low-volume releases should add to flows to the St. Lucie Estuary, but not in excessive quantities, helping maintain appropriate salinity ranges (USACE, 2008b).

Upon fully implementing the Lake Okeechobee Regulation Schedule (USACE 2008a), water managers began conducting another regulation schedule study (System Operating Manual Study). This study will take into account construction of early CERP projects, including projects expedited by the SFWMD, which will provide many additional options for water storage and management. Water managers will also take into account an adjusted lake level afforded by the Herbert Hoover Dike Rehabilitation Project in future revisions to the regulation schedule.

3.1.2 State and Local Efforts

There are several state and local government rules, plans, and programs in place that contribute to the goals and objectives of the SLRWPP. In addition to the Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan (LOP2TP) and Caloosahatchee River Watershed Protection Plan (CRWPP), these water quality initiatives include the Environmental Resource Permit (ERP) program, the Lake Okeechobee 40E-61 rule, and agricultural and urban Best Management Practices (BMPs).

3.1.2.1 Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan

The LOP2TP was developed in response to NEEPP. The purpose of the LOP2TP is to provide an overall strategy for improving quality, quantity, timing and distribution of water in the Northern Everglades ecosystem and achieve the TP total maximum daily loads (TMDLs) for Lake Okeechobee. The plan is intended to achieve the following objectives:

- Meet Lake Okeechobee watershed TMDLs;
- Manage Lake Okeechobee water levels within an ecologically desirable range;
- Manage water flows to meet desirable salinity ranges for the St. Lucie and Caloosahatchee Estuaries through the delivery of appropriate freshwater releases from Lake Okeechobee made possible by additional water storage north of the lake; and
- Identify opportunities for alternative water management facilities and practices in the watershed to meet specified goals.

Many of the projects identified in the LOP2TP are also included as MMs in this SLRWPP.

3.1.2.2 Caloosahatchee River Watershed Protection Plan

The CRWPP was also developed in response to NEEPP. As with this SLRWPP, the CRWPP addresses undesirable water flows and nutrient loading to the Caloosahatchee River and has the same three main components: (1) a construction project, (2) a pollutant control program, and (3) a Research and Water Quality Monitoring Program (RWQMP).

3.1.2.3 Indian River Lagoon Surface Water Improvement and Management Plan

The Surface Water Improvement and Management Act (SWIM) of 1987, Sections 373.451-373.4595, F.S. (1987), was established to aid in the restoration of priority waterbodies throughout Florida. One such priority waterbody is the IRL, a 156-mile estuary stretching from New Smyrna Beach in Volusia County to Jupiter Inlet in Palm Beach County. The IRL is within the jurisdiction of two water management districts: St. John's River Water Management District (SJRWMD) and the SFWMD. The IRL SWIM Plan boundary includes the St. Lucie Estuary and its contributing watershed, and is designed to develop and execute a combination of research

and practical implementation to protect or restore the environmental resources of the St. Lucie Estuary and the IRL. The IRL SWIM Plan has three main goals:

- Attain and maintain water and sediment of sufficient quality to support a healthy, seagrass-based estuarine ecosystem;
- Attain and maintain a functioning seagrass ecosystem that supports threatened and endangered species, fisheries, and wildlife; and
- Achieve heightened public awareness and coordinated interagency management.

The focus of this effort has been on the improvement of water quality entering the estuary and lagoon in terms of quantity, timing, and distribution of fresh water, as well as the associated suspended materials and nutrients that are transported into the system.

The IRL 2000 to 2005 SWIM Plan update provided specific direction on goals, objectives, strategies, and tasks that are necessary for restoration and water quality improvement. This specificity will assist the SFWMD in developing appropriate budgets for implementation activities that are clearly connected to the intent and purpose of the program. Participation by cities, counties, and water control districts will likely grow as they work to meet their responsibilities for achieving Pollutant Load Reduction Goals, related resource targets, and wetland management targets.

3.1.2.4 Regulatory and Source Control Programs

Source control programs are currently in operation in the St. Lucie River watershed and upstream Lake Okeechobee watershed. These control programs have been developed and implemented cooperatively by the SFWMD, FDEP, and FDACS. Examples include widespread development and implementation of agricultural BMPs, restrictions on the application of wastewater residuals, and implementation of the Florida Yards and Neighborhoods Program and Florida's consolidated stormwater management programs.

An overview of the nutrient source control programs underway in the St. Lucie River watershed is provided in Chapter 7.0 of this document.

3.1.2.4.1 Environmental Resource Permit Program

The existing ERP program is a statewide permitting program that began in the mid-1990s and is implemented by both FDEP and the water management districts. The ERP program regulates activities in, on, or over wetlands or other surface waters and the management and storage of all surface waters. This includes activities in uplands that alter stormwater runoff as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that activities do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems. The program applies to new activities only, or to modifications of existing activities, and requires an applicant to provide reasonable assurances that an activity will not cause adverse impacts to existing surface water storage and conveyance capabilities, and will not adversely affect the quality of receiving waters such that any applicable water quality standards will be violated. Therefore, the applicant must address the long-term

water quality impacts of a proposed activity and must prevent any discharge or release of pollutants from the system that will cause water quality standards to be violated.

In May 2007, FDEP initiated the development of the Unified Statewide Stormwater rule. In June 2007, the SFWMD also initiated rule development to incorporate the Unified Statewide Stormwater Rule. The rule will be based on a performance standard of post-development total nitrogen (TN) and total phosphorus (TP) loading not exceeding pre-development natural conditions. The pre-development natural condition is proposed to be defined as the condition of the site as if it were naturally vegetated, not necessarily the conditions existing at the site today. The intended effect of the rule is to increase the level of treatment required for TN and TP in stormwater from new development, which is anticipated to adequately address the discharge of nutrients in general. Methods for estimating treatment efficiency in typical water management BMPs and in low-impact design type water management BMPs are proposed to be included in the rule, as well as retrofit projects, redevelopment, and compensating treatment. The rule is also anticipated to have an incidental effect of reducing the volume of stormwater. The target date for rule adoption is July 2009.

In March 2008, the SFWMD initiated rule development for an ERP Basin Rule with supplemental criteria designed to result in no increase in total runoff volume from new development that ultimately discharges to Lake Okeechobee or the Caloosahatchee and St. Lucie Estuaries. This rule will be supplemental to existing criteria and the proposed Unified Statewide Stormwater Rule. Average annual discharge volumes and specific storm event discharge volumes are proposed to be addressed. Methods for estimating storage capacities in typical water management BMPs and in low-impact design-type water management BMPs are also proposed to be included in this rule. The target effective date of the rule is July 2009.

3.1.2.4.2 40E-61 Regulatory Nutrient Source Control Rule

Chapter 40E-61, Florida Administrative Code (F.A.C.), the Lake Okeechobee 40E-61 rule, was adopted in 1989 as a result of the Lake Okeechobee SWIM Plan. The rule limits the amount of P that can be discharged from lands within the regulatory boundary defined by the rule. This is accomplished by issuing permits that approve a P source control plan. The rule criteria are based on initiatives in place at the time the rule was adopted. At this time, it is necessary to update the criteria in this rule to be consistent with current objectives.

The original purpose of the rule was to ensure that discharges to Lake Okeechobee from lands regulated by the SFWMD met the legislative policies established in Chapter 373, F.S. The SFWMD is updating the rule criteria to be compatible with current initiatives and amendments to the NEEPP legislation, specifically to:

- Implement a P source control program utilizing BMPs for all lands within the St. Lucie River watershed;
- Provide agricultural land uses of greater than 100 acres the option of participating in the FDACS BMP program to meet the intent of the 40E-61 rule;

- Define the monitoring network necessary to monitor the rule's effectiveness, to make compliance determinations, and to enhance performance of downstream treatment facilities;
- Establish a plan for optimizing the BMP program should the expected water quality criteria not be met;
- Ensure that the rule is consistent with data presented in SLRWPP; and
- Include incentives for permit holders to participate in P reduction demonstration projects that will provide valuable data for expanding, accelerating, and optimizing the implemented BMPs to meet water quality objectives and for further refinement of the rule as necessary.

To ensure consistency with the SLRWPP, rule development is expected to begin in early 2009.

3.1.2.4.3 Agricultural Best Management Practices

The Florida Watershed Restoration Act, Section. 403.067, F.S. (1999), authorized FDACS to develop, adopt by administrative rule, and implement agricultural BMPs statewide. In the ensuing years, FDACS has developed and adopted comprehensive BMP manuals for citrus, vegetables, and agronomic crops; containerized nurseries; and sod production. BMP manuals for sod, beef cattle production, and the equine industry are scheduled to be adopted by administrative rule by early 2009.

Agricultural landowners participating in the FDACS BMP programs must implement nutrient management plans and other applicable BMPs, and maintain records verifying their implementation. In addition to nutrient management, typical BMPs include irrigation management (which includes an evaluation of the irrigation system efficiency), surface water management (installation of modern water control structures), and comprehensive ditch maintenance programs.

Critical components in the success of the agricultural BMP program are the collection and analysis of data to determine whether BMPs are working as anticipated. The interagency team is committed to continue funding on-farm BMP demonstration projects at representative sites that will provide both BMP effectiveness data. In cooperation with the University of Florida Institute of Food and Agriculture Sciences (UF/IFAS), FDACS is conducting BMP demonstration and evaluation projects at representative sites for all agricultural land uses in the watershed as funding becomes available.

3.1.2.4.4 Urban Best Management Practices

There is a continued focus in the St. Lucie River watershed on reducing the impacts of non-point source pollution from urban land use through rules, public education programs, and other non-structural BMPs. Urban BMPs are practices determined by the coordinating agencies to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality in urban discharges. Examples of urban BMPs implemented in the St. Lucie River watershed include the Florida Yards and Neighborhoods

Program, comprehensive planning initiatives, and the urban turf fertilizer rule, which are discussed in more detail below.

The Florida Yards and Neighborhoods Program is an excellent example of a nonstructural urban BMP program. By educating citizens and builders about proper landscape design (e.g., "right plant-right place" practices), this program is helping minimize the use of pesticides, fertilizers, and irrigation water. FDEP has an ongoing monitoring program to determine the effectiveness of this program in reducing nutrient loads.

Comprehensive planning initiatives involve cities, counties, and other entities in the St. Lucie River watershed that are responsible for comprehensive planning and land development approvals. FDEP works with those entities to review current comprehensive plans and associated land development regulations to ensure that they promote low-impact design and proper stormwater treatment. The objective is to implement low-impact design measures basin wide to achieve additional P reductions and water storage.

In August 2007, FDACS adopted a statewide Urban Turf Fertilizer rule. The rule limits the P and N content in fertilizers for urban turf and lawns, thereby significantly reducing the amount of P and N applied in urban areas and limiting the amount of those compounds reaching Florida's water resources. It requires that all fertilizer products labeled for use on urban turf, sports turf, and lawns be limited to the amount of P and N needed to support healthy turf maintenance. FDACS expects a 20 to 25 percent reduction in N and a 15 percent reduction in P in every bag of fertilizer sold to the public. The rule was developed by FDACS with input from UF/IFAS, FDEP, the state's five water management districts, the League of Cities, the Association of Counties, fertilizer manufacturers, and concerned citizens. It enhances efforts currently underway to address excess nutrients in the Northern and Southern Everglades. As a component of the Lake Okeechobee and Estuary Recovery (LOER) Plan, the new rule is an essential component to improve water quality through nutrient source control.

3.1.3 Stormwater Master Programs

Martin and St. Lucie Counties have established stormwater master programs, which are discussed below.

3.1.3.1 Martin County Stormwater Master Program

Martin County adopted a Stormwater Master Plan in 1997 in order to address flooding and water quality problems within unincorporated Martin County. The Stormwater Master Plan was incorporated into the county's Comprehensive Growth Management Plan, which had provided extensive goals, objectives, and policies to protect coastal areas, estuaries, wetlands, and aquifers, and to provide drainage. Many existing drainage facilities were identified in that plan as being Level of Service deficient for flood protection. Comprehensive stormwater retrofitting projects in the Stormwater Master Plan will provide water quality treatment, roadway flood protection, and structure flood protection for Martin County. Most Martin County projects rely on wet detention to provide water quality treatment and flow attenuation.

3.1.3.2 St. Lucie County Stormwater Master Program

In 1999, the St. Lucie County Commission adopted the St. Lucie County Stormwater Management Program for the unincorporated portion of the county. The main goals of the program are to manage St. Lucie County stormwater systems in order to prevent flooding and property damage, to protect water quality for the safety and enjoyment of county citizens, and to preserve the environment and enhance wildlife habitat. The cities of Ft. Pierce, Port St. Lucie, and St. Lucie Village carry out most of the stormwater management responsibilities within their corporate boundaries, while the management responsibilities for the unincorporated portion of the county are shared by the SFWMD, the North St. Lucie River Water Control SFWMD, Fort Pierce Farms and Water Control SFWMD, and St. Lucie County. Some of the management activities include maintenance and cleaning of roadside swales, drainage ditches, and larger canals in the western reaches of the county; replacing deteriorated roadway culverts and stormwater drainage pipe systems; and developing plans to improve flood protection and to improve the quality of stormwater that discharges into surrounding waterbodies.

3.2 Problems

The quality of water entering the St. Lucie Estuary directly affects the health of the system. Evaluating water quality and quantity can determine long-term trends and the state of this estuary. Historical drainage patterns within the St. Lucie River watershed have been highly altered since pre-drainage times. Loss of natural habitat from riverfront and coastal development, increased urban development, construction of drainage canals, and agricultural activities have affected the timing, quantity, quality, and distribution of runoff to the estuary. Wet season flows have increased due to additional runoff from land clearing and impervious areas; and dry season flows have decreased due to increased water supply demand for agricultural and urban development.

The general problems associated with water entering the St. Lucie Estuary include:

- Excess discharges resulting from Lake Okeechobee and watershed runoff;
- Insufficient low flows to the St. Lucie Estuary; and
- Excess nutrient loads to St. Lucie River and its estuary.

This following sub-sections first focus on the ecological problems in the St. Lucie Estuary, then identify the possible causes of the problems, and finally consider opportunities to improve conditions in the St. Lucie Estuary.

3.2.1 Ecological Concerns in the St. Lucie Estuary

This section focuses on seagrasses, oysters, muck accumulation, and algal blooms. Seagrass and oysters are Valued Ecosystem Components (VECs). VECs sustain an important ecological resource and/or water resource function by providing food, living space, refuge, and foraging sites for other desirable species in the estuary [Restoration Coordination and Verification (RECOVER), 2007]. This approach assumes that environmental conditions suitable for VECs are also suitable for other desirable species and that enhancement of VECs will lead to enhancement of other species. Specific VECs identified to promote and sustain the St. Lucie

Estuary are: (1) oyster populations; (2) freshwater, brackish, and marine SAV; and (3) fish larvae (Mote Marine Laboratory, 1995). All three of these VECs have been used to formulate water management objectives for the SLE, but oysters and SAV have been more widely applied because they:

- Are indicators of healthy estuarine ecosystems;
- Are currently present in the estuary;
- Were present historically (post inlet construction) in the St. Lucie Estuary;
- Are sessile and therefore cannot avoid harmful salinity;
- Can be supported by literature regarding salinity tolerances; and
- Have well-established monitoring methods.

Another important function of an estuary is to provide a suitable low-salinity nursery habitat for the development of estuarine resident and dependent fish larvae and juveniles. RECOVER is currently conducting several field studies to determine if fish larvae are a viable VEC for the St. Lucie Estuary. The intent of the field studies is to determine a time series of low flows to enhance the area and quality of fish nursery habitat in the North and South Forks. Information from these studies will be used to address an environmentally optimum low-flow regime in the near future. Although fish larvae are mobile and there is limited literature addressing salinity tolerances, further insight into the relationship between inflows and the response of fish larvae and juveniles is needed to mature the concept of fish larvae as a VEC. (SFWMD – Coastal Ecosystem Division, 2008).

3.2.1.1 Seagrass

SAV is a critical component of a healthy estuarine ecosystem. In the St. Lucie Estuary, the SAV community includes both seagrasses and algae. Seagrasses are underwater flowering plants that produce oxygen. The depth of water that seagrasses thrive in is limited by the amount of sunlight able to penetrate through the water column. Their distribution is also limited by salinity levels.

If healthy SAV beds are present, then a diverse and productive faunal community will also be present. A number of important functions are attributed to SAV, including: (1) providing food for estuarine organisms; (2) providing shelter and nursery habitat for many commercially and recreationally important fin and shell fish species; (3) habitat for a variety of invertebrate fauna including snails, star fish, sea urchins, sea cucumbers, pink shrimp, blue crab, and spiny lobster; and (4) enhancing water quality from binding shallow underwater sediments and taking up dissolved nutrients.

Early seagrass surveys of the St. Lucie Estuary performed in the 1950s (Phillips and Engle, 1960) documented three species of SAV: (1) manatee grass near the mouth of the river; (2) "very abundant" shoal grass in the mid and lower estuary; and (3) widgeon grass in the mid and lower estuary. Historic SAV distribution maps (URS Greiner Woodward Clyde, 1999) indicate relatively large SAV beds in the North Fork (especially in the Kitching Cove area), while in the South Fork SAV distribution has been sparse.

The first known SAV map of the St. Lucie Estuary was prepared in 1997 by URS Greiner Woodward Clyde (1999) based on detailed field investigations using sub-meter accuracy GPS technology. The most recent SLE SAV map was completed in the summer of 2007 (Ibis Environmental, Inc., 2007). The results of these mapping efforts indicated a decline of the spatial extent of seagrasses in the St. Lucie Estuary. The 1997 seagrass survey effort indicated an absence of seagrass in the middle estuary, where it historically existed. The 2007 study (Ibis Environmental Inc., 2007) documented the presence of small amounts of both Shoal and Johnson's seagrasses in the middle estuary. No SAV was found in the North Fork during either the 1997 or 2007 surveys. Very small amounts of SAV were found in the South Fork in 1997 (mouth of Danforth Creek), but those areas were devoid of SAV in the summer of 2007.

3.2.1.2 Oysters

Oysters are ecologically important indicator species. They filter particles from the water column, provide habitat, and play an important role in the food chain. Oysters require firm and stable substrate for attachment; water flows adequate to provide food supplies of plankton and algae; oxygen concentrations greater than 3 parts per million (ppm); and salinity ranges between 10 to 30 parts per thousand (ppt), with 15 to 18 ppt as optimal conditions. The American oyster (*Crassostrea virginica*), also known as the Eastern or Virginia oyster, is the dominate oyster species in the St. Lucie Estuary. It can tolerate very high (40 ppt) or very low (2 ppt) salinities for very brief periods (Gunter and Geyer, 1955). Oysters are also very susceptible to parasitic diseases, which are more prevalent during periods of high salinity (greater than 25 ppt) and high temperatures. The distribution of oysters has also declined in the St. Lucie Estuary in past decades, especially in the middle estuary where higher salinity has expanded habitat for predators historically found only in areas closer to the ocean (USACE and SFWMD, 2004).

3.2.1.3 Muck Accumulation and Resuspension

Development and agricultural practices near surface waters introduces point- and non-point source pollutants into the watershed. Point source pollutants are typically associated with piped surface water and can be directly attributed to a specific source (e.g., pipe). Non-point source pollutants can have numerous contributing sources that make it difficult to decipher their origin, such as runoff from landscaping, construction, and agricultural practices. The discharge from both point- and non-point source pollutants introduces sediments and nutrients into the watershed.

Sediment is considered a pollutant when it enters a river or estuary in large amounts and carries pollutants attached to its particles. Sediments contribute to nutrient loads, decrease light penetration, and can smother the benthic community. A river's sensitivity to an increase or decrease of pollutants is dependent upon a river's ability to sustain pollution input without degrading the water quality.

Regulatory releases from Lake Okeechobee and development in the St. Lucie River watershed contribute "…organic and inorganic sediments which contribute to deposits of muck in the estuary" (Shrader, 1984; Gunter and Hall, 1963; Pitt, 1972). This muck has accumulated along the bottom of the St. Lucie Estuary in several areas (Gunsalus, pers. comm.) and is contributing to the decline of suitable seagrass and oyster habitat in the St. Lucie Estuary. Large

accumulations of muck on the bottom of the estuary can also decrease the quality and quantity of habitat for benthic macroinvertebrates, oysters, and finfish.

The re-suspension of muck deposits from wave energy is also a problem because muck in the water column reduces light penetration resulting in a reduction in seagrass photosynthesis and dissolved oxygen (DO). Efforts to attenuate wave energy and reduce re-suspension of sediments along unconsolidated shoreline will be attempted through placement of riprap, artificial reefs, and oyster reefs wherever appropriate.

3.2.1.4 Algal Blooms and Low Dissolved Oxygen

An over-enrichment or excess of nutrients and/or fresh water can change the balance of an estuarine ecosystem and alter its food web. These effects can include increased turbidity; a change in nutrient ratios and phytoplankton community; a change in the reproduction, growth, and survival of pelagic and benthic organisms; and the occurrence and frequency of harmful algal blooms. Nutrient inputs to the estuary occur through surface water discharges, groundwater, and atmospheric deposition. The problem occurs when nutrient levels entering the estuary (receiving water) exceed the rate of discharge (outflow), causing an increase in primary production (algal blooms and possibly fisheries production). Ultimately, the balance between production and metabolism of organic matter in the ecosystem is disrupted (Cloern, 2001).

Harmful algal blooms result in increased uptake of oxygen by biological organisms (biological oxygen demand) and decreased DO, which leads to excessive nutrients (eutrophication) and fish kills. An ecosystem with low DO (less then or equal to 2 milligrams/liter) is referred to as hypoxic, whereas an anoxic system completely lacks DO (Diaz, 2001). Mallin et al. (2006) describes two types of hypoxic and anoxic conditions, acute and chronic. Acute conditions occur from organic waste loading from sources outside the waterbody, while chronic conditions are a result of processes within the waterbody itself (Mallin et al., 2006).

Hypoxic or anoxic conditions can also occur as a result of stratification in the water column, which prevents natural circulation of high DO levels from the upper water column to bottom waters. Hypoxic conditions suffocate most marine organisms, and anoxic conditions provide an unsustainable environment. Both photosynthesis by phytoplankton and mixing at the air/water interface supply DO to the water column. As a result, surface waters are typically rich in DO; however, the system relies on natural mixing to transport oxygen throughout the rest of the water column to avoid hypoxic and/or anoxic conditions at greater depths. Shallow embayments, poorly flushed coastal rivers, or areas of "low physical energy (tidal, currents, or wind) and large freshwater input" are most susceptible to stratification and hypoxic or anoxic conditions (Diaz, 2001).

The SFWMD conducts monitoring for blue-green algae in the St. Lucie Estuary as required. Monitoring results and observations indicate typical signs of eutrophication including intense algal blooms and periods of hypoxia and anoxia (SFWMD-Coastal Ecosystem Division, 2008). In August 2005, higher than average concentrations of *Microcystis* algae were documented in the South Fork (monitoring station SE03 = 7.3 micrograms/liter) with a medium to heavy layer observed on the surface (SFWMD, 2006). Despite these conditions, no succinct correlation of toxic algal concentrations to biological response (i.e., mass fish kills) has been identified in the

St. Lucie Estuary (Pfeuffer, pers. comm.). Physical and biological water quality monitoring as proposed in the SFWMD's Research & Water Quality Monitoring Plan may provide insight into the link between algae blooms and hypoxic or anoxic conditions in the St. Lucie River and Estuary.

3.2.2 Potential Causes

The potential causes of the ecological problems in the St. Lucie Estuary discussed above include excess water discharges from Lake Okeechobee regulatory releases and the St. Lucie River watershed, insufficient discharges from the St. Lucie River watershed, and nutrient loading. These potential causes and their relationship to the ecological problems are discussed below.

3.2.2.1 Discharges from Lake Okeechobee Regulatory Releases and the St. Lucie River Watershed

Lake Okeechobee regulatory discharges are sent to the St. Lucie Estuary through the C-44 Canal (see section 3.1.1.1 for a description of the regulatory releases). These have led to extreme and sudden low-salinity conditions within the St. Lucie Estuary. Although this SLRWPP accounts for Lake Okeechobee regulatory releases, plans to attenuate these releases are addressed in the LOP2TP. This plan focuses on discharges from the St. Lucie River watershed.

Wet season surface water flows to the St. Lucie Estuary from the St. Lucie River watershed have increased due to surface water runoff from cleared lands and impervious areas. These excess discharge events result in undesirable low salinity ranges in the St. Lucie Estuary. Based on extensive monitoring of the St. Lucie Estuary and flows and loads from the associated basins and Lake Okeechobee, a discharge/salinity relationship was established for very low salinities in the St. Lucie Estuary (RECOVER, 2006). Flows to the St. Lucie Estuary between 725 to 3,280 cubic foot per second (cfs) produced salinities ranging from 1 to 5 ppt. Flows of 2,000 cfs, the middle of this range, produced extreme low salinities (less than 3 ppt). Salinities this low were implicated in the oyster mortality of 1998 and 1999 (RECOVER, 2007), and such low salinities would result in seagrass mortality (Kenworthy and Dipiero, 1991). Greater than 2,000 cfs causes stress to the ecosystem and greater than 3,000 cfs causes severe damage; therefore, a 3 ppt salinity level and surface water discharges of 2,000 cfs are threshold values for seagrass and oyster survival (RECOVER, 2007).

Based on data from the period of record from 1970 to 2005 (432 months), the modeled mean monthly surface water flows exceeded 2,000 cfs for 65 months (15 percent of the total months), and 28 of those months had exceedences above 3,000 cfs. Even with implementation of all LOP2TP projects, it is projected that the mean monthly surface water flows exceeding 2,000 cfs for this period of record would have occurred in 52 months, and 20 of those exceedences would be above 3,000 cfs. The resulting extreme low-salinity conditions stress oyster and seagrass communities and can ultimately lead to reduced populations and coverage. These excess discharges are also resulting in the muck accumulation within the estuary.

3.2.2.2 Salinity in the St. Lucie Estuary

Salinity in the St. Lucie Estuary is typically lower during the wet season when freshwater discharges from the St. Lucie River watershed and Lake Okeechobee are greatest, and highest during the dry season when discharges are lower due to increased water supply demands from agricultural and urban developments in the watershed. Desirable salinity ranges in the St. Lucie Estuary are between 8-25 ppt as measured from the Roosevelt Bridge. Problems with the low salinity in the St. Lucie Estuary and the relationship between salinity in the St. Lucie Estuary and freshwater surface discharges from the St. Lucie River watershed in Lake Okeechobee are discussed above in section 3.2.2.1.

Although high salinity in the St. Lucie Estuary is uncommon, a low flow threshold value was determined for the St. Lucie Estuary. Based on the Natural Systems Model (NSM) effort done for the IRL-S PIR, the low flow threshold value for survival of American oyster (*Crassostrea virginicia*) and Shoal grass (*Halodule wrightii*) was determined to be 350 cfs from both groundwater and surface water sources (RECOVER, 2007). It is considered more favorable to the health of the ecosystem for groundwater flows to maintain this low flow threshold. SFWMD preliminary groundwater flow data taken during the current two-year drought suggests that groundwater flows alone may be sufficient to prevent undesirable high salinity in the St. Lucie Estuary. However additional groundwater flow data is necessary to fully understand the groundwater contribution to the estuary, and whether and when supplemental watershed flows are necessary to achieve this target.

3.2.2.3 St. Lucie River and Estuary Nutrient Loading

Along with the frequency and duration of freshwater discharges to the St. Lucie Estuary, the discharges contain untreated stormwater runoff with high levels of nutrients, pesticides, herbicides, suspended solids, and heavy metals. Nutrients can also enter the estuary through ground water flows as a result of failing septic systems and sewage treatment plants, and from polluted air and rain,. The main nutrients of concern for the St. Lucie Estuary and the TMDL process are P and N. These nutrients ultimately end up and accumulate in the St. Lucie Estuary. Increased nutrient loading in the St. Lucie Estuary may be contributing to harmful algal blooms and associated fish kills.

3.3 Planning Objectives

The problems described above in section 3.2 directly lead to the following objectives discussed in sections 3.3.1 through 3.3.3 below. Measures to reduce discharges and nutrient loading from Lake Okeechobee through the C-44 Canal are addressed in the LOP2TP. Performance measures used to evaluate the performance of the alternative plans are described in Section 3.5.

3.3.1 High Discharge Criteria and Estuary Salinity Envelope Objectives

The objectives of the High Discharge Criteria and the Salinity Envelope are to:

- Manage Lake Okeechobee and local watershed discharges to meet desirable salinity ranges for the estuary; and

- Meet key estuarine-dependent species requirements.

3.3.2 Water Quality Objective

The water quality objectives of the St. Lucie Estuary are to:

- Meet TMDLs;
- Reduce pollutant loads by improving management of pollutant sources throughout the watershed; and
- Establish a RWQMP sufficient to implement the program and projects.

3.4 Planning Constraints

3.4.1 Water Supply and Flood Protection

NEEPP legislation requires that water-related needs of the region, including water supply and flood protection, will continue to be met. Recommendations contained in the SLRWPP must continue to meet water supply and flood protection for the watershed.

3.4.2 Minimum Flows and Levels

Minimum flows and levels are set in Chapter 40E-8 F.A.C., as revised in April 2007. Minimum flows are established to identify where further withdrawals would cause significant harm to the water resources, or to the ecology of the area. The following minimum flow and level criterion has been set for the St. Lucie Estuary in Rule 40E-8.341, F.A.C.:

> "Mean monthly surface water flows to the St. Lucie Estuary should not fall below 28 cfs from the Gordy Road structure to the St. Lucie River North Fork for two consecutive months during a 365-day period, for two consecutive years."

If flows fall below this minimum for 2 consecutive months, the minimum flow criteria will be exceeded and harm is considered to have occurred to estuarine resources. If harm occurs during 2 consecutive years, significant harm and a violation of minimum flow criteria occurs. SLRWPP recommendations cannot reduce the ability to meet this minimum flow and level criteria.

3.4.3 Lake Okeechobee Proposed Target Minimum Water Level Condition

The proposed target minimum water level condition for Lake Okeechobee allows for only one occurrence over a 6-year period when water levels drop below 11 feet NGVD for more than 80 days. SLRWPP recommendations should not reduce the ability to meet this proposed minimum water level condition.

3.4.4 Lake Okeechobee Service Area Irrigation Demand

Another SLRWPP planning constraint is to ensure that the plan does not adversely affect the Lake Okeechobee Service Area (LOSA) water supply demands.

3.4.5 State Water Quality Standards

Recommendations contained in the SLRWPP must be permittable with respect to protecting and maintaining all applicable water quality standards.

3.5 Performance Measures and Indicators

Alternatives were specifically formulated to meet the performance measure targets to the greatest extent possible. The alternative plans were then compared to the performance measure targets to determine their efficiency and effectiveness in achieving SLRWPP objectives. Performance indicators are planning constraints or other parameters of interest that the alternative plans could directly or indirectly affect. Alternative plans were compared to the performance indicators to ensure planning constraints were met and to determine if ancillary impacts on other parameters would occur and, if so, to what extent.

Below, **Table 3-1** describes the relationships between the problems, objectives, performance measures, and indicators for this project. Water resources problems for the study area are described in Section 3.2 of this document. Identification of the water resources problems led to establishment of the project objectives, which are described in Section 3.3. The performance measures and indicators were developed based on these problems and objectives. All of the performance measures for this project were developed by the RECOVER Program for the CERP (RECOVER, 2005). A favorable maximum monthly total flow was developed for the estuary (2,000 cfs) that will provide suitable salinity conditions to provoke the development of important benthic communities (e.g., oysters and seagrass). Mean monthly total flows above 3,000 cfs result in freshwater conditions throughout the estuary, causing severe impacts to estuarine biota. Average monthly total flows below 350 cfs will produce high-salinity conditions (greater than 25 ppt) that are unfavorable to estuarine biota.

Table 3-1. St. Lucie River Watershed Protection Plan – Problems, Objectives, Performance Measures and Indicators, and Targets

Problem	Objective	Performance Measure/Indicator	Target
Excess freshwater discharges from Lake Okeechobee regulatory discharge events and local watershed runoff leading to an undesirable low salinity condition and muck accumulation	Manage the frequency and duration of excess freshwater discharges to the St. Lucie Estuary from the St. Lucie River watershed	The number of times discharge from the St. Lucie River watershed exceeds the High Discharge Criteria of: 1. Mean monthly flows from the St. Lucie River watershed of greater than 2,000 cfs (14-day moving average); and 2. Mean monthly flows from the St. Lucie River watershed of greater than 3,000 cfs	1. Limit mean monthly flows greater than 2,000 cfs to 21 months or less over a 432-month period 2. Limit mean monthly flows greater than 3,000 cfs to 6 months or less over a 432-month period
Excess nutrient loads from groundwater flows and surface water discharges leading to algae blooms and fish kills	Maximize N and P load reductions to meet TMDLs as they are established for the St. Lucie Estuary	Maximize load reduction and compare against TMDLs as appropriate	Meet TMDLs as established by FDEP
An increased occurrence in undesirable low and high salinity conditions in the St. Lucie Estuary due to excess or insufficient ground water and surface water flows flow from the St. Lucie River watershed which have led to unfavorable conditions for estuarine organisms	Manage watershed discharges to maintain a salinity range conducive to the ecological health of the St. Lucie Estuary (8 to 25 ppt measured from the US-1 Highway Roosevelt Bridge)	Number of months that salinity envelope in the St. Lucie Estuary is not met due to little or no flow, or excessive flows from watershed based on the low-flow target of 350 cfs and the high-flow target of between 2,000 and 3,000 cfs	1. Limit the occurrence of average monthly flows below 350 cfs (surface and groundwater combined) to 31 months or less over a 432-month period 2. Limit the occurrence of flows from the St. Lucie River watershed that are between 2,000 and 3,000 cfs for 14 days or more to 28, based on a 14-day moving average
Lake Okeechobee water levels falling below ecologically desirable levels.	Maintain Lake Okeechobee water levels within a desirable range for ecological needs ,	Number of occurrences that the Lake Okeechobee minimum water level condition was not met during the 432-month Period of Record	Limit to no more than one occurrence every six years when Lake Okeechobee water levels fall below 11 feet NGVD for more than 80 days
Water supply cutbacks that affect the ability to meet existing and future municipal, industrial, and agricultural water supply needs in the region.	Ensure plan does not adversely affect the Lake Okeechobee Service Area water supply demands	Evaluate the LOSA demand cutback volumes during 7 drought events and annual percentage of water supply demands not met during the period of record.	Maintain or reduce the percent of LOSA cutbacks and the annual water supply demands not met

CHAPTER 4

INTERAGENCY COORDINATION AND PUBLIC INVOLVEMENT

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4.0 INTERAGENCY COORDINATION & PUBLIC INVOLVEMENT

A concerted effort was made during the St. Lucie River Watershed Protection Plan (SLRWPP) planning process to involve all appropriate and relevant agencies and keep the public and stakeholders informed about the project. A public outreach initiative was developed and implemented throughout the planning process. Specific objectives of this initiative included the following:

- Develop and implement an approach that would reach all stakeholders;
- Integrate the public outreach efforts with all other aspects of the planning process; and
- Take advantage of other on-going public efforts being conducted by the South Florida Water Management District (SFWMD) and collaborating agencies as part of other St. Lucie Estuary restoration programs.

The SLRWPP public outreach initiative focused on the following activities:

- Interagency coordination;
- Public involvement and stakeholder notification; and
- Internal management and communication.

4.1 Interagency Coordination

The legislation authorizing the Northern Everglades and Estuaries Protection Program (NEEPP) required the SFWMC to work in collaboration with coordinating agencies such as the Florida Department of Environmental Protection (FDEP) and the Florida Department of Agriculture and Consumer Services (FDACS) to develop the SLRWPP.

Input from other agencies was solicited through informal interaction and during stakeholder and interagency meetings that were periodically held, such as:

- The SLRWPP Working Team;
- The Water Resources Advisory Commission (WRAC);
- The WRAC Lake Okeechobee Committee; and
- The Northern Everglades Interagency Meeting.

Table 4-1 identifies the key meetings or briefings at which input on SLRWPP planning was actively sought.

Table 4-1. Summary of SLRWPP Interagency Coordination

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Northern Everglades Interagency Meeting	September 5, 2007	Okeechobee, FL	• Northern Everglades Update
Lake Okeechobee WRAC Meeting	September 5, 2007	Naples, FL	• Northern Everglades Briefing
WRAC Meeting	September 6, 2007	Naples, FL	• Northern Everglades and Estuaries Protection Program Update
Ten County Coalition Meeting	September 14, 2007	Okeechobee, FL	• Northern Everglades Briefing
Northern Everglades Interagency Meeting	October 17, 2007	Okeechobee, FL	• Northern Everglades Update
SLRWPP Working Team Meeting #1 (Kick-Off Meeting)	October 24, 2007	Stuart, FL	• Briefing on legislation • Introduced key working team members • Formed the plan schedule • Opened for public comments
Research and Water Quality Monitoring Program Working Team Meeting #1 (Kick-Off Meeting)	October 25, 2007	Stuart, FL	• Briefing on legislation • Introduced key working team members • Formed the plan schedule • Opened for public comments
Lake Okeechobee WRAC Meeting	October 31, 2007	Okeechobee, FL	• Northern Everglades Update
WRAC Meeting	November 8, 2007	West Palm Beach, FL	• Northern Everglades and Estuaries Protection Program Update
Northern Everglades Interagency Meeting	November 27, 2007	Okeechobee, FL	• Northern Everglades Update
Lake Okeechobee WRAC Meeting	November 28, 2007	Clewiston, FL	• Northern Everglades Update
SLRWPP Working Team Meeting #2	November 29, 2007	Stuart, FL	• Briefing on plan status and schedule • Coordinating agencies update • Opened for public comments
Research and Water Quality Monitoring Program Working Team Meeting #2	November 29, 2007	Stuart, FL	• Briefing on plan status and schedule • Opened for public comments
Ten County Coalition Meeting	November 30, 2007	Okeechobee, FL	• Northern Everglades Update
Walt Disney World Environmentality Expo Day	December 3, 2007	Orlando, FL	• Northern Everglades display
Joint Meeting of WRAC/South Florida Ecosystem Restoration Task Force	December 5, 2007	Miami	• Northern Everglades Update
Stetson University	December 8, 2007	Deland, FL	• Northern Everglades presentation
Combined Lake Okeechobee Committee and WRAC	January 3, 2008	West Palm Beach, FL	• Northern Everglades Briefing
SLRWPP Working Team Meeting #3	January 15, 2008	Stuart, FL	• Briefing on plan status and schedule and coordinating agencies update • Management Measures • Opened for public comments

Table 4-1. Summary of SLRWPP Interagency Coordination

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Research and Water Quality Monitoring Program Working Team Meeting #3	January 15, 2008	Stuart, FL	• Briefing on plan status and schedule • Opened for public comments
Northern Everglades Interagency Meeting	January 29, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
Lake Okeechobee WRAC Meeting	January 30, 2008	Ft. Myers, FL	• Northern Everglades: River Watershed Protection Plans Update
WRAC Meeting	February 7, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
SLRWPP Working Team Meeting #4	February 26, 2008	Stuart, FL	• Briefing on plan status and schedule and coordinating agencies update • Management Measures • Opened for public comments
Research and Water Quality Monitoring Program Working Team Meeting #4	February 26, 2008	Stuart, FL	• Briefing on plan status and schedule • Opened for public comments
Lake Okeechobee WRAC Meeting	February 27, 2008	Stuart, FL	• Northern Everglades: River Watershed Protection Plans Update
Ten County Coalition Meeting	February 29, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
WRAC Meeting	March 6, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Environmental Preservation Committee	March 12, 2008	Tallahassee, FL	• Northern Everglades and Estuaries Protection Program Briefing
Lee County Meeting	March 19, 2008	Fort Myers, FL (Conference Call)	• Caloosahatchee River Watershed Protection Plan Discussion
SLRWPP Working Team Meeting #5	March 25, 2008	Stuart, FL	• Briefing on plan status and schedule and coordinating agencies update • Management Measures • Opened for public comments
Lake Okeechobee WRAC Meeting	March 26, 2008	Okeechobee, FL	• Lake Okeechobee Technical Plan, Phase II and River Watershed Protection Update
Northern Everglades Interagency Meeting	March 27, 2008	Stuart, FL	• Northern Everglades and Estuaries Protection Program Update
Research and Water Quality Monitoring Program Working Team Meeting #5	March 28, 2008	Stuart, FL	• Briefing on plan status and schedule • Opened for public comments
WRAC Meeting	April 3, 2008	Jupiter, FL	• Northern Everglades: River Watershed Protection Plans Update

Table 4-1. Summary of SLRWPP Interagency Coordination

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Governing Board Workshop	April 9, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
SLRWPP Working Team Meeting #6	April 22, 2008	Stuart, FL	• Briefing on plan status and schedule and coordinating agencies update • Management Measures • Base conditions and development of alternatives • Opened for public comments
Research and Water Quality Monitoring Program Working Team Meeting #6	April 22, 2008	Stuart, FL	• Briefing on plan status and schedule • Opened for public comments
Meeting with DCA Secretary Pelham and staff	April 28, 2008	NA (Conference Call)	• Northern Everglades and Estuaries Protection Program Coordination Meeting
Lake Okeechobee WRAC Meeting	April 30, 2008	Clewiston, FL	• Northern Everglades: River Watershed Protection Plans Update
WRAC Meeting	May 8, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Okeechobee Board of Realtors	May 21, 2008	Okeechobee, FL	• Northern Everglades Update
SLRWPP Working Team Meeting #7	May 27, 2008	Stuart, FL	• Briefing on plan status and schedule and Coordinating agencies update • Status on regional simulation model and water quality spreadsheet analysis • Opened for public comments
Lake Okeechobee WRAC Meeting	May 28, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Ten County Coalition Meeting	May 30, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
Northern Everglades Interagency Meeting	June 4, 2008	Okeechobee, FL	• Northern Everglades Update
Okeechobee Economic Council Meeting	June 4, 2008	Okeechobee, FL	• Northern Everglades Update
WRAC Meeting	June 5, 2008	Hollywood, FL	• Northern Everglades: River Watershed Protection Plans Update • Analysis of Impacts of Lake Regulation Schedules and its Relation to Northern Everglades
Governing Board Workshop	June 11, 2008	Ft. Myers, FL	• Presentation regarding contracts for St. Lucie River Watershed 5/5/5 Projects

Table 4-1. Summary of SLRWPP Interagency Coordination

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
SLRWPP Working Team Meeting #8	June 24, 2008	Stuart, FL	• Briefing on plan status and schedule and Coordinating agencies update • Status on regional simulation model and water quality spreadsheet analysis • Alternatives formulation • Opened for public comments
Research and Water Quality Monitoring Program Working Team Meeting #7	June 24, 2008	Stuart, FL	• Briefing on plan status and schedule • Opened for public comments
Lake Okeechobee WRAC Meeting	June 25, 2008	Ft. Myers, FL	• Northern Everglades: River Watershed Protection Plans Update
Highlands County Conservation Connection Day	June 25, 2008	Sebring, FL	• Northern Everglades Display
WRAC Meeting	July 3, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Martin County Staff Meeting	July 10, 2008	Stuart, FL	• Northern Everglades Update
Palm Beach Community College	July 11, 2008	Palm Beach Gardens, FL	• Northern Everglades Presentation
Sanibel Mayor Nick Denham	July 21, 2008	Fort Myers, FL	• Northern Everglades Projects impact
SLRWPP Working Team Meeting #9	July 22, 2008	Stuart, FL	• Briefing on plan status and schedule and Coordinating agencies update • Status on regional simulation model and water quality spreadsheet analysis • Alternatives formulation • Opened for public comments
Lake Okeechobee WRAC Meeting	July 24, 2008	Stuart, FL	• Northern Everglades: River Watershed Protection Plans Update
Martin County Commission	August 13, 2008	Stuart, FL	• Northern Everglades display
Ten County Coalition Meeting	August 29, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
Governing Board Workshop	September 11, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Lake Okeechobee WRAC and WRAC Meetings	September 16, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Northern Everglades Interagency Meeting	October 2, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Plan
Public Workshop for Caloosahatchee River Watershed Protection Plan	October 27, 2008	Fort Myers, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Public Workshop for St. Lucie River Watershed Protection Plan	October 28, 2008	Stuart, FL	• Overview of the draft St. Lucie River Watershed Protection Plan

4.2 Public Involvement and Stakeholder Notification

The objectives of the public outreach effort for the SLRWPP planning process were to achieve the following goals:

- Increase public awareness of the overall goals and objectives of the NEEPP;
- Inform the public and receive input regarding the project goals, objectives, progress, issues, and findings;
- Involve stakeholders, agencies, and other interested groups and individuals as the plan was developed, to ensure that public values regarding the project were fully considered;
- Reduce potential conflict among interested and affected parties by building consensus solutions to emerging issues; and
- Improve the substantive quality of project-level decisions as a result of public participation.

4.3 Public Comments

The draft SLRWPP was released for public comment on October 1, 2008. The public, stakeholders, and agencies were invited to review and provide comments on the Draft SLRWPP. Over XX comments were received over the 4-week public comment period, which closed on November XX, 2008 (see Appendix H). These comments were considered during the finalization of the SLRWPP.

CHAPTER 5

TOTAL MAXIMUM DAILY LOADS

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5.0 TOTAL MAXIMUM DAILY LOADS

5.1 Background

The Northern Everglades and Estuaries Protection Program (NEEPP) in Section 373.4595, Florida Statutes (F.S.) requires the SLRWPP to contain an implementation schedule for pollutant load reductions consistent with any adopted Total Maximum Daily Loads (TMDLs) and in compliance with applicable state water quality standards. The Florida Department of Environmental Protection (FDEP) was formulating TMDLs for the St. Lucie River watershed during the formulation of the SLRWPP. This chapter summarizes the TMDL process and the status of the St. Lucie River watershed TMDL development in middle to late 2008. Detailed information on TMDLs in the St. Lucie River watershed will be provided in FDEP's *TMDL Report Nutrient and Dissolved Oxygen TMDL for the St. Lucie Basin,* which was being developed concurrent with the SLRWPP development.

5.1.1 Clean Water Act and Florida Watershed Restoration Act

A TMDL is the maximum loading of a particular pollutant that can be discharged in a surface water and still meets its designated uses and applicable water quality standards. TMDLs provide quantitative water quality restoration goals that will guide restoration activities.

The TMDL requirements were originally promulgated as a part of the Federal Pollution Control Act of 1972 and were later expanded by the Clean Water Act (CWA) of 1977 and the Water Quality Act of 1987. The law requires states to define state-specific water quality standards for various designated uses and to identify waterbodies for which the ambient water quality has been determined not to meet established standards (Subsection 303(d)). Waterbodies that do not achieve such water quality standards as a result of human-induced conditions are considered impaired. An updated list of impaired waterbodies must be presented by the state to the U.S. Environmental Protection Agency (USEPA) every 2 years and must designate which of the listed impaired waterbodies will require implementation of the TMDL process.

In Florida, a TMDL is required when a water segment is determined to be impaired. This process has been defined by the Florida Watershed Restoration Act (Section 403.067). Regulations have been promulgated under the Impaired Waters Rule [Chapter 62-303, Florida Administrative Code (F.A.C.)]. The rule defines methods to identify water segments requiring a TMDL.

The two-step process for the listing of impaired waters is based on the Florida Watershed Restoration Act. The first step involves developing the initial "planning list" that names potentially impaired waters based on existing impairment-related data. The second step involves developing a focused list of "verified" impaired waters based on additional data. The list of waters for which impairments have been verified using the methodology in the Impaired Waters Rule is referred to as the verified list. This "verified list" is adopted by the FDEP Secretary and constitutes the required 303(d) list. The FDEP has developed these lists since 1992, and Florida's 1998 303(d) list included 571 waterbodies.

5.1.2 Total Maximum Daily Load Development Timelines

The schedule for TMDL development is driven by the Consent Decree (also known as the 98 List) and the Subsection 403.067(4), Florida Statutes (F.S.) of the Florida Watershed Restoration Act. Both documents require a list of impaired waters in each basin. The Consent Decree identified a due date for specific waterbody pollutant combinations. Meanwhile, the Florida Watershed Restoration Act also laid out timelines for the development of other TMDLs. This legislation requires the lists of impaired waters to be updated annually and to include updates of each basin statewide. The Florida Watershed Restoration Act stated that all previous Florida 303(d) lists of impairments were for planning purposes only and directed the FDEP to develop, and to 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, F.A.C. (Impaired Waters Rule), in April 2001, and modified it in 2006 and again in 2007.

5.1.3 Total Maximum Daily Load Process

In Florida, the TMDL process is multi-phased and includes the identification, the verification, and the listing of impaired waters, followed by the development and implementation of the TMDL. Below are the phases of Florida's TMDL process.

1. Preliminary data compilation and assessment
2. Strategic monitoring and assessment to verify water quality parameters
3. Development and adoption of TMDL
4. Development of Basin Management Action Plan and allocations
5. Implementation of Best Management Action Plan to meet TMDL and monitoring of results

5.1.4 Watershed Approach

In order to address pollutants in the state's waterbodies, the FDEP has adopted a watershed-based management approach, which is implemented using a cyclical management process that rotates through the state's 52 major hydrologic basins in five groups over a 5-year cycle (FDEP Basin 411 Web site-see references). Each of the FDEP Districts is divided into five geographically based groups of watersheds, as broken down in **Table 5-1**. **Figure 5-1** illustrates the basin groups as well as the rotation schedule for each group.

5.2 Development of Total Maximum Daily Loads for St. Lucie River Basin

Florida's impaired waters assessment process divides waters into segments, each of which is assigned a unique waterbody identification number. The St. Lucie Basin is divided into nine waterbody identification numbers included on Florida's verified impaired (1998 303(d)) list for various pollutants including nutrients (chlorophyll-a) and dissolved oxygen (DO). **Figure 5-2** shows the St. Lucie River Basin boundary.

Table 5-1. Basin Groups and Florida Department of Environmental Protection Districts

FDEP District	Group 1 Basins	Group 2 Basins	Group 3 Basins	Group 4 Basins	Group 5 Basins
Northwest	Ochlockonee-St. Marks	Apalachicola-Chipola	Choctawhatchee-St. Andrews Bay	Pensacola Bay	Perdido Bay
Northeast	Suwannee	Lower St. Johns	-	Nassau-St. Marys	Upper East Coast
Central	Ocklawaha	Middle St. Johns	Upper St. Johns	Kissimmee	Indian River Lagoon
Southwest	Tampa Bay	Tampa Bay Tributaries	Sarasota Bay-Peace-Myakka	Withlacoochee	Springs Coast
South	Everglades West Coast	Charlotte Harbor	Caloosahatchee	Fisheating Creek	Florida Keys
Southeast	Lake Okeechobee	St. Lucie-Loxahatchee	Lake Worth Lagoon-Palm Beach Coast	Southeast Coast-Biscayne Bay	Everglades

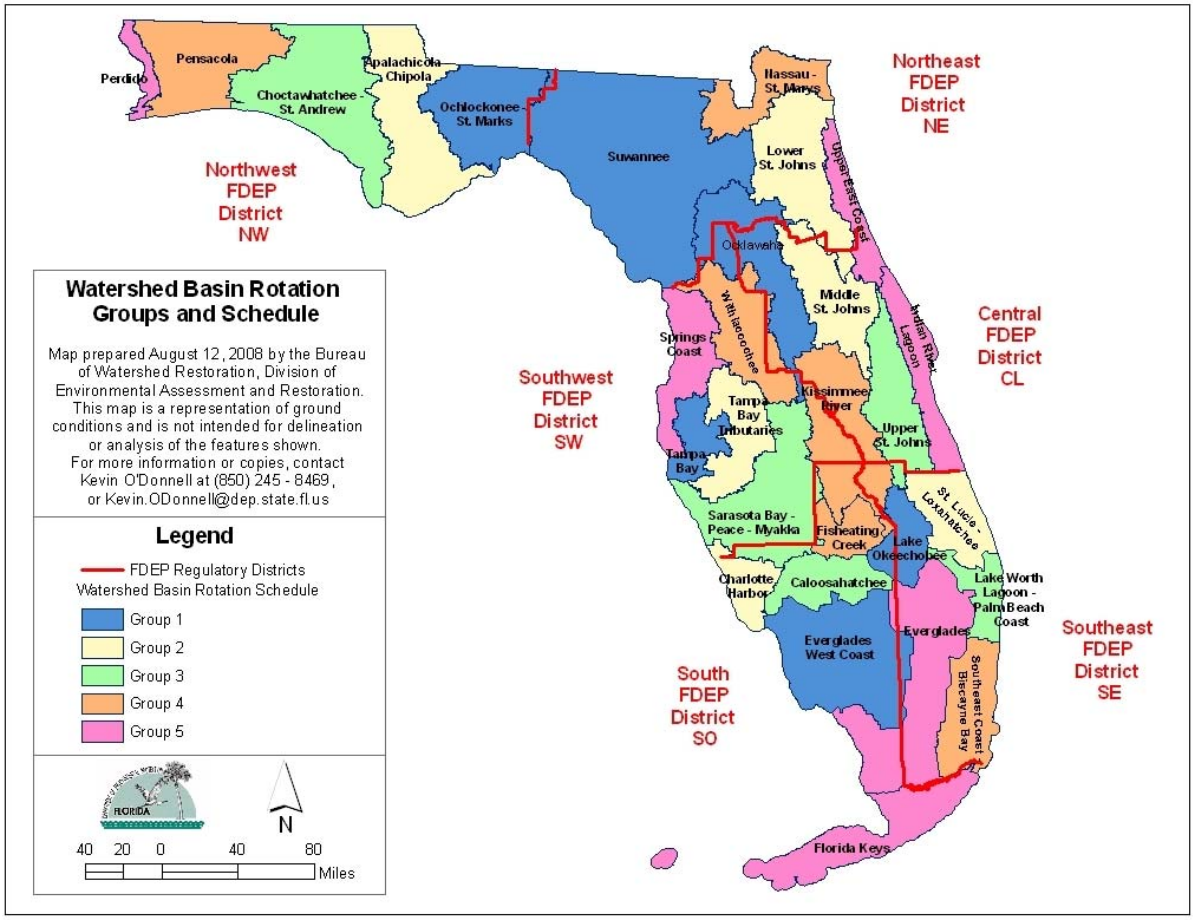

Figure 5-1. Watershed Basin Rotations Groups and Schedule

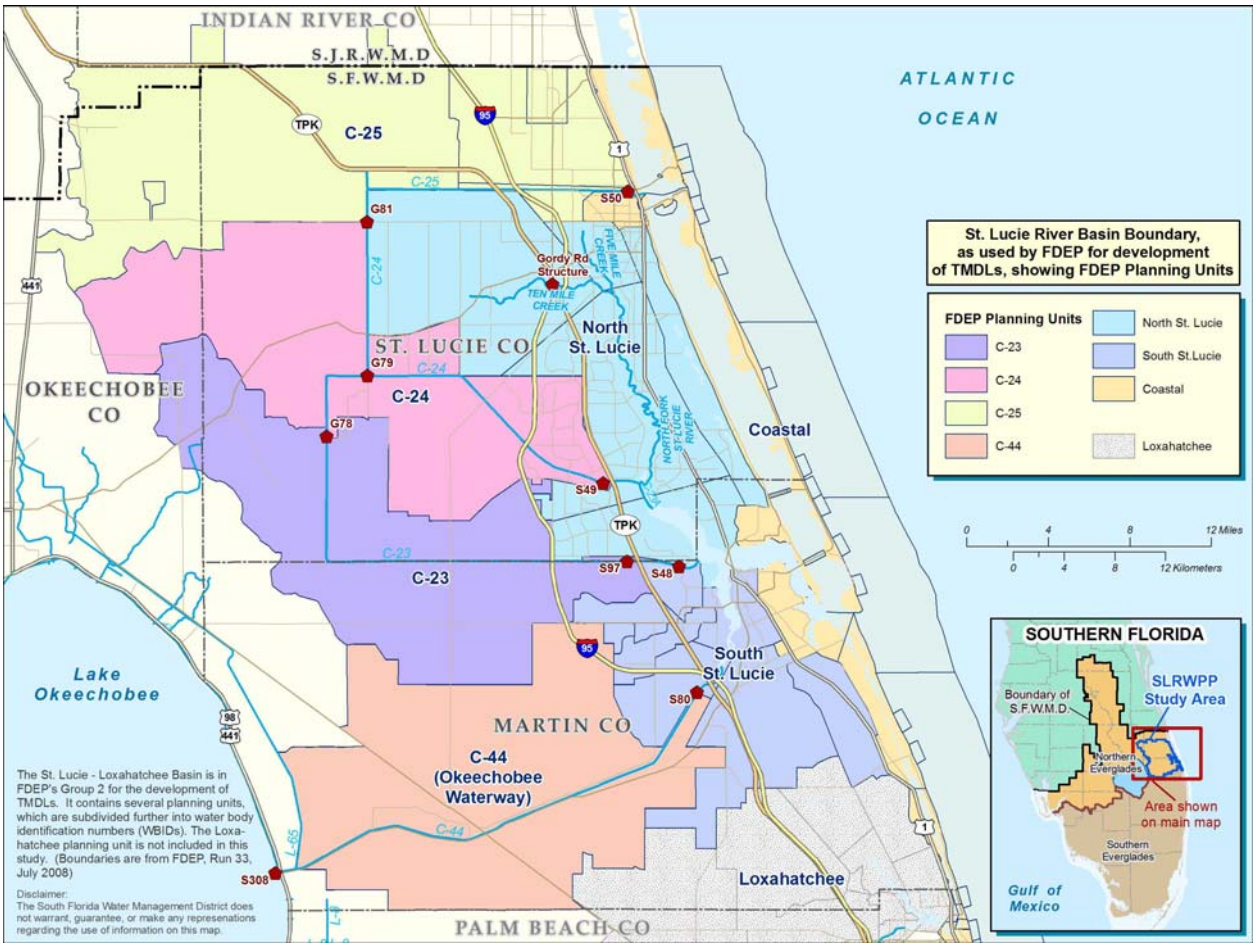

Figure 5-2. The St. Lucie River Basin boundary

5.2.1 Impaired Waterbody Identification Numbers

Table 5-2 and **Figure 5-3** display the waterbody identification numbers in the St. Lucie Basin determined to be impaired for either DO or nutrients (chlorophyll-a) during the verified period. These waterbody identification numbers were verified as impaired for nutrients based on annual chlorophyll-a data exceeding 20 micrograms per liter in freshwater segments and 11 micrograms per liter for marine waters. These are threshold values that the FDEP uses to implement the narrative nutrient criteria (see 62-302, F.A.C.).

Waterbody identification numbers were verified as impaired for DO if the data showed that DO levels were below state standards more than 10 percent of the time. The St. Lucie Basin is composed of Class III waterbodies, with a designated use of recreation, propagation, and maintenance of healthy, well-balanced populations of fish and wildlife. The Class III water quality criterion for DO in fresh water is that it shall not be less than 5.0 milligrams per liter. For marine waterbodies, DO shall not average less than 5.0 milligrams per liter in a 24-hour period and shall never be less than 4.0 milligrams per liter. As a Group 2 Basin in the TMDL basin

rotation cycle, the verified list for the St. Lucie is being revised this year, with adoption of the updated verified list (Cycle 2) expected in 2009.

Table 5-2. Impaired Waterbodies Included in the Current St. Lucie TMDL

Waterbody	Waterbody Identification Number	Impairment Status	
		DO	Nutrients
St. Lucie Lower Estuary	3193	Not Impaired	Impaired
North Fork St. Lucie River	3194	Impaired	Impaired
North St. Lucie Estuary	3194B	Impaired	Impaired
C-24	3197	Impaired	Impaired
C-23	3200	Impaired	Impaired
South St. Lucie Estuary	3210	Not Impaired	Impaired
South Fork St. Lucie River	3210A	Impaired	Impaired
Bessey Creek	3211	Impaired	Impaired
C-44	3218	Impaired	Not Impaired

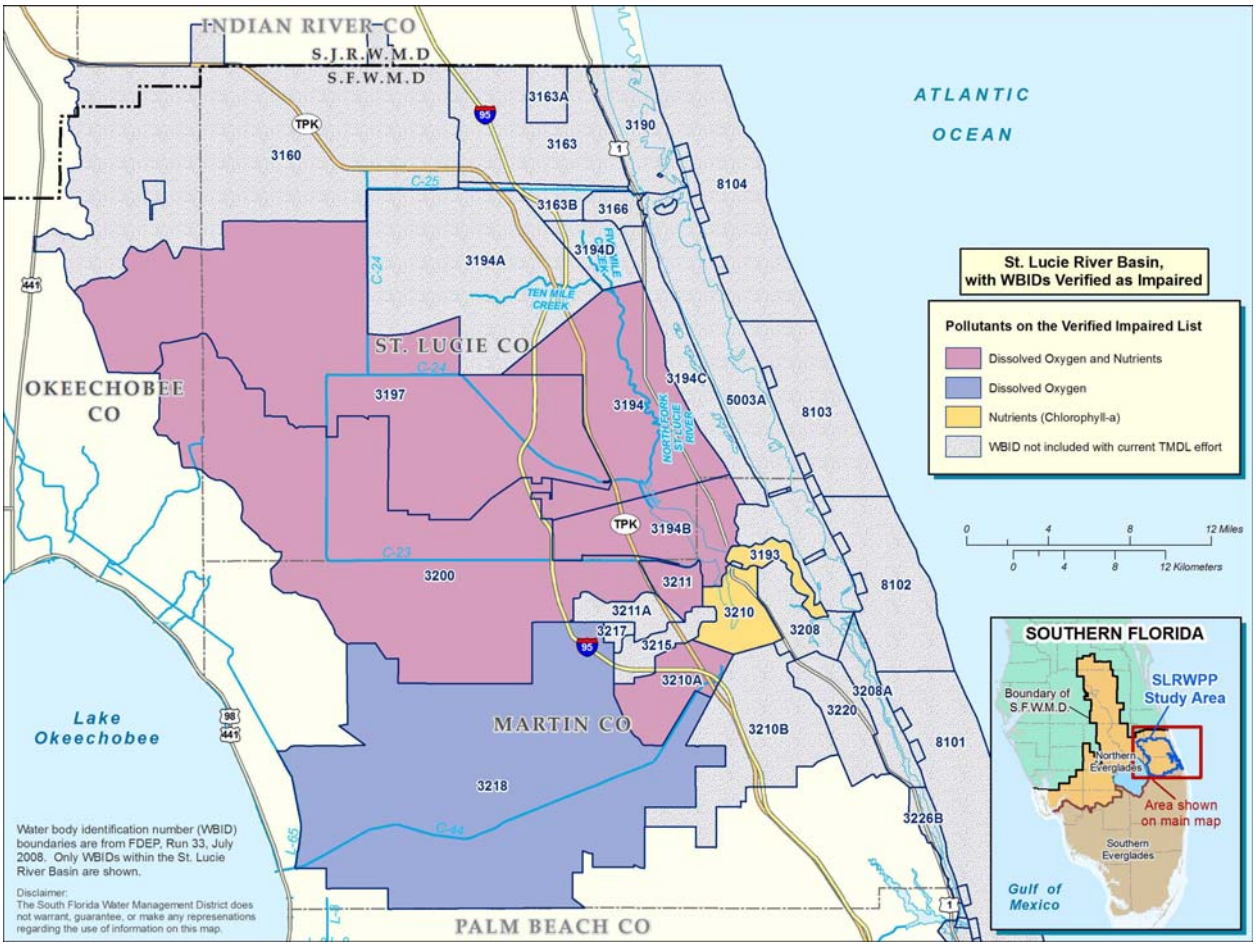

Figure 5-3. Impaired Waterbodies Included in Current St. Lucie Total Maximum Daily Load (Waterbody Identification Numbers 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218)

5.2.2 Modeling Efforts

The Watershed Hydrology and Water Quality (WaSh) Model is a distributed process-based, coupled hydrologic, hydrodynamic, and water quality model originally developed for the unique hydrologic conditions in South Florida (URS, 2008). The WaSh Model was originally configured and applied to basins draining to the St. Lucie Estuary for previous studies conducted by the South Florida Water Management District (SFWMD). Over the course of 3 years, with participation from local stakeholders and the SFWMD, the original model was updated using more recent and high-intensity data collected in the watershed.

Work continues to calibrate and to validate the water quality components of the model. However, the model's hydrologic response has been configured and successfully calibrated and validated for all of the basins influencing the St. Lucie Estuary (URS, 2008). The flow calibration consisted of comparisons of daily flow measurements over a 6-year period (1995 to 2000) and comparisons to monthly salinity data for a 3-year period (2003 to 2005). Given confidence in the hydrodynamic calibration and validation, flows from the WaSh Model were used in calculation of the St. Lucie TMDL.

5.3 Development of Total Maximum Daily Loads for St. Lucie Basin

5.3.1 Target Nutrient Reduction Goals

Establishing quantitative targets is one of the first steps in TMDL development. After considering several options, FDEP selected the total phosphorus (TP) and total nitrogen (TN) targets from the 2004 Central and Southern Florida (CS&F) Project *Indian River Lagoon – South Final Integrated Project Implementation Report and Environmental Impact Statement* (IRL-S PIR) as the end point for calculating the TMDLs for the affected waterbody identification numbers. These targets [81 micrograms per liter or parts per billion (ppb) TP and 0.74 milligrams per liter or parts per million (ppm) TN] applied at the Roosevelt Bridge are supported by several additional lines of evidence developed through subsequent evaluations by the FDEP and the SFWMD (see the FDEP TMDL Report, *Nutrient and DO TMDL for the St. Lucie Basin,* for more information).

5.4 Timetable for Total Maximum Daily Load Completion

An estimate for adoption of the nutrient (TP and TN) and DO TMDLs for the St. Lucie Basin is provided in **Table 5-3**. The schedule is based on best available data, but it may be subject to change.

Table 5-3. St. Lucie Basin Total Maximum Daily Load Schedule

Action Item		Schedule
1	Writing Draft TMDL Documents with Reviewer Inputs	In Progress
2	Review TMDL Documents by SFWMD and Working Group	August 2008
3	Consensus from Working Group on Final TMDL Document	September 2008
4	TMDL Public Meeting and Comment Period	October 2008
5	Finalize TMDL Documents to Address Public Comments	Early November –Mid November 2008
6	Administrative Steps for Adoption	Late November –Early December 2008
7	FDEP Adoption of TMDLs	Mid December 2008
8	USEPA Review	To Be Determined
9	Best Management Action Plan Kickoff	2009

5.5 Basin Management Action Plans

This TMDL will be implemented primarily through a Basin Management Action Plan. Section 373.4595 F.S. requires that the Best Management Action Plan be initiated no later than 90 days after adoption of this TMDL, and that the Best Management Action Plan be completed as soon as practicable. In the St. Lucie River watershed, the Best Management Action Plan process will be closely coordinated with the NEEPP Watershed Protection Plan. As discussed in Chapter 1, the St. Lucie River Watershed Protection Plan (SLRWPP) is being developed primarily by the SFWMD, with participation from FDEP, Florida Department of Agriculture and Consumer Services (FDACS), and a variety of interested stakeholders. The SLRWPP is due to the Florida Legislature on January 1, 2009.

Section 373.4595 F.S. calls for expeditious implementation of the SLRWPP, and states that implementation of the SLRWPP and any related Best Management Action Plans is a reasonable means of achieving TMDLs and compliance with state water quality standards. The SFWMD and FDEP are working closely together to coordinate the NEEPP and Best Management Action Plan processes, avoid overlap, and ensure that implementation efforts are timely and cost-effective. Prior to initiation of the Best Management Action Plan, the FDEP will closely review the SLRWPP and identify components of the Watershed Plan that are directly applicable to the Best Management Action Plan. Basic Best Management Action Plan guidelines are outlined in 403.067(7) F.S., including:

- Appropriate load reduction allocations among the affected parties, or to the basin as a whole [403.067(7)(a)2.];
- A description of the appropriate management strategies to be undertaken, including regional treatment systems or other public works, where appropriate;
- An implementation schedule;
- A basis for evaluating the plan's effectiveness;
- Feasible funding strategies;
- Linkages to affected National Pollution Discharge Elimination System (NPDES) permits;
- Mechanisms by which potential future increases in pollutant loading will be addressed;

- A water quality monitoring component sufficient to evaluate progress in pollutant load reductions; and
- An assessment process to occur no less than every 5 years.

The Best Management Action Plan will likely include other factors beyond these basic elements. The Best Management Action Plan development process will occur with the close cooperation of local stakeholders and FDEP's partner NEEPP agencies (SFWMD and FDACS), many of whom were involved in development of this TMDL.

CHAPTER 6.0

ST. LUCIE RIVER WATERSHED CONSTRUCTION PROJECT

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6.0 ST. LUCIE RIVER WATERSHED CONSTRUCTION PROJECT

Section 373.4595(4)(b)1., Florida Statutes (F.S.), requires the establishment of a St. Lucie River Watershed Construction Project. The purpose of the project is to identify potential water quality and quantity projects within the St. Lucie River watershed and Estuary, formulate alternatives based on the projects identified, and identify a Preferred Plan that results in the most benefits to the St. Lucie Estuary.

This chapter includes the following five sections, which describe the tools and processes used to formulate and evaluate alternatives to meet overall project objectives for water quality and quantity. As a result, a Preferred Plan is identified that provides the best overall strategy for improving the hydrology, water quality, and aquatic habitats within the SLRWPP study area. The basis for the identification of the Preferred Plan is discussed in Section 6.5. A detailed description of the Preferred Plan is included in Chapter 9.0.

Section 6.1 - Management Measures – This section discusses the different Management Measures (MMs) identified within the St. Lucie River Watershed that can address one or more of the planning objectives. MMs discussed include watershed water quality projects, estuary water quality projects, water quantity/storage projects, water disposal projects, and land management and restoration projects.

Section 6.2 - Water Quantity Analysis Methods – This section provides an overview of the analysis method used to evaluate project alternatives in terms of water quantity performance measures.

Section 6.3 - Water Quality Analysis Method and Base Condition Characterization – This section provides an overview of the method used to evaluate project alternatives in terms of water quality performance measures. Section 6.3 also characterizes the current water quality conditions of the St. Lucie River watershed and provides a discussion of the water quality benefits of the base projects included in the River Watershed Base Condition (base condition).

Section 6.4 - Formulation of Alternative Plans – This section describes the St. Lucie River Watershed Protection Plan (SLRWPP) formulation process including the goals, challenges, and development of alternatives. The alternative plans were formulated and evaluated by the coordinating agencies in consultation with the SLRWPP Working Team. The water quality and quantity benefits of each alternative are summarized.

Section 6.5 - Alternative Plan Evaluation and Comparison – This section evaluates and compares the water storage and quality results of the four alternatives to the water quantity and water quality targets. This section also identifies the St. Lucie River Watershed Construction Project Preferred Plan.

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SECTION 6.1

MANAGEMENT MEASURES

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6.1 Management Measures

A management measure (MM) is a current or future feature, activity, or technology that can be implemented at a specific site within the study area to address one or more planning objectives. A feature is a structural element that requires construction or on-site assembly. Storage reservoirs, Stormwater Treatment Areas (STAs), and structural best management practices (BMPs) are examples of features. An activity is a non-structural action or practice, such as operational changes, regulatory programs, and modified land management practices, which achieve one or more goals.

The coordinating agencies developed MMs by seeking input from the St. Lucie River Watershed Protection Plan (SLRWPP) Working Team, a working group of the cooperating agencies and interested stakeholders. MMs are building blocks that can be combined to form viable alternative plans.

6.1.1 Management Measures Toolbox

The MM toolbox is a compilation of various MMs that, if implemented in the St. Lucie Estuary and its watershed, could achieve the stated project objectives. MMs include both project-specific to the St. Lucie River watershed and Estuary and MMs from the Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan (LOP2TP) that were determined would have direct effects on the estuary. The MM toolbox is provided in Appendix B.

The MM fact sheets provide the general description/background of each MM and its purpose, sub-watershed, size, capacity of the feature, and the status of the initiative as provided to the Working Team (see definition is Section 3.1); they also include the summary of final water quality and water quantity benefits as determined by the Working Team. On the fact sheets, each MM was designated with individual identification codes. MMs included in the LOP2TP begin with the letters LO. MMs specific to the St. Lucie River watershed and Estuary that are not included in the LOP2TP begin with the letters SLE. These letters were followed by numbers that were assigned in the order that the MMs were identified.

Each MM was also assigned a feasibility level using the following scale:

- Level 1 – Already constructed or implemented, or construction and/or implementation is imminent;
- Level 2 – Construction/implementation likely, detailed design/activity development ongoing, siting location well defined;
- Level 3 – Implementation certainty unknown, conceptual level of design/activity development complete, siting location may be defined;
- Level 4 – Implementation certainty unknown, and conceptual idea with rough order of magnitude costs and siting location; and
- Level 5 – Implementation certainty unknown, conceptual idea with limited information.

6.1.2 Risk and Uncertainties Analysis

With any large water resources planning effort, there are numerous sources of uncertainty that can potentially impact project outcome. Because each MM carries a level of risk, the risks were also carried over to the alternatives, subjecting them to some level of uncertainty. Sources of uncertainty may include:

- Scale of the project,
- Complexity and diversity of the problems and potential solutions,
- Relationships between the impacted physical processes,
- Conceptual nature of some of the plan components based on assigned level, and
- Uncertainty related to the performance of MMs.

6.1.3 Estimating Uncertainties Associated with Management Measure Levels

The potential risks associated with the MMs' assigned level was evaluated so that appropriate risk management approaches could be considered. Because MMs risks fall between Level 1 (substantially defined) to Level 5 (conceptual), all MMs were evaluated allowing for the following criteria.

Level 1 MMs include the following characteristics:

- Substantial data supports the technologies effectiveness in similar conditions and scale.
- Planning, design/ engineering and permitting has been completed and shows that, compared to other MMs, this measure is the most appropriate for the site-specific situation.
- Private landowners, stakeholders, interest groups, the general public, and other agencies have been involved in development of the plan.
- Cost estimates have been prepared.
- Site selection has occurred and/or required real estate interests have been obtained.
- Funding has been budgeted and encumbered.
- Construction may have begun or even completed.

Level 5 MMs may contain the following characteristics:

- The proposed technology may be untested for the use and scale being considered.
- Only conceptual descriptions of the approach have been developed.
- Limited or no coordination has occurred between stakeholders.
- Design work has not been initiated.
- Site selection has not occurred except on a regional basis.
- Funding has not been established.
- Permitting has not been initiated due to lack of information.

6.1.4 Estimating Uncertainties Associated with Management Measure Performance

A very conservative approach was taken when quantifying water quantity and water quality benefits anticipated from individual MMs. When MMs were evaluated for water quantity or water quality benefits, values were estimated as minimum, most likely, and maximum. The most likely performance value was then assigned to the MM. If a MM was submitted with a benefit enumerated, that number was verified and accepted. Many water quality MMs did not have performance values assigned due to insufficient or preliminary information. These MMs may provide additional water quality benefits that are not included in the estimates for the four alternatives.

Despite this conservative approach, uncertainties associated with the performance of MMs remain. Uncertainties in potential water quantity were related to the following factors:

- Availability of adequate land,
- Cost of available land,
- Existence of geotechnical conditions conducive to construction of surface storage reservoirs,
- Availability of land in locations most suitable for capturing and storing flows,
- Interactions among various storage facilities, and
- Specific operational criteria for storage features.

Uncertainties in potential TP and TN load reduction performance of MMs are related to the following factors:

- Extent of nutrient control with different technologies,
- Most appropriate technology for nitrogen control and how to optimize treatment for nitrogen reduction,
- The availability of lands,
- Accuracy of projected flow volumes and nutrient concentrations,
- Inflow water chemistry, and
- Synergy and interactions between treatment facilities and storage facilities.

6.1.5 Types of Management Measures

The MMs in the toolbox can be applied either at the parcel scale (local features) or at a sub-watershed scale (regional features). Local features typically have minimal requirements for engineering, construction, and operations. These local features also have relatively less real estate requirements and promote landowner involvement. In contrast, regional features require significant amounts of real estate acquisition, engineering, construction, and operations. Another scale designation is source control, which includes projects that contain pollutants on site, many of which are included in the report entitled *Nutrient Loading Rates, Reduction Factors, and Implementation Costs Associated with BMPs and Technologies Phosphorus and Nitrogen reductions* (Soil and Water Engineering Technology, Inc., 2008).

MMs can also be broadly grouped into five general categories described below. These categories include watershed water quality projects, estuary water quality projects, water quantity/storage projects, water disposal projects, and land management and restoration projects. **Table 6.1-1** (at the end of this section) shows the scale, general category, and sub-watershed for each MM in the toolbox.

6.1.5.1 Water Quantity/Storage

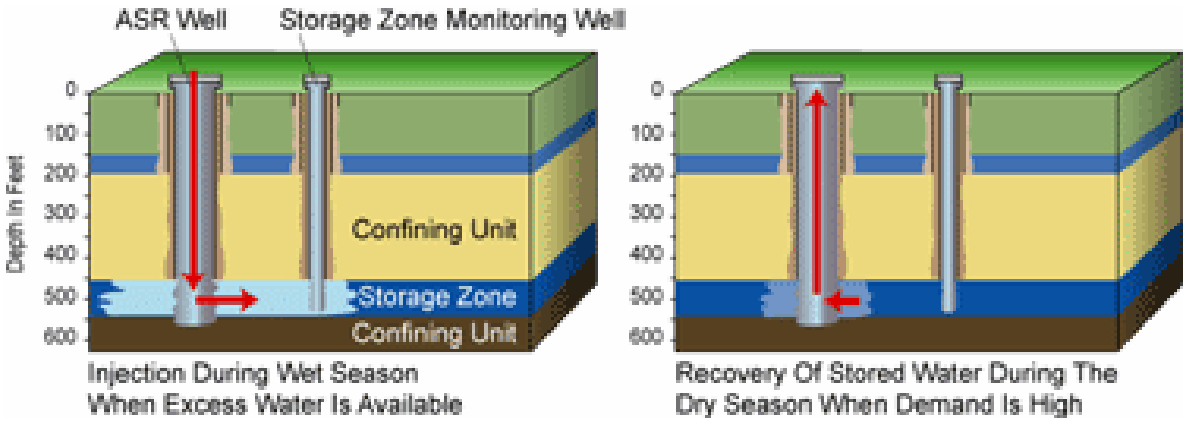
MMs considered for capturing and storing stormwater runoff in the watershed included aboveground reservoirs, Alternative Water Storage Facilities, (AWSFs), and Aquifer Storage and Recovery (ASR) wells.

6.1.5.1.1 Reservoirs

Aboveground reservoirs are the most common types of surface water storage features that comprise large areas of land surrounded by levees that are used to store water. They also provide ancillary quality benefits because nutrients and contaminants tend to settle out within the reservoir. Reservoir storage sites are planned at various sites throughout the St. Lucie River watershed, including treatment areas along the C-44 Canal, C-23/24 Canals, and the North Fork of the St. Lucie River.

6.1.5.1.2 Aquifer Storage and Recovery

ASR involves injecting water into an aquifer through wells and then pumping it out from the same aquifer when needed. The aquifer essentially functions as a water bank. Deposits are made in times of surplus, typically during the rainy season, and withdrawals occur when available water is needed, typically during a dry period. Storage zone monitoring wells are also put in place and equipped with water-level recorders to track the water levels within the storage zone. Monitoring wells can also be used to test water quality parameters such as chloride, alkalinity, bicarbonate, pH, sulfate, sodium, potassium, magnesium, total dissolved solids, specific conductance, salinity, temperature, and turbidity [SFWMD and U.S. Army Corps of Engineers (USACE), 2008]. **Figure 6.1-1** displays how a typical ASR well system works under wet and dry season conditions.



Source: SWFWMD, 2004.

Figure 6.1-1. Typical Aquifer Storage and Recovery Well System

Interest and activity in ASR wells in South Florida has greatly increased over the past 10 to 15 years. ASR wells have typically been used in South Florida to store excess fresh water during the wet season and subsequently recover it during the dry season for use as an alternative drinking-water supply source. Many utility-operated ASR facilities now have wells completed in deep confined aquifers for this purpose. Large-scale application of the ASR technology is under evaluation as a storage option in the Comprehensive Everglades Restoration Plan (CERP).

A series of CERP pilot projects and a regional ASR study are currently underway and are being evaluated to help determine the magnitude of ASRs needed to assist with managing Lake Okeechobee water levels at more ecologically desirable ranges and to reduce undesirable discharges to the Caloosahatchee and St. Lucie Estuaries. The CERP ASR Program initially included three ASR pilot projects: Lake Okeechobee, Hillsboro Canal, and the Caloosahatchee River. However, because of the extensive scope of ASR envisioned for Lake Okeechobee, the Lake Okeechobee ASR Pilot Project was later split into three distinct project locations: Kissimmee River, Port Mayakka, and Moore Haven, bringing the total pilot project sites to five (SFWMD and USACE, 2008).

6.1.5.1.3 Alternative Water Storage Facilities

AWSFs essentially prevent the runoff from reaching the regional drainage system or improve the timing of its delivery, and can be developed on available private, public, and tribal lands. They are used to store and/or dispose of excess water by capturing it prior to runoff or pumping it from areas or canals with excess water, and holding it in the facility. In most cases, low technology approaches such as the use of pumps to move water to the desired area and the construction of weirs, berms, and small impoundments to detain the water in the facility are utilized. AWSFs typically require minimal design, engineering, and construction effort. If they are established on existing wetlands they are designed and operated to improve the existing wetland functions.

Several AWSFs are currently in operation or are planned for the Lake Okeechobee and St. Lucie River watersheds on both private and public lands. Numerous additional sites are currently being evaluated for AWSFs.

6.1.5.2 Water Disposal

Deep injection wells involve disposing of fluids via injection wells deep below the earth's surface and have been used extensively in the State of Florida for more than 20 years [U.S. Environmental Protection Agency (USEPA), 2005]. Deep injection wells are classified by the USEPA as belonging to one of five classes, namely, I, II, III, IV, and V, depending upon the nature of the fluid to be discharged and the depth of the well. The requirements for siting, permitting, and monitoring and the costs for construction and operation vary significantly by well class.

Permitting requirements for deep injection wells are generally easier to meet than those for ASR wells (because ASR wells typically inject into drinking-water aquifers, whereas deep injection wells typically inject into aquifers containing salt water). Deep injection wells also have the added advantage of permanent disposal of stormwater containing nutrients. Additionally, injection wells can typically be operated at higher pumping rates than ASR wells because water

is injected into a high-capacity aquifer (the injection zone). The primary disadvantage of using existing deep injection wells is that once the water is injected it cannot be easily recovered without major retrofitting. New wells can be designed with recovery options. **Figure 6.1-1** shows a deep injection well system compared with a typical ASR well and water well. Deep injection wells were considered by the SLRWPP planning team to dispose of excess stormwater runoff at selected locations in the watershed. A typical deep injection well is 24 inches in diameter and discharges 2,000 to 3,000 feet below the surface into the injection zone (see **Figure 6.1-2**). They are conceptually installed in clusters of four arranged in a linear array, and can dispose up to 17 million gallons of stormwater runoff per day per well.

6.1.5.3 Watershed Water Quality Projects

Watershed water quality projects focus on reducing nitrogen (N) and phosphorus (P) loading within the watershed before these nutrients reach the St. Lucie Estuary. MMs that may reduce N and P loading include source control/BMPs, STAs, chemical treatment, Hybrid Wetland Treatment Technology, and alternative treatment.

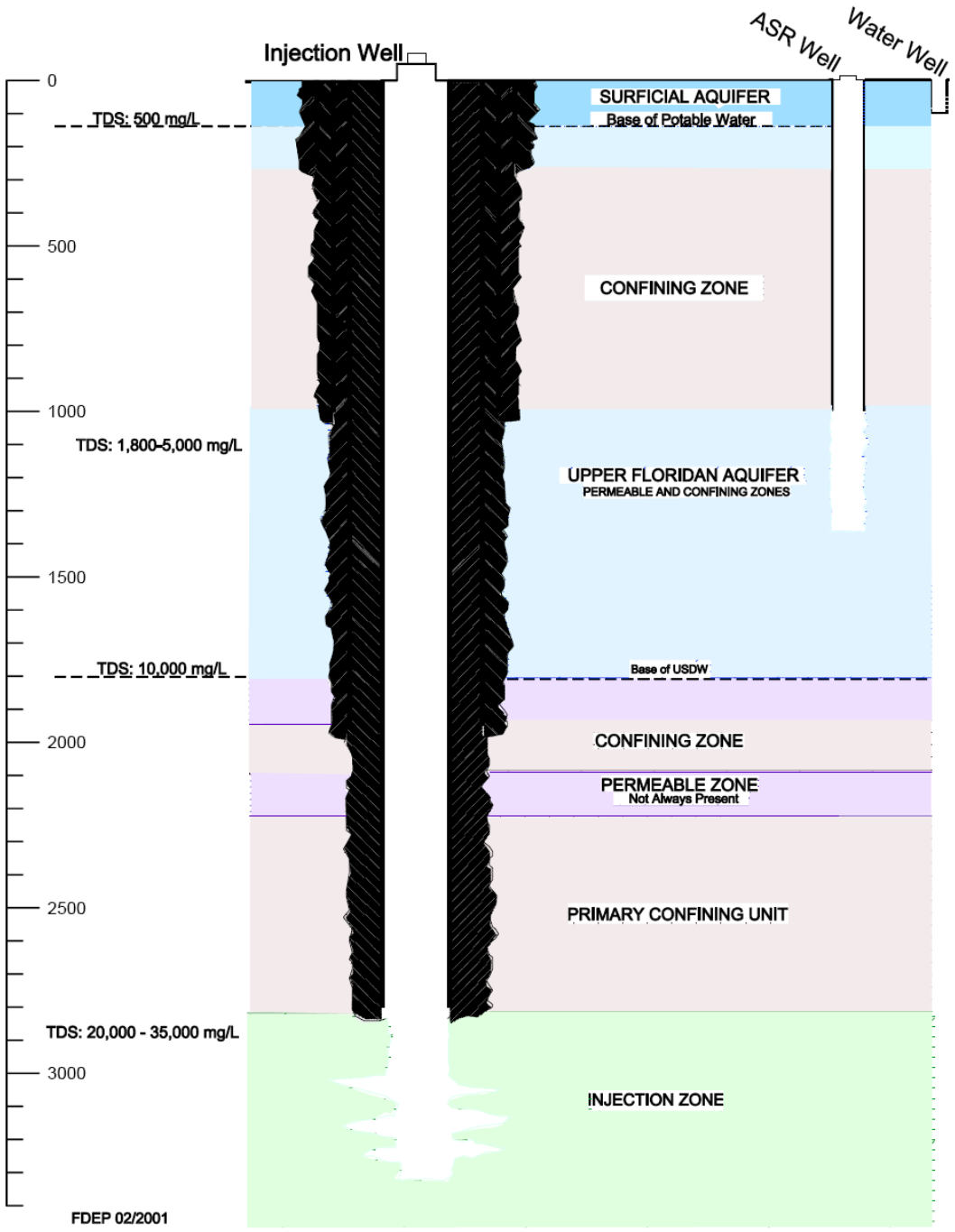
6.1.5.3.1 Source Control

Source control projects include activities and measures that focus on capturing nutrients at the source and prevent nutrients from leaving the site and entering other surface waters. The main purposes of source control projects are to:

- Minimize the use of nutrients on site;
- Ensure the nutrients are applied in an effective manner; and
- Prevent nutrient laden waters from leaving the site.

Agricultural and urban BMPs are examples of efficient and effective source control measures. The Northern Everglades and Estuaries Protection Program (NEEPP) legislation defines a BMP as "*a practice or combination of practices determined by the coordinating agencies, based on research, field-testing, and expert review, to be the most effective and practicable on-location means including economic and technological considerations for improving water quality in agricultural and urban discharges. Best management practices for agricultural discharges shall reflect a balance between water quality improvements and agricultural productivity,*" Section 373.4595(2)(a), Florida Statutes (F.S.)(2007). BMPs include structural measures such as creating physical changes in the landscape to reroute local discharges and erecting fences and barriers; and include non-structural measures such as education, operational changes, fertilizer application techniques, and establishing regulations.

Regardless of how it is achieved, source control is integral to the success of any water resource protection or restoration program. BMPs or other treatments are often utilized in a series to improve water quality by controlling the introduction (source) of nutrients into the local runoff and the movement of off-site nutrients (loss) into the drainage system. This combination of treatment technologies is known as a treatment train, because BMPs and other treatment are implemented in a series, like cars on a train. Without BMPs as the first stage technology utilized within water quality treatment trains, treatment and cost effectiveness of large, regional, capital projects such as reservoirs and STAs will be limited.



Source: FDEP, 2001.

Figure 6.1-2. Typical Municipal Class I Injection Well, Aquifer Storage and Recovery Well, and Water Well in Southeast Florida

6.1.5.3.2 Stormwater Treatment Areas

STAs are constructed wetlands that have been successful in South Florida in treating nutrients in stormwater runoff. Typically, STAs comprise flooded cells with emergent or submerged vegetation (**Figure 6.1-3**). When water flows through these cells, wetland plants and algae absorb nutrients from the water. Constructed wetlands have been shown to be very efficient in reducing nutrient loads and concentrations. Even after plants in an STA die, leaf decomposition helps sequester sediments on the wetland bottom. Cattail roots readily absorb P from these sediments (Newman et al., 1998). Over the past decade, more than 40,000 acres of STAs have been constructed and are being operated in South Florida by the South Florida Water Management District (SFWMD) to facilitate restoration of the Everglades.

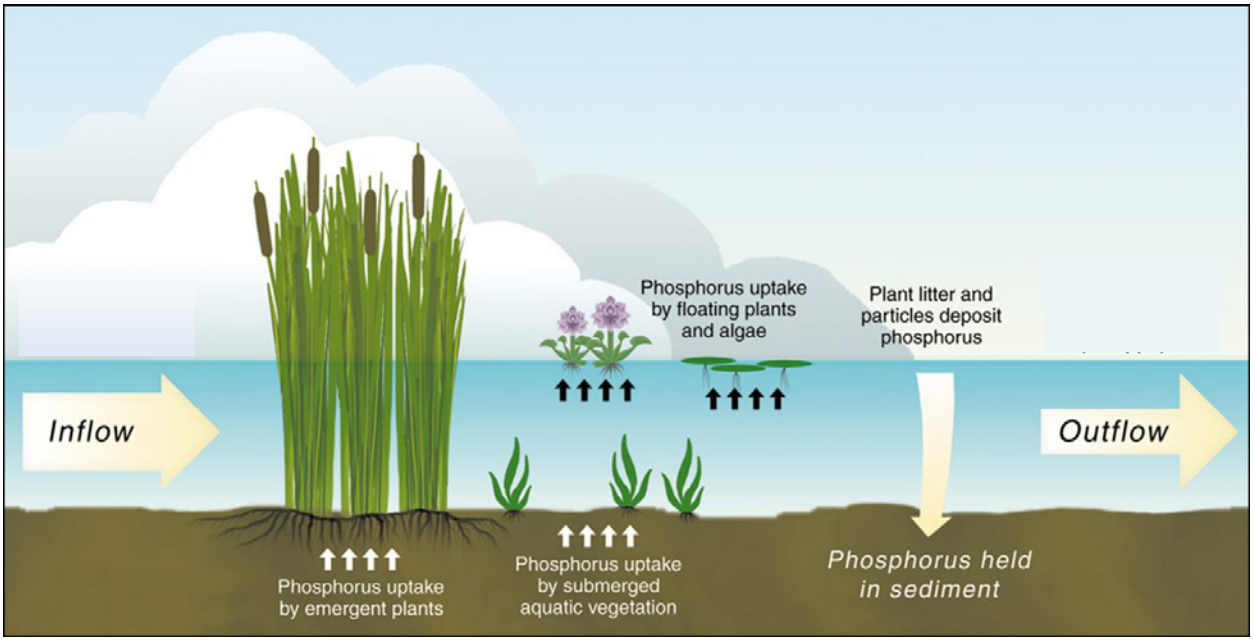


Figure 6.1-3. Typical STA with Emergent and Submerged Vegetation

The primary advantage of STAs is that they are relatively easy to design, construct, and operate. They do not use any chemicals to precipitate nutrients and are very environmentally friendly (green technology). However, they require large tracts of land and have relatively high evapotranspiration (ET) rates. STAs also require adaptive management and maintenance in order to maintain their required performance level. As more information of the lifecycle performance of these facilities is obtained, it will be used to validate the efficiencies of STAs. Understanding the removal efficiencies over time will help to identify the performance levels, maintenance, and adaptive management needs. Factors to be considered in the adaptive management process include the size of the watershed, treatment area, inflow/outflow, and nutrient rates.

There are both regional-scale and local-scale STAs included in the MMs for this plan. The regional-scale STAs include the C-44 and C-23/24 STAs, which also include reservoir components that are discussed further in the water quantity/storage section (Section 6.1.5.1.1). Local-scale STAs are discussed as wet detention projects in the following section on stormwater management.

6.1.5.3.3 Stormwater Management

The installation or upgrade of an urban stormwater management system can improve surface water quality in the watershed. A variety of structures (e.g. wet detention ponds, vegetated swales, diversion weirs, baffle boxes etc.) within a surface water management system can attenuate surface water flow to increase percolation for groundwater storage, facilitate settling, and promote nutrient uptake prior to receiving water discharge. Local scale STAs, such as smaller wet detention projects associated with older residential developments that lack stormwater treatment systems, have the potential to make a big difference in water quality within the St. Lucie Estuary.

System retrofit projects and local government Stormwater Master Plan implementation projects are MMs that will improve the conveyance of stormwater during storm events and reduce pollutant loadings from urban runoff.

6.1.5.4 Waste Management

Waste management projects reduce the N and P loading from animal and human waste. There are several waste management project MMs including an On-site Sewage Treatment and Disposal System inspection and pump-out program (SLE 13), improved management of sludge disposal in St. Lucie County through the use of an innovative technology (Plasma-Arc) (SLE 16), the North River Shores Vacuum Sewer (SLE 22), and Small Acreage Manure Management (SLE 46).

Waste management could also include improvements to wastewater treatment facilities. Effluent discharges from existing domestic wastewater treatment facilities are required to meet minimum secondary treatment standards in accordance with Rule 62-600.420(1), Florida Administrative Code (F.A.C.). New facilities and modifications of existing facilities discharging to Class I waters require treatment beyond that specified by secondary treatment. New facility permits and modification/renewal permits are frequently requiring alternative effluent discharge methods, such as reuse and groundwater injection, which reduce the N and P load entering the estuary through direct discharge. In addition, other MMs will result in the diversion of wastewater effluent discharges from treatment plants where there is insufficient demand for reclaimed water to facilities that have reclaimed water storage and distribution infrastructure already in place. There are no wastewater treatment facility MMs included in the MM toolbox at this time.

6.1.5.4.1 Chemical Treatment

Chemical treatment involves application of chemicals into contaminated stormwater runoff to aid in reduction of contaminant loads and concentrations, and of turbidity (suspended solids) in the water. It has also been successfully used to reduce turbidity and nutrient concentrations in drinking water and wastewater. Application of chemicals to stormwater to reduce nutrient loads

is relatively new and has been tested with varying levels of success in some locations such as Lake Apopka and the Everglades [SFWMD, Florida Department of Environmental Protection (FDEP), and Florida Department of Agriculture and Consumer Services (FDACS), 2007]. Chemical treatment can be used in combination with wet detention of stormwater, treatment of runoff prior to storage, or with supplemental treatment associated with reservoirs or STAs. The specific technology that will work best at any given location will primarily depend upon inflow water quality and the quantity of water to be treated.

Review of available literature indicates that calcium, iron, and aluminum salts are effective at reducing total phosphorus (TP) loads in stormwater runoff (SFWMD, FDEP, and FDACS, 2007). These technologies can be applied both in-stream and in off-line treatment systems. Aluminum sulfate (alum) treatment of runoff has been used as a stormwater retrofit option for the past 20 years. This technology is a viable retrofit option for urban areas. Alum treatment of stormwater consistently provides removal efficiencies of 85 to 95 percent for TP, >95 percent for total suspended solids (TSS), 35 to 70 percent for total nitrogen (TN), 60 to 90 percent for metals, and 90 to >99 percent for total and fecal coliform bacteria (Harper, 2007). The Platt's Creek Alum Enhancement MM (SLE 07) is an example of chemical treatment technology.

6.1.5.4.2 Hybrid Wetland Treatment Technology

Hybrid Wetland Treatment Technology (**Figure 6.1-4**) combines the strengths of the two top-ranked nutrient removal technologies, namely treatment wetlands and chemical injection system. This synergy results in nutrient removal efficiencies beyond those attainable by either separate technology with lower capital and operating costs. Optimization of system performance is achieved by adjusting hydraulic retention time (area of facility) and/or chemical dosing rates. Hybrid Wetland Treatment Technology has been previously demonstrated to reduce P concentrations from over 1,000 parts per billion (ppb) to less than 100 ppb (Watershed Technologies, Inc. 2007). Preliminary data from the existing full-scale Hybrid Wetland Treatment Technology facilities in Lake Okeechobee and St. Lucie watersheds show P concentration reductions in the range of 84 to 94 percent.

Four pilot Hybrid Wetland Treatment Technology systems are currently being field tested. Three systems are located in the Lake Okeechobee watershed and one system is located in the St. Lucie River watershed. If successful, other locations will be evaluated for application of this technology. Depending on the success of the pilot projects, additional Hybrid Wetland Treatment Technology MMs may be included in future plan updates.

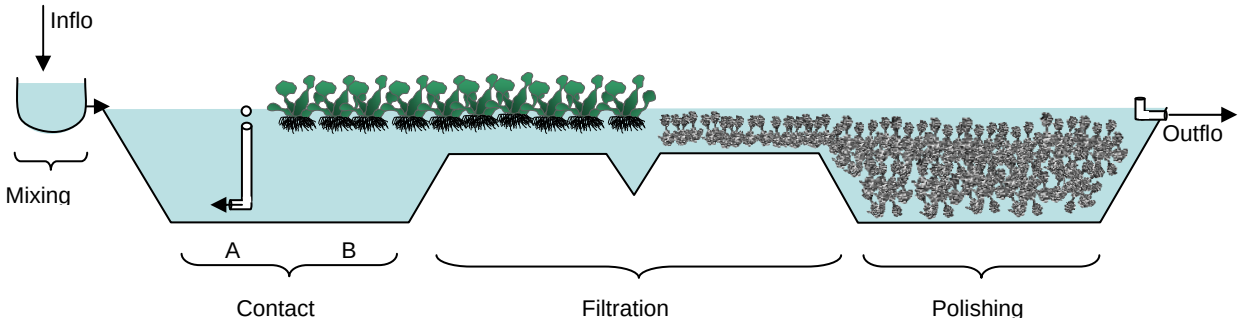


Figure 6.1-4. Example of Hybrid Wetland Treatment Technology

6.1.5.5 Estuary Water Quality Projects

Estuary water quality projects are located within the estuary and focus on reducing N and P that have accumulated in the St. Lucie Estuary. Water quality MMs in the estuary include muck sediment removal and oyster habitat creation.

6.1.5.5.1 Muck Sediment Removal

Muck remediation involves the removal of muck within the St. Lucie Estuary that has accumulated from suspended solids in runoff from the watershed. Muck accumulation has smothered substrate that once supported healthy submerged aquatic vegetation (SAV) and oyster communities. Removal of this sediment will expose this substrate, allowing for re-colonization of SAV and oysters. Removing the muck will also improve water quality by improving the clarity and light attenuation of the water.

Four muck accumulation hot spots were identified in the Indian River Lagoon - South Final Integrated Project Implementation Report and Environmental Impact Statement (IRL-S PIR): two areas in the St. Lucie River North Fork, one area in the St. Lucie River South Fork, and one in the Mid-Estuary. Muck removal in these locations as well as in Manatee Pocket, Danforth Creek, Warner Creek, and Hidden River tributaries is included as estuary water quality projects in this plan.

6.1.5.5.2 Oyster Habitat Creation

Established oyster reefs provide many ecological benefits, including improvement to water quality. Oysters are a key indicator of the health of the St. Lucie Estuary system and are also very effective bio-filters of fine sediments and nutrients in the water column. Oyster habitat creation includes placing suitable substrates such as “oyster balls” and limestone rocks, relic shell bags under docks or on open slopes, and allowing oysters to naturally colonize on the substrate. Martin County has constructed one small demonstration project (2004-2005) and a subsequent one-half acre project in the Mid-Estuary in 2006. Oyster habitat creation in this SLRWPP will build upon existing efforts to create suitable oyster substrate in the estuary using natural or man-made conditions.

6.1.5.6 Land Management and Restoration

Characterization of land uses and opportunities for restoration of natural areas within the St. Lucie Estuary and its watershed were also being incorporated into the SLRWPP. MMs include creation and restoration of wetlands and incorporation of growth management techniques and initiatives that integrate environmental objectives into urban growth planning.

6.1.5.6.1 Wetland Restoration

Natural wetlands sequester surface water flows and provide water quality treatment through assimilation and sedimentation. Wetland restoration includes enhancing degraded wetlands or restoring areas that were historically wetlands. Wetland restoration may include stand-alone projects such as restoring the North Fork floodplain (SLE 26) or the Allapattah Complex (SLE 09b), or it may be integral components of other MMs such as Alternative Water Storage and programs such as the Florida Ranchlands Environmental Services Project.

6.1.5.6.2 Land Conservation

Conservation of natural areas in urban settings provides both natural and social benefits. One example is the Coastal and Estuarine Land Conservation Program (LO 9), which was established in 2002 to protect coastal and estuarine lands considered important for their ecological, conservational, recreational, historical, or aesthetic values. The program provides state and local governments with matching funds to purchase significant coastal and estuarine lands, or conservation easements on such lands, from willing sellers. Lands or conservation easements acquired with Coastal and Estuarine Land Conservation Program funds are protected in perpetuity so that they may be enjoyed by future generations.

Another example is the Farm and Ranchland Protection Program Partnership (LO 91), which seeks to acquire easements on private lands to remain in agriculture and to provide water quality and storage benefits in support of the Northern Everglades initiative.

6.1.5.6.3 Integrated Growth Management and Restoration

This category includes programs and projects that integrate environmental restoration objectives with urban growth initiatives. Planning and economic incentives are typically provided to encourage the use of innovative and flexible planning and development strategies and creative land use planning techniques that minimize the footprint of developments while conserving natural lands and open spaces. Comprehensive Planning-Land Development Regulations (LO 68) is an initiative to work with entities (e.g. cities and counties) in the Lake Okeechobee watershed responsible for comprehensive planning and land development proposals to review current comprehensive plans and associated land development regulations to ensure that they promote low-impact design and proper stormwater treatment.

In 2001, the Florida Legislature established Section 163.3177(11)(d), Florida Statutes, the Rural Land Stewardship Area Program. This program allows counties to designate Rural Land Stewardship Areas, to include all or portions of lands classified in the future land use element as predominantly agricultural, rural, open, open-rural, or a substantively equivalent land use.

Table 6.1-1. Management Measure Summary Table

MM#	Project Feature/Activity	Category	Sub-Watershed	Project Scale
LO 1	Agricultural BMPs - Owner Implemented , Funded Cost Share, and Cost Share Future Funding (Combined LO 1, 2, and 49	Source Control	St. Lucie River watershed	Source Control
LO 3	Urban Turf Fertilizer Rule [Lake Okeechobee Estuary and Recovery (LOER)]	Source Control	St. Lucie River watershed	Source Control
LO 4	Land Application of Residuals	Source Control	St. Lucie River watershed	Source Control
LO 5	Florida Yards and Neighborhoods	Source Control	St. Lucie River watershed	Source Control
LO 7	Environmental Resource Permit (ERP) Regulatory Program	Source Control	St. Lucie River watershed	Source Control
LO 8	National Pollutant Discharge Elimination System (NPDES) Stormwater Program	Source Control	St. Lucie River watershed	Source Control
LO 9	Coastal and Estuarine Land Conservation Program	Land Management and Restoration	St. Lucie River watershed	Regional
LO 12	Alternative Water Storage - Lake Okeechobee and Estuary Recovery			
LO 12f	Alternative Water Storage - Indiantown Citrus Growers Association	Water Quantity/Storage	C-44	Regional
LO 12j	Alternative Water Storage - Dupuis	Water Quantity/Storage	C-44	Regional
LO 12m	Alternative Water Storage - Waste Management St. Lucie Site	Water Quantity/Storage	C-44	Regional
LO 12q	Alternative Water Storage - Caulkins	Water Quantity/Storage	C-44	Regional
LO 12r	Alternative Water Storage – Private Agricultural Lands	Water Quantity/Storage	C-44	Regional
LO 14	CERP – IRL-S PIR: C-44 Reservoir/STA	Water Quantity/Storage & Water Quality	C-44	Regional
LO 15	St. Lucie River Watershed 40E-61 Rule Regulatory P Source Control Program	Source Control	St. Lucie River watershed	Source Control
LO 21	Lake Okeechobee and Estuary Watershed Basin Rule (LOER)	Source Control	St. Lucie River watershed	Source Control
LO 38	C-44 Littoral	Water Quality	Outside of St. Lucie River watershed	Regional
LO 50	Agricultural BMPs - Additional Agricultural BMPs	Source Control	St. Lucie River watershed	Source Control
LO 63	Wastewater and Stormwater Master Plans	Source Control	St. Lucie River watershed	Source Control
LO 64	Unified Statewide Stormwater Rule	Source Control	St. Lucie River watershed	Source Control
LO 65	L-65 Culvert to L-8 Tieback	Water Diversion	C-44	Regional
LO 68	Comprehensive Planning-Land Development Regulations	Land Management and Restoration	St. Lucie River watershed	Regional
LO 87 Revised	Florida Ranchlands Environmental Services Project- existing, future, and full implementation			
LO 87a_1	Alderman-Deloney Ranch (C-25 Basin)	Land Management and Restoration	C-25	Regional

391 **Table 6.1-1.** Management Measure Summary Table (continued)

MM#	Project Feature/Activity	Category	Sub-Watershed	Project Scale
LO 87c	Florida Ranchlands Environmental Services Project- full implementation	Land Management and Restoration	St. Lucie River watershed	Regional
SLE 02	White City Drainage Improvements (canals B, C,D, E, F, G) SLE2a and 2b	Water Quality	North Fork	Local
SLE 03	White City Drainage Improvements (Citrus/Saeger)	Water Quality	North Fork	Local
SLE 06	Indian River Estates/Savannas Ecosystem Management Project	Water Quality	North Fork	Local
SLE 07	Platt's Creek Wetland Restoration	Water Quality	North Fork	Local
SLE 09	Natural Lands in CERP-IRL-S PIR			
SLE 09a	CERP – IRL-S PIR: PalMar Complex - Natural Storage and Water Quality Area	Land Management and Restoration	C-44, South Fork	Regional
SLE 09b	CERP – IRL-S PIR: Allapattah Complex - Natural Storage and Water Quality Area	Land Management and Restoration	C-23	Regional
SLE 09c	CERP – IRL-S PIR: Cypress Creek/Trail Ridge Complex - Natural Storage and Water Quality Area	Land Management and Restoration	C-23	Regional
SLE 10	St. Lucie Watershed Natural Area Registry Program	Land Management and Restoration	St. Lucie River watershed	Local
SLE 11	Creation of suitable oyster substrate in the St. Lucie Estuary at Various sites identified in IRL-S PIR (Artificial Habitat Creation)	In-Estuary Water Quality	St. Lucie Estuary	Regional
SLE 13	On-site Sewage Treatment and Disposal System inspection and pump-out program	Water Quality	St. Lucie River watershed	Local
SLE 16	Improved management of sludge disposal in St. Lucie County through the use of an innovative technology (Plasma-Arc)	Water Quality	C-23/C-24	Local
SLE 18	Additional Reservoir Storage and Treatment Areas			
SLE 18a	Reservoir and/or STA along the south side of the C-44 Canal	Water Quantity/Storage & Water Quality	C-44	Regional
SLE 18b	C-23/24 Water Quality Treatment Project	Water Quantity/Storage & Water Quality	C-24	Regional
SLE 19	Conversion of existing canals into "linear wetland treatment areas"	Water Quality	St. Lucie River watershed	Local
SLE 22	North River Shores Vacuum Sewer System	Water Quality	North Fork	Local
SLE 24	CERP – IRL-S PIR: C-23/24 Reservoir/STA	Water Quantity/Storage & Water Quality	C-23, C-24, North Fork	Regional
SLE 26	CERP – IRL-S PIR: Northfork Natural Floodplain Restoration	Land Management and Restoration	North Fork	Regional

392 **Table 6.1-1.** Management Measure Summary Table (continued)

MM#	Project Feature/Activity	Category	Sub-Watershed	Project Scale
SLE 27	CERP – IRL-S PIR: Muck Remediation	In-Estuary Water Quality	St. Lucie Estuary	Regional
SLE 28	Tropical Farms Roebuck Creek Stormwater Quality Retrofit	Water Quality	South Fork	Local
SLE 29	Old Palm City Phase III Stormwater Quality Retrofit	Water Quality	4, 5, & 6	Local
SLE 30	Manatee Pocket Dredging Project	Water Quality	South Fork	Local
SLE 31	Stormwater Baffle Box Retrofit - City of Stuart	Water Quality		Local
SLE 32	Danforth Creek Stormwater Quality Retrofit	Water Quality	4, 5, & 6	Local
SLE 33	North St. Lucie River Water Control District Stormwater Retrofit; Structures 81-1-2 and 85-1-2	Water Quality	North Fork	Local
SLE 35	All American Boulevard Ditch Retrofit	Water Quality	4, 5, & 6	Local
SLE 36	Everglades Comprehensive Plan Amendment	Land Management and Restoration	St. Lucie River watershed	Regional
SLE 37	Living Shoreline Initiative	Land Management and Restoration	St. Lucie Estuary	Local
SLE 38	Urban BMP Program	Source Control	St. Lucie River watershed	Source Control
SLE 39	ASR			
SLE 39a	ASR at C-44 Reservoir (IRL-S PIR)	Water Quantity/Storage	C-44	Regional
SLE 39b	ASR at C-23/24 Reservoir (IRL-S PIR)	Water Quantity/Storage	C-23, C-24	Regional
SLE 40	CERP – IRL-S PIR: Southern Diversion C-23 to C-44 interconnect	Water Diversion	C-23, C-44	Regional
SLE 41	Martin County Baffle Boxes	Water Quality	South Fork, 4-5-6, North Fork	Local
SLE 42	Jensen Beach Retrofit	Water Quality	North Fork	Local
SLE 43	Leilani Hts/ Warner Creek Retrofit - Phase 1, 2 & 3	Water Quality	North Fork	Local
SLE 44	Manatee Creek Water Quality Retrofit; Phase II & Phase III; New Monrovia, Dixie Park	Water Quality	South Fork	Local
SLE 45	10 Mile Creek - Reservoir and STA	Water Quantity/Storage & Water Quality	North Fork	Regional
SLE 46	Small Acreage Manure Management	Water Quality	St. Lucie River watershed	Local
SLE 47	Deep Well Injection			
SLE 47a	Deep Well Injection- C-44 St. Lucie Canal (LO 96)	Water Quantity/Storage & Water Quality	C-44	Regional
SLE 48	Danforth Creek Muck Removal Dredging project	In-Estuary Water Quality	St. Lucie Estuary	Local
SLE 49	Warner Creek Muck Removal Dredging Project	In-Estuary Water Quality	St. Lucie Estuary	Local
SLE 50	Hidden River Muck Removal Dredging Project	In-Estuary Water Quality	St. Lucie Estuary	Local
SLE 51	Residential Canal Weirs along North and South Fork	In-Estuary Water Quality	St. Lucie Estuary	Regional

Table 6.1-1. Management Measure Summary Table (continued)

MM#	Project Feature/Activity	Category	Sub-Watershed	Project Scale
SLE 52	E-8 Canal Stormwater Retrofit	Water Quality	North Fork	Local
SLE 53	Frazier Creek Water Quality	Water Quality	South Fork	Local
SLE 54	Haney Creek Wetland Restoration	Water Quality	South Fork	Local
SLE 55	Poppleton Creek	Water Quality	South Fork	Local
SLE 56	Farm and Ranchland Partnerships	Land Management and Restoration	St. Lucie River watershed	Regional

Note: SLE MM identification numbers were assigned as potential MMs were identified in the planning process. Some of the potential MMs were not included in the MM toolbox for the SLRWPP and their identification numbers were not re-used. LO MM identifications mirror the identification numbers assigned in the LOP2TP.

SECTION 6.2

WATER QUANTITY ANALYSIS METHODS

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6.2 Water Quantity Analysis Methods

This section describes the method used to analyze water quantity for the St. Lucie River watershed, while water quantity results are presented in Section 6.5. To establish a baseline condition to which all alternatives will be compared, the River Watershed Protection Plan Base (RWPPB) Condition is characterized and described. Finally, water quantity performance measures and targets used to evaluate how well each alternative achieves the project goals are described.

The St. Lucie River Watershed Protection Plan (SLRWPP) builds upon the Northern Everglades Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan (LOP2TP). Thus, the analysis method, modeling tools and overall evaluation methodologies employed in the current planning efforts are similar to the previous plan. These same methods and tools were utilized for the Caloosahatchee River Watershed Protection Plan (CRWPP) as well. This approach ensures consistency in the water quantity analysis conducted for the three Northern Everglades watersheds.

6.2.1 Modeling Tools

The water quantity analysis method used in SLRWPP involves the generation of water budgets for each alternative plan. The water budget information provided by the model feeds into a set of performance measures which, in turn, are used to differentiate and compare alternative plans.

A water budget reflects the relationship among all the components of hydrologic input and output for a given area. Water generally enters a system through precipitation as well as surface and groundwater flows. Water generally exits the system through human consumption (domestic, municipal, industrial, and agricultural), surface and groundwater flows, evaporation from water surfaces, and evapotranspiration from vegetation. The RWPPB Condition is a scenario that reflects conditions with the LOP2TP in place. Alternatives were developed from a series of management measures (MMs) that are intended to improve water quantity and quality consistent with the planning objectives. Each alternative plan represents a unique combination of MMs simulated in the Northern Everglades Regional Simulation Model (NERSM) and whose relative effectiveness is evaluated through a standard set of hydrologic performance measures.

The SLRWPP water quantity analysis was performed at each increment of alternative plan development. Lessons learned from the existing alternatives were used to formulate the next alternative. The NERSM was selected as the modeling tool to carry out the water quantity analysis.

6.2.1.1 Northern Everglades Regional Simulation Model (NERSM)

The NERSM is a link-node based model designed to simulate the water budget of a regional scale drainage basin. The model assumes that water in each waterbody is distributed in level pools. Therefore, local-scale features within a watershed, e.g. stages at specific gauging stations and flows across specific transects, are not simulated. The model domain covers Lake Okeechobee and four major watersheds: Kissimmee, Lake Okeechobee, St. Lucie River, and Caloosahatchee River. The watersheds were further divided into sub-watersheds as described in

the following subsections. Several MMs were combined to produce a number of alternatives whose individual impacts on pre-established performance measures were evaluated. The model was an effective tool in comparing the relative performance of the proposed alternatives for the SLRWPP.

The computational engine for NERSM was constructed using an object-oriented approach, which allows new objects to be added without the need to significantly alter the previously coded modules and objects in the computer program. For example, adding the operation of a new reservoir would be simulated as adding a discrete "object" that is automatically assigned with the features and functions commonly defined for a reservoir in the water management system. Input data for the model includes daily records of hydrologic and meteorological data (rainfall and potential evapotranspiration) as well as discharges at the boundaries for the period between 1970 and 2005. Other model input data includes physical description of management features, e.g. reservoir stage-storage relationship, structure capacities, etc. and corresponding operating rules, e.g. maximum operating levels, reservoir outflow priorities, etc.

6.2.1.1.1 Model Setup

The NERSM model boundary includes the Lake Okeechobee, St. Lucie, and Caloosahatchee River watersheds (**Figure 6.2-1**). In the LOP2TP the East Okeechobee (St Lucie River), West Okeechobee (Caloosahatchee River), and the Everglades Agricultural Area (EAA) watersheds were not explicitly modeled in NERSM. However, in the River Watershed Protection Plans planning efforts, the NERSM domain was expanded to include direct simulations in the St. Lucie and Caloosahatchee watersheds. Because the EAA is not explicitly modeled, impacts of the EAA reservoir on the other portions of the study area were considered as boundary conditions. This section focuses on the model set-up common to both LOP2TP and RWPPB Condition. The following section will provide additional details on how the two river watersheds were incorporated into the model.

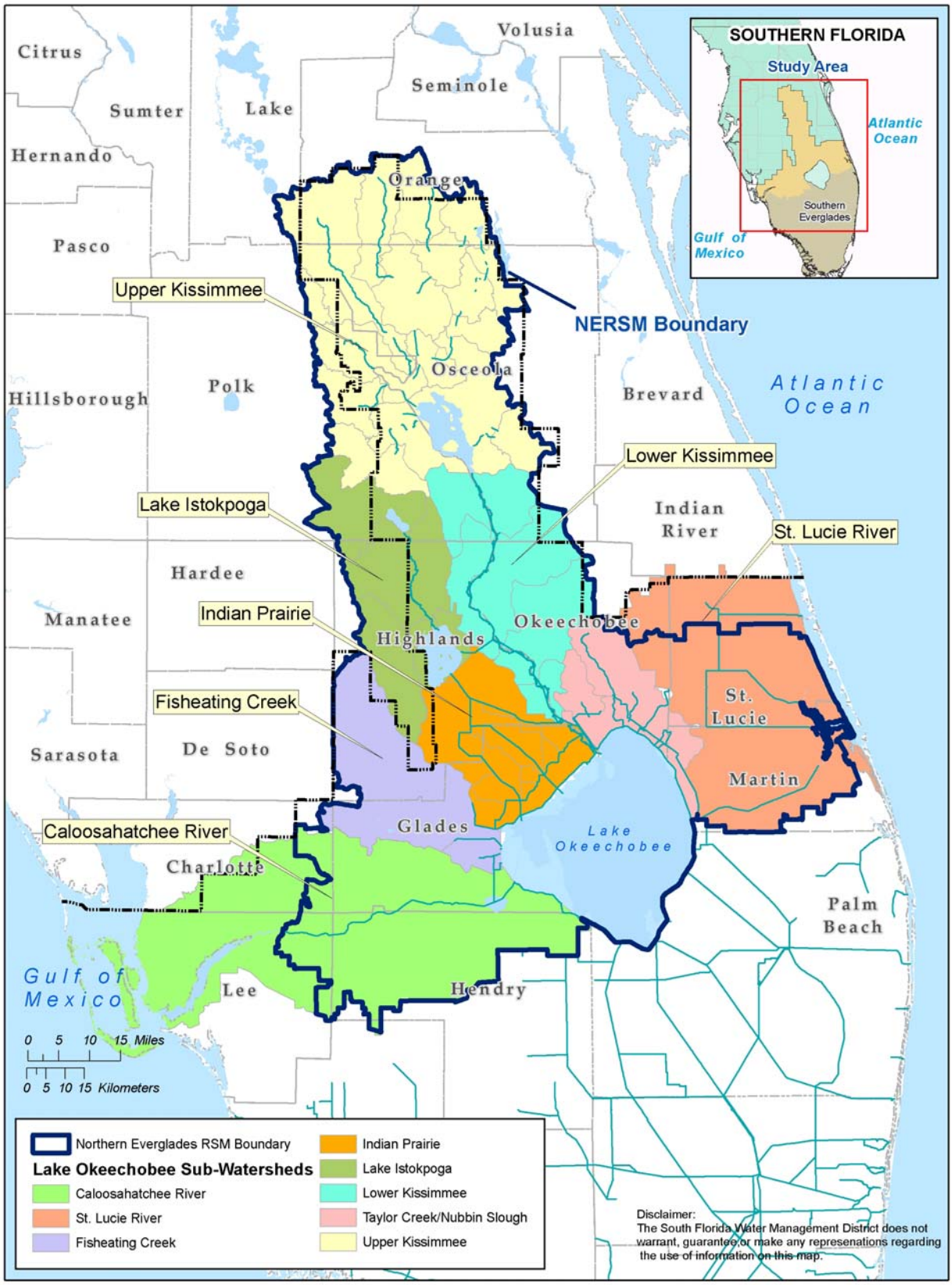

Figure 6.2-1. Watersheds Simulated in the Northern Everglades Regional Simulation Model (NERSM)

Lakes in the Upper Kissimmee watershed, and pools in the Lower Kissimmee watershed are simulated as level pools. Watershed inflows such as local runoff were treated as boundary conditions and were generated from other hydrologic models or from historical data. A flow pass-through approach is used for the other watersheds where historical runoff into Lake Okeechobee is modified based on proposed MMs specific to these watersheds.

Lake Okeechobee was also simulated using the lumped hydrologic approach. Certain inflows and outflows from Lake Okeechobee are not simulated and are incorporated into a modified delta storage term or imposed as boundary conditions. The South Florida Water Management Model (SFWMM) is the main source of boundary conditions for NERSM. Boundary conditions include environmental releases to the Everglades and water supply deliveries to the Lower East Coast urban areas, respectively. Regulatory releases from Lake Okeechobee to the Caloosahatchee and St. Lucie Estuaries and to the Water Conservation Areas (WCAs) are simulated based on the Water Supply/Environmental Regulation Schedule (WSE). The Hybrid Lake Okeechobee Water Shortage Management (LOWSM) water supply management scheme is simulated in conjunction with fixed demand boundary conditions to approximate the water supply cutbacks for Lake Okeechobee Service Area (LOSA) basins. Lake Okeechobee is a primary or secondary source of water supply to the LOSA basins.

The selected period of record, 1970 to 2005, is slightly different from the 36-year period of record (1965 to 2000) typically used by the SFWMM. The inclusion of the latter 5 years (2001 to 2005) in the NERSM period of record was driven by the desire to use the most current climatic information available, which includes extreme events such as Hurricanes Charlie, Frances, and Jeanne in 2004, and Hurricane Wilma in 2005.

No detailed verification was done during initial model set-up; however, NERSM was validated by making comparative runs with established models currently in use within the model domain: the UKISS for the Upper Kissimmee watershed (Fan, 1986) and the SFWMM for Lake Okeechobee and areas farther south.

A series of assumptions were developed to facilitate model set-up; these are documented in Appendix C. Additional information on how each individual watershed was modeled is also included in this appendix.

6.2.1.1.2 Conceptualization in the River Watershed Protection Plan

As mentioned in the previous section, additional conceptualization beyond what was done in LOP2TP was necessary for the two river watersheds in order to simulate specific MMs outside the original NERSM model domain. For a more detailed description of the model setup and conceptualization for Caloosahatchee River and St. Lucie River watersheds see Appendix C.

St. Lucie River Watershed

The St. Lucie River watershed is conceptualized as a series of interconnected nodes (e.g., single or multiple basins/storage) and links (e.g., single or multiple-purpose structure). A simple example of the node-link diagrams used for the model is shown in **Figure 6.2-2**. The St. Lucie River watershed was subdivided into four non-tidal nodes: C-44, C-23, C-24, and Ten-mile

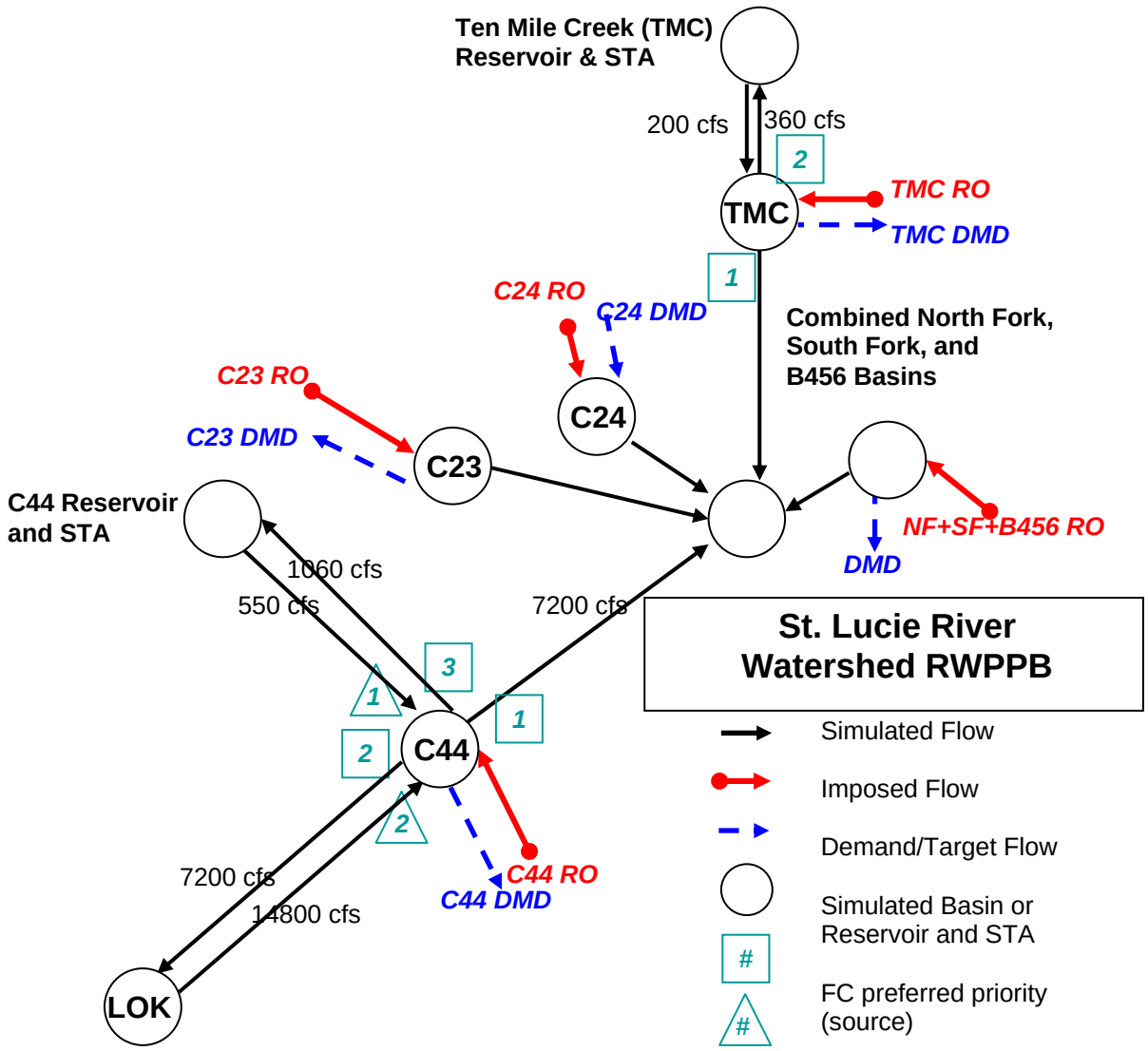

Figure 6.2-2. St. Lucie River Watershed Simulation Configuration for RWPPB

Creek; and one tidal node: Basins 4,5&6, South Fork, and tidal portion of North Fork, which is outside the Ten Mile Creek Basin. The non-tidal nodes are linked to the St. Lucie Estuary via structures, S-80, S-48, and S-49, respectively. The tidal node discharges freely into the estuary without an intervening control structure.

NERSM, as used in the LOP2TP conceptualized the St. Lucie River watershed as two nodes: C-44 and Non-C-44. It was recognized in RWPP that more detail was needed in the non-C-44 model node in order to simulate the proposed storage facilities in the different sub-basins that comprise this node. Therefore, five basins were simulated in the RWPP model runs including C-44, C-23, C-24, Ten Mile Creek, and one tidal basin [comprised of the North Fork (excluding Ten Mile Creek), South Fork and Basins 456].

Three important time series drive this model: basin irrigation demands, basin runoff, and the St. Lucie Estuary target flows. Pre-processed supplemental irrigation demands and basin runoff were associated with each basin represented in the model. Except for the C-44 Basin, all runoff and demand time series were obtained from WaSh modeling (Wan and Roaza, 2003). The runoff and demand time series for C-44 Basin (a part of the LOSA), were derived from the Agricultural Field Scale Irrigation Requirements Simulation Water Budget (AFSIRS/WATBAL) model, instead of the Watershed Hydrology and Water Quality (WaSh) modeling, to be consistent with the rest of LOSA. Non-C-44 Basins in the St. Lucie River watershed are not connected directly to Lake Okeechobee and, thus, do not receive supplemental irrigation deliveries from it. Backflow from the C-44 Basin into Lake Okeechobee is initiated when the simulated stages for Lake Okeechobee drop below 14.5 feet National Geodetic Vertical Datum (NGVD).

For the RWPPB, the C-44 and Ten Mile Creek reservoirs and Stormwater Treatment Areas (STAs) were added as additional nodes that represent storage facilities that are expected to be in place by 2015. Both the reservoir and STA facilities in each of these basins were simulated as a combined unit such that only two additional model nodes are used.

A third important time series that drives the St. Lucie River watershed simulation is the St. Lucie Estuary target time series. This time series represents the anticipated discharges into the St. Lucie River after features of the Indian River Lagoon-South Final Integrated Project Implementation Report and Environmental Impact Statement (IRL-S PIR) preferred alternative are put in place. Output from the Reservoir Optimization Model (OPTI-5 that was subsequently upgraded to OPTI-6) used in IRL-S PIR was the source for the St. Lucie Estuary target time series and is referred to as NERSM operational targets for the estuary. In order to take advantage of the increased resolution in modeling the area, the time series was parsed into each individual contributing (non-tidal) basin. To be consistent with the objectives of the SLRWPP, no Lake Okeechobee releases were made in the model to meet the low-flow operational targets for the estuary.

For SLRWPP alternative formulation, a combined C-23/C-24 Reservoir and C-23/C-24 STA model nodes were created with associated operating rules. These features are consistent with the IRL-S PIR Recommended Plan. The multiple model node representation of non-C-44 basins facilitates various scenarios for water transfer to occur between C-23 and C-44 Reservoir/STA, C-23/C-24 STA and Ten Mile Creek Basin, C-23 Basin and C-23/C-24 Reservoir, C-24 Basin and C-23/C-24 Reservoir, and C-23/C-24 Reservoir and C-23/C-24 STA as specified in the IRL-S PIR Recommended Plan (see Appendix C, Section 2.2.6.1 for more details).

Caloosahatchee River Watershed

The Caloosahatchee River watershed is conceptualized using the same node-link approach as the St. Lucie River watershed. Demand and runoff in the eastern and western Caloosahatchee River basins (ECAL and WCAL) are very different in magnitude. Therefore, in order to better account for available water for capture by individual water MMs proposed in the CRWPP, the two basins were modeled as two separate nodes. The Caloosahatchee Estuary and the S-4 Basin were also simulated as individual nodes. Specific management measures such as reservoirs and water

quality treatment features proposed in the CRWPP were modeled as storage nodes. The link-node diagrams for all the model runs are included in Appendix C.

Storage nodes are linked by single- or multi-purpose water control structures. Inflow into the ECAL includes the S-77 structure, which is used for water supply, environmental, and regulatory purposes; and the S-235 structure, which discharges excess runoff from the S-4 Basin. S-77 will also allow natural backflow into Lake Okeechobee when lake stage is below 11.5 feet NGVD. This backflow component was identified as a separate outflow time series from ECAL (S-77BK). ECAL and WCAL are connected through the S-78 structure, which controls discharge for water supply, environmental, and flood control purposes. WCAL discharges into the Caloosahatchee Estuary through S-79, which handles both deliveries to meet estuary needs and upstream excess.

Runoff generated on ECAL and WCAL was applied directly to each corresponding basin node as a boundary condition. These runoff time series were adjusted for each alternative in order to account for the footprint of proposed MMs (reservoirs and stormwater treatment areas) to be simulated within the alternative. Agricultural and public water supply demands in ECAL and WCAL, and environmental needs in the estuary drive water supply and environmental deliveries in the model. Surface water demand from the Olga public water supply plant in Lee County was accounted for in the WCAL demand time series. Excess in upstream nodes were first used to meet water supply and environmental demands in downstream nodes. The remaining water supply need was met from Lake Okeechobee subject to the Hybrid LOWSM cutback scheme.

In the RWPPB and alternative simulations, the proposed Comprehensive Everglades Restoration Project (CERP) Caloosahatchee River (C-43) West Basin Storage Reservoir was included. The purpose of this reservoir is to store basin excess and Lake Okeechobee regulatory releases that exceed estuary demands. During times of low upstream excess and absence of lake regulatory releases, the reservoir is used to meet estuary demands before any additional water is brought in from Lake Okeechobee for environmental purposes. The remaining environmental need may be met from Lake Okeechobee as long as the lake stage is above 11.5 feet NGVD.

6.2.1.1.3 Boundary Conditions

St. Lucie River Watershed

Except for the C-44 Basin, all runoff and demand time series were obtained from WaSh modeling. Because the C-44 Basin is a part of LOSA, the runoff and demand input time series was derived from the AFSIRS/WATBAL model instead of from WaSh modeling. WaSh is a time-dependent, coupled hydrologic and hydraulic simulation model. It includes many features specifically required to simulate conditions in the St. Lucie River watershed basins, such as irrigation demand and supply, high water table conditions, fully coupled groundwater and surface interactions, reservoirs and STAs, and flow structures.

Operational flow targets in NERSM were assigned downstream of each contributing basin (represented as model nodes) and were established using OPTI-6. The optimization model OPTI-6 determines the optimal sizing and operating rules for reservoirs in the watershed such that the long-term natural flow distribution of stormwater discharges to the estuary is matched. It

also minimizes the required capacities of the detention reservoirs while providing reliable supplemental irrigation at the required pumping levels (Wan et al., 2006).

The St. Lucie River watershed basins demand/runoff flow time series as produced by WaSh was used as an input to OPTI-6 to produce operational flow targets for all basins so that NERSM could know whether to hold the water or to release it to the estuary. By meeting these operational flow targets, NERSM can essentially mimic OPTI-6 performance in terms of meeting its ecological/environmental goals.

Caloosahatchee River Watershed

The NERSM runoff/demand time series for ECAL, WCAL, and S-4 Basins were obtained from the AFSIRS/WATBAL as used in the SFWMM modeling in support of the Caloosahatchee River (C-43) West Basin Storage Reservoir Project. The AFSIRS/WATBAL hydrologic model is a simplified basin-scale water budget model and is based on the AFSIRS model (Smajstrla, 1990). The AFSIRS/WATBAL calculates the supplemental (beyond local net rainfall and storage) demands for irrigated and non-irrigated lands and provides basin scale estimates of runoff. Output from AFSIRS/WATBAL was used as input to both SFWMM, and more recently, to the NERSM.

A 36-year (1970 to 2005) period of record was used for this project. Even though the ECAL and WCAL basins were represented in the AFSIRS/WATBAL model, the calibration was performed for the entire Caloosahatchee basin as a whole (Wilcox and Konyha, 2003).

6.2.1.2 Long-term Salinity Model

To simulate the influence of watershed freshwater inflow on estuarine salinity, a two-dimensional hydrodynamic/salinity model (RMA-2, 4) was developed for the St. Lucie Estuary/Indian River Lagoon (Hu, 1999) in 2000, as discussed below. During this planning process, the NERSM output was used as input into the long-term salinity model to predict estuarine salinity levels resulting from the various modeled conditions. The salinity data from the long-term salinity model were then used as input in the oyster model discussed below to evaluate oyster mortality response to changing hydrologic conditions.

RMA-2 computes water surface elevation and horizontal flow velocity for sub-critical, free-surface flow by solving the Reynolds form of the Navier-Stokes equation in a two-dimensional flow field. RMA-4 simulates the depth-averaged salinity through the advection-diffusion processes in an aquatic environment. The RMA model was calibrated using a wide range of flow conditions with flow, elevation, and salinity data collected throughout the estuary. The model was applied in the IRL-S PIR by generating a family of dynamic-equilibrium solutions. These solutions were generated for steady inflows and a repeating series of tidal boundary conditions. The dynamic equilibrium simulations were used to develop a utility salinity model. This model considers the salinity transition time and allows for long-term simulation of daily average salinity. The predicted salinity agrees well with measured salinity data.

6.2.1.3 Oyster Model

The Eastern oyster (*Crassostrea virginica*) was selected as a valued ecosystem component for evaluation of the influence of watershed hydrology on estuarine ecosystem health. The salinity data from the long-term salinity model were then used as input in the oyster salinity stress model, which was developed based on available literature data as described below.

A hyperbolic cosine function of daily salinity along with a temperature factor is employed in the model. The model calculates oyster stress based on the magnitude and duration of low salinity events (salinity < 12 ppt) induced by freshwater discharge. An annual stress index is obtained to classify the year into one of four categories: No stress, Stress, Harm, and Death. This simple oyster stress model was used in the IRL-S PIR for comparison of restoration alternatives. Recent updates to this model include salinity tolerance thresholds for each life stage of oysters, i.e., eggs, larvae, spat, and adult. The larval presence from March to May follows egg development from January to April. Spat and juvenile oysters are present from April through July, while year class adults are present from June to December. This update allows for evaluation of salinity stress for each of the oyster life stages. The model does not incorporate mortality from predation or increased stress from disease that are associated with low-flow, high-salinity conditions.

6.2.1.4 Model Scenarios

The modeling tools were used to evaluate project alternatives by comparing the modeling results to the performance measure targets. Base conditions were established to provide a starting point by which relative comparisons will be made between the project alternatives. The following is a summary of the various scenarios that were modeled to determine system-wide impacts likely to be associated with implementation of each alternative:

- **Current Base** (CBASE)—This scenario includes the following assumptions:
  - Represents the conditions as they existed in the Northern Everglades Watershed in 2005;
  - Assumes there are no CERP projects or Lake Okeechobee Watershed Protection Plan Construction Project, Phase II Technical Plan projects in place; and
  - Lake Okeechobee releases to the estuary and WCAs are based on the existing WSE regulation schedule.
- **River Watershed Protection Plan Base (RWPPB)**—This scenario assumes base condition of 2015 with the following projects in place:
  - LOWCP P2TP Recommended Projects: Combined reservoir storage, STA storage and Aquifer Storage and Recovery (ASR) capacity equal to 914,000 acre-feet, 54,000 acre-feet, and 66 million gallons per day (MGD), respectively. Additional details can be found in the LOP2TP;
  - A8 Projects: C-43 (Caloosahatchee River) Reservoir, C-44 (St. Lucie Canal) Reservoir and STA, and A-1 (Everglades Agricultural Area Reservoir A-1);
  - Kissimmee Projects: Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization;
  - Ten Mile Creek Reservoir in St. Lucie Watershed; and

- Authorized MODWATERS and C-111 projects.

- **Alternative Plans**—MMs were combined to develop alternative plans to meet the performance measure targets (water quantity and quality goals).

6.2.2 Water Quantity Performance Measures and Targets

Performance measures and performance indicators provide a means to evaluate how well each alternative achieves the project goals. Alternative plans are specifically formulated to achieve the targets set for each of the performance measures (e.g., flow ranges, limits, and distribution) as described in Section 6.4. Each alternative is then evaluated on how efficiently and effectively it meets such performance measure targets as discussed in Section 6.5. The performance measures and indicators utilized in the comparison include the high discharge criteria, the salinity envelope criteria, the proposed Lake Okeechobee minimum water level criteria, and the supplemental irrigation requirements.

6.2.2.1 High Discharge Criteria

As discussed in Section 3.5, favorable maximum monthly flow (from surface water sources) for the St. Lucie Estuary [2,000 cubic feet per second (cfs)] will provide suitable salinity conditions to promote the development of important benthic communities (e.g., oysters and seagrass). Mean monthly flows above 3,000 cfs result in freshwater conditions throughout the estuary, causing severe impacts to estuarine biota [Restoration Coordination and Verification (RECOVER), 2005].

The restoration target high discharge criterion for the St. Lucie Estuary is as follows:

1. Limit mean monthly flows greater than 2,000 cfs and less than 3,000 cfs to 21 months or less over a 432-month period.
2. Limit mean monthly flows greater than 3,000 cfs to 6 months or less over a 432-month period.

6.2.2.2 Salinity Envelope

Discharges from the watershed should be managed to maintain a salinity range conducive to the ecological health of the St. Lucie Estuary (8 to 25 ppt measured from the US-1 Highway Roosevelt Bridge) (RECOVER, 2005). The relationship between high flows and low salinity conditions are discussed above and addressed in the high discharge criteria section. As discussed in Section 3.5, average monthly flows below 350 cfs will produce high salinity conditions [(>25 parts per trillion (ppt)] that are unfavorable to estuarine biota. The restoration target for the salinity envelope performance indicator in the St. Lucie Estuary is as follows:

1. Limit mean monthly flows below 350 cfs to 31 months or less over a 432-month period.
2. Limit the number of times flows from the St. Lucie River watershed exceed 2,000 cfs for 14 days or more to 28 based on a 14-day moving average.

The low-flow target of 31 months is based on both surface water and groundwater sources. It is considered more favorable to the health of the ecosystem for groundwater flows to maintain this

low-flow threshold as discussed in Section 3.2.2.2. Because the NERSM model only accounts for surface water flows, a target of 196 months was used to achieve the low-flow performance comparable with the IRL-S PIR**.**

6.2.2.3 Lake Okeechobee Proposed Minimum Water Level Criterion

This criterion is being used as a performance indicator to ensure that alternatives do not cause any adverse impacts on Lake Okeechobee minimum water levels. The target of the Lake Okeechobee proposed minimum water level performance indicator allows for only one occurrence over a 6-year period when water levels drop below 11 feet NGVD for more than 80 days.

6.2.2.4 Supplemental Irrigation Requirements

Supplemental irrigation requirements are being evaluated to ensure that the plan does not adversely affect LOSA water supply demands. This was done utilizing the following two water supply performance indicators. The first indicator evaluates water supply cutback volumes during the 7 worst drought years, and the second indicator evaluates demands not met based on the entire period of record. The goal of both indicators is to ensure that LOSA demands not met and cutback volumes are equal to or better than existing conditions.

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SECTION 6.3

WATER QUALITY ANALYSIS METHOD AND BASE CONDITION CHARACTERIZATION

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6.3 Water Quality Analysis Method and Base Condition Characterization

This section provides an overview of the water quality analysis method, and based on the results of the analysis, it provides a description of the water quality conditions and conclusions for the St. Lucie River watershed and each individual sub-watershed.

6.3.1 Water Quality Spreadsheet

Water quality modeling was accomplished using algorithms in a Microsoft Excel spreadsheet to estimate nutrient loads and the load reductions that would result from the implementation of various management alternatives. This simplified approach was selected because of time constraints and, more importantly, limitations in the data needed to populate a more complex, process-based model.

Watershed loading simulations were based on land use specific total nitrogen (TN) and total phosphorus (TP) loading rates that were compiled from various sources by Soil and Water Engineering Technology, Inc. (SWET, 2008). As described below, calibration of the model was done using flow and nutrient concentrations measured at various structures in the river. The water quality spreadsheet is categorized by sub-watershed and the three basic water quality conditions: the Current Base (CBASE) Condition, the River Watershed Protection Plan Base (RWPPB) Condition, and the Alternative Conditions. **Table 6.3-1** shows an example of the water quality spreadsheet for TN, using Alternative 1 as a representative Alternative Condition. Similar calculations were made for TP, although for simplicity, these results are not shown in the table. The following sections describe the components of the water quality spreadsheet and define the columns, the origin of the data, and how the values were calculated.

6.3.1.1 Current Base Condition (CBASE)

The water quality CBASE Condition section of the water quality spreadsheet (**Table 6.3-1**) is the first building block of the spreadsheet and represents the 2005 condition of the Caloosahatchee River watershed. It summarizes the average annual discharge (column 3a), the average annual TP or TN load (column 3b), and the resulting average annual TP or TN concentration (column 3c), based on the 1995 to 2005 period of record.

In determining average annual discharge and average annual TN or TP loads, measured data were used for flow and loads from the C-23 sub-watershed, C-24 sub-watershed, and C-44 and the S-153 sub-watershed. The Watershed Hydrology and Water Quality (WaSh) Model output data were used for flow and loads from the North Fork sub-watershed; South Fork sub-watershed; and the Basins 4, 5, and 6 sub-watershed.

It is important to note that runoff from the C-44 and S-153 sub-watershed is discharged both to the St. Lucie Estuary and to Lake Okeechobee. As a result, only 77 percent of the average annual TP load and 79 percent of the average annual TN load from C-44 and S-153 sub-watershed reaches the St. Lucie Estuary, with the remaining loads going to Lake Okeechobee. The values in the average annual TP and TN column (3c) for the C-44 and S-153 sub-watershed represent 77 and 79 percent of the total TP and TN loading, respectively, from the C-44 and S-153 sub-watershed.

Table 6.3-1. Water Quality Spreadsheet Example

(1) Sub-watershed	(2) Area (acres)	(3) CBASE Condition[1/]			(4) RWPPB Condition				
		(3a) Average Annual Discharge (1995-2005) (Acre-ft)	(3b) Average Annual TP Load (1995-2005) (metric tons)	(3c) Average Annual TP Conc. (Calculated) (ppb)	(4a) Load Red. (metric tons)	(4b) Remain. Discharge (acre-ft)	(4c) Remain. Conc. (ppb)	(4d) Adjusted Remain. Load[2/] (metric tons)	(4e) Base Projects Load Reduction (%)
Basins 4 5 6	15,055	23,620	6.38	218.96	0.00	23,620	218.96	6.38	0
C-23	112,675	152,789	90.57	480.55	0.00	152,789	480.55	90.57	0
C-24	87,706	178,853	75.73	343.25	0.00	178,853	343.25	75.73	0
C-44&S-153	129,719	158,194	39.69	203.38	26.10	158,194	81.00	15.81	60
North Fork	119,168	126,152	43.26	278.00	4.45	126,152	249.40	38.81	10
South Fork	49,965	59,408	20.90	285.16	0.00	59,408	285.16	20.90	0
Lake Okeechobee	-	414,754	96.25	188.14	67.39	170,805	136.96	28.86	70
Total for SLRW	514,287	699,016	276.51	320.69	30.55	699,016	285.26	248.18	10
Total for SLRW & Lake O	514,287	1,113,771	372.76	271.33	97.95	869,821	256.14	277.04	26

(5) Alternative 1											
(5a) Owner Implemented BMPs[3/]		(5b) Cost-Share BMPs[4/]		(5c) Local Projects		(5d) Regional Projects		(5e) Summary of Alternative 1			
Load Red. (metric tons)	Remain. Load (metric tons)	Load Red. (metric tons)	Remain. Load (metric tons)	Load Red. (metric tons)	Remain. Load (metric tons)	Load Red. (metric tons)	Remain. Load (metric tons)	Load Red. (metric tons)	Remain. Conc. - (ppb)	Adjusted Remain. Load[5/] (metric tons)	Alt 1 Load Reduction (%)
0.40	5.98	0.49	5.49	0.03	5.46	0.00	5.46	0.92	187.46	5.46	14%
6.88	83.69	9.21	74.48	0.00	74.48	38.96	35.52	55.05	188.48	35.52	61%
6.41	69.32	8.70	60.62	0.00	60.62	0.00	60.62	15.11	274.77	60.62	20%
2.38	13.42	2.85	10.57	0.00	10.57	2.71	7.86	7.94	81.00	15.81	0%
1.82	36.99	2.11	34.88	3.15	31.73	0.57	31.16	7.65	200.25	31.16	20%
1.91	18.99	2.21	16.78	0.21	16.57	0.00	16.57	4.32	226.18	16.57	21%
0.00	28.86	0.00	28.86	0.00	28.86	0.00	28.86	0.00	136.96	28.86	0%
19.78	228.40	25.57	202.83	3.39	199.44	42.24	157.20	90.98	191.53	165.14	33%
19.78	257.26	25.57	231.69	3.39	228.30	42.24	186.06	90.98	180.81	194.00	30%

1/ CBASE conditions for the C-23, C-24, C-44/S-153, and Lake Okeechobee are based on measured data for the period 1995 to 2005. WaSh Model output data are used for CBASE conditions for North Fork, South Fork, and Basin 4, 5, 6.
2/ Where load reductions were projected to results in concentrations less than 81 ppb, the remaining load was estimated by multiplying the basin flow by 81 ppb.
3/ Owner-implemented BMPs are adjusted for urban pervious areas and the percentages of BMPs that have already been implemented (30 percent for row crops and sugar cane, 50 percent for ornamentals/nurseries, and 80 percent for citrus).
4/ Cost-share BMPs are adjusted for the percentages of the BMPs that have already been implemented (percent that became urban after 1988, 30 percent for row crops and sugar cane, 50 percent for ornamentals/nurseries, and 80 percent for citrus).
5/ For the C-44 and S-153 sub-watershed, only 77 and 79 percent of the total TP and TN BMP load reductions were applied to St. Lucie Estuary loading to account for the loading from this sub-watershed to Lake Okeechobee.

In determining average annual discharge and average annual TN or TP loads, measured data were used for flows and loads from the C-23 sub-watershed, C-24 sub-watershed, and C-44 and the S-153 sub-watershed. WaSh Model output data were used for flow and loads from the North Fork sub-watershed; South Fork sub-watershed; and the Basins 4, 5, and 6 sub-watershed.

6.3.1.2 River Watershed Protection Plan Base Condition (RWPPB)

The water quality RWPPB Condition is the second building block of the water quality spreadsheet, and represents the anticipated loading to the estuarine system after the implementation of several base projects. These base projects are presumed to be in place in the near future and include full restoration of the Kissimmee River, including the Kissimmee River Headwaters Revitalization project, the Northern Everglades Lake Okeechobee Watershed Construction Project, Phase 2 Technical Plan (LOP2TP) Preferred Plan, the Ten Mile Creek Water Preserve Area in the North Fork sub-watershed, the C-44 Reservoir/Stormwater Treatment Area (STA) in the C-44 and S-153 sub-watershed, and other Acceler8 projects.

The base projects include the LOP2TP projects, which will affect the inflow from Lake Okeechobee to the St. Lucie River watershed. The post-project average annual inflow was estimated at 171,000 acre-feet, as compared to 415,000 acre-feet in the pre-project condition, based on output from the RSM Alt4 modeled discharge at S-77 for the period 1995 to 2005. Due to the difficulty of modeling the mobility and transport of TP and TN within the lake, which is highly affected by hurricane and drought events, estimates of average annual loads for inflow to the Caloosahatchee River were not available. Thus, based on the results of the Lake Okeechobee Water Quality Model, a simple percentage of reduction in concentration was assumed (James, 2008). TN concentration was assumed to be reduced by 10 percent. TP concentration was assumed to be reduced by as much as 20 percent. The combination of reduced volume and reduced concentration resulted in an estimated reduction of TP load of 70 percent and of TN load of 68 percent for inflows from Lake Okeechobee.

In **Table 6.3-1**, column 4a represents the sum of the load reductions from the base projects. Column 4b represents the remaining discharge after implementation of the base projects, and column 4c represents the resulting concentrations, calculated by dividing total load by total flow.

The resulting concentration was then checked against the minimum value that would be expected for a freshwater riverine system under natural conditions for southern Florida. To be conservative, where simulated load reductions resulted in a concentration less than the natural condition, the "natural-condition" concentration value was used to calculate the remaining load (column 4d). For this study, the natural-condition concentration for TP was estimated as 81 parts per billion (ppb) [0.081 milligram per liter (mg/L)] and TN as 0.72 parts per million (ppm) (0.72 mg/L) (RECOVER, 2007). This adjustment of concentration and load for the natural-condition concentration is repeated in the water quality spreadsheet for all of the alternative conditions.

The adjusted remaining load shows the estimated loads from the sub-watersheds under the RWPPB Condition. Column 4e shows the percent reduction in loads that result from the base projects, as compared to the CBASE Condition.

6.3.1.3 Alternative Condition

The Alternative Condition is the third building block of the water quality spreadsheet and represents the anticipated TP and TN load reductions upon implementation of the alternatives. For the purposes of this discussion, Alternative 1 was used as the example for the water quality spreadsheet. Management Measures (MMs) that contribute to load reductions for Alternative 1 include BMPs as well as local and regional MMs.

As described more fully in Section 6.4, Alternative 1 includes the "common elements" that are presumed as "given" and will be part of all subsequent alternative formulations. Alternative 2 contains MMs that are optimized for water quantity requirements, in addition to the given Alternative 1 projects. Alternative 3 is independent from Alternative 2 and contains MMs that are optimized for improvement of water quality, in addition to the given Alternative 1 projects. Alternative 4 represents the alternative that optimizes both quality and quantity. It contains the given Alternative 1, 2 and 3 projects, plus a few additional MMs.

The Alternative Condition columns in the spreadsheet are identical for each of the alternatives, except that the BMPs (columns 5a and 5b) are only included in Alternative 1. The BMPs are tabulated for Alternative 1 and thus are implicitly included as "common elements" in all of the subsequent alternatives. Columns 5c, 5d, and 5e are included for all of the alternatives.

BMPs are described more fully in Chapter 7. Owner-implemented BMPs generally include practices that can be implemented by individual landowners without the need for explicit funding by the state. Cost-share BMPs generally consist of programs that require additional funding.

Estimates of removal efficiencies for various BMPs are presented in Appendix D (SWET, 2008). These estimates represent the best available information based on available literature and expert opinion. For each land-use type, a percentage of load reduction was estimated for owner-implemented BMPs and cost-share BMPs. Estimates were developed for TP and TN. For some land-use types, it was presumed that some level of BMP implementation was already in place, and the load reduction was adjusted accordingly. For example, cost-share BMPs for row crops were estimated to reduce TN load by 30 percent for the estimated 70 percent of the row-crop lands that do not yet have cost-share BMPs in place. Load reductions, in metric tons per year, thus were calculated as the product of existing load, percent reduction, and percent of area available for reduction. The calculations were made for each land-use type and for the acreages in each basin, and the load reductions were totaled by sub-watershed. Column 5a in the water quality spreadsheet shows the load reduction and remaining load for the application of owner-implemented BMPs, and column 5b shows the load reduction and remaining load for the subsequent application of cost-share BMPs.

The values in columns 5c and 5d contain the load reductions and remaining loads for the local-project MMs and the regional-project MMs, respectively. In the water quality spreadsheet, the potential load reductions for the individual local and regional MMs were totaled for each sub-watershed. Local and regional MMs are described in Section 6.1, and a complete list of MMs is given in Table 6.1-1. The values used for removal efficiency and percent participation, which varied by MM, are provided in the water quality and water quantity summary at the bottom of each MM fact sheet (**Appendix B**). Load reductions for some MMs, such as the Urban Turf Fertilizer Rule, were presumed to be accounted for by the calculations for BMP removals. Some

MMs were developed primarily for water quantity benefits and are expected to have little or no direct effect on water quality.

The values in the remaining load columns (under 5e) were calculated by combining the potential load reductions from columns 5a, 5b, and 5c and subtracting them from the remaining load in the RWPPB Condition (column 4d). The resulting concentration was calculated from total load and discharge, as described previously, and compared to the "natural-condition" concentration. The final column under 5e shows the percent reduction in loads that result from the alternative condition. For each alternative in the water quality spreadsheet, the percentage represents the cumulative reduction in load as compared to the RWPPB Condition.

6.3.2 St. Lucie River Watershed Water Quality CBASE Base Condition Characterization

The data and results contained in the water quality spreadsheet allow for the evaluation of the relative contribution of TP and TN loadings by sub-watershed, their magnitudes, and the potential for the combinations of MMs to reduce the nutrient loadings contributed from the watershed to the estuarine system

The CBASE Condition is intended to represent the water quality conditions in the SLRWPP study area as they existed in 2005. Specifically, the CBASE Condition is based on the 1995 to 2005 monitoring records supplemented by estimations of runoff and source loadings that are based on the 2004 to 2005 land-use types for the basins and sub-watersheds in the study area. The RWPPB Condition represents the anticipated flows and loadings after implementation of the base projects. For the SLRWPP study area, the RWPPB Condition presumes that the LOP2TP, C-44 Reservoir/STA, and Ten Mile Creek Reservoir will be in place.

6.3.2.1 St. Lucie River Watershed Water Quality Profile

The St. Lucie River watershed has a total drainage area of approximately 514,288 acres**.** A land use map for the St. Lucie River Watershed was provided previously as **Figure 2-4** in Section 2.0. **Table 6.3-2** provides a total summary of the annual average flows, TP and TN loads, and concentrations discharged from the St. Lucie River watershed to the St. Lucie Estuary, in addition to each sub-watershed's individual contribution. Approximately 62.8 percent of the total average annual discharge to the St. Lucie Estuary is from the St. Lucie River watershed, with the remaining 37.2 percent from Lake Okeechobee. Approximately 74.2 percent TP and 58.4 percent TN loads to the St. Lucie Estuary are from the St. Lucie River watershed, with the remaining 25.8 percent TP and 41.6 percent TN loads coming from Lake Okeechobee.

6.3.2.2 Sub-Watershed Water Quality Profiles

This section provides information on the primary land use and TP and TN loading rate within each sub-watershed that discharges directly to the St. Lucie Estuary under the CBASE. The sub-watersheds that drain into the St. Lucie Estuary include the 4-5-6, C-23, C-24, C-44 and S-153, North Fork, and the South Fork/Tidal St. Lucie. The discharge and loading for each sub-watershed is shown in **Table 6.3-2** and loading rates and a breakdown of land use for each sub-watershed is shown in **Table 6.3-3**. .It is important to note that a sub-watershed water quality profile for the South Coastal Sub-watershed is not included because no data from this sub-watershed were available.

166 **Table 6.3-2.** Summary of Average Annual Flows, TP and TN Loads, and Concentrations to the St. Lucie Estuary from Each Sub-
167 watershed under the CBASE

Sub-watershed	Area (acres)	Percentage of Total St. Lucie River Watershed	Average Annual Discharge (1995-2005 POR) (ac-ft)[1/]	Percentage of Total Discharge (%)	Average Annual TP Load (1995-2005 POR) (mt/yr)[1/]	Percentage of TP Load (%)[2/]	Average Annual P Conc. (ppb)	Average Annual TN Load (1995-2005 POR) (mt/yr)[1/]	Percentage of TN Load (%)[2/]	Average Annual N Conc. (ppm)
4-5-6	15,055	2.9	23,620	2.1	6.38	1.7	218.96	34.43	1.6	1.18
South Fork	49,965	9.7	59,408	5.3	20.90	5.6	285.16	91.13	4.1	1.24
C-24	87,706	17.1	178,853	16.1	75.73	20.3	343.25	355.00	16.0	1.61
C-23	112,675	21.9	152,789	13.7	90.57	24.3	480.55	329.78	14.9	1.75
North Fork	119,168	23.2	126,152	11.3	43.26	11.6	278.00	185.31	8.4	1.19
C-44 and S-153	129,719	25.2	158,194	14.2	39.69	10.6	203.38	300.49	13.5	1.54
Subtotal	514, 287	100	699, 016	62.8	276.51	74.2	320.69	1,296.14	58.4	1.50
Lake Okeechobee[3]	-	-	414,754	37.2	96.25	25.8	188.14	922.00	41.6	1.80
TOTAL	**514,287**	**100.0**	**1,113,771**	**100.0**	**372.76**	**100.0**	**-**	**2,218.14**	**100.0**	**-**

1/ District measured data were used for flows and loads from the C-23, C-24, C-44 and S-153 sub-watersheds. District Wash Model output data were used for flows and loads from the North Fork, South Fork, and 4-5-6 sub-watersheds.

2/ Calculated using the average annual load and the average annual discharge.

3/ Lake Okeechobee is not an actual sub-watershed. This row represents discharges from Lake Okeechobee through the C-44 Canal to the St. Lucie Estuary. These discharges are shown for informational purposes only and are being addressed through the LOP2TP (South Florida Water Management District [SFWMD], Florida Department of Environmental Protection [FDEP], and Florida Department of Agriculture and Consumer Services [FDACS], 2007). The flows are derived from outputs of Regional Simulation Model results for the LOP2TP, which is paired with concentration reductions of 20 percent for TP and 10 percent for TN.

168 **Table 6.3-3.** Loading Rates and Distribution of Land Use in the St. Lucie River Watershed by Sub-watershed

	Loading Rate (lbs/ac/yr)		Basins 4-5-6		South Fork		C-24		C-23		North Fork		C-44 and S-153	
Land Use[1]	**TP**	**TN**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Residential Low Density	0.49	4.95	**4,316**	**28.66**	3,330	6.66	1,236	1.41	1,909	1.69	9,445	7.93	1,814	1.4
Residential Medium Density	1.4	7.2	**1,236**	**8.21**	3,392	6.79	2,506	2.86	304	0.27	**30,453**	**25.56**	315	0.24
Residential High Density	3	10.8	703	4.67	1,730	3.46	295	0.34	0	0	4,784	4.01	186	0.14
Other Urban[2]	1.54	7.8	1,151	7.65	3,026	6.06	783	0.89	1,385	1.23	8,974	7.53	588	0.45
Improved Pastures	1.9	9.99	1,007	6.69	**9,552**	**19.12**	**33,950**	**38.71**	**33,628**	**29.85**	4,999	4.19	**23,185**	**17.87**
Unimproved Pastures	0.92	4.95	86	0.57	1,094	2.19	6,064	6.91	5,062	4.49	558	0.47	2,168	1.67
Woodland Pastures/Rangeland	0.66	3.69	769	5.11	**3,764**	**7.53**	7,110	8.11	10,301	9.14	4,566	3.83	12,841	9.9
Row Crops	4.5	13.5	156	1.04	2,460	4.92	1,550	1.77	1,696	1.51	1,166	0.98	853	0.66
Sugar Cane	0.63	7.2	0	0	322	0.64	0	0	0	0	0	0	5,240	4.04
Citrus	1.8	7.65	30	0.2	3,025	6.06	**17,488**	**19.94**	**32,466**	**28.81**	**20,678**	**17.35**	**42,755**	**32.96**
Sod Farms	2.52	8.1	0	0	0	0	0	0	0	0	0	0	294	0.23
Ornamentals	2.9	10.8	211	1.4	504	1.01	25	0.03	0	0	238	0.2	268	0.21
Horse Farms	1.82	14.4	54	0.36	71	0.14	14	0.02	54	0.05	0	0	592	0.46
Dairies	9.38	18	0	0	0	0	0	0	419	0.37	0	0	0	0
Other Areas	2.78	7.91	165	1.1	121	0.24	958	1.09	2,137	1.9	159	0.13	567	0.44
Tree Plantations	0.18	2.79	0	0	0	0	0	0	0	0	0	0	0	0
Water	0.05	0.81	383	2.54	1,791	3.59	1,218	1.39	1,811	1.61	4,317	3.62	1,891	1.46
Natural Areas[3]	0.14	1.88	**4,052**	**26.92**	**14,541**	**29.1**	**13,885**	**15.83**	**20,121**	**17.86**	**25,043**	**21.01**	**27,738**	**21.38**
Transportation	1.65	8.28	298	1.98	1,157	2.31	521	0.59	455	0.4	2,623	2.2	611	0.47
Communication/Utilities	0.48	5.4	439	2.92	83	0.17	102	0.12	926	0.82	1,164	0.98	7,814	6.02
Total			15,055	100	49,965	100	87,706	100	112,675	100	119,168	100	129,719	100

1- Land use in the St. Lucie River Watershed is based on District data and reflects the 2005 land use.

169 2- Other urban areas include low-, medium-, and high-density residential, commercial and services, industrial, extractive, institutional, and recreational land-uses.

170 Note: Bold cells indicate the three most prevalent land use types in each sub-watershed.

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Basins 4-5-6—The 4-5-6 sub-watershed is the smallest in size (2.9 percent) of the sub-watersheds, with a total drainage area of approximately 15,055 acres (23.5 square miles). A majority of the land use within this sub-watershed include residential low density (28.7 percent); natural areas (26.9 percent); and residential medium density (8.2 percent). The 4-5-6 sub-watershed contributed approximately 2.1 percent of flows to the St. Lucie Estuary. The average annual loading was 1.7 percent TP and 1.6 percent TN of loading to the St. Lucie Estuary. Overall, this represented the lowest average annual loading rates of the six sub-watersheds. This is most likely due to the relatively small drainage area of this sub-watershed and the lower loading rates of the two most abundant land uses types within this sub-watershed.

South Fork Sub-Watershed—The South Fork basin comprises 9.7 percent of the St. Lucie River watershed, with a total drainage area of approximately 49,965 acres (78.1 square miles). Major land uses types within this sub-watershed include natural areas (29.1 percent), improved pastures (19.1 percent), and woodland pastures/rangeland areas (7.5 percent). The South Fork sub-watershed contributed approximately 5.3 percent of the total flows to the St. Lucie Estuary, It contributed 5.6 percent TP and 4.41 percent TN loading to the St. Lucie Estuary.

C-24 Sub-Watershed—The C-24 sub-watershed comprises 17.1 percent of the St. Lucie River watershed, with a total drainage area of approximately 87,706 acres (137 square miles). Major land uses types include improved pasture (38.7 percent), citrus farms (19.9 percent), and natural areas (15.8 percent). The C-24 sub-watershed contributed 16.1 percent of total flows to the St. Lucie Estuary. It contributed 20.3 percent of TP and 16.0 percent of TN loading to the St. Lucie Estuary.

C-23 Sub-Watershed—The C-23 sub-watershed makes up 21.9 percent of the St. Lucie River watershed, with a total drainage area of approximately 112,675 acres (176 square miles). Major land use types include improved pastures (29.9 percent), citrus farms (28.8 percent), and natural areas (17.9 percent). This sub-watershed also includes 419 acres (0.4 percent) of land use classified as dairies. This is important to note because the loading rate of the dairies land use classification is the highest of the 20 land use categories, at 9.4 pounds per acre per year for TP and 18.0 pounds per acre per year for TN. The C-23 sub-watershed contributed 13.7 percent of total flows to the St. Lucie Estuary The C-23 sub-watershed contributed 24.3 percent TP and 14.9 percent TN loading to the St. Lucie Estuary.

North Fork Sub-Watershed—The North Fork sub-watershed makes up 23.2 percent if the St. Lucie River watershed, with a total drainage area of approximately 119,168 acres (186.2 square miles). Major land use types include residential medium density (25.6 percent), natural areas (21.0 percent), and citrus farms (17.4 percent). The North Fork sub-watershed contributed approximately 11.3 percent of total flows to the St. Lucie Estuary. It contributed 11.6 percent TP and 8.4 percent TN loading.

C-44 and S-153 Sub-Watershed—The C-44 and S-153 sub-watershed makes up 25.2 percent of the St. Lucie River watershed, with a total drainage area of approximately 129,719 acres (202.7 square miles). Major land use types include citrus farms (33 percent), natural areas (21.4 percent), and improved pastures (17.9 percent). The C-44 and S-153 sub-watershed contributed 14.2 percent of total flows to the St. Lucie Estuary. It contributed 10.6 percent TP and 13.5 percent TN loading to the estuary. It is important to note that the discharges, concentrations, and

loading from this sub-watershed do not include contributions from Lake Okeechobee. Lake Okeechobee contributions have been separated out from C-44 and S-153 sub-watershed data and are represented in a separate row on **Table 6.3-2** above.

6.3.2.3 Benefits from Base Projects in the RWPPB Condition

The water quality benefits from the base projects are represented in the RWPPB Condition. As stated earlier in Section 6.3.1.2, the base projects include:

- The C-44 Reservoir/STA in the C-44 and S-153 sub-watershed,
- The Ten Mile Creek Water Preserve Area in the North Fork sub-watershed, and
- The LOP2TP Preferred Alternative projects.

Table 6.3-4 and **Table 6.3-5** compare average annual TP and TN loads (metric tons per year or mt/yr) and concentrations (ppb), respectively, with and without base projects. These tables highlight the substantial reductions in TP and TN loading from the North Fork and C-44 and S-153 sub-watersheds and from Lake Okeechobee that the base projects provide.

Table 6.3-4. Comparison of Average Annual TP loads (mt/yr) and Concentrations (ppb) with and without Base Projects in the North Fork and C-44 and S-153 Sub-watersheds and from Lake Okeechobee Discharges

	Load without Base Projects	Load with Base Projects	Percent Reduction	Concentrations without Base Projects	Concentrations (ppb) with Base Projects	Percent Reduction
North Fork	43.26	38.81	10.3	278.00	249.40	10.3
C-44 and S-153	39.69	15.81	60.1	203.38	81.00	60.2
Lake Okeechobee	96.25	28.86	70.0	188.14	136.96	27.2
Total (Adjusted)	**179.20**	**83.48**	**53.4**	-	-	-
1- See MM sheets LO 14 (C-44 Reservoir/STA) and SLE 45 (Ten Mile Creek Water Preserve Area) for a description of how the load reductions for these sub-watersheds were determined.						
2- Lake Okeechobee load reductions were calculated by including flows and concentrations anticipated to result from the LOP2TP.						

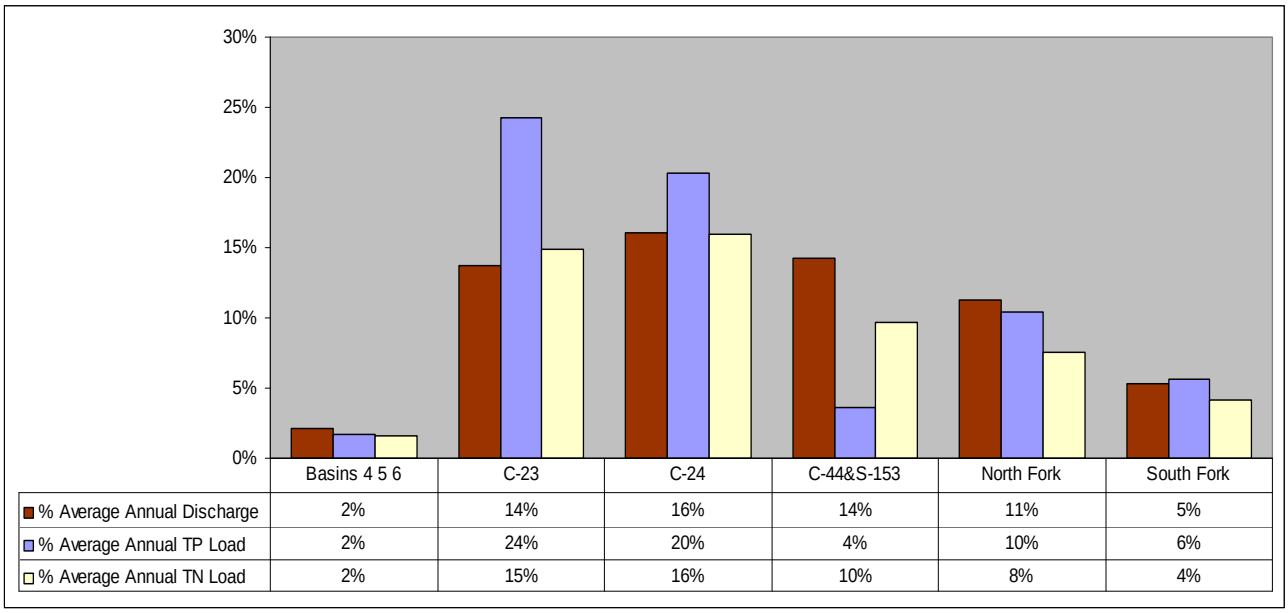
Table 6.3-5 Comparison of Average Annual TN Loads (mt/yr) and Concentrations (ppm) with and without Base Projects in the North Fork and C-44 and S-153 Sub-watersheds and from Lake Okeechobee Discharges

	Load without Base Projects	Load with Base Projects	Percent Reduction	Concentrations without Base Projects	Concentrations (ppb) with Base Projects	Percent Reduction
North Fork	185.31	166.81	10.0	1.19	1.07	10.1
C-44andS-153	300.49	215.48	28.3	1.54	1.10	28.6
Lake Okeechobee	922.00	298.09	67.7	1.80	1.41	21.7
Total (Adjusted)	**1,407.80**	**680.38**	**51.7**	-	-	-
1-See MM sheets LO 14 (C-44 Reservoir/STA) and SLE 45 (Ten Mile Creek Water Preserve Area) for a description of how the load reductions for these sub-basins were determined.						
2- Lake Okeechobee load reductions were calculated by including flows and concentrations anticipated to result from the LOP2TP.						

The RWPPB Conditions loads are used as the basis for computing the relative load reductions among the various alternative conditions, and are discussed further in Section 6.5.2.

6.3.2.4 Comparison of Flows and Loads from Sub-watersheds

The purpose of this section is to identify those sub-watersheds with disproportionately large TP and TN loads compared to discharges after implementation of the base projects (RWPPB Condition). **Figure 6.3-2** is based on the percent of average annual discharge and the percent of annual TP and TN loads information provided in **Table 6.3-2** above. The first bars represent the percent of total average annual discharge, the second bars represent the percent of average annual TP loading, and the third bars represent the percent of average TN loading. When the second or third bars are higher than the middle bars, this indicates a disproportionate ratio between the average annual nutrient load and the average annual discharge. The figure shows a disproportionately high phosphorus loading from the C-24 and C-25 Basins. These sub-watersheds were targeted for water quality MMs, such as agricultural BMPs.



	Basins 4 5 6	C-23	C-24	C-44&S-153	North Fork	South Fork
% Average Annual Discharge	2%	14%	16%	14%	11%	5%
% Average Annual TP Load	2%	24%	20%	4%	10%	6%
% Average Annual TN Load	2%	15%	16%	10%	8%	4%

Figure 6.3-2. Comparisons of Percent Average Annual Discharge and Average Annual TP and TN Loads from Each Sub-watershed

6.3.3 Water Quality Conclusions

This section provides the following conclusions based on the water quality information presented in this section:

- There is disproportionately high TP and TN loading from the C-23 sub-watershed, and TP loading from the C-24 Basin. Targeting these sub-watersheds with water quality MMs, especially agricultural BMPs, would be beneficial.
- The base projects, the C-44 Reservoir/STA in the C-44 and S-153 sub-watershed and the Ten Mile Creek Water Preserve Area in the North Fork sub-watershed, will greatly reduce loading from these sub-watersheds.

- Significant TP (10 percent) and TN (68 percent) load reductions from Lake Okeechobee to the St. Lucie Estuary will result from the LOP2TP. The LOP2TP reduced flow from Lake Okeechobee by 59 percent and concentrations by 20 percent for TP and 10 percent for TN.

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SECTION 6.4

FORMULATION OF ALTERNATIVE PLANS

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6.4 FORMULATION OF ALTERNATIVE PLANS

This section describes the four alternative plans formulated and evaluated by the working team. Water quality and storage planning targets are identified, which is followed by a description of the management measures (MMs) that were used as building blocks for each of the plans. Information on key components and projected performance of individual alternative plans is also presented.

6.4.1 Planning Goals

The sections below reiterate the water quality and water quantity goals of the St. Lucie River Watershed Protection Plan (SLRWPP), which the alternatives were formulated to achieve.

6.4.1.1 Water Quantity Storage Goal

The legislative intent of Northern Everglades and Estuaries Protection Program (NEEPP) finds that the expeditious implementation of the Lake Okeechobee Protection Plan and the River Watershed Protection Plans is needed to improve the quality, quantity, timing and distribution of water in the northern Everglades ecosystem, Section 373.4595(1)(h), F.S. (2007). The water quantity storage goals for the St. Lucie River watershed are to store enough water to meet the high discharge criteria and salinity envelope in the St. Lucie Estuary as follows:

1. The restoration target high discharge criteria for the St. Lucie Estuary is to:
   - Limit mean monthly flows greater than 2,000 cubic feet per second (cfs) to 21 months or less over a 432-month period; and
   - Limit mean monthly flows greater than 3,000 cfs to 6 months or less over a 432-month period.
2. The restoration salinity envelope target for the St. Lucie Estuary is to:
   - Limit mean monthly flows below 350 cfs to 31 months or less over a 432-month period; and
   - Limit the number of times flows from the St. Lucie River watershed exceed 2,000 cfs for 14 days or more to 28 occurrences or less based on a 14-day moving average over a 432-month period.

The basis for these goals is discussed in detail in Section 6.2. This section identifies the storage gained with each alternative in acre-feet, while Section 6.5 discusses the modeling results as they specifically relate to the water quantity storage goals.

6.4.1.2 Water Quality Goal

The NEEPP legislation requires pollutant load reductions consistent with any adopted Total Maximum Daily Loads (TMDLs) for the St. Lucie River watershed as the water quality objective for the SLRWPP planning process. During the formulation of the SLRWPP the TMDLs were under development, but had not yet been established for any impaired waterbody segments in the St. Lucie River watershed.

Because nutrient TMDLs did not exist during this planning process, a water quality goal of maximizing nutrient load reductions was utilized. Progress in meeting the total phosphorus (TP) and total nitrogen (TN) water quality goals is measured in the planning process via the water quality spreadsheet, which is discussed in detail in section 6.3.1. This tool compiles the benefits of the various MMs and performance measures for the existing conditions, the River Watershed Protection Plan Base Condition, and four alternatives. Once TMDLs are established for the watershed, they will be used in future plan updates to assess water quality performance of the plan. Specifically, the TMDLs will be used to determine whether sufficient pollutant load reductions have been implemented in the watershed to achieve the waterbody's designated use and whether any plan refinements are necessary.

6.4.2 SLRWPP Formulation Challenges

During the SLRWPP formulation process, numerous challenges needed to be resolved, including the challenges listed below.

1. Alternative plans were developed that concurrently addressed two discrete and sometimes competing project objectives, namely TP and TN load reductions and water storage.
2. Multiple MMs were considered for each project objective.
3. TMDLs have not yet been established in the St. Lucie River watershed, so an interim goal of maximizing load reductions was used for this planning process. Once TMDLs are established in the St. Lucie River watershed they will be applied in future SLRWPP updates to assess water quality performance of the plan.
4. Water quantity or water quality benefits for some MMs could not be quantified due to the nature or development stage of the projects, although water quantity or water quality benefits are anticipated. These projects were included in the alternatives, but did not contribute to the overall TP and TN load reductions or the water storage capacity for the alternatives.
5. The process had to allow for equitable consideration of all reasonable alternatives; no feasible alternative could be arbitrarily eliminated without being evaluated.
6. Cumulative water management and nutrient loading problems in the St. Lucie Estuary are the result of combined inputs from all seven sub-watersheds previously identified. Solutions had to be identified for individual sub-watersheds, as solutions identified for one sub-watershed would not necessarily address issues that exist in another non-contiguous sub-watershed.
7. Average annual discharge and TP and TN loading data are not available for the South Coastal Sub-Watershed at this time.
8. The numerous challenges previously discussed in Section 3.4.

One of the challenges in formulating the SLRWPP alternatives was that certain MMs with the primary purpose of improving water quality had un-quantifiable water quality benefits. The four main reasons for this were: (1) insufficient data on the loading rates to the St. Lucie River watershed from the source (e.g. SLE 46- Small Acre Manure Management); (2) insufficient project design information (e.g. SLE 54- Haney Creek Wetland Restoration); (3) the MM contributed to lowering TP and TN in the St. Lucie Estuary itself, but did not contribute to load reductions from

the St. Lucie River watershed (e.g. SLE- Creation Suitable Oyster Substrate in the St. Lucie Estuary); or (4) the nature of the project did not lend to quantifying the benefit (e.g. LO 87- Florida Ranchlands Environmental Services Projects). These projects were included in the alternatives, but did not contribute to the overall TP and TN load reductions for the SLRWPP alternatives as summarized in the following sections. Furthermore, when quantifying the TP and TN load reductions for each MM, an anticipated range of load reductions was determined when possible. The lowest end of the range (minimum load reduction) was the load reduction applied to the MMs. Because of this conservative approach towards applying load reductions to MMs, it is anticipated that the actual load reductions from each alternative will be greater than reported in the following sections.

6.4.3 Formulation of Alternatives

The alternatives were formulated by combining MMs from the MM Toolbox previously discussed in section 6.1.1 to meet pre-established planning objectives. Both the SLRWPP and the Caloosahatchee River Watershed Protection Plan (CRWPP) have four alternatives with the main objectives as listed below.

Alternative 1: Common elements for incorporation into all subsequent alternatives
Alternative 2: Maximize water storage
Alternative 3: Maximize nutrient load reductions
Alternative 4: A combination of MMs from Alternatives 1-3 intended to maximize both water storage and nutrient load reductions

Even if no additional MMs were added for an alternative (i.e. Alternatives 2 and 4), the alternative was still discussed for consistency purposes between the two river-watershed protection plans.

Table 6.4-5 at the end of this section identifies the quantified water quality and storage benefits associated with each MM. The MM fact sheets in Appendix B provide the methods used for determining the water quality and storage benefits associated with each MM as determined by the working team. The following sections provide details of the four SLRWPP alternatives discussed above and the associated anticipated water quantity and water quality benefits.

6.4.4 Alternative 1 – Common Elements

Alternative 1 is defined as the "common elements" alternative and includes all Level 1 and Level 2 MMs because these projects were either already constructed/ implemented or their construction/ implementation was imminent, and Level 3-5 MMs for which construction/implementation was imminent pending resolution of certain issues. (Refer to Section 6.1.1 for a description of the MM levels). All Indian River Lagoon – South Final Integrated Project Implementation Report and Environmental Impact Statement (IRL-S PIR), and source control MMs are included in Alternative 1.

The key MMs of Alternative 1 are listed below and categorized by the scale of the project: regional, local, and source control. Regional projects are site-specific projects designed to reduce nutrient loads from regional scale sources. Local projects are site-specific projects designed to reduce nutrient loads from local sources. Source control projects are activities and measures that

focus on capturing pollutants at the source, preventing the pollutants from leaving the site and entering other surface waters. The water storage capacity and TP and TN reductions for Alternative 1 MMs are also provided and summarized in **Table 6.4-1**.

- **Regional Projects** – The regional projects in Alternative 1 include the Coastal and Estuarine Land Conservation Program, Alternative Water Storage (four sites), IRL-S PIR C-23/24 Reservoir/Stormwater Treatment Area (STA), IRL-S PIR Northfork Natural Floodplain Restoration, IRL-S PIR Muck Remediation, IRL-S PIR Southern Diversion C-23 to C-24 interconnect, Comprehensive Planning and Land Development Regulations, Florida Ranchlands Environmental Services Project (existing projects and full implementation), Natural Lands in CERP-IRL South Project (3 sites), and Creation of Suitable Oyster Substrate in the St. Lucie Estuary (Alternative Habitat Creation). These Alternative 1 regional projects provide an annual average surface water storage capacity of approximately 124,468 acre-feet and annual average TP and TN reductions of approximately 42.2 (17 percent) and 175.0 metric tons per year (14.7 percent), respectively.
- **Local Projects** – The local projects in Alternative 1 include White City Drainage Improvements (canals B, C, D, E, F, G), White City Drainage Improvements (Citrus/Saeger), Indian River Estates/Savannas Ecosystem Management Project, Platt's Creek Wetland Restoration, Improved management of sludge disposal in St. Lucie County through use of Plasma-Arc technology, North River Shores Vacuum Sewer System, Tropical Farms Roebuck Creek Stormwater Quality Retrofit, Old Palm City Phase III Stormwater Quality Retrofit, Manatee Pocket Dredging Project, Jensen Beach Retrofit, Leilani Heights/Warner Creek Retrofit (Phases 1, 2, and 3), Manatee Creek Water Quality Retrofit, E-8 Canal Stormwater Retrofit, Frazier Creek Water Quality and Stormwater Retrofit, Haney Creek Wetland Restoration, and Poppleton Creek Regional Detention Basin. These Alternative 1 local projects provide an annual average surface storage capacity of approximately 32 acre-feet and annual average TP and TN reductions of approximately 3.4 (1.4 percent) and 10.6 (0.9 percent) metric tons per year, respectively.
- **Source Control Projects** – The source control projects in Alternative 1 include Owner-implemented Agricultural BMPs, Cost-shared Agricultural Best Management Practices (BMPs), Urban BMP Program, Urban Turf Fertilizer Rule, Land Application of Residuals, Florida Yards and Neighborhoods, Environmental Resource Permit Program, National Pollutant Discharge Elimination System (NPDES) Stormwater Program, Works of District Regulatory Phosphorus Source Control Program, Proposed Lake Okeechobee and Estuary Watershed Basin Rule, Wastewater and Stormwater Master Plans, and proposed Unified Statewide Stormwater Rule. These Alternative 1 source control projects are anticipated to provide annual average TP and TN reductions of approximately 45.4 (18.3 percent) and 219.1 (18.37 percent) metric tons per year, respectively.

Approximately 68 percent of the Alternative 1 MMs had quantified water quality benefits and approximately 13 percent had quantified water storage benefits. These Alternative 1 benefits are summarized by project scale in **Table 6.4-1**. Benefits for each individual MM associated with the alternatives are provided in **Table 6.4-5** at the end of this section.

Table 6.4-1. Alternative 1 TP and TN Load Reductions and Storage in Acre-Feet (ac-ft) by Project Scale

Project Scale	TP Load Reduction[1/]	TN Load Reduction [1/]	Storage (ac-ft) [2/]
Regional Projects	42.2 mt/yr	175.0 mt/yr	124,468 ac-ft
Local Projects	3.4 mt/yr	10.6 mt/yr	32 ac-ft
Source Control Projects	45.4 mt/yr	219.1 mt/yr	Not Applicable

1/ Values are from the water quality spreadsheet described in Section 6.3.1.
2/ Values are a sum of the storage for each MM provided in the MM summary sheets as determined by the coordinating agencies.

6.4.4.1.1 Alternative 1 Storage Capacity

Water storage benefits from Alternative 1 are a sum of the storage benefits for each Alternative 1 MM, which are shown on **Table 6.4-5** at the end of this section. When considering the Alternative 1 MMs plus the C-44 Reservoir and Ten Mile Creek Reservoir base projects, the total annual average surface storage capacity in the St. Lucie River watershed is approximately 200,000 acre-feet. Based on the Northern Everglades Regional Simulation Model (NERSM) modeling effort discussed in Section 6.2.1, this quantity of storage provided significant water quality benefits. Of the Alternative 1 storage components, IRL-S PIR MMs provided the majority of the surface water storage.

6.4.4.1.2 Alternative 1 Load Reductions

Table 6.4-2 summarizes the water quality benefits from Alternative 1 as captured in the water quality spreadsheet. Alternative 1 would provide a total TP load reduction of 90.10 metric tons per year and a total TN load reduction of 404.76 metric tons per year. The resulting TP load from the St. Lucie River watershed would be 165.14 metric tons per year TP and 810.73 metric tons per year TN. Resulting concentrations for TP and TN would be 191.53 ppb and 0.94 ppm, respectively.

Table 6.4-2. TP and TN Summary – Alternative 1

	TP[1/]	TN[1/]
Current Load from CBASE	**276.51 mt/yr**	**1,296.1 mt/yr**
Load Reduction from RWPPB	30.55 mt/yr	103.51 mt/yr
Total Load Reduction for Alternative 1[2/]	90.10 mt/yr	404.76 mt/yr
Remaining Load from Watershed[3/]	**165.14 mt/yr**	**810.73 mt/yr**
Remaining Concentration	**191.53 ppb**	**0.94 ppm**

1/ Values are from the water quality spreadsheet described in Section 6.3.1.
2/ Total reduction may be less than the sum by project scale in Table 6.4-1 due to the load reduction adjustment.
3/ Values do not equal the CBASE minus the RWPPB and Alternative 1 load reductions due to the application of the load reduction adjustment.

6.4.4.2 Alternative 2 – Maximizing Storage

Alternative 2 is intended to maximize water storage capacity in the St. Lucie River watershed; however, according to the Regional Simulation Model (RSM) modeling, Alternative 1 maximized the water storage goals for the watershed. Accordingly, no additional water storage MMs were identified in the MM toolbox for Alternative 2. Alternative 2 mirrors Alternative 1; therefore,

Alternative 2 load reductions and water storage capacities are identical to those for Alternative 1 as discussed above in Section 6.4.2.1. However as discussed in Section 6.5.1, there were slight differences between the water quantity modeling results between Alternatives 1 and 2. These variations may be due to implementation of additional water storage components in Alternative 2 in the CRWPP that are included in the NERSM. They influence Lake Okeechobee water storage and Lake Okeechobee discharges to the St. Lucie River Estuary because there are interdependencies between the St Lucie and Caloosahatchee River watersheds and Lake Okeechobee. These interdependencies are reflected in the NERSM, which is a regional model for the entire Northern Everglades. The CRWPP additional Alternative 2 MMs were CRE 128, the East Caloosahatchee Storage Reservoir, and CRE-LO 40, the Lake Hicpochee Reservoir.

6.4.4.3 Alternative 3 – Maximizing Water Quality Improvements

Alternative 3 is intended to maximize nutrient load reductions in water from the St. Lucie River watershed. Using Alternative 1 as the basis, new MMs were added to increase TP and TN load reductions. The water storage capacity and TP and TN reductions based on project scale are also provided and summarized in **Table 6.4-3**. This plan consisted of all features from Alternative 1 plus the 12 new MMs listed below.

- **Regional Projects** – The only additional regional project included in Alternative 3 is the C-23/24 Water Quality Treatment Project. This additional regional project would provide annual average TP and TN reductions of 30 and 100 metric tons per year, respectively.
- **Local Projects** – The additional local projects included in Alternative 3 include the On-site Sewage Treatment and Disposal System inspection and pump-out program, conversion of existing canals into Linear Wetland Treatment Areas, Stormwater Baffle Box Retrofit for the City of Stuart, Danforth Creek Stormwater Quality Retrofit, North St. Lucie River Water Control District Stormwater Retrofit (Structures 81-1-2 and 85-1-2), All American Boulevard Ditch Retrofit, Martin County Baffle Boxes, Small Acreage Manure Management, Danforth Creek Muck Removal Dredging Project, Warner Creek Muck Removal Dredging Project, and the Hidden River Muck Removal Dredging Project. These additional local projects for Alternative 3 would provide annual average TP and TN reductions of 0.1 and 0.2 metric tons per year, respectively.

Of the 12 additional MMs added in Alternative 3, 25 percent had quantified water quality benefits and none had quantified water storage benefits.

Table 6.4-3. TP and TN load Reductions by Project Scale for the 12 New Additional Alternative 3 MMs

Project Scale	TP Load Reduction[1/]	TN Load Reduction[1/]
Alternative 3 Additional Regional Projects	30.0 mt/yr	100.0 mt/yr
Alternative 3 Additional Local Projects	0.1 mt/yr	0.2 mt/yr
1/ Values are from the water quality spreadsheet described in Section 6.3.1		

6.4.4.3.1 Alternative 3 Storage Capacity

Alternative 3 was formulated to maximize water quality. It is not possible to quantify the water storage benefits attributable to the additional project features at this time. Therefore, Alternative 3 has approximately the same amount of storage as Alternatives 1 and 2 (200,000 acre-feet).

6.4.4.3.2 Alternative 3 Load Reductions

Table 6.4-4 summarizes the water quality benefits from Alternative 3 as captured in the water quality spreadsheet. The additional 12 new project features would collectively reduce TP loading by 30.1 mt/yr and TN loading by 100.2 mt/yr. Thus, Alternative 3 would provide a total TP load reduction of 120.31 mt/yr and a total TN load reduction of 490.85 mt/yr. This would leave a St. Lucie River watershed loading of 135.9 mt/yr TP and 723.54 mt/yr TN, and concentration of 157.61 ppb and 0.84 ppm, for TP and TN respectively.

Table 6.4-4. Final TP and TN Summary- Alternative 3

	TP[1/]	TN[1/]
Current Load from Watershed (Current Base)	276.5 mt/yr	1,296.14 mt/yr
Load Reduction with Base Projects (River Watershed Base Condition)	30.55 mt/yr	1103.51 mt/yr
Load Reduction for Alternative 1 Common Elements	90.10 mt/yr	404.76 mt/yr
Load Reduction for Additional Alternative 3 Projects	30.1 mt/yr	100.2 mt/yr
Total Load Reduction for Alternative 3[2/]	120.2 mt/yr	504.96 mt/yr
Remaining Load from Watershed[3/]	135.05 mt/yr	710.50 mt/yr
Remaining Concentration	156.63 ppb	0.82 ppm
1/ Values are from the water quality spreadsheet described in Section 6.3.1. 2/ Sum of load reductions from common elements and additional alternative 3 projects. 3/ Values do not equal the CBASE minus the RWPPB and total Alternative 3 load reductions due to the application of the load reduction adjustment.		

6.4.4.4 Alternative 4 – Optimizing Storage and Water Quality Improvements

The main objective of Alternative 4 is to optimize both water storage and TP and TN load reductions from the St. Lucie River watershed. The Working Team evaluated the potential for adding additional MMs to for additional storage and load reductions; however, no additional MMs were identified. There was a consensus among the Working Team that the common elements and the additional management measures included in Alternative 3 optimized water storage and TP and TN load reductions to the greatest extent practicable at this time; therefore, Alternative 4 mirrors Alternative 3 (MMs, load reductions, and water storage). No additional MMs were added.

Table 6.4-5. Summary of MMs Associated with the SLRWPP Alternatives

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
LO 1	Agricultural BMPs - Owner Implemented and Cost Share (Combined LO 1, 2, and 49)	Implementation of agricultural BMPs and water quality improvement projects to reduce the discharge of nutrients from the watershed.	1	√	√	√	√
LO 3	Urban Turf Fertilizer Rule (LOER)	Florida Department of Agriculture and Consumer Services (FDACS) rule, which regulates the content of phosphorus and nitrogen in urban turf fertilizers to improve water quality.	1	√	√	√	√
LO 4	Land Application of Residuals	Subsection 373.4595(4)(b)2.of the NEEPP requires that after December 31, 2007, the department may not authorize the disposal of domestic wastewater residuals within the St. Lucie River watershed unless the applicant can affirmatively demonstrate that the nutrients in the residuals will not add to nutrient loadings in the watershed.	1	√	√	√	√
LO 5	Florida Yards and Neighborhoods	Provides education about the land use and design to the citizens by promoting the Florida Yards & Neighborhood programs to minimize the pesticides, fertilizers, and irrigation water.	1	√	√	√	√
LO 7	Environmental Resource Permit (ERP) Program	The ERP program regulates activities in, on, or over wetlands or other surface waters and the management and storage of all surface waters. This includes activities in uplands that alter stormwater runoff as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that activities do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems. The program applies to new activities only, or to modifications of existing activities, and requires an applicant to provide reasonable assurances that an activity will not cause adverse impacts to existing surface water storage and conveyance capabilities, and will not adversely affect the quality of receiving waters such that any applicable water quality standards will be violated.	1	√	√	√	√
LO 08	NPDES Stormwater Program	To reduce stormwater pollutant loads discharged to surface waters, especially from existing land uses and drainage systems. This is especially true for the master drainage systems owned and operated by cities, counties, FDOT, and Chapter 298 water control districts. This also can help to reduce stormwater pollutant loads from existing industrial sites and from new construction sites.	1	√	√	√	√
LO 09	Coastal and Estuarine Land Conservation Program	Protecting important coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values, or that are threatened by conversion from their natural or recreational state to other uses" (CELCP Final Guidelines, 2003).	1	√	√	√	√

238 **Table 6.4-5.** Summary of MMs Associated with the SLRWPP Alternatives (continued)
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MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
LO 12f	AWS - Indiantown Citrus Growers Association	Rehabilitation and relocation of pump stations and detention of stormwater within the existing ditch system will result in 3,550 ac-ft of water storage on 1,775 acres of project area. The projects will promote water conservation and reduce the volume of surface water discharge to the St. Lucie River and Estuary.	1	√	√	√	√
LO 12j	AWS – Dupuis	The purpose of this project is to design, engineer, and implement an additional 1 foot of storage in the Dupuis marsh before on-site stormwater enters the L-8 Canal. This project could potentially provide 2,500 ac-ft of water storage.	4	√	√	√	√
LO 12m	AWS - Waste Management St. Lucie Site	Plans are to enter into a partnership arrangement to modify borrow areas into minor above ground impoundments. Preliminary hydrologic investigation is in process and water quality/quantity benefits have yet to be determined.	4	√	√	√	√
LO 12q	AWS - Caulkins	Project includes rehabilitation and relocation of internal pump stations. During regulatory releases to the St. Lucie Estuary, irrigation facilities will be utilized to draw excess stormwater into the 3,400-acre project site. The detention of stormwater within the existing ditch system will result in water quality improvements, thereby promoting water conservation and reducing the volume of surface water discharge from the site.	4	√	√	√	√
LO 14	CERP – IRL South: C-44 Reservoir / STA	The C44 Reservoir/ STA Project is located on approximately 12,000 acres of land owned by SFWMD. This project comprises three components (Reservoir, West STA, and East STA) identified in the Indian River Lagoon south (IRL-S) Project Implementation (PIR).	1	√	√	√	√
LO 15	St. Lucie River Watershed 40E-61 Rule Regulatory Nutrient Source Control Program	To implement a nutrient source control program utilizing BMPs for the St. Lucie River watershed. Ongoing activities include revising Chapter 40E-61, Florida Administrative Code to reflect the requirements of the Northern Everglades Protection Act and to expand the rule boundary to include the St. Lucie River watershed as defined by the act.	2	√	√	√	√

Table 6.4-5. Summary of MMs Associated with the SLRWPP Alternatives (continued)

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
LO 21	Proposed LO and Estuary Watersheds Basin Rule (LOER)	In March 2008, the South Florida Water Management District (SFWMD) initiated rule development for an ERP Basin Rule with supplemental criteria designed to result in no increase in total runoff volume from new development that ultimately discharges to Lake Okeechobee or the Caloosahatchee or St. Lucie Estuaries. This rule will be supplemental to existing criteria and the proposed Unified Statewide Stormwater rule. Average annual discharge volumes and specific storm event discharge volumes are proposed to be addressed. Methods for estimating storage capacities in typical water management BMPs and in low-impact design type water management BMPs are also proposed to be included in this rule.	3	√	√	√	√
LO 63	Wastewater and Stormwater Master Plans	Implement urban stormwater retrofitting projects or wastewater projects to achieve additional nutrient reductions and water storage basin wide by working with entities responsible for wastewater and stormwater programs in the service area.	4	√	√	√	√
LO 64	Proposed Unified Statewide Stormwater Rule	Intended to increase the level of nutrient treatment of stormwater from new development and thereby reduce the discharge of nutrients and excess stormwater volume. Treatment rule will be based on a performance standard of post-development nutrient loading that does not exceed pre-development nutrient loading.	4	√	√	√	√
LO 68	Comprehensive Planning-Land Development Regulations	Basin-wide work with state agencies, cities, and counties to review current plans and ensure promotion of low-impact design through coordinated comprehensive planning and growth management initiatives.	3	√	√	√	√
LO 87 Revised	Florida Ranchlands Environmental Services Project- existing, future, and full implementation	The Florida Ranchlands Environmental Services Project will design a program in which ranchers in the Northern Everglades' sell environmental services of water retention, nutrient load reduction, and wetland habitat expansion to agencies of the state and other willing buyers. A planning level estimate of the static water retention capacity of the eight projects is 8,260 ac-ft of water for a single storm event with the average ac-ft of storage per acre being 0.98 feet.	1	√	√	√	√

Table 6.4-5. Summary of MMs Associated with the SLRWPP Alternatives (continued)

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 02	White City Drainage Improvements (canals B, C,D, E, F, G) SLE2a and 2b	Purpose is to improve water quality of stormwater flows to the North Fork the St. Lucie River by modifying canal stages and reducing the potential for pollutant run-off from pastures using modern storm systems and BMPs. Water quality benefits are considered negligible due to the small size and nature of the project.	2	√	√	√	√
SLE 03	White City Drainage Improvements (Citrus/Saeger)	Purpose is to capture, store and treat run-off and provide controlled releases to the St. Lucie River by constructing a 4-acre stormwater detention pond with associated outfall structure. The project would result in 0.01 and 0.03 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 06	Indian River Estates/Savannas Ecosystem Management Project	Project will improve flood control and treat stormwater that currently discharges directly to the Indian River Lagoon and North Fork of the St. Lucie River by constructing a pump station, infrastructure and water detention cells within a 1,200-acre basin adjacent to the Indian River Lagoon and the North Fork. The project would result in 0.76 and 0.83 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 07	Platt's Creek Wetland Restoration	Project would improve the performance of an existing stormwater treatment system by adding Alum injection and modifying the current outfalls and discharge conveyance to be incorporated into the restoration of a prior citrus operation to floodplain forest, marsh and flatwoods. The project would result in 0.03 and 0.11 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 09	Natural Lands in CERP IRL-South Project	The recommended plan includes approximately 92,000 acres of natural storage areas that will be hydrologically restored to provide a variety of project benefits including approximately 30,000 ac-ft of freshwater storage, reductions in nitrogen and phosphorus loads, increased acreage of wetlands, and aquifer recharge.	-	√	√	√	√
SLE 09a	CERP - IRL South: PalMar Complex - Natural Storage and Water Quality Area	The PalMar Complex includes approximately 17,143 acres of pastureland in the C-44 Basin that has been identified for use as alternative storage, nutrient removal, rehydration, and habitat restoration. The project will provide 5,700 ac-ft of water storage and result in 3.43 and 13.39 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√

244 **Table 6.4-5.** Summary of MMs Associated with the SLRWPP Alternatives (continued)
245

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 09b	CERP - IRL South: Allapattah Complex - Natural Storage and Water Quality Area	The Allapattah Complex - Natural Storage and Treatment Area, is located in Martin County and includes approximately 42,348 acres of land in the C-23 Basin. This land has been identified for use as alternative storage, rehydration, habitat restoration, and to provide incidental water quality treatment. The project will provide 13,800 ac-ft of water storage and result in 8.47 and 32.73 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 09c	CERP - IRL South: Cypress Creek/Trail Ridge Complex - Natural Storage and Water Quality Area	The Cypress Creek/Trail Ridge Complex includes approximately 32,639 acres of primarily pastureland, along with some of the last remaining large tracts of forested wetland habitat in St. Lucie County that has been identified for use as alternative storage, re-hydration, habitat restoration, and water quality improvements. The project will provide 10,500 ac-ft of water storage and result in 6.49 and 25.29 mt/yr reductions in TP and TN, respectively.	2	√	√	√	√
SLE 11	Creation of suitable oyster substrate in the St. Lucie Estuary at Various sites identified in IRL-South PIR (Artificial Habitat Creation)	The project will build upon existing efforts to create suitable oyster substrate in the St. Lucie Estuary using natural or man-made conditions (i.e. "oyster balls," limestone rocks, relict shell bags, etc.) placed under docks or on open slopes. It is anticipated that the project will reduce TP and TN from within the St. Lucie Estuary; however, the magnitude of these benefits is undetermined.	1	√	√	√	√
SLE 13	On-site Sewage Treatment and Disposal System inspection and pump-out program	The project will include an incentive program to help residents identify damaged or non-functioning septic systems by providing financial assistance and technical expertise (covering approximately 10,500 eligible systems) in order to reduce the amount of water quality problems that result from failing systems. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	4	-	-	√	√
SLE 16	Improved management of sludge disposal in St. Lucie County through the use of an innovative technology (Plasma-Arc)	The current disposal practices of land applying Biosolids will be phased out in favor of the Plasma Arc Gasification process to be utilized at the St. Lucie County Solid Waste Baling & Recycling facility in order to remove a major pollution source of bacteria and nutrients to area waters. Removal will start at 1,500 tons per day initially, and then expand to 3,000 tons per day. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	1	√	√	√	√

246 **Table 6.4-5.** Summary of MMs Associated with the SLRWPP Alternatives (continued)
247

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 18	Additional Reservoir Storage and WQ Treatment Areas	Additional Reservoirs and/or Stormwater Treatment Areas to capture and treat any remaining undesired releases from Lake Okeechobee and/or the local watershed to the St. Lucie River and Estuary not addressed by the proposed improvements north of the lake.	5	-	-	√	√
SLE 18b	C-23/34 Water Quality Treatment Project	Additional Reservoirs and/or Stormwater Treatment Areas along the C-23 and C-24 Canal to capture and treat any remaining undesired releases from Lake Okeechobee and/or the local watershed to the St. Lucie River and Estuary not addressed by the proposed improvements north of the lake.	5	-	-	√	√
SLE 19	Conversion of existing canals into linear wetland treatment areas	Project will result in conversion of existing canals into linear wetland/shallow lake treatment areas, which will provide additional treatment of stormwater entering the North Fork and South Fork of the St. Lucie River by creating linear standing pools upstream of installed weir structures. These standing pools will create the opportunity for longer residence time resulting in nutrient assimilation and attenuation during times of base flow and low-flow conditions. The project is still in a conceptual phase; therefore, water quality benefits have yet to be determined.	4	-	-	√	√
SLE 22	North River Shores Vacuum Sewer System	Project includes a vacuum assisted gravity sewer collection system to provide service to approximately 750 single and multi-family residential units presently disposing of approximately 190,000 gallons per day of waste through septic tanks. The project will result in 2.18 and 8.57 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 24	CERP - IRL South: C-23/24 Reservoir/STA	Project includes two reservoirs (C-23/24 North and South reservoirs) totaling approximately 47,799 acres and a 2,568-acre STA in order to improve the quality, quantity, timing and distribution of water discharge to the St. Lucie River and Estuary from the local watershed. The two reservoirs and one STA will provide 94,468 ac-ft of water storage and result in 24.0 and 104.2 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 26	CERP - IRL South: Northfork Natural Floodplain Restoration	Project includes acquisition and preservation of approximately 3,100 acres of floodplain and adjacent lands, which will provide significant environmental improvement in the health of this portion of the river by preventing such degradation as increased stormwater runoff, increased turbidity, and increased influence of exotic plants and animals from the surrounding areas that are under significant development pressure. The project will provide approximately 0.57 and 2.23 mt/yr reductions in TP and TN, respectively.	2	√	√	√	√

248 **Table 6.4-5.** Summary of MMs Associated with the SLRWPP Alternatives (continued)

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 27	CERP - IRL South: Muck Remediation	Muck remediation involves the removal of accumulated muck within the SLE from areas that are effectively "dead zones." Muck accumulation has covered substrate that once supported a healthy SAV and oyster community. Removal of this sediment would greatly improve estuarine conditions by exposing this substrate making it suitable for colonization by target species.	3	√	√	√	√
SLE 28	Tropical Farms / Roebuck Creek Stormwater Quality Retrofit	The project is designed to capture the first inch of runoff from 540-acres and convey the runoff to a proposed Lake / Stormwater Treatment Area (STA) that will provide 39 acre-feet of stormwater attenuation and water quality treatment. The project consists of the installation of approximately 8,500 linear feet of storm pipe ranging from 18" to 48" diameter and the construction of a 1.5-acre lake and a 21 acre lake / STA system.	1	√	√	√	√
SLE 29	Old Palm City Phase III Stormwater Quality Retrofit	Phase 3 of the Old Palm City Retrofit project includes construction of two STAs that will serve 106 acres of residential land and provide 8.5 ac-feet of water quality treatment and stormwater attenuation. The project would result in 0.03 and 0.07 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 30	Manatee Pocket Dredging Project	The project will remove approximately 250,000 cubic yards of muck sediments over 47 acres within Manatee Pocket and its tributaries. It is anticipated that the project will reduce TP and TN from within the St. Lucie Estuary; however, the magnitude of these benefits is undetermined.	1	√	√	√	√
SLE 31	Stormwater Baffle Box Retrofit - City of Stuart	Project includes baffle boxes located in storm systems throughout the city of Stuart that provide sediment and floatable debris removal from storm systems before discharge to the St. Lucie River. Water quality benefits anticipated include reductions of Total Suspended Solids, with negligible TP and TN reductions.	1	-	-	√	√
SLE 32	Danforth Creek Stormwater Quality Retrofit	This project would provide approximately 4 ac-ft of additional treatment and storage for a 50-acre untreated residential development area. The project would result in 0.01 and 0.03 mt/yr reductions in TP and TN, respectively.	3	-	-	√	√
SLE 33	North St. Lucie River Water Control District Stormwater Retrofit; Structures 81-1-2 and 85-1-2	This project involves retrofitting for water control structures located within the North St. Lucie River Water Control District. The retrofits will improve the efficiency of structure operations and provides better control of flows to Ten Mile Creek during storm events while also providing control of sedimentation released downstream. Water quality/quantity benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	1	-	-	√	√

Table 6.4-5. Summary of MMs Associated with the SLRWPP Alternatives (continued)

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 35	All American Boulevard Ditch Retrofit	The purpose of the project is to re-grade the All American ditch and pipe the flows to an approximately 12.5 acre Lake / Stormwater Treatment Area for water quality treatment and provide some attenuation. The goal is to provide 1 inch of treatment to the basin, resulting in 25 ac-ft of water quality treatment.	3	-	-	√	√
SLE 38	Urban Best Management Practices Program (An Extension of the Florida Yards and Neighborhoods Program)	The Florida Yards and Neighborhoods Program is an environmental education program designed to improve the water quality of the Indian River Lagoon and the St. Lucie Estuary (SLE) by reducing non point sources of pollution from properties throughout the watershed.	1	√	√	√	√
SLE 40	CERP – IRL South: Southern Diversion C-23 to C-44 interconnect	The project would result in the canal directing excess water from the C-23, C-24, C-25 Canal system through the C-44 STA and into the St. Lucie Canal (C-44) where it could be diverted to Lake Okeechobee anytime the lake was below 14.5 feet mean sea level, used to meet local irrigation demands, or sent to tide at a point less damaging than the C-23. The Project Implementation Report estimates that, in an average year 31,000 ac-ft could be gravity discharged to Lake Okeechobee via S-308 and 22,000 ac-ft could be sent to tide through the S-80 structure. Final water quality/quantity benefits have yet to be determined.	1	√	√	√	√
SLE 41	Martin County Baffle Boxes	Currently, Martin County has identified and prioritized nearly 30 locations for potential baffle box installations to provide sediment and debris traps to prevent discharges directly into either the Indian River or the St. Lucie River. Water quality benefits anticipated include reductions of Total Suspended Solids, with negligible TP and TN reductions.	4	-	-	√	√
SLE 42	Jensen Beach Retrofit	This project proposes to provide detention and/or retention for stormwater runoff in vaults and/or in exfiltration for an older developed area in downtown Jensen Beach, Florida. The project would result in 0.01 and 0.03 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√

Table 6.4-5. Summary of MMs Associated with the SLRWPP Alternatives (continued)

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 43	Leilani Hts/ Warner Creek Retrofit - Phase 1, 2, and 3	The purpose of this three-phase project is to provide treatment to today's standards for runoff from existing sub-standard development, to resolve conveyance capacity within the system to reduce flooding, to provide attenuation of increased flows resulting from internal conveyance improvements, and to recharge groundwater with runoff that currently flows directly to the St. Lucie Estuary. This three-phase project would result in 0.16 and 0.41 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 44	Manatee Creek Water Quality Retrofit; PhII & PhIII; New Monrovia, Dixie Park	The Manatee Creek drains is approximately 833 acres. The basin is located; south of Cove Road, north of the Mariner Sands subdivision, west of Dixie Highway (CR A1A), and extends one-half mile west of US Highway 1. Phase 1 of the Manatee Creek Retrofit is complete and constructed 10 acre ft of storage and STA marsh filtration. Phases II and III of the project will provide an additional 15.3 ac-ft of water quality treatment in wet detention and STA marsh filtration.	1	√	√	√	√
SLE 45	10 Mile Creek – Reservoir and Stormwater Treatment Area	The intent of the Ten Mile Creek Water Preserve Area project is to attenuate summer stormwater flows into the North Fork of the St. Lucie River, which originate in the Ten Mile Creek basin by capturing and storing the passing stormwater. The sedimentation of suspended solids that occurs in the storage reservoir will reduce sediment loads delivered to the estuary. In addition, it is the intention that the captured stormwater be passed through a polishing cell for additional water quality treatment before being released into the North Fork of the St. Lucie River.	1	√	√	√	√
SLE 46	Small Acreage Manure Management	The purpose of the project is to reduce the amount of nutrients released into the regional system from landowner storage of manure on the banks of the creeks in these watersheds by providing a centrally located and properly managed facility for the collection and/or composting of manure waste. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits was not determined due to unknown loading rates to the St. Lucie River watershed from manure.	3	-	-	√	√
SLE 48	Danforth Creek Muck Removal Dredging project	The project would result in removal of approximately 20,000 cubic yards of accumulated muck sediments from Danforth Creek in order to improve estuarine habitat as well as improve water quality conditions. It is anticipated that the project will reduce TP and TN from within the St. Lucie Estuary; however, the magnitude of these benefits is undetermined. This project will partially implement MM SLE 27.	2	-	-	√	√

255 **Table 6.4-5.** Summary of MMs Associated with the SLRWPP Alternatives (continued)

MM ID#	MM Title	MM Description	Level	Alternative			
				1	2	3	4
SLE 49	Warner Creek Muck Removal Dredging Project	The project would result in removal of approximately 16,000 cubic yards of accumulated muck sediments from Warner Creek in order to improve estuarine habitat as well as improve water quality conditions. It is anticipated that the project will reduce TP and TN from within the St. Lucie Estuary; however, the magnitude of these benefits is undetermined. This project will partially implement MM SLE 27.	2	-	-	√	√
SLE 50	Hidden River Muck Removal Dredging Project	The project would result in removal of accumulated muck sediments from Hidden River (exact volume to be determined) in order to improve estuarine habitat as well as improve water quality conditions. It is anticipated that the project will reduce TP and TN from within the St. Lucie Estuary; however, the magnitude of these benefits is undetermined. . This project will partially implement MM SLE 27.	2	-	-	√	√
SLE 52	City of Port St. Lucie – E-8 Canal Stormwater Retrofit	The treatment area will reduce sediment and nutrient loading to the North Fork of the St. Lucie River by reducing the flow rate and through bioremediation.	1	√	√	√	√
SLE 53	Frazier Creek Water Quality – City of Stuart	The 3.6 ac-ft detention pond is located south of the Roosevelt Bridge in the northwest quadrant of the city within the Frazier Creek drainage basin (approximately 500 acres). The detention pond services approximately 75 acres of single family residential and light commercial property.	1	√	√	√	√
SLE 54	Haney Creek Wetland Restoration	This project includes restoration of wetland area within the approximately 1,200-acre Haney Creek Watershed serving approximately 436 acres of upstream development. The project will provide conservation and water quality enhancement within the watershed. Reductions in both TP and TN would be negligible.	1	√	√	√	√
SLE 55	Poppleton Creek	This project involves an on-line regional detention basin (30.0 ac-ft) providing storage treatment for approximately 170 acres within the Poppleton Creek drainage basin. The project would result in 0.09 and 0.16 mt/yr reductions in TP and TN, respectively.	1	√	√	√	√
SLE 56	Farm and Ranchland Partnerships	There are two U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) programs that help farmers and ranchers keep their land in agriculture: the Farm and Ranchlands Protection Program) and the Wetlands Reserve Program. Both programs provide funds to purchase conservation easements.	4	-	-	-	√

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SECTION 6.5

ALTERNATIVE PLAN EVALUATION AND COMPARISON

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6.5 Alternative Plan Evaluation and Comparison

Section 6.5 evaluates and compares the water quantity and water quality results for Alternatives 1 through 4 of the Caloosahatchee River Watershed Protection Plan (CRWPP). The four alternatives are a combination of various Management Measures (MMs) more fully described in Sections 6.1, 6.4, and Appendix B**.**

Alternative 1: Alternative 1 is defined as the "common elements" alternative and is included in all subsequent alternatives. Alternative 1 includes all of the Level 1 and 2 MMs, Level 3 through 5 MMs that construction or implementation were determined imminent by the Working Team, all MMs that were also part of the Central and Southern Florida Project Indian River Lagoon – South Final Integrated Project Implementation Report and Environmental Impact Statement (IRL-S PIR) recommended projects, and all source control MMs.

Alternative 2: Alternative 2 maximizes surface water storage in the St. Lucie River watershed. As discussed in the water quantity section, Section 6.5.1 below, Alternative 1 achieved the water storage goal in the St. Lucie River watershed; therefore, no additional MMs were included in Alternative 2.

Alternative 3: Alternative 3 maximizes the total phosphorus (TP) and total nitrogen (TN) load reductions in water from the St. Lucie River watershed and builds upon Alternative 1. Twelve new MMs were added to Alternative 1, including the regional C-23/24 Water Quality Treatment Project and 11 additional local projects.

Alternative 4: Alternative 4 is intended to optimize water storage in and maximize TP and TN load reductions from the St. Lucie River watershed. Consideration was given to incorporating additional MMs into Alternative 4 for further storage and TP and TN reductions. However, it was determined by the working team that no additional MMs were needed because the common elements and the additional management measures included in Alternative 3 optimized water storage and TP and TN load reductions to the greatest extent practicable at this time.

It is important to note that the St. Lucie River Watershed Protection Plan (SLRWPP) mirrors the CRWPP in terms of the main purpose of the four alternative plans. Therefore even though there are no differences between SLRWPP Alternatives 1 and 2, and Alternatives 3 and 4 in terms of MMs, they were still shown as separate alternatives.

6.5.1 Water Quantity

Per the Northern Everglades and Estuary's Protection Program (NEEPP legislation), an objective of the SLRWPP is to reduce the frequency and duration of harmful freshwater releases into the St. Lucie Estuary. There are two performance measures for evaluating the plan alternatives with respect to water quantity impacts on the estuary: (1) the High Discharge Criteria, and (2) the Salinity Envelope Criteria. These performance measures are based on the ecological health of the system and therefore do not distinguish between source of flows. They consider total flows

to the St. Lucie Estuary, including surface water and groundwater flows; however, the Northern Everglades Regional Simulation Model (NERSM) is only capable of evaluating surface water flows. Furthermore, there are insufficient data on groundwater flows from the sub-watersheds to the St. Lucie Estuary. It is preferable to achieve these performance targets through rainfall, groundwater, and watershed surface flows and to eliminate or minimize surface water flows from Lake Okeechobee. The SLRWPP is only attempting to address the St. Lucie River watershed contribution to the St. Lucie Estuary. Lake Okeechobee discharges were addressed in the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP).

6.5.1.1 High Discharge Criteria

The restoration target high discharge criterion for the St. Lucie Estuary is as follows:

- Limit mean monthly flows greater than 2,000 cubic feet per second (cfs) and less than 3,000 cfs to 21 months or less over a 432-month period; and
- Limit mean monthly flows greater than 3,000 cfs to 6 months or less over a 432-month period.

The basis for the high discharge criteria is discussed in Section 6.2.2.1.

6.5.1.1.1 High Discharge Criteria

The performance of the base conditions and the four alternatives compared to the high discharge criteria target are provided in **Figure 6.5-1**. The left bars represent a tally of the mean monthly flows between 2,000 and 3,000 cfs and the right bars represent a tally of the mean monthly flows greater than 3,000 cfs.

Occurrences of discharges between 2,000 and 3,000 cfs decreased with the River Watershed Protection Plan Base (RWPPB) Condition by 4 compared to the Current Base (CBASE) Condition. The occurrences of total discharges greater than 3,000 cfs decreased by 8 with the RWPPB Condition compared to the CBASE Condition. These improvements result from the base projects added to the RWPPB Condition including the LOP2TP Preferred Alternative, Ten Mile Creek Water Preserve Area, and the C-44 Reservoir.

There are no notable differences between the four alternatives. With the alternatives, discharges between 2,000 and 3,000 cfs decreased from the CBASE Condition by 13 to 11 occurrences and from the RWPPB Condition by 7 to 9 occurrences. The occurrences of total discharges greater than 3,000 cfs also decreased by 11 to 12 compared to the CBASE and by 3 to 4 compared to the RWPPB.

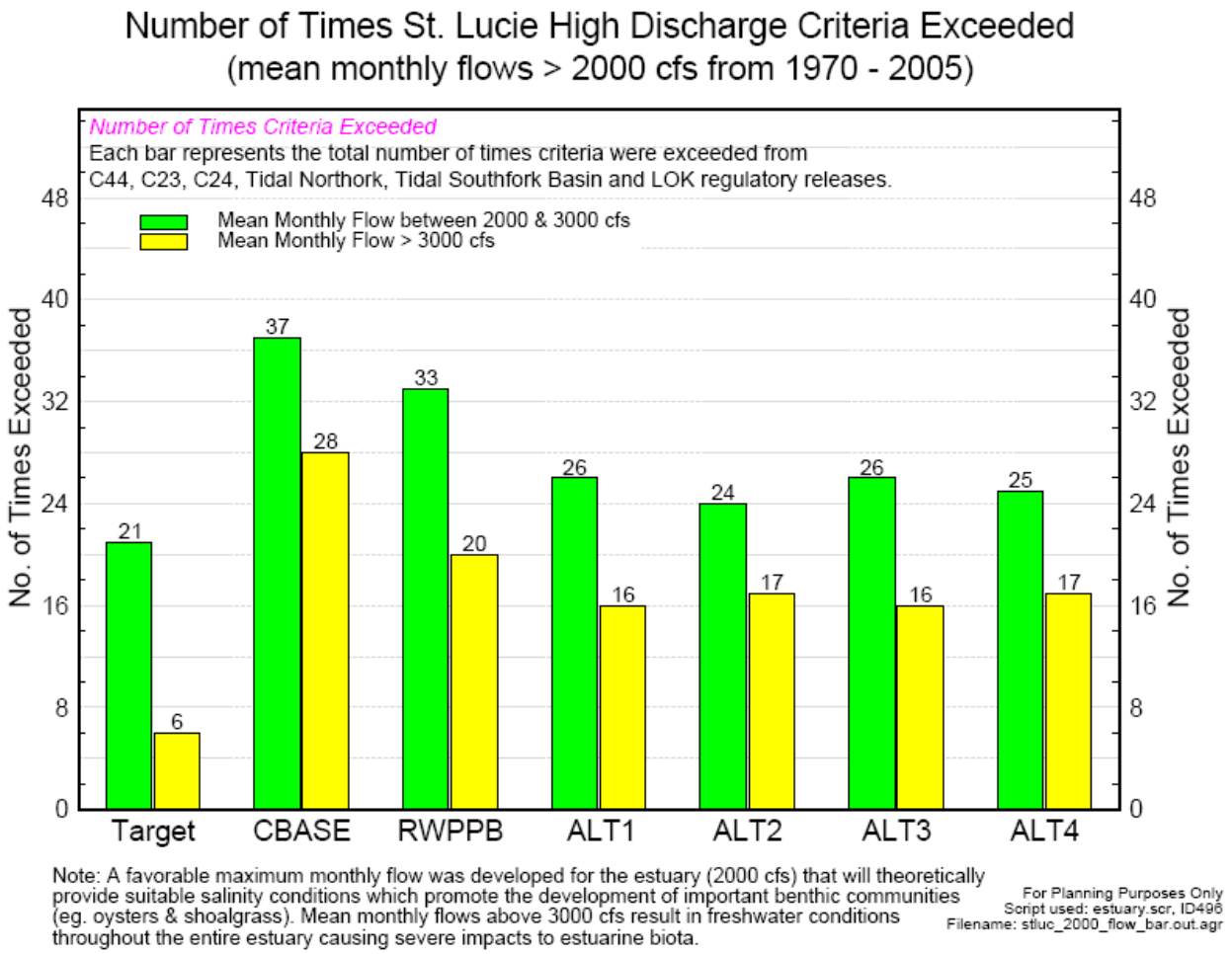

Figure 6.5-1. High Discharge Criteria Performance

Although Alternative 2 mirrors Alternative 1 for water storage, there are slight differences between the water quantity modeling results between Alternatives 1 and 2. These variations may be due to implementation of additional storage components in Alternative 2 in the CRWPP that are included in the NERSM. They influence Lake Okeechobee storage and Lake Okeechobee discharges to the St. Lucie Estuary because there are interdependencies between the St Lucie and Caloosahatchee River Watersheds and Lake Okeechobee. These interdependencies are reflected in the NERSM, which is a regional model for the entire Northern Everglades. The CRWPP includes additional Alternative 2 MMs such as CRE 128, the East Caloosahatchee Storage Reservoir, and CRE-LO 40, the Lake Hicpochee Reservoir.

Table 6.5-1 provides a breakdown of the exceedances displayed in **Figure 6.5-1** by source. This is important because the RWPPB is only attempting to address the watershed contribution to the estuary. Lake Okeechobee discharges were addressed in the LOP2TP. Focusing on the St. Lucie River watershed contribution only, the occurrences of discharges between 2,000 and 3,000 cfs from the watershed with the alternatives were 17, 4 occurrences below the target of 21. Also with the alternatives, the occurrences of discharges greater than 3,000 cfs were 7 to 8**,** which is 4 to 5 less than the RWPPB Condition and 5 to 6 occurrences less than the CBASE Condition. This represents 1 to 2 occurrences above the target of 6.

The number of months when the St. Lucie River watershed or Lake Okeechobee discharges did not exceed the high discharge criteria individually, but their combined discharges did is also shown in **Table 6.5-1**. For discharges between 2,000 and 3,000 cfs, these occurrences ranged from 7 to 9 times and for discharges greater than 3,000 cfs, these occurrences ranged from 8 to 9 times. This highlights the damaging effect that can result from a combination of St. Lucie River watershed flows and Lake Okeechobee discharges.

Table 6.5-1. Breakdown of Exceedences of the High Discharge Performance Measure Targets by Source (number of months out of 432 total months of simulation for 1970 to 2005 period of record)

Discharges Between 2,000 and 3,000 cfs	**CBASE**	**RWPPB**	**ALT1**	**ALT2**	**ALT3**	**ALT4**
St. Lucie River Watershed	25	23	**17**	**17**	**17**	**17**
Lake Okeechobee	1	2	0	0	0	0
St. Lucie River Watershed and Lake Okeechobee Combined	11	8	9	7	9	8
TOTAL	37	33	**26**	**24**	**26**	**25**
Discharges Greater Than 3,000 cfs	**CBASE**	**RWPPB**	**ALT1**	**ALT2**	**ALT3**	**ALT4**
St. Lucie River Watershed	13	12	**7**	**8**	**7**	**8**
Lake Okeechobee	1	0	0	0	0	0
St. Lucie River Watershed and Lake Okeechobee Combined	14	8	9	9	9	9
TOTAL	28	20	**16**	**17**	**16**	**17**

Alternative 1 displayed exceptional water quantity performance. The coordinating agencies, in consultation with the Working Team, determined that Alternative 1 maximized the water storage in the SLR Watershed needed to minimize damaging flows to the SLR Estuary. Therefore, no additional surface water storage MMs were added for subsequent alternatives. Of the Alternative 1 storage components, IRL-S PIR MMs provided the majority of the surface water storage. Minor changes between alternatives result from the impacts that storage in the CRWPP has on Lake Okeechobee water levels.

6.5.1.2 Salinity Envelope

The second SLRWPP water quantity performance measure is the salinity envelope target. The goal of the restoration salinity envelope targets is to maintain desirable salinity levels in the St. Lucie Estuary conducive to the St. Lucie Estuary's ecological health. This target considers both the quantity and duration of discharges to the St. Lucie Estuary from the St. Lucie River watershed.

The restoration salinity envelope targets for the St, Lucie Estuary are as follows:

- Limit mean monthly flows below 350 cfs for 31 months or less over a 432-month period (salinity envelope low flow criterion); and

- Limit the number of times flows from the St. Lucie River watershed exceed 2,000 cfs for 14 days or more to 28, based on a 14-day moving average (salinity envelope high flow criterion).

The basis for these goals is discussed in detail in Section 6.2.2.2. Because the NERSM model only accounts for surface water flows, a target of 196 months was used to achieve the low-flow performance comparable with the IRL-S PIR.

6.5.1.2.1 Salinity Envelope Results

The performance of the base conditions and the four alternatives compared to the salinity envelope target and the number of consecutive months that the salinity envelope criterion were not met are provided in **Figure 6.5-2.** For the exceedances, often the criteria are identified by source to assist with determining the appropriate location and size of any water storage needed within the St. Lucie River watershed. All water storage features addressing Lake Okeechobee discharges are addressed in the LOP2TP. Lake Okeechobee flows were not used to meet the salinity envelope low flow criteria (350 cfs); therefore, the left bars only represent flows from the St. Lucie River watershed.

As mentioned above, because the NERSM model only accounts for surface water flows, an operational target of 196 months was used to achieve the low-flow performance comparable with the IRL-S PIR, not the ecological target of 31. Low flows are not a significant issue for the St. Lucie Estuary because the low-flow target is typically achieved through groundwater flows. It is more beneficial for the low-flow criterion to be met by groundwater flows instead of watershed runoff. The groundwater flow within the St. Lucie River watershed provides a constant base flow to the St. Lucie Estuary and any supplemental flows needed from surface water sources to address low-flow conditions are ideally provided from the North Fork of the St. Lucie River. The salinity model and the oyster response model will likely be better tools to evaluate salinity conditions in the St. Lucie Estuary. Results of the oyster stress model are presented in section 6.5.1.2.2 below.

From the St. Lucie River watershed, the high-flow criterion was reduced by 7 occurrences with the RWPPB Condition compared to the CBASE Condition. From Lake Okeechobee regulatory releases, the high-flow criterion was reduced by 15 occurrences with the RWPPB Condition compared to the CBASE Condition. These improvements result from the base projects added to the RWPPB Condition including the LOP2TP Preferred Alternative, Ten Mile Creek Water Preserve Area, and the C-44 Reservoir.

Both the high-flow criterion and the low-flow criterion improved with the alternatives. Exceedances of the high-flow criterion were reduced by 24 to 26 compared to the CBASE Condition and by 17 to 19 compared to the RWPPB Condition. However, the high flow target of 28 is exceeded with the four alternatives by 18 to 20 occurrences.

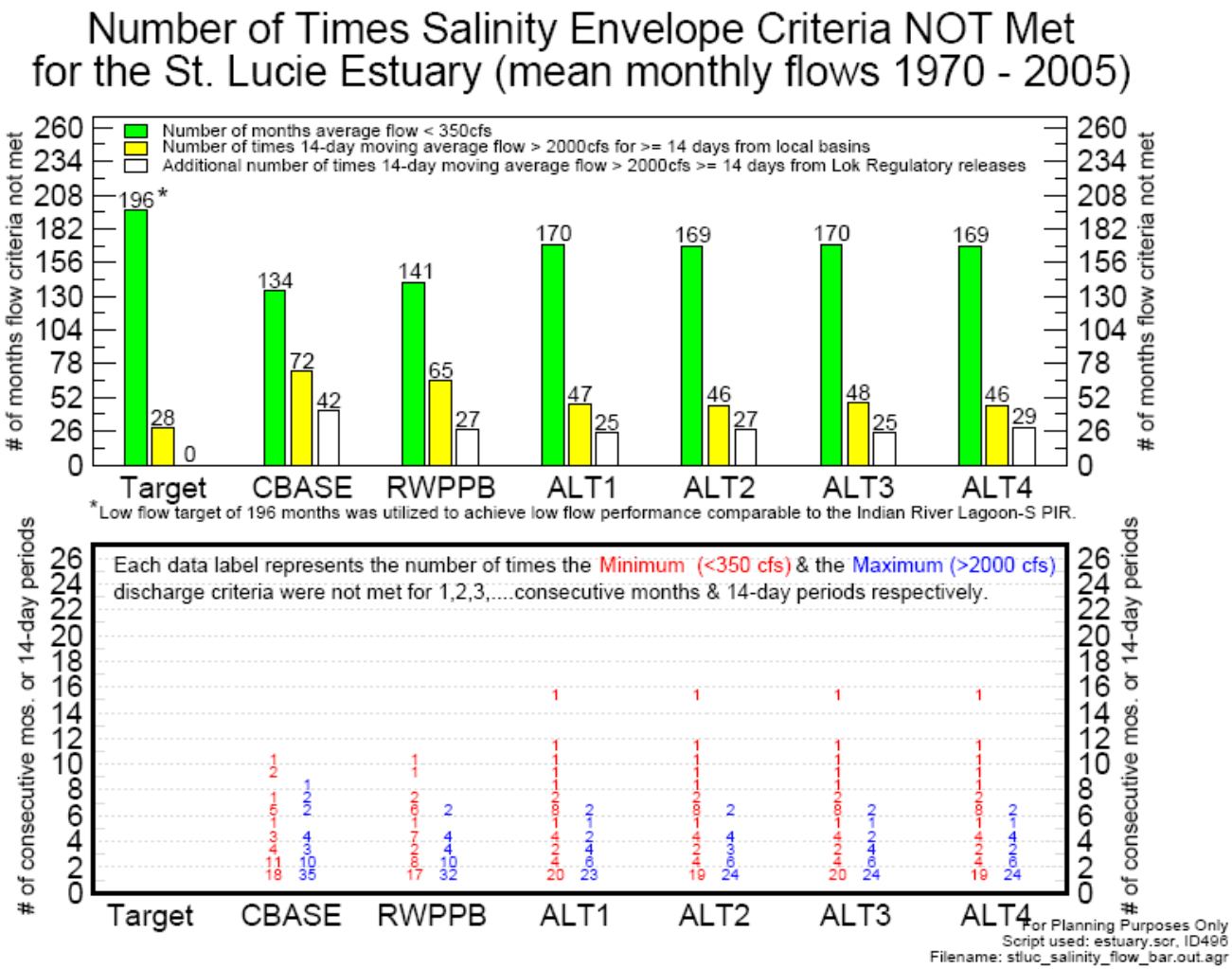

Figure 6.5-2. Salinity Envelope Criteria Performance

6.5.1.2.2 Oyster Stress Model Evaluation of Water Management Scenarios

Results from the NERSM modeling for the base and alternative conditions were subjected to additional analysis to assess potential oyster mortality utilizing the oyster stress model. For the oyster stress model, daily inflows to the inner estuary are used to simulate daily salinity at the confluence of the North and South Forks (Roosevelt Bridge), which is immediately upstream of the major oyster population. These daily salinities, in turn, are used as input to the oyster stress model to determine the effects of daily low salinity (high flows) durations on the oyster's life history. Results of the oyster analysis are then compared among water management scenarios and are presented in **Table 6.5-2**.

Table 6.5-2. Number of Oyster Life History Mortality Years During the Period of Record (1970 To 2005) for Historical Base Conditions and Potential Future Conditions

	CBASE	RWPPB	Alt 1	Alt 2	Alt 3	Alt 4
Adults	12	9	6	6	6	6
Spat	15	8	7	9	7	9
Larvae	19	14	10	10	10	10
Eggs	16	11	9	9	9	9
Total	62	42	32	34	32	34

Compared to the historical base inflow conditions that caused numerous oyster mortality events, all other water management scenarios tested provided significant reductions in mortality events due to an improved salinity environment. The RWPPB future base case, without the benefit of the C23/C24 Reservoir, reduced mortality events of the historical base case by approximately a third, whereas all alternatives scenarios with the C23/24 Reservoir decreased mortality events by nearly a half. However, of the four alternatives, Alternatives 1 and 3 had the least mortality events due to a further decrease in spat mortality during the beginning of the wet season when most of the spat are present in the middle estuary.

6.5.1.3 Lake Okeechobee Proposed Minimum Water Level Criteria

The target minimum water level condition for Lake Okeechobee allows for only one occurrence over a 6-year period when water levels drop below 11 feet National Geodetic Vertical Datum (NGVD) for more than 80 days. The model results are provided in **Figure 6.5-3**.

The most significant difference measured was the five decreased occurrences with the RWPPB Condition compared to the CBASE Condition. This is due to implementation of the base projects.

There were no notable changes between the RWPPB Condition and the alternatives. One minor difference was the reduction of one occurrence with Alternatives 2 and 4 compared to Alternatives 1 and 3. This is likely a result of the added water storage MMs in the Caloosahatchee River Watershed with the CRWPP Alternative 2 alleviating some of the water supply demands from Lake Okeechobee. No negative impacts to this performance measure occurred.

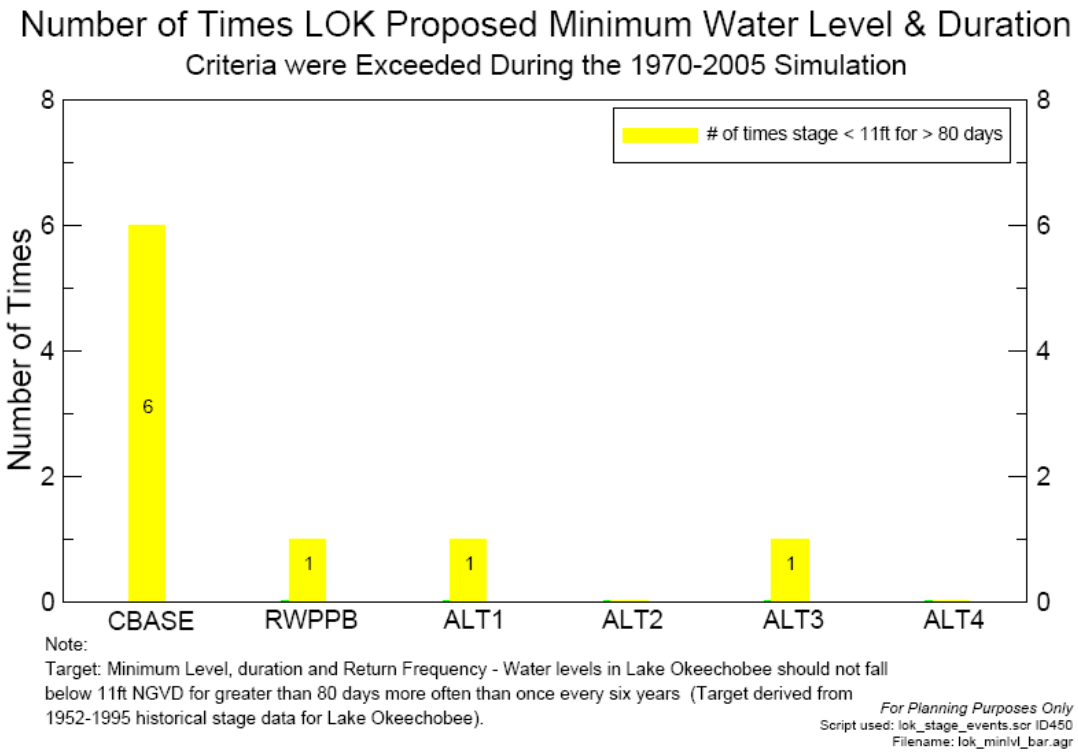

Figure 6.5-3. Lake Okeechobee Minimum Water Level Performance

6.5.1.4 Lake Okeechobee Service Area Irrigation Demand

Another SLRWPP performance indicator is ensuring that the plan does not adversely affect the Lake Okeechobee Service Area (LOSA) water supply demands. The water supply impact of the RWPPB and each of the alternatives are shown in **Figure 6.5-4**.

The most significant difference measured is the decreased volumes of LOSA demand cutbacks with the RWPPB Condition compared to the CBASE Condition. This is due to implementation of the base projects.

There were either no or minimal changes between the RWPPB Condition and the four alternatives.

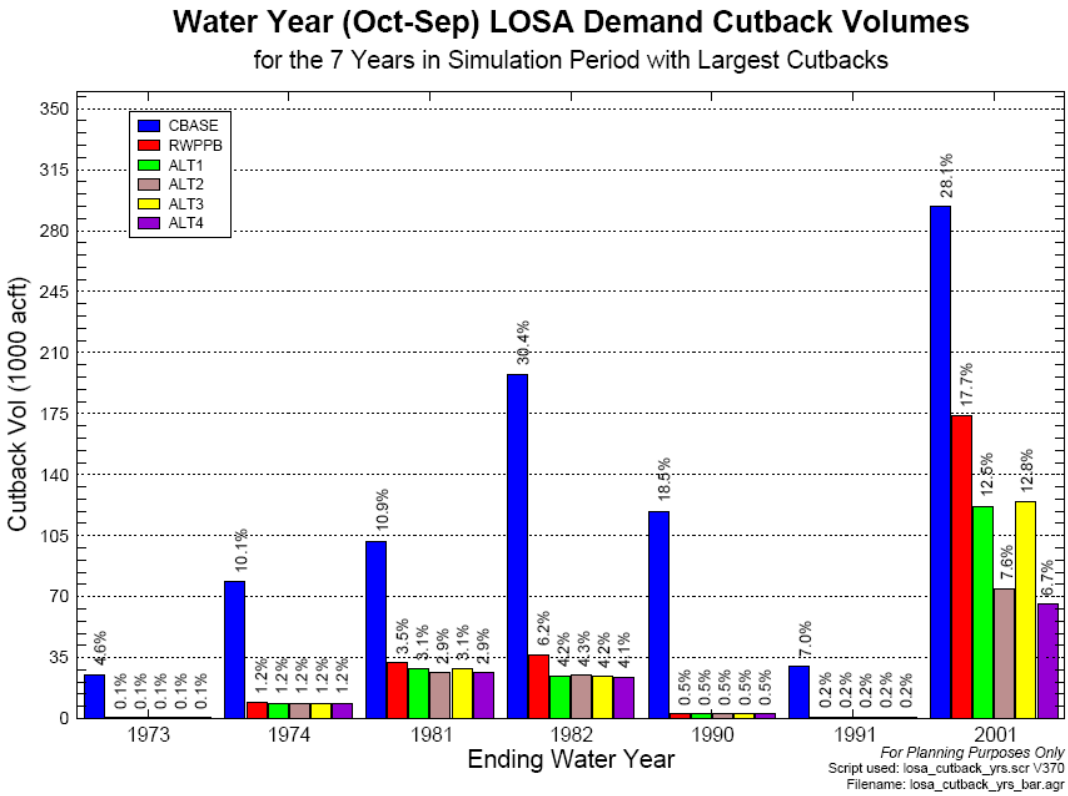

Figure 6.5-4. Lake Okeechobee Service Area Performance

Figure 6.5-5 shows the sources and volumes of water supplies (the top two figures) and the mean annual percentage of water supply demands not met for the Everglades Agricultural Area (EAA) and LOSA (the bottom two figures), for the same 7 years with the most severe LOSA water supply cutbacks. The most significant difference measured are the decreases in demands not met with the RWPPB Condition compared to the CBASE Condition. This is due to implementation of the base projects. All of the alternatives reduced the demands not met, with Alternative 4 providing the lowest percent of demands not met.

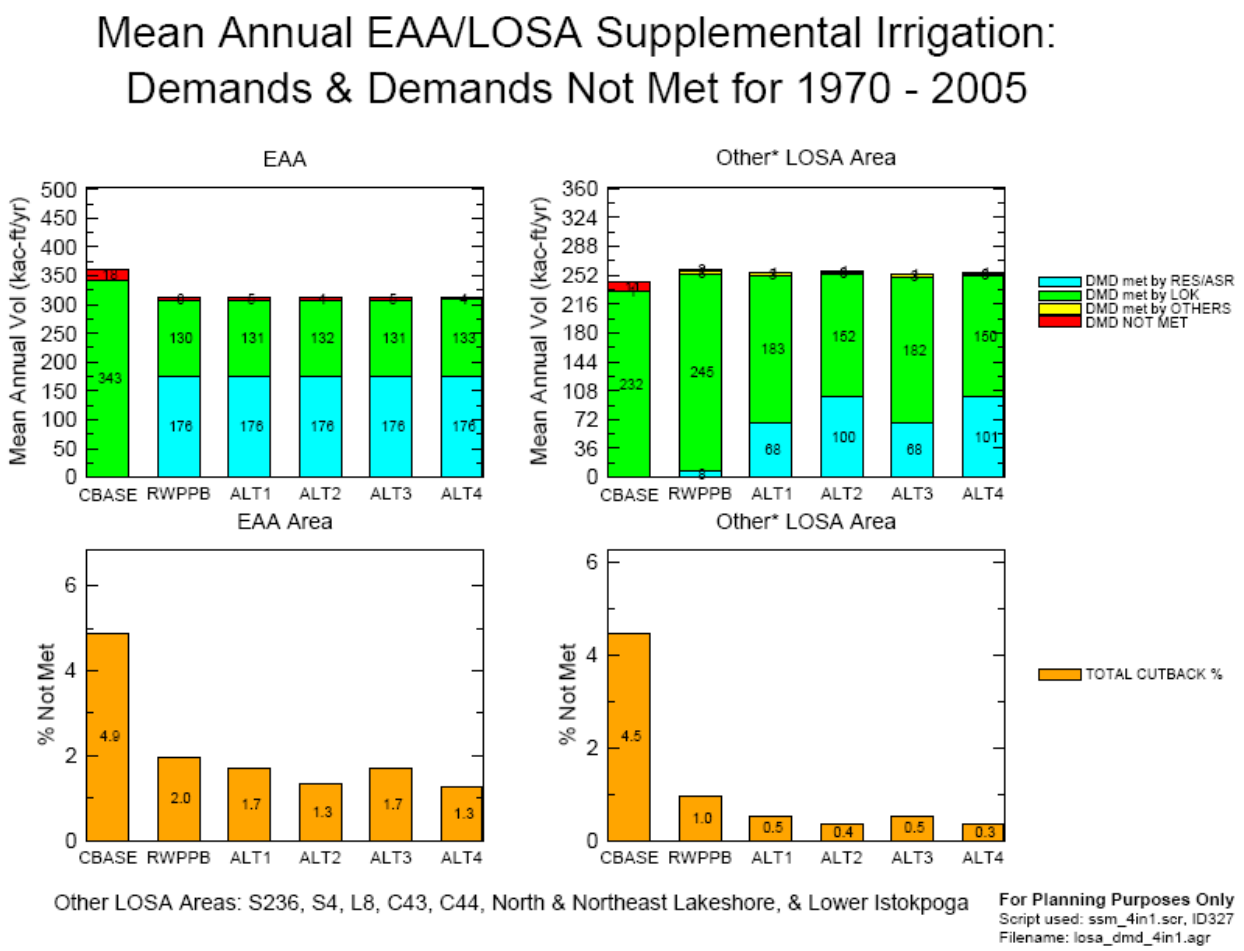

Figure 6.5-5. Lake Okeechobee Supplemental Irrigation Performance

6.5.2 Water Quality

The NEEPP in Section 373.4595, Florida Statutes (F.S.) requires the SLRWPP to contain an implementation schedule for pollutant load reductions consistent with any adopted Total Maximum Daily Loads (TMDLs) and in compliance with applicable state water quality standards. The Florida Department of Environmental Protection (FDEP) was formulating TMDLs for the St. Lucie River watershed during the formulation of the SLRWPP and as a result, an interim water quality goal was used by the coordinating agencies to maximum nutrient load reductions. NEEPP requires the SLRWPP to be updated every 3 years. Therefore, the water quality goals will be updated in the 3-year update of the SLRWPP to include any established TMDLs in the St. Lucie River watershed.

The Working Team also considered estimated natural background concentrations of TP and TN as developed by the Restoration Coordination and Verification (RECOVER) Program for the Comprehensive Everglades Restoration Project (CERP) (RECOVER, 2007) as a water quality indicator. The estimated natural background concentrations were 81 parts per billion (ppb) for TP and 0.72 parts per million (ppm) for TN. Based on the IRL-S PIR, 81 ppb TP is expected when annual loading from the St. Lucie River watershed is at or below 110 metric tons and 0.72

ppm TN is expected when the annual loading from the St. Lucie River watershed is reduced by 30 percent (665.4 metric tons per year), that is, when the annual loading is at or below 1552.7 metric tons per year TN.

The water quality evaluation method was described in Section 6.3. The base projects that influence anticipated TP and TN loading to the St. Lucie Estuary are the Ten Mile Creek Water Preserve Area in the North Fork sub-watershed; the C-44 Reservoir/STA in the C-44 and S-153 sub-watershed; and implementation of the LOP2TP.

6.5.2.1 Water Quality Results

Summaries of TP and TN load reductions are provided in **Table 6.5-3** and **Table 6.5-4**, respectively. As discussed in Section 6.5 above, Alternatives 1 and 2 are identical and Alternatives 3 and 4 are identical with regards to MMs within the St. Lucie River watershed (additional MMs are included within the Caloosahatchee Watershed); therefore, there are no changes in TP and TN reductions between the identical alternatives.

P and N loading was reduced from Lake Okeechobee by 70 and 68 percent, respectively, and from the St. Lucie River watershed by 10 and 8 percent, respectively, with the RWPPB Condition compared to the CBASE Condition. The total load reduction to the St. Lucie Estuary is 26 percent TP and 33 percent TN with the RWPPB Condition. The reductions from the St. Lucie River watershed are a result of base projects within the watershed (Ten Mile Creek Water Preserve Area and the C44 Reservoir/STA).

Each of the four alternatives provides a reduction in annual TP and TN loads compared to the CBASE and the RWPPB Condition, with Alternative 4 achieving the maximum load reductions. The load of reductions from the St. Lucie River watershed represent water quality benefits from the SLRWPP projects only. Alternative 4 resulted in a 46 percent reduction of TP loading and a 40 percent reduction of TN loading from the St. Lucie River watershed. With Alternative 4, the combined average annual TP and TN loading was reduced 56 percent for TP and 55 percent for TN compared to the CBASE Condition, and 41 percent for TP and 32 percent for TN compared to the RWPPB Condition.

It should be noted that the total load reduction of 55 percent for nitrogen (N) has resulted in a remaining load and concentration of 1,009 metric tons and 0.94 ppm, respectively, which are well below the natural background levels summarized above. On the other hand, the total load reduction of 56 percent for phosphorus has resulted in a remaining load and concentration of 164 metric tons and 153 ppb, respectively. Remaining TP concentrations are higher than the natural background concentrations, although to a much lesser extent than under the CBASE and RWPPB Conditions. Currently, phosphorus (P) loading from the St. Lucie River watershed is askew with excessively high P levels. Therefore, the major focus of management measures implemented for nutrient reductions in the watershed is (P) treatment, especially in the C-23 and C-24 sub-watersheds, which are major contributors of high (P) levels as discussed below and also in Section 6.3.2.4.

269 **Table 6.5-3.** Total Phosphorus Load Reductions

Total Phosphorus		Annual Load (mt/yr)	Concentration (ppb)	Load Reduction (%)	
				RWPPB Condition[1/]	CBASE Condition[2/]
RWPPB Condition	Lake Okeechobee	28.86	136.96	NA	70%
	St. Lucie River Watershed	248.18	285.26	NA	10%
	Combined	277.04	256.14	NA	26%
Alt 1	Lake Okeechobee	28.86	136.96	0%	70%
	St. Lucie River Watershed	165.14	191.53	33%	40%
	Combined	194.00	180.81	30%	48%
Alt 2	Lake Okeechobee	28.86	136.96	0%	70%
	St. Lucie River Watershed	165.14	191.53	33%	40%
	Combined	194.00	180.81	30%	48%
Alt 3	Lake Okeechobee	28.86	136.96	0%	70%
	St. Lucie River Watershed	135.05	156.63	46%	51%
	Combined	163.91	152.77	41%	56%
ALT 4- PREFERRED PLAN	Lake Okeechobee	28.86	136.96	0%	70%
	St. Lucie River Watershed	135.05	156.63	**46%**	**51%**
	Combined	**163.91**	**152.77**	**41%**	**56%**
1/ Percent load reduction compared to RWPPB Condition					
2/ Percent load reduction compared to CBASE Condition					

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Table 6.5-4. Total Nitrogen Load Reductions

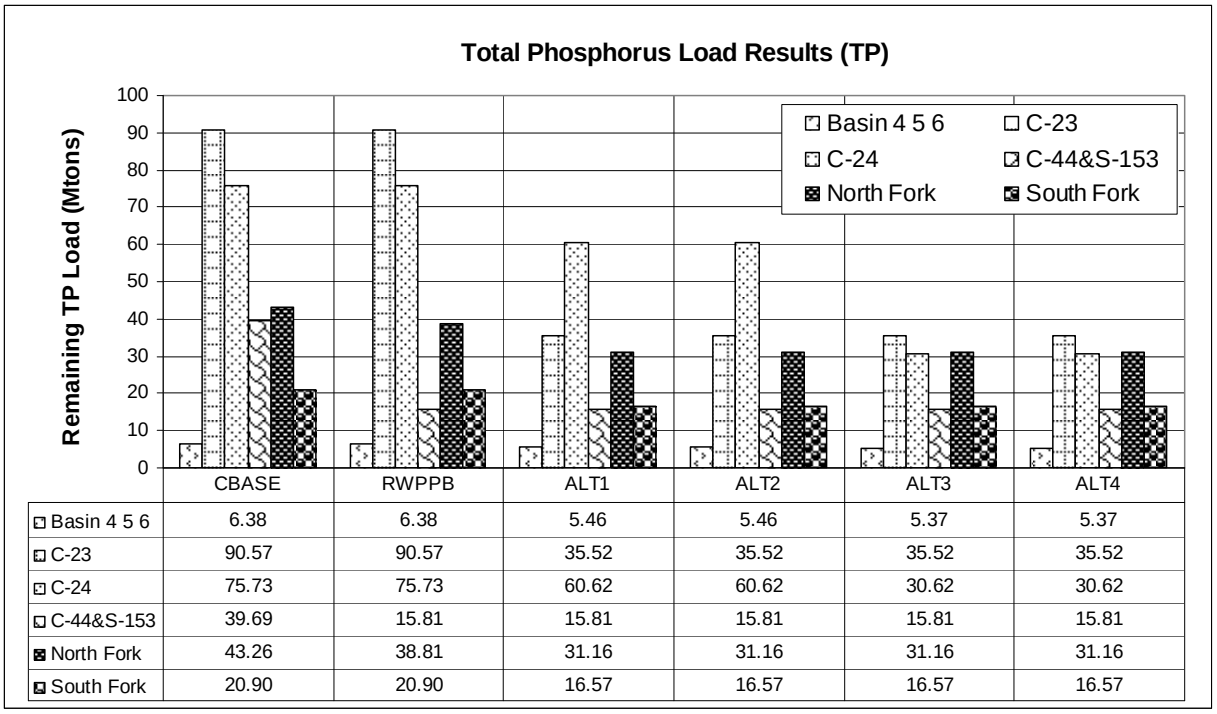
Total Nitrogen		Annual Load (mt/yr)	Concentration (ppm)	Load Reduction (%)	
				RWPPB Condition[1/]	CBASE Condition[2/]
RWPPB Condition	Lake Okeechobee	298.09	1.41	NA	68%
	St. Lucie River Watershed	1,192.63	1.38	NA	8%
	Combined	1,490.72	1.39	NA	33%
Alt 1	Lake Okeechobee	298.09	1.41	0%	68%
	St. Lucie River Watershed	810.73	0.94	32%	37%
	Combined	1,108.82	1.03	26%	50%
Alt 2	Lake Okeechobee	298.09	1.41	0%	68%
	St. Lucie River Watershed	810.73	0.94	32%	37%
	Combined	1,108.82	1.03	26%	50%
Alt 3	Lake Okeechobee	298.09	1.41	0%	68%
	St. Lucie River Watershed	710.50	0.82	40%	45%
	Combined	1,008.59	0.94	32%	55%
ALT 4- PREFERRED PLAN	Lake Okeechobee	298.09	1.41	0%	68%
	St. Lucie River Watershed	710.50	0.82	40%	45%
	Combined	1,008.59	0.94	32%	55%

1/ Percent load reduction compared to RWPPB Condition

2/ Percent load reduction compared to CBASE Condition

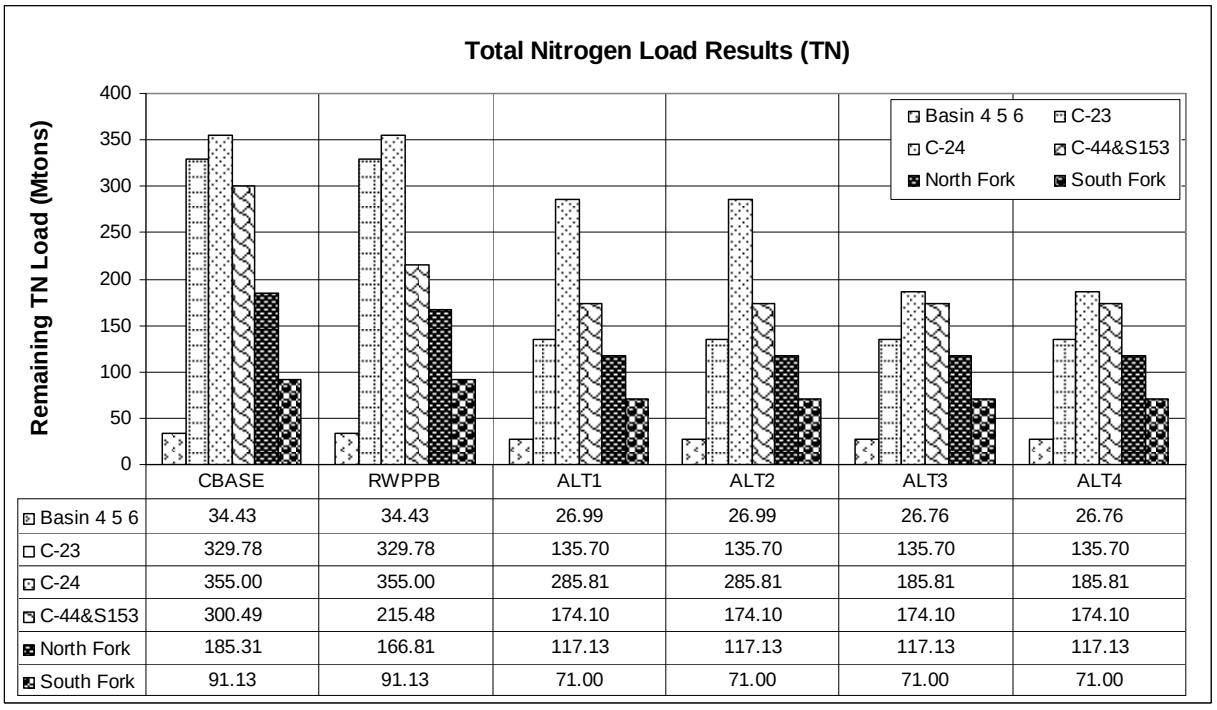
A very conservative approach was taken when quantifying water quantity and water quality benefits anticipated from individual MMs. When water quantity or water quality benefits were evaluated for a MM, a range of lowest anticipated and highest anticipated performance was estimated. The lowest anticipated performance was assigned to each MM. Furthermore, many water quality MMs do not have water quality performance values assigned to them due to insufficient information or because the nature of the project was not conducive to quantifying the benefits. These MMs will provide additional water quality benefits that were not included in the quantified water quality benefits of the four alternatives. Therefore, it is anticipated that the actual water quality benefits from the alternatives will be greater than the performance of each alternative reported in this section.

As discussed in Section 6.3.2.4, the C-23 and C-24 sub-watersheds were identified "hot spots" (sub-watersheds with disproportionately high annual TP loads compared to water discharges); therefore, they were targeted for water quality MMs. The focused water quality efforts applied to these sub-watersheds is highlighted in **Figures 6.5-6 and 6.5-7** (the reduction of height in the C-23 and C-24 bars). Remaining loads to the estuary from the C-23 sub-watershed were reduced 61 percent for TP and 59 percent for TN. Similarly, from the C-24 Sub-watershed remaining loads were reduced 60 percent for TP and 48 percent for TN.



	CBASE	RWPPB	ALT1	ALT2	ALT3	ALT4
Basin 4 5 6	6.38	6.38	5.46	5.46	5.37	5.37
C-23	90.57	90.57	35.52	35.52	35.52	35.52
C-24	75.73	75.73	60.62	60.62	30.62	30.62
C-44&S-153	39.69	15.81	15.81	15.81	15.81	15.81
North Fork	43.26	38.81	31.16	31.16	31.16	31.16
South Fork	20.90	20.90	16.57	16.57	16.57	16.57

Figure 6.5-6. Remaining Total Phosphorus Loads by Sub-Watershed



	CBASE	RWPPB	ALT1	ALT2	ALT3	ALT4
Basin 4 5 6	34.43	34.43	26.99	26.99	26.76	26.76
C-23	329.78	329.78	135.70	135.70	135.70	135.70
C-24	355.00	355.00	285.81	285.81	185.81	185.81
C-44&S153	300.49	215.48	174.10	174.10	174.10	174.10
North Fork	185.31	166.81	117.13	117.13	117.13	117.13
South Fork	91.13	91.13	71.00	71.00	71.00	71.00

Figure 6.5-7. Remaining Total Nitrogen Loads by Sub-Watershed

6.5.3 Identification of the Preferred SLRWPP Construction Project

NEEPP requires the SLRWPP to contain an implementation schedule for pollutant load reductions consistent with any adopted TMDLs and applicable state water quality standards, and to consider and balance water supply, flood control, estuarine salinity, aquatic habitat, and water quality considerations when assessing current water management practices within the St. Lucie River watershed.. Both TP and TN load reduction from watershed flows to the St. Lucie Estuary and additional storage capacity in the St. Lucie River watershed is required to achieve the restoration goals for the St. Lucie Estuary.

Each alternative was evaluated for its performance at reducing damaging discharges to the St. Lucie Estuary and TP and TN loads, and maintaining existing levels of water supply. Alternative 4 was selected as the plan that best met the legislative intent of NEEPP. Alternative 4 is referred to as the Preferred SLRWPP or the Preferred Plan from this point forward.

The Preferred Plan achieved a total load reduction of 55 percent for TN and 56 percent for TP, as shown in **Table 6.5-5**. These results reflect the "big picture" benefits provided by implementation of the LOP2TP and the St. Lucie River Watershed Preferred Plan. The load reductions to the estuary achieved by each plan are also included in **Table 6.5-5**. It should be noted that the total load reduction of 55 percent for N has resulted in a remaining load and concentration of 1,009 metric tons and 0.94 ppm, respectively, which are well below the natural background levels summarized above. On the other hand, the total load reduction of 56 percent for P has resulted in a remaining load and concentration of 164 metric tons and 153 ppb, respectively. Remaining TP concentrations are higher than the natural background concentrations, although to a much lesser extent than under current conditions. Currently, P concentrations in the estuary are primarily resulting from excessively high P levels throughout the watershed. The potential for reducing TP and TN loads from the St. Lucie River watershed alone to the estuary is 113 metric tons per year (46 percent) and 482 metric tons per year (40 percent), respectively.

Table 6.5-5. Load Reductions Achieved by the Preferred Plan for Total Nitrogen and Total Phosphorus

	Total Nitrogen	**Total Phosphorus**
Total Load Reduction[1/]	55%	56%
Watershed Load Reduction[2/]	40%	46%
Lake Okeechobee Load Reduction[3/]	70%	68%
Resulting Load	1,009 metric tons	164 metric tons
Resulting Concentration	0.94 ppm	153 ppb

[1/]Total load reduction from Lake Okeechobee and St. Lucie River watershed compared to CBase Condition
[2/] Load reductions only from the St. Lucie River watershed compared to RWPPB Condition
[3/] Load reductions only from the Lake Okeechobee compared to CBase Condition

In addition to the water quality benefits mentioned above, implementation of the Preferred Plan is anticipated to result in the following water quality and water quantity benefits:

Water Quality

- Implementation of BMPs on 297,442 acres of agricultural lands;
- Implementation of BMPs on 83,861 acres of urban lands;
- Completing Environmental Resource Permit and 40E-61 rule revisions;
- Construction of approximately 8,500 acres of STAs;
- Restoring approximately 95,000 acres of wetlands and natural areas within the SLR Watershed; and
- Removing approximately 250,000 cubic yards of silty muck sediment from Manatee Pocket in the SLR Estuary, thereby improving water quality.

Water Quantity

- Construction of approximately 11,800 acres of reservoirs and over 8,500 acres of STAs;
- Providing approximately 200,000 acre-feet of water storage within the SLR Watershed;
- Achieving a 75 percent reduction of the occurrences of flows between 2,000 and 3,000 cfs;
- Achieving a 50 percent reduction in flows greater than 3,000 cfs;
- Improved low flow performance; and
- Achieving a 45 percent improvement in the number of years with oyster mortality as compared to current conditions.

CHAPTER 7

ST. LUCIE RIVER WATERSHED POLLUTION CONTROL PROGRAM

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7.0 ST. LUCIE RIVER WATERSHED POLLUTANT CONTROL PROGRAM

Pollutant source control is integral to the success of any water resource protection or restoration program. Source control programs in the St. Lucie River watershed are evolving and expanding through cooperative and complementary efforts by the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (FDACS), and the South Florida Water Management District (SFWMD). The St. Lucie River Watershed Pollutant Control Program is designed to be a multi-faceted approach to reducing pollutant loads that includes improving the management of pollutant sources within the watershed through implementation of regulations and development and implementation of Best Management Practices (BMPs) focusing on nitrogen (N) and phosphorus (P). The Northern Everglades and Estuaries Protection Program (NEEPP) enacted in Section 373.4595, Florida Statutes (F.S.) (2007) further refines the responsibilities of the coordinating agencies to achieve the objectives of the St. Lucie River Watershed Protection Plan (SLRWPP) on an expedited basis, including:

- Implementation of non-point source BMPs on agricultural and non-agricultural lands to ensure that the amount of nutrients discharged off site are minimized to the greatest possible extent;
- Coordination with local governments to implement the non-agricultural, non-point-source BMPs within their respective geographic boundaries;
- Assessment of current water management practices within the watershed and development of recommendations for structural, nonstructural, and operational improvements that consider and balance water quality and supply, flood control, estuarine salinity, and aquatic habitat considerations;
- Ensuring that domestic wastewater residuals within the St. Lucie River watershed do not contribute to nutrient loadings in the watershed;
- Coordination with the Florida Department of Health to ensure that septage disposal within the watershed is under an approved agricultural use plan limiting applications based on nutrient loading limits established in the SFWMD's 40E-61 Regulatory Nutrient Source Control Program;
- Ensuring that entities utilizing land-application of animal manure develop a resource management system level conservation plan;
- Utilization of alternative and innovative nutrient control technologies;
- Utilization of federal programs that offer opportunities for water quality treatment, including preservation, restoration, or creation of wetlands on agricultural land; and
- Implementation of a source control monitoring program to measure the collective performance and progress of the coordinating agencies' programs, support adaptive management within the programs, identify priority areas of water quality concern and BMP optimization, and provide data to evaluate and enhance performance of downstream treatment facilities.

Source control programs are anticipated to be implemented through a phased approach based on identified priority areas of water quality concern.

7.1 Non-Point Source Best Management Practices

Nutrient source controls refer to activities and measures (many are referred to as BMPs) that can be utilized on agricultural and non-agricultural lands to ensure that the amount of nutrients, specifically P and N, in offsite discharge is minimized, thereby preventing excessive nutrients from entering the waterways. Implementation of BMPs is a relatively cost-effective pollutant reduction and prevention measure. BMPs include structural and non-structural measures. Structural measures include creating physical changes in the landscape to reroute discharges, installing water control structures, and erecting barriers. Non-structural source control measures include education, operational or behavioral changes, and establishing regulations.

The major categories of commonly used BMPs are nutrient management, water management, and erosion control. Nutrient management considers the amount, timing, and placement of nutrients such as fertilizer. Water management considers the timing, volume, maintenance, and overall efficiency of the stormwater and irrigation systems. Erosion control practices prevent the transport off site of nutrients in particulate matter and sediment.

One key component of an effective BMP program is education to make participants aware of practices and activities that may contribute to pollutants in discharges. The education component of source control also includes providing the latest technical information, through demonstration and research projects, to continually optimize the effectiveness of BMPs and to introduce alternative nutrient source control technologies. Much of the region-specific BMP research to date has been conducted in partnership with the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS). Another key component of an effective source control program is the proper implementation of the BMPs. There is a complementary effort being made by the coordinating agencies to follow up with participants on BMP implementation.

There are existing and proposed nutrient source control programs within the St. Lucie River watershed. These programs are developed and implemented cooperatively by the SFWMD, the FDEP, and the FDACS, in collaboration with local governments and private landowners. Examples include development and implementation of agricultural and non-agricultural BMPs, development of agricultural use plans that limit nutrient loading, restrictions on the application of domestic wastewater residuals and septage, implementation of the Florida Yards and Neighborhoods Program, and several urban stormwater management programs.

These nutrient source control programs will continue, regardless of the number, size, and configuration of the capital water quality improvement projects described and prioritized elsewhere in this plan. Nutrient source control is a critical component of watershed restoration, and it is typically less expensive to prevent pollution than remediate its impacts. Further, these programs operate under authorities and requirements independent of the NEEPP.

7.1.1 South Florida Water Management District Nutrient Source Control Programs

7.1.1.1 Environmental Resource Permit Program

One of the earlier pollutant source control programs began in the 1980s in Chapter 17-25, Florida Administrative Code (F.A.C.) and focused on the regulation of stormwater. Since the 1990s, stormwater quality has been regulated under the Environmental Resource Permit (ERP) program, which is found in Part IV of Chapter 373, F.S. The ERP program regulates activities involving the alteration of surface-water flows, and it includes activities in uplands that alter stormwater runoff as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that alterations do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems.

The ERP program is implemented by the state's five water management districts. Under the ERP program, all five water management districts are developing a Unified Stormwater Rule that will allow for consistency in stormwater quality treatment throughout the state. In the SFWMD area, the program applies to new or modified development only, and it operates on the assumption that permit requirements will result in water-storage capacity and no increase in P loading. In March 2008, the SFWMD initiated rule development for an ERP basin rule with specific supplemental criteria designed to result in no increase in total runoff volume from new development that discharges ultimately to Lake Okeechobee and/or the Caloosahatchee or St. Lucie Estuaries. The proposed date for rule adoption is July 2009.

In order to attain additional load reductions of nutrients (N and P), the primary source of waterbody impairment statewide, the FDEP and the water management districts are currently working on a statewide stormwater treatment rule that will be based on a performance standard of post-development nutrient loading not exceeding pre-development nutrient loading. The rule's intended effect is to increase the level of treatment required for nutrients (N and P) in stormwater from new development, which is anticipated to adequately address the discharge of N and P, in general. It will also have an incidental effect of reducing the volume of stormwater. The proposed date of the rule is July 2009.

7.1.1.2 St. Lucie River Watershed Regulatory Nutrient Source Control Program

Another existing SFWMD program, the 40E-61 Regulatory Nutrient Control Program under Chapter 40E-61, F.A.C., was adopted in 1989 as a result of the Lake Okeechobee Surface Water Improvement and Management (SWIM) Plan to provide a regulatory source control program specifically for P. The NEEPP legislation expanded the program boundary to the St. Lucie River watershed and included N in addition to P as the focus of nutrient source controls. The program applies to new and existing activities with the goal of reducing nutrients in offsite discharges.

The SFWMD will be modifying Chapter 40E-61, F.A.C. criteria to be compatible with current initiatives and amendments to the NEEPP, specifically to:

- Implement a nutrient source control program utilizing BMPs for agricultural and non-agricultural lands within the Northern Everglades, including the St. Lucie River watershed;

- Recognize agricultural lands that are greater than 100 acres and are participating in the FDACS BMP program as meeting the intent of the proposed rule, to prevent duplication of effort;
- Define the monitoring network necessary to gauge the collective effectiveness of the source control programs implemented by the coordinating agencies, make water quality compliance determinations as necessary, identify priority areas of water quality concern, and provide data to evaluate and enhance performance of downstream treatment facilities;
- Establish water quality performance criteria specific to the collective source control programs, and develop a plan for optimizing the collective BMP programs should the expected water quality performance criteria not be met;
- Establish nutrient concentration limits for sites utilized for septage application or disposal;
- Ensure that the rule is consistent with data presented in the SLRWPP; and
- Include incentives to participate in nutrient reduction demonstration and research projects that will provide valuable data for expanding, accelerating, and optimizing the implemented BMPs to meet water quality objectives and for further refinement of the programs as necessary.

The original timeline for rule development proposed a completion date of September 2007; however, with the latest legislative changes, the SFWMD rulemaking team is re-evaluating the effort to ensure that the latest authorizations are considered in proposed amendments. To ensure consistency with the SLRWPP, the anticipated amended rule adoption is anticipated in early 2009.

7.1.2 Florida Department of Agriculture and Consumer Services Nutrient Source Control Programs

7.1.2.1 Agricultural Best Management Practices Program

The Florida Watershed Restoration Act (section 403.067, F.S.), enacted in 1999, authorizes the FDACS to develop, to adopt by administrative rule, and to implement agricultural BMPs statewide. Through the Office of Agricultural Water Policy, FDACS develops, adopts, and implements agricultural BMPs to reduce water quality impacts from agricultural discharges and enhance water conservation.

The Office of Agricultural Water Policy's role involves assisting agricultural producers in selecting, funding, properly implementing, and maintaining BMPs. The Office of Agricultural Water Policy employs field staff and contracts with service providers to work with producers to identify and to implement BMPs appropriate for their operations. A detailed explanation of adopted agricultural BMPs can be found at www.floridaagwaterpolicy.com, and printed BMP manuals can be obtained in local extension offices at county agricultural centers or by contacting Office of Agricultural Water Policy field staff.

The Office of Agricultural Water Policy has adopted by rule BMPs that address the following operations in the St. Lucie River watershed:

- Container Nurseries (Chapter 5M-6, F.A.C.);
- Vegetable and Agronomic Crops (Chapter 5M-8, F.A.C.); and
- Citrus (Chapter 5M-2, F.A.C.).

The Office of Agricultural Water Policy is currently developing and will be adopting BMP manuals of statewide application for cow/calf, equine, container nursery, and sod operations. BMPs for all agricultural land uses in the St. Lucie River watershed are expected to be adopted and available for enrollment by early 2009.

When the 2007 Florida legislature enacted the NEEPP legislation, significant portions of agricultural acreage within the St. Lucie River watershed were already implementing water resource protection BMPs previously adopted by FDACS. As of the date of completion of the SLRWPP, agricultural acreage within Martin and St. Lucie Counties enrolled in the FDACS BMP program totaled 145,850 acres or approximately 49 percent of total agricultural acres in the two counties. Enrolled acreage is expected to increase dramatically when the beef cattle BMP manual is adopted in early 2009.

To meet the intent of the NEEPP legislation with regard to agriculture in the St. Lucie River watershed, the Office of Agricultural Water Policy will conduct the following activities during 2008 to 2012, as necessary and feasible:

- Adopt BMP manuals for cow/calf, equine, container nursery, and sod operations;
- Intensify its efforts to sign up cow/calf and equine producers for BMP implementation in the St. Lucie River watershed;
- Work with FDEP to identify priority cow/calf and equine BMPs and verify their effectiveness;
- Develop a BMP implementation assurance program to follow up with selected cow/calf and equine operations on whether they are implementing BMPs and keeping appropriate records;
- Provide or participate in training and educational opportunities for producers regarding BMP implementation and its importance to water quality;
- Evaluate the need for BMP enrollment and implementation for other commodities in the basin and conduct these on a priority basis; and
- Continue on-farm BMP demonstration projects at representative sites, to provide BMP effectiveness data and insight into what new or modified BMPs may be necessary to reach nutrient reduction goals.

7.1.2.2 Animal Manure Application Rule

In February 2008, FDACS initiated rule development to control the land application of animal wastes in the St. Lucie River watershed. The proposed rule includes minimum application

setbacks from wetlands and all surface waters. Landowners who apply more than one ton per acre of manure must develop U.S. Department of Agriculture/U.S. Natural Resource Conservation Service (USDA/USNRCS)-approved conservation plans specifically addressing the application of animal wastes, and conducting soil testing to demonstrate the need for manure application. All use of animal manure must be recorded and included in the operation's overall nutrient management plan. The FDACS expects to complete rule making for this effort by the fall of 2008.

7.1.2.3 Urban Turf Fertilizer Rule

In August 2007, FDACS adopted a statewide Urban Turf Fertilizer Rule [5E-1.003(2) F.A.C]. The rule limits the P and N content in fertilizers for urban turf and lawns, thereby reducing the amount of P and N applied in urban areas and limiting the amount of those compounds reaching Florida's water resources. It requires that all fertilizer products labeled for use on urban turf, sports turf, and lawns be limited to the amount of P and N needed to support healthy turf maintenance. FDACS expects a 20 to 25 percent reduction in N and a 15 percent reduction in P in every bag of fertilizer sold to the public.

The rule was developed by FDACS with input from UF/IFAS, FDEP, the state's five water management districts, the League of Cities, the Association of Counties, fertilizer manufacturers, and concerned citizens. It enhances efforts currently underway to address excess nutrients in the northern and southern Everglades. As a component of the Lake Okeechobee and Estuary Recovery (LOER) Plan established in October 2005 by former Governor Jeb Bush, the new rule is an essential component to improve water quality through nutrient source control.

7.1.3 Florida Department of Environmental Protection Pollutant Source Control Programs

FDEP is responsible for several existing and planned source control programs primarily targeting urban and non-agricultural issues. Programs include initiatives to improve existing stormwater and wastewater infrastructure, implementation of pollutant reduction plans for municipal stormwater management systems, land development regulations to promote proper stormwater treatment, enhancement to existing regulations for the management of domestic wastewater residuals within the watershed, coordination with applicable authorities on septage disposal to ensure that nutrient loadings are considered, and administering the National Pollution Discharge Elimination System (NPDES) permit program.

7.1.3.1 Stormwater and Wastewater Infrastructure Updates and Master Planning

Stormwater and wastewater infrastructure updates and master planning are the responsibility of, and implemented by, the local governments. Portions of the St. Lucie River watershed urbanized area were developed prior to the implementation of ERP. In these areas, stormwater retention and treatment levels are often inadequate to protect surface water quality. Local governments in the St. Lucie River watershed have been conducting stormwater management projects for more than 10 years, well before the initiation of municipal stormwater permits in the watershed (see Section 7.1.3.2 below).

7.1.3.1.1 National Pollution Discharge Elimination System Wastewater Facilities

Wastewater facilities are permitted under the FDEP's NPDES program to ensure that water and groundwater in the St. Lucie River watershed are adequately protected. Wastewater facilities are classified as domestic or industrial depending on the type and extent of wastewater the facility is designed to treat. In general, domestic wastewater facilities are those principally designed to collect and treat sanitary wastewater or sewage from dwellings or homes, business buildings, institutions, and the like. The remaining individually permitted facilities are classified as industrial wastewater facilities. Sources of industrial wastewater include manufacturing, commercial businesses, mining, agricultural production and processing, and wastewater from cleanup of petroleum and chemical contaminated sites. Industrial wastewater discharged under NPDES permits may be subject to federal Effluent Limitations Guidelines, and must provide reasonable assurance of meeting Florida's Water Quality Standards for surface water or groundwater in order to receive a discharge permit. According to the FDEP Waste Application Facilities Report database, 15 NPDES permitted wastewater facilities exist in the St. Lucie River watershed (see **Table 7-1**). Of the permitted facilities, 2 are domestic wastewater and 13 are industrial wastewater types.

Table 7-1. National Pollution Discharge Elimination System Wastewater Facilities Located in the St. Lucie River Watershed (FDEP 2008)

WBID	Facility Name	Facility ID	Type	Surface Water Discharge?	Permitted Flow (MGD)
3194	St. Lucie County Fairgrounds	FL0434698	Domestic Wastewater	Yes	0.0134
3194	Prestige AB Mgmt Co LLC - Ft. Pierce	FLG110569	Industrial Wastewater		
3194	Rinker Materials of Florida Inc. W. Ft. Pierce Plant	FLG110576	Industrial Wastewater		
3194	Adonel Ft. Pierce Plant	FLG110638	Industrial Wastewater		
3197	Florida Rock industry	FL0140406	Industrial Wastewater	Yes	13.824
3200	Gracewood Dairy	FLA187577	Industrial Wastewater		
3210	Tarmac America - Stuart Plant	FL0126411	Industrial Wastewater		
3210	Rinker Materials - Stuart Plant	FLG110333	Industrial Wastewater		
3210	Continental FL Matl - Stuart	FLG110543	Industrial Wastewater		
3218	Florida Power and Light Plant co- Martin County	FL0030988	Domestic Wastewater	Yes	No Limit
3218	Indian Town Cogeneration Plant Emergency Discharge	FL0183750	Industrial Wastewater	Yes	No Limit
3218	Payson Park Thoroughbred Training Center	FLA413950	Industrial Wastewater		
3218	Rinker Materials of Florida Inc. Indiantown	FLG110724	Industrial Wastewater		
3218	Circle K store # 7403	FLG912597	Industrial Wastewater		
5003A	Sailfish Point Utilities Corp	FL0037001	Industrial Wastewater	Yes	0.115

Five NPDES permitted wastewater facilities discharge directly to surface water: the Florida Power Plant and Light Company Martin County, the St. Lucie County Fairgrounds, Florida Rock Industry, Indiantown Co-Generation Plant, and Sailfish Point Utilities. Based on review of the permit conditions for these facilities, discharges are not expected to contribute significantly to nutrient loads to the St. Lucie River watershed.

7.1.3.1.2 Stormwater Infrastructure and Master Planning

Local governments have constructed and continue to build stormwater retrofits, such as detention/retention facilities and swales, to improve the quality of urban stormwater runoff. The cities of Stuart and Port St. Lucie have stormwater utilities in place to fund these efforts. Martin and St. Lucie Counties do not have stormwater utilities in place but do have dedicated mechanisms (stormwater municipal service taxing units) that are used to fund stormwater improvements.

Martin and St. Lucie Counties adopted Stormwater Master Plans in 1997 and 1999, respectively in order to address flooding and property damage concerns, address water quality issues, and preserve the environment and enhance wildlife habitat. Martin County's Stormwater Management Program was incorporated into the county's Growth Management Plan, and includes comprehensive stormwater retrofitting projects relying mostly on wet detention to provide water quality treatment and flow attenuation, roadway flood protection, and structure flood protection. Responsibilities of the St. Lucie County Stormwater Master Plan are mostly carried out by the cities of Ft. Pierce, Port St. Lucie, and St. Lucie Village within their corporate boundaries, while the management responsibilities for the unincorporated portion of the county are shared by the SFWMD, the North St. Lucie River Water Control District, Fort Pierce Farms and Water Control District, and St. Lucie County. Some of the management activities addressed in the St. Lucie Stormwater Master Plan include maintenance and cleaning of roadside swales, drainage ditches, and larger canals; replacing deteriorated roadway culverts and stormwater drainage pipe systems; and developing plans to improve flood protection and to improve the quality of stormwater that discharges into surrounding waterbodies.

Local utilities are also aggressively pursuing upgrades to their wastewater management systems to protect water quality. Improvements to lift stations, inspection frequency and replacement of leaking sewer lines, and related activities help limit the introduction of nutrients into surface waters.

7.1.3.2 Municipal Separate Storm Sewer System Permit Program

Local governments (St. Lucie County, Martin County, Stuart, and Port St. Lucie), the Florida Department of Transportation (FDOT) District 4, and the Florida Turnpike Enterprise operate permitted Municipal Separate Storm Sewer Systems (MS4s) in the St. Lucie River watershed. An MS4 is a publicly owned conveyance or system of conveyances designed or used for discharging stormwater, which can include streets, curbs, gutters, ditches, and storm drains. These water conveyance systems are permitted through the statewide MS4 permitting program and receive a NPDES permit administered by the FDEP (see Rule 62-624, F.A.C.). The purpose of the MS4 permit program is to develop, implement, and enforce a stormwater management plan to reduce the discharge of pollutants to the maximum extent practicable, to protect water quality and comply with the water quality requirements of the Clean Water Act (CWA).

There are six permitted MS4s in the St. Lucie Basin: Martin County #FLR04E013, St. Lucie County #FLR04E029, City of Stuart #FLR04E031, City of Port St. Lucie #FLR04E001, FDOT District 4 #FLR04E083, and Florida Turnpike Enterprise #FLR04E049. Permit duration is 5 years. All MS4 permits in the St. Lucie River watershed are Phase II permittees, up for renewal in 2008.

7.1.3.2.1 Phase II Municipal Separate Storm Sewer Systems

Phase II MS4s are regulated under an NPDES generic permit that requires implementation of BMPs to meet the following six minimum control measures:

- Education and outreach (e.g., Florida Yards and Neighborhoods Program);
- Public participation;
- Illicit discharge detection and elimination;
- Construction site runoff control;
- Post-construction runoff control (met through state stormwater permitting; requirements [ERP] under Part IV, Chapter 373, F.S., as a qualifying alternative program); and
- Pollution prevention/good housekeeping.

Note: Stormwater Master Plans only apply to Phase I MS4 permittees. In the St. Lucie River watershed, only Phase II MS4s exist. Thus, the above paragraph does not apply to the St. Lucie MS4s.

7.1.3.3 Comprehensive Planning - Land Development Regulations

The Office of Intergovernmental Programs coordinates FDEP's involvement in statewide planning efforts conducted under various authorities, including Chapter 187, F.S. (the State Comprehensive Plan), which sets forth goals that articulate Florida's desired future. The State Comprehensive Plan is reviewed annually, and local plans are updated every 5 to 7 years through the Evaluation and Appraisal Report process. Throughout this process, the FDEP has the formal opportunity to evaluate proposed amendments to the comprehensive plan, which are based upon the evaluation and appraisal report, to ensure that they are consistent with FDEP's rules and policies.

Local governments in the St. Lucie River watershed are taking steps to implement low-impact design principles to minimize nutrient sources and loss and enhance water storage.

7.1.3.4 Domestic Wastewater Residuals – Senate Bill 392/2007 Changes to 373.4595, Florida Statutes

In response to the 2007 residuals-related changes to Section 373.4595, F.S., the FDEP's Division of Water Resource Management promulgated a program guidance memo providing general procedures for the FDEP district offices to implement the requirements within the current regulatory framework of Chapter 62-640, F.A.C. This guidance is consistent with the NEEPP legislation, which states that "After December 1, 2007, disposal of domestic wastewater residuals within the St. Lucie watershed is prohibited unless the applicant can affirmatively demonstrate

that the nutrients in the residuals will not add to nutrient loadings in Lake Okeechobee or its tributaries" Section 373.4595(3)(c)6., F.S. (2007).

Effectively, the provisions will be phased in as wastewater treatment facility permits expire. Permit renewals must include the appropriate nutrient balance demonstration required by the statute in the site Agricultural Use Plan submitted with the facility permit renewal application. Additionally, Chapter 62-640, F.A.C., is undergoing rule making. Under the proposed revisions, the nutrient balance demonstration must be submitted with the Nutrient Management Plan when a land application site is permitted.

7.1.4 Other Pollutant Source Control Programs

7.1.4.1 Application of Septage – Senate Bill 392/2007 Changes to Section 373.4593, Florida Statutes

Sections 373.4595(4)(a)2.f. and (4)(b)2.f., F.S., require all entities disposing of septage within the Caloosahatchee and St. Lucie River watersheds to develop and submit to the Florida Department of Health, an agricultural use plan that limits applications based upon nutrient loading. In response to these NEEPP requirements, Florida Department of Health has notified all county permitting authorities in the watersheds of the requirement that entities disposing of septage within the watersheds develop and submit to Florida Department of Health an agricultural use plan that limits applications based upon nutrient loading. At this time, there are no known septage application sites in these watersheds. Once the SFWMD or the FDEP has promulgated nutrient concentration limits for runoff from sites in these watersheds through the SFWMD's 40E-61 regulatory nutrient control programs or another validly adopted rule, the Florida Department of Health will notify all county permitting authorities in the watersheds that nutrient concentrations originating from these application sites may not exceed the established limits.

7.1.4.2 Florida Ranchlands Environmental Services Project

Launched in October 2005, the Florida Ranchlands Environmental Services Project will design a program under which ranchers in the northern Everglades watersheds can sell environmental services of water retention, P load reduction, and wetland habitat expansion to agencies of the state and other willing buyers. To document the level of environmental services provided by ranch water-management projects, Florida Ranchlands Environmental Services Project will field test different methods of using monitoring and modeling of hydrology, water and soil chemistry, and vegetation change.

These ranchers will bring such services on line quickly as compared to other options because land purchase is not required, and the program will complement public investment in regional water storage and water treatment facilities. The sale of the water retention services will add income for ranchers and will provide an incentive to combat converting land uses for more intensive agriculture and urban development—land uses that can increase stormwater flow, pollution, and habitat impacts.

Florida Ranchlands Environmental Services Project is being implemented through a collaboration of the World Wildlife Fund (WWF), eight participating ranchers, USDA/USNRCS,

FDACS, SFWMD, and FDEP. Technical support is being provided by scientists from the MacArthur Agro-Ecology Research Center and the University of Florida. Funding from federal, state, and private sources exceeds $5 million for Phase One, which includes pilot project implementation and program design.

7.1.4.3 Florida Yards and Neighborhoods Program

The Florida Yards and Neighborhoods Program is an excellent example of a non-structural program. It is a partnership of UF/IFAS, Florida's water management districts, the FDEP, the National Estuary Program, the Florida Sea Grant College Program, concerned citizens, members of private industry, and numerous other non-governmental agencies. It is implemented through the counties' UF/IFAS Cooperative Extension Service. The program addresses the serious problems of pollution in stormwater runoff, water shortages, and disappearing habitats by enlisting Floridians to preserve and to protect our natural resources. By educating citizens and builders about proper landscape design (e.g., "right plant-right place" practices), this program is helping minimize the use of pesticides, fertilizers, and irrigation water. FDEP has an ongoing monitoring program to determine the effectiveness of this program in reducing nutrient loads. More information on this program as well as other FDEP BMPs can be found at: http://www.dep.state.fl.us/water/nonpoint/pubs.htm.

7.2 Summary

Source control is integral to the success of any water resource protection or restoration program, and it is typically less expensive to prevent pollution than remediate its impacts. Source control programs in the St. Lucie River watershed are evolving and expanding through cooperative and complementary efforts by the FDEP, the FDACS, and the SFWMD. Activities underway that will significantly improve the source control program's contribution to the achievement of the objectives of the NEEPP legislation include:

- All agricultural land uses in the St. Lucie River watershed are expected to have FDACS-adopted BMP manuals by early 2009, including adoption of BMP manuals for cow/calf, equine, container nursery, and sod operations;
- Proposed revisions will be implemented to supplement the ERP program, including the proposed statewide stormwater treatment rule that is intended to increase the level of treatment required for nutrients (N and P) in stormwater from new development, and the proposed basin rule for the Lake Okeechobee and estuary watershed basins with specific supplemental criteria designed to result in no increase in total runoff volume from new development;
- Expansion of the SFWMD's nutrient regulatory source control program (Chapter 40E-61, F.A.C.) to the St. Lucie River watershed is planned for both P and N; and
- Restrictions on the disposal of domestic wastewater residuals, septage, and animal manure within the watershed are proposed.

Collectively, these source control programs will require all agricultural and non-agricultural land uses to implement and be accountable for BMPs through the FDACS BMP program or the SFWMD's nutrient source control program, or demonstrate compliance with water quality standards, as applicable.

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CHAPTER 8

ST. LUCIE RIVER WATERSHED RESEARCH AND WATER QUALITY MONITORING PROGRAM SUMMARY

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8.0 RESEARCH AND WATER QUALITY MONITORING PROGRAM

The Northern Everglades and Estuaries Protection Program (NEEPP) legislation requires the establishment of a St. Lucie River Watershed Research and Water Quality Monitoring Program (RWQMP). According to the legislation, this program shall build upon the South Florida Water Management District's (SFWMD) existing research program and be sufficient to carry out, comply with, or assess the plans, program, and other responsibilities created by the St. Lucie River Watershed Protection Plan (SLRWPP). The RWQMP shall also conduct an assessment of the water volumes and timing from the Lake Okeechobee and St. Lucie River watershed and their relative contributions to the timing and volume of water delivered to the St. Lucie Estuary. This section provides the summary of the RWQMP, whereas the full version of the program is included as Appendix E.

The objective of the RWQMP is to identify scientifically based solutions to improve the water quality and quantity in the St. Lucie River watershed and to provide more accurate predictions for responding to ecological changes in the St. Lucie River watershed. Information generated through monitoring, modeling, and research efforts will help to identify and support potential changes in the design and operation of the NEEPP.

8.1 Research and Water Quality Monitoring Program Document Structure

The RWQMP includes five chapters, which are described in the following paragraphs.

Chapter 1 provides an introduction to the Plan, a brief summary on the ecological history of the St. Lucie River watershed, and the rationale for the Plan.

Chapter 2 identifies the specific goals and objectives of the RWQMP based on the legislation. This chapter specifies how research, modeling, and monitoring contribute to the adaptive management of nutrient load reduction goals and the implementation and operation of projects designed to achieve them.

Chapter 3 presents the current state of knowledge regarding hydrology, water quality, and aquatic habitat in the St. Lucie River watershed. It also identifies the effects of discharges from Lake Okeechobee on the St. Lucie Estuary, along with salinity and freshwater inflow goals. Also included in this chapter is a detailed chemical and physical analysis of the water quality, along with the ecological importance and distribution of submerged aquatic vegetation, oysters, and floodplain vegetation.

Chapter 4 is a summary of existing monitoring programs for hydrology, water quality, and aquatic habitat. The programs are evaluated based on their ability to meet program goals and potential improvements are identified. Finally, a recommended monitoring plan is described.

Chapter 5 describes ongoing research and modeling applicable to the SLRWPP. Plans for future research and modeling are also described and prioritized. Integration of research, modeling, and monitoring will establish scientifically sound performance measures and support improvements to the St. Lucie Estuary through the adaptive management process.

8.2 Goals and Objectives

Research, modeling, and monitoring are essential for the design and operation of programs to restore and protect the St. Lucie River watershed.

The following nine objectives are keys to the success of the RWQMP:

- Build upon the SFWMD's existing monitoring, research and modeling programs;
- Adequate to carry out, comply with, or assess the plans, programs, and other responsibilities of NEEPP;
- Assess the water volumes and timing from Lake Okeechobee and the St. Lucie River and Caloosahatchee River watersheds and their relative contributions to the timing and volume of water delivered to each estuary;
- Facilitate creation of predictive and/or numeric modeling tools;
- Provide the empirical data and conceptual understanding of the St. Lucie River watershed and St. Lucie Estuary for support and improvement of predictive models and to identify new water quality management measures;
- Collect data as necessary to quantify load reductions in order to meet any applicable Total Maximum Daily Loads (TMDLs) in the St. Lucie River watershed;
- Implement salinity monitoring sufficient to measure the frequency and duration of undesirable salinities for those biotic resources upon which salinity envelopes are based;
- Monitor oysters and seagrasses to determine if reductions in undesirable salinities and/or nutrient loads have the desired ecological result; and
- Support annual reporting of the conditions of hydrology, water quality, and aquatic habitat required by the NEEPP in Section 373.4595(6), F.S.

8.3 Status, Trends, and Targets

The status of most waters in the St. Lucie River watershed and estuary are Class III (Section 62-302.400(1), Florida Administrative Code [F.A.C.]), which are defined for use as recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife and based on water quality criteria. Other waters in the St. Lucie River watershed are Class IV waters, secondary and tertiary canals located in agricultural areas defined for use as agricultural water supplies. There are no Class I or II waters located in the St. Lucie River watershed or estuary.

A recent water quality assessment of the St. Lucie River watershed, conducted by Florida Department of Environmental Protection (FDEP) (FDEP, 2004) for the development of TMDLs, indicates that the waters are impaired with low dissolved oxygen (DO), and high nutrients. DO is a critical indicator of the health of an estuarine ecosystem (Engle et al., 1999). As discussed in Chapter 3 of the SLRWPP, high nutrient levels can result in algal blooms that can in turn result in lowering DO.

Trends in water quality were identified in Chapter 3 of the RWQMP and are listed below.

1. Low DO conditions in the St. Lucie River watershed occur mostly in the wet season due mostly to enhanced primary productivity under higher temperatures, and elevated nutrient concentrations from increased watershed runoff.
2. Concentrations of most water quality parameters decreased in an easterly direction from the mouth of the St. Lucie Estuary as a result of nutrient-laden freshwater inflows to both the North and South Forks.
3. Low DO is likely a result of water stratification in some areas with some monitoring stations exceeding the U.S. Environmental Protection Agency (USEPA) standards more then 20 percent of the time over the last decade. Stratification tends to occur during wet events.
4. Salinity varies on daily, monthly, seasonal, and annual time scales**,** as is true for many estuaries because salinity levels are mostly driven by freshwater inflow. Salinity is higher in the dry season, likely due to less freshwater runoff from the sub-watersheds.
5. Nutrient loading rates are controlled by both discharge rate and nutrient concentrations and there is a strong correlation between nutrient concentrations in runoff and land use. Regressions between total annual flow and annual loadings show that annual loading is largely controlled by flow, which explains about 81 percent of loading variation for both total nitrogen (TN) and total phosphorus (TP).
6. The average annual loading totals 2,218 metric tons per year (mt/yr) for TN and 373 mt/yr for TP into the St. Lucie Estuary based on the analyses conducted from 1995 to 2005. Annual loadings varied from year to year. The years of 1995, 2004, and 2005 are wet years and the annual nutrient loading amounts to about 4,000 mt/yr for TN and 600 mt/yr for TP. Lake Okeechobee discharge contributes significantly to nutrient loading such as the year of 1998. For dry years such as 1996, 1997, and 2000, the loading was only about 1,000 mt/yr for TN and 100 to 170 mt/yr for TP.

The flow targets provide criteria that can be used for screening various alternative water management scenarios. The desired range of flows (salinity envelope) needed to enhance the St. Lucie Estuary is between 350 and 2,000 cubic feet per second (cfs) of total freshwater inflow, which equates to a salinity range of about 22 to 8 parts per thousand (ppt) at the confluence of the North and South Forks. The desired flow ranges and duration are summarized as follows (based on a 36-year Period of Record for a total of 432 months):

- Flows less than 350 cfs for 178 months or less (or 47.8 percent of the time) of a total of 432 months;
- Flows between 350 and 2,000 cfs for 171 months or more (or 46.0 percent) over a total of 432 months;
- Flows between 2,000 and 3,000 cfs for 21 months or less (4.8 percent) over a total of 432 months; and
- Flows greater than 3,000 cfs for 6 months or less (1.3 percent) over a total of 432 months.

The combination of enhanced drainage in the St. Lucie River watershed, flood control releases from Lake Okeechobee, population growth and urban and agricultural development have created problems for the St. Lucie Estuary. Seasonal and short term fluctuations in stormwater runoff drive changes in salinity that are beyond the tolerance limits of most marine and estuarine organisms. The St. Lucie Estuary shows typical signs of eutrophication (extreme nutrient levels) including intense algal blooms and periods of hypoxia (low DO levels) and anoxia (absence of DO). Other environmental problems identified include accumulation of "muck" sediments, fish lesions, degraded benthic communities, and decreases in spatial extent of seagrasses and loss of functioning oyster reef.

8.4 Monitoring, Research, and Modeling Assessment

The application of adaptive management is an integral part of the SLRWPP. Assessments of monitoring, research, and modeling will be used to keep track of the progress and to identify if the plan goals and targets are being met. They will also aid in identifying potential shortfalls or accomplishments. For example, information gained from monitoring, modeling, and research can be used to identify any necessary refinements to flow and salinity envelopes, pollutant load reduction goals, and changes to facility operations and implementation priorities.

Research and monitoring in the St. Lucie and Caloosahatchee River watersheds have been ongoing for more than 40 years (Phillips, 1960; Gunter and Hall, 1962). Continued monitoring with the integration of research and modeling will establish scientifically sound performance measures and support improvements to the St. Lucie Estuary through the adaptive management process.

8.4.1 Monitoring Assessment

The environmental monitoring in the RWQMP has two major purposes: (1) to quantify long-term change, and (2) to support adaptive management. Quantification of long-term change measures progress towards program goals such as meeting any adopted TMDLs. The monitoring program includes establishing a goal/target, the systematic collection of data, using that data to measures change or progress towards the goal/target, and determining when modifications to the project are required.

The objectives of the RWQMP were already identified in section 8.2 above. One of the objectives is to build upon existing monitoring programs. A brief summary of the existing programs is provided in the following paragraphs, and detailed discussion of the programs can be found in Chapter 4 of the RWQMP.

8.4.1.1 Existing Watershed Monitoring Programs

Flow Monitoring Program—The existing flow monitoring is conducted at major water control structures and along the major tributaries of the North Fork and South Fork sub-watersheds. In general, the existing program focuses on surface water flows from the western sub-watersheds and Lake Okeechobee; however, flows from coastal sub-watersheds are not monitored adequately. Presently, the inflow data from coastal sub-watersheds are generated by the Hydrologic Watershed (WaSh) Model.

Water Quality Monitoring Programs—Existing water quality monitoring programs include monitoring at major water control structures (Water Quality Monitoring Program), and a

monitoring network within smaller tributaries (St. Lucie Tributary Monitoring Program [SLT]). The Water Quality Monitoring Program is a long-term program that measures both flow and water quality in the watershed of the St. Lucie Estuary, while the SLT is a short-term monitoring program designed to measure Best Management Practice (BMP) effectiveness, support adaptive management, and measure tributary loads.

8.4.1.2 Existing Estuarine Monitoring Programs

Existing estuarine monitoring programs include salinity monitoring, water quality monitoring, and bacterial monitoring.

- **Salinity Monitoring**—Salinity monitoring is essential to supporting water quality modeling, refinement of salinity envelopes, and quantifying the goal of reducing undesirable salinity ranges. The long-term tide and salinity monitoring network in the St. Lucie Estuary was established in 1997. All tide and salinity monitoring stations take water level, temperature, and conductivity measurements at 15-minute intervals. The current monitoring is sufficient for basic salinity monitoring needs.
- **Water Quality Monitoring**—This program was established in 1990 to detect long-term spatial and temporal trends in the St. Lucie Estuary and monitors multiple parameters. It is sufficient to measure progress towards targets or concentrations resulting from nutrient load reductions. The monthly frequency of data collection is adequate to quantify long-term trends, but may miss important episodic evidence such as algal blooms.
- **Bacteria Monitoring**—Currently, the St. Lucie County and the Martin County Health Departments monitor fecal coliform and Enterococci bacteria in the St. Lucie Estuary to protect human health. The city of Port St. Lucie in St. Lucie County monitors 15 stations in the North Fork on a monthly basis, while Martin County monitors a station near SE03 on a weekly basis.

8.4.1.3 Aquatic Habitat (Oyster and Seagrass) Monitoring

- **Seagrass Monitoring**—Seagrass monitoring includes monitoring seagrasses on both a landscape scale and patch scale. Monitoring is performed semiannually to collect long-term data to assist with determining the health of seagrass in the lagoon, monthly to collect short-term (5-year) data to help document seasonal changes and associated macro-algae, and bi-monthly to determine the Comprehensive Everglades Restoration Plan (CERP) pre-condition and effects, increase understanding of ecosystem dynamics and cause-and-effect relationships, and improve the ability to interpret unanticipated results. The monitoring includes a mapping effort. The current monitoring is adequate to detect trends and assess status of seagrass.
- **Oyster Monitoring**—A long-term monitoring program of Eastern oysters (*Crassostrea virginica*) was established in 2004. It emphasizes spatial and size distribution patterns of adult oysters, distribution and frequency patterns of oyster diseases, reproduction and recruitment, and juvenile oyster growth and survival. This effort includes mapping the existing distribution of oyster reefs and the mean density of living oysters on each oyster bed. The current sampling regime is adequate to detect trends and assess status of oysters.

8.4.2 Research Projects Assessment

Research projects are intended to reduce or eliminate key uncertainties in flow and salinity envelopes, and to optimize the operation protocols. The three research projects in the RWQMP are summarized below. Chapter 5 of the RWQMP provides a detailed description of these projects, and assesses their adequacy in achieving the SLRWPP goals/targets.

- **Estuarine Nutrient Budget**—This project will construct nutrient budgets of nitrogen (N) and phosphorus (P) for the St. Lucie Estuary. Terms in the nutrient budget will be determined by a variety of methods. Some of the terms in the nutrient budget can be derived from existing information (i.e. nutrient load from C-23, C-24 and C-44). Other nutrient budgets from parameters such as stormwater runoff in unmeasured portions of the St. Lucie River watershed may only be able to be determined through modeling efforts. Results of this project can be used to support water quality modeling efforts, which will increase the capability to predict effects of various management measures, including BMPs.
- **DO Dynamics**—This project will identify the factors causing the DO impairment in the St. Lucie Estuary. Once causes are known, appropriate management solutions can be implemented. The results of this study will provide critical information that will guide the selection of these management solutions. This project supports the SLRWPP goal of achieving any adopted TMDLs in the St. Lucie Estuary and improving DO conditions.
- **Low Salinity Zone**—This project examines the effects of freshwater discharges on the production of fish larvae and utilization of the low salinity zones in the North and South Forks of the St. Lucie Estuary as a nursery area. The relationship between freshwater discharge and the nursery function of estuaries is not understood well enough to provide generic information relevant to the management of freshwater inflow to estuaries. Site-specific determination of flows adequate to support and/or enhance the nursery function in the St. Lucie Estuary is required to maintain a healthy ecology. Results of this study will be used to refine the salinity envelope and to provide environmental guidelines for delivery of fresh water to the North and South Forks of the St. Lucie Estuary.

8.4.3 Modeling Assessment

An integrated modeling framework combining the resource-based Valued Ecosystem Component (VEC) approach and linked watershed and estuarine models has been used for years in the Minimum Flows and Levels Program (MFL) and for CERP-related projects. Integrated or linked models have been used to simulate the effects of changes in population, land use, or management practices in the watershed on estuarine physics, chemistry, and ecology (Chesapeake Bay Program and IAN, 2005; Wan et al., 2002; Wan et. al., 2006). Three existing modeling efforts include the Watershed Hydrology and Water Quality Models, the Estuary Hydrodynamic and Water Quality Models, and the Ecological Response Model.

8.4.3.1 St. Lucie Watershed Hydrology and Water Quality Models

Effective management that aims to protect water quality requires a big picture view of water resources at the watershed-scale. Watershed models provide the necessary links for this purpose, particularly when it comes to understanding how non-point sources of pollution interact with point sources, and how these jointly affect the downstream water quality. The Watershed

Hydrology and Water Quality Models include the WaSh model, the Reservoir Optimization Model (OPTI) and the Northern Everglades Regional Simulation Model (NERSM). The capability of these models is provided in **Table 8-1**.

Table 8-1. Capabilities of the Watershed Hydrology and Water Quality Models

WaSh Model	
Hydrology	**Water Quality**
1. Simulates daily surface and subsurface flow/stage, water budget, and structure operation in canals, sub-basins, and cells. 2. Simulates agricultural irrigation demand and supply. 3. Provides boundary conditions/input data for estuarine models, the OPTI Model, and the NERSM Model.	1. Simulates nutrient production from various land use types. 2. Simulates in-stream eutrophication processes including nutrient cycling and DO dynamics 3. Provides nutrient loading estimation for estuarine models.
OPTI Model	
Planning-Level Applications	**Operation-Level Applications**
1. Optimizes operation of reservoirs to meet the estuarine flow distribution requirements and supplemental irrigation needs. 2. Simulates inter-basin transfer of flows for environmental restoration. 3. Provides the optimal storage capacity of the reservoirs in the entire watershed.	1. Provides day-to-day operational support for reservoirs and Stormwater Treatment Area (STA) in the watershed to meet the target of the Natural System Model (NSM) flow distribution.
NERSM Model	
1. Uses WaSh Model output to evaluate alternatives with pre-established performance measures. 2. Uses operational criteria and simulation targets from the OPTI Model.	

8.4.3.2 Estuary Hydrodynamic and Water Quality Models

For St. Lucie Estuary hydrodynamic and water quality simulation, modeling tools are needed that are capable of: (1) simulating the impacts induced by the watershed loading; (2) assessing estuary hydrodynamics; and (3) assessing estuary water quality processes. The Estuary Hydrodynamic and Water Quality Models include the St. Lucie Estuary 2-D Hydrodynamic Model and the St. Lucie Estuary 3-D Hydrodynamic and Water Quality Model. The capability and water management practice applications of these models are provided in **Table 8-2**.

8.4.3.3 Ecological Response Model

The Ecological Response Model was developed based on available literature data to evaluate the influence of watershed hydrology on stream ecosystem health. Currently, it includes an Oyster Salinity Stress Model which calculates oyster stress based on the magnitude and duration of low salinity (<12 ppt) events induced by freshwater discharges. An annual stress index classifies the year in one of the following four categories: (1) no stress; (2) stress; (3) harm; and (4) death. This model allows for the evaluation of salinity stresses for each of the oyster life stages. The model does not incorporate mortality from predation or increased stress from disease that is associated with low-flow, high-salinity conditions.

Table 8-2. The Capability and Water Management Practice Application for St. Lucie Estuary Estuarine Models

Hydrodynamic/Sediment Transport	Water Quality	Water Management Practices
1. Simulates circulation and stratification. 2. Simulates tidal stage and salinity in the entire St. Lucie Estuary. 3. Simulates long-term (41 years) conditions. 4. Provides input data for estuarine Ecological Response Model.	1. Simulates nutrient cycling and eutrophication processes, including sediment digenesis. 2. Simulates DO dynamics and its interaction with hydrodynamic mixing and eutrophication processes. 3. Evaluates estuarine response with anticipated loading reductions.	1. Evaluate Reservoirs and STAs operation. 2. Evaluate loading reduction. 3. Identify location and efficiency of muck removal.

8.5 Research and Water Quality Monitoring Program Recommendations

The recommended RWQMP has been formulated to fulfill the goals and reporting requirements of the SLRWPP and to support adaptive management. It builds upon the existing monitoring, research, and modeling components discussed above, and makes recommendations/modifications to these efforts to better achieve and assess the goals/targets of the SLRWPP.

8.5.1 Monitoring Needs

The recommended monitoring plan has been formulated to fulfill the goals and reporting requirements of the SLRWPP as well as to support adaptive management.

8.5.1.1 Watershed Quality and Flow Monitoring in the Watershed

The RWQMP recommends that the existing water quality monitoring program and the SLT programs continue with the addition of three new water quality parameters to the monthly suite of grab sample analytes in order to meet any adopted TMDLs in the SLR Watershed. These parameters are: Dissolved Total Kieldahl Nitrogen (DTKN), 5-day biological oxygen demand (BOD_5) and Total Organic Carbon (TOC). The sampling suite will be re-evaluated and updated in future SLRWPP updates. Recommendations also included optimization of the existing watershed network.

The SFWMD will expand its Pollutant Source Control Program within the boundaries of the SLRWPP. On-going monitoring will be continued at a sub-watershed level to assess the collective performance and progress of FDACS, FDEP, SFWMD pollutant source control BMP programs; to support adaptive management within such programs; to identify priority areas of water quality concern and BMP optimization; and to provide data to evaluate and enhance performance of downstream treatment facilities. Monitoring will consist of flow weighted P and N concentrations and flow parameters measured daily during discharge. Because these will be long-term monitoring sites for regulatory purposes, every effort will be made to utilize existing sites where applicable. Once priority areas of concern are identified for BMP optimization activities using regional level monitoring data, a secondary level of local monitoring will be conducted by the SFWMD for a limited period of time to ascertain the most appropriate BMPs associated with the water quality concerns identified.

8.5.1.2 Water Quality and Salinity Monitoring in the St. Lucie Estuary

The recommended RWQMP supports the existing salinity, water quality, and aquatic habitat monitoring programs. It is also recommended that three new water quality parameters be added to the monthly suite of grab sample analytes in order to meet the TMDL. These parameters are DTKN, BOD_5, and TOC. Data from the St. Lucie Estuary program is required to measure water quality improvements due to load reductions. A 30-month formal review of the data will be used to determine data sufficiency and whether any modifications to the existing monitoring are needed. This review will also help to refine numerical water quality models for predicting effects of changing freshwater inflows and nutrient loads on estuarine water quality. It is also recommended that the current fecal coliform and Enterococci bacteria monitoring programs in the St. Lucie Estuary continue to monitor progress towards meeting the TMDL. This is also important because impairments for bacteria in the St. Lucie Estuary have been determined.

8.5.1.3 Aquatic Habitat Monitoring

The bi-monthly seagrass monitoring will be sufficient to meet the goals of the SLRWPP and it is recommended that this program continue. Specifically, results of this monitoring are critical for annual reporting requirements and documenting improvement in aquatic habitat as nutrient loads and stressful salinity fluctuations are curtailed.

Mapping of seagrasses by aerial photography should continue at its present frequency of 2 to 3 years. This sampling frequency should capture large-scale changes in seagrass distribution resulting from extreme unpredictable events such as droughts and hurricanes. Continued coordination with the St. Johns River Water Management District will allow quantification of lagoon-wide patterns of change. Restoration Coordination and Verification (RECOVER) currently produces maps every 5 years. The 2- to 3-year preferred frequency can be achieved if the RECOVER mapping is supplemented through this or other programs on an alternating 2- to 3-year basis.

The oyster monitoring conducted will be sufficient to meet the goals of the SLRWPP and it is recommended that this program continue. Specifically, results of this monitoring are critical for: (1) annual reporting requirements and (2) tracking progress towards the restoration goal of 890 acres of oysters as nutrient loads and stressful salinity fluctuations are curtailed.

8.5.2 Prioritization of Research

Each major research project (e.g. Nutrient Budget) can be broken down into several components. Examinations of the components of each project show that several projects may have common components. The commonalities between components of the various projects are summarized in **Table 8-3**. The source of data for each component is provided (existing data, new measurements, model etc). Items funded in any given year may be prioritized according to the number of projects to which they belong.

8.5.3 Model Refinements

The following refinements to the existing models are included in the recommended RWQMP:

- Integrate water quality and optimization components into the NERSM;

- Further enhance the Curvilinear Hydrodynamics 3-Dimensional (CH3D) Model by including seasonal groundwater seepage and refining turbulence schemes to better simulate stratification and mixing in the St. Lucie Estuary; and
- Expand the Estuarine Ecological Response Model to include other VECs such as seagrass and fish larvae.

Table 8-3. Commonalities between Components of the Various Projects

Research Component	Research Projects			Source
	Nutrient Budget	DO Dynamics	Low Salinity Zone	
INPUTS				
Canal Loads (C-23,C-24,C-25)	√	√	√	Monitoring
Ungauged				
Surface Flow	√	√	√	
Groundwater	√	√	√	Groundwater Model to be Developed
	√	√	√	Analysis of Data
Ocean Input	√	√		Concentration from Literature/Flow from Model
Atmospheric Input	√			Literature/ Data Search
INTERNAL CYCLING				
Primary Productivity/Water Column Resp	√	√	√	New Measurements
Organic Matter Decomp/ Incl DON	√	√		New Measurements
Benthic Flux	√	√		New Measurements
DO Time Series		√	√	New Contract In-house
OUTPUTS				
Export to Ocean	√			Model
Denitrification	√			Benthic Flux Project
North and South Fork Narrows:				
Larval /Juvenile Fish (Species, size, number and gut content)				
Adult Fish (movement and spawning				
Zooplankton (species, stage, and reproductive state)			√	New Measurements
Benthos (species, feeding type, number)				
Phytoplankton (species and size)				

CHAPTER 9.0

RECOMMENDED PROJECTS AND ACTIONS

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9.0 THE PREFERRED ST. LUCIE RIVER WATERSHED PROTECTION PLAN

The St. Lucie River Watershed Protection Plan (SLRWPP) was developed in response to the Northern Everglades and Estuaries Restoration Program (NEEPP), Section 373.4595, Florida Statutes (F.S.) (2007). The legislation requires the SLRWPP to include a river watershed construction project, pollutant control program, and research and water quality monitoring program (RWQMP). This chapter provides an overview of the Preferred St. Lucie River Watershed Protection Plan and describes the plan implementation strategy, initial cost and funding estimates, cost share opportunities, and process for plan refinements and revisions.

9.1 Construction Project Preferred Plan

The features of the St. Lucie River Watershed Construction Project Preferred Plan can be broadly grouped into the following four general categories: (1) St. Lucie River Watershed Water Quality; (2) St. Lucie Estuary Water Quality; (3) Water Quantity/Storage; and (4) Land Management and Restoration.

9.1.1 Water Quantity/Storage

The Preferred Plan water quantity/storage projects are designed to capture and store stormwater runoff in the St. Lucie River watershed and include above ground reservoirs, and Alternative Water Storage Facilities (AWSFs). These projects include both local and regional projects.

9.1.1.1 Reservoirs

Aboveground reservoirs are the most common type of surface water storage features. Aboveground reservoirs typically comprise large areas of land surrounded by levees that are used to store water. This water is typically withdrawn from the St. Lucie River watershed and stored during the wet season to provide attenuation and reduce the discharge of freshwater into the St. Lucie Estuary. In the dry season this water can then be released to reduce the demand on the St. Lucie River for freshwater to be used for irrigation. These types of reservoirs also provide ancillary quality benefits; nutrients and other contaminants tend to settle out within the reservoir.

Reservoir storage sites included in the Preferred Plan include the reservoirs associated with the C-44 Reservoir/Stormwater Treatment Area (STA) (LO 14-base project), which includes the Southern Diversion C-23 to C-44 interconnect (SLE 40) and the C-23/24 Reservoir/STA (SLE 24).

9.1.1.2 Alternative Water Storage Facilities

AWSFs essentially prevent the runoff from reaching the regional drainage system or improve the timing of its delivery, and can be developed on available private, public, and tribal lands. They are used to store and/or dispose of excess water by capturing it prior to runoff or pumping it from areas or canals with excess water, and holding it on site. AWSFs typically require minimal design, engineering, and construction efforts as compared to constructed reservoirs because of the use of low technology approaches including the use of existing infrastructure such as pumps to move water to the desired area and the weirs, berms, and small impoundments needed to

detain the water in the facility. If they are established on existing wetlands they are designed and operated to improve the existing wetland functions.

AWSFs located in the Preferred Plan consist of the Indiantown Citrus Growers Association (LO 12f), Dupuis (LO 12j), St. Lucie Site Waste Management, (LO 12m), and Caulkins (LO 12q).

9.1.2 Watershed Water Quality Projects

St. Lucie River watershed water quality projects focus on reducing nitrogen (N) and phosphorus (P) loading within and from the watershed. The projects are a combination of the source control efforts described in Section 9.2 and projects including water quality treatment areas (WQTAs)/ STAs, and stormwater management, waste/wastewater management, and innovative nutrient control technologies (e.g., hybrid wetland treatment technology).

9.1.2.1 Water Quality Treatment Areas and Stormwater Treatment Areas

(WQTAs are constructed wetlands designed for optimal nutrient removal. When water flows through flooded wetland cells, plants and algae remove nutrients from the water. Constructed wetlands have been shown to be very efficient in reducing nutrient loads and concentrations.

STAs, a type of WQTA, are constructed wetlands that have been used very successfully in South Florida to treat nutrient-rich stormwater runoff. Typically, wetland cells in STAs include emergent vegetation or a combination of emergent and submerged vegetation.

There are both regional scale and local scale WQTA/STAs included in the Preferred Plan. The C-44 STA (LO 14) which includes the Southern Diversion C-23 to C-44 interconnect (SLE 40) and C-23/24 STAs (SLE 24) are two of the regional scale STAs in the Preferred Plan. They are components of the Comprehensive Environmental Restoration Program (CERP) Indian River Lagoon – South Project Implementation Report and Environmental Impact Statement (IRL-S PIR) and include associated reservoir components.

In addition, the C-23/24 Water Quality Treatment Project (SLE 18b) was developed in recognition that additional P treatment may be needed for the C-23/C-24 sub-watersheds. This project is in the conceptual design phase and the exact nature of this feature will be determined in the future and included with future SLRWPP updates/refinements.

9.1.2.2 Stormwater Management

The installation or upgrade of an urban stormwater management system can improve surface water quality in the St. Lucie River watershed. A variety of structures (e.g., wet detention ponds, vegetated swales, diversion weirs, baffle boxes, etc.) within a surface water management system can attenuate surface water flow to increase percolation for groundwater storage, facilitate settling, and promote nutrient uptake prior to receiving water discharge. System retrofit projects and local government Stormwater Master Plan implementation projects are management measures that will improve the conveyance of stormwater during storm events and reduce pollutant loadings from urban runoff.

The Preferred Plan includes a total of 18 local scale stormwater projects, most of which are either wet detention or baffle box projects associated with older residential developments that

lack stormwater treatment systems. These consist of: White City Drainage Improvements - canals B, C, D, E, F, G (SLE 2); White City Drainage Improvements - Citrus/Saeger (SLE 03); Indian River Estates/Savannas Ecosystem Management Project (SLE 06); Tropical Farms Roebuck Creek Stormwater Quality Retrofit (SLE 28); Old Palm City Phase III Stormwater Quality Retrofit (SLE 29); Stormwater Baffle Box Retrofit-City of Stuart (SLE 31); Danforth Creek Stormwater Quality Retrofit (SLE 32); North St. Lucie River Water Control District Stormwater Retrofit - Structures 81-1-2 and 85-1-2 (SLE 33); All American Boulevard Ditch Retrofit (SLE 35); Martin County Baffle Boxes (SLE 41); Jensen Beach Retrofit (SLE 42); Leilani Hts/Warner Creek Retrofit - Phase 1, 2 & 3 (SLE 43); Manatee Creek Water Quality Retrofit; Phases 2 & 3 - New Monrovia, Dixie Park (SLE 44); E-8 Canal Storm Water Retrofit (SLE 52); Frazier Creek Water Quality (SLE 53); Haney Creek Wetland Restoration (SLE 54); and Poppleton Creek (SLE 55).

9.1.2.3 Waste/Wastewater Management

Several waste and wastewater management programs are integrated into the Preferred Plan. These include an on-site Sewage Treatment and Disposal System inspection and pump-out program (SLE 13), improved management of sludge disposal in St. Lucie County through the use of an innovative technology (Plasma-Arc) (SLE 16), the North River Shores Vacuum Sewer (SLE 22), and Small Acreage Manure Management (SLE 46).

9.1.2.4 Hybrid Wetland & Chemical Treatment

Hybrid Wetland Treatment Technology combines the strengths of the two top-ranked nutrient removal technologies, namely treatment wetlands and chemical injection systems. This technology forms a synergistic relationship that results in nutrient removal efficiencies beyond those attainable by either technology separately, but with lower capital and operating costs (Watershed Technologies, Inc., 2007). Optimization of system performance is achieved by adjusting hydraulic retention time (area of facility) and/or chemical dosing rates. Hybrid Wetland Treatment Technology has been previously demonstrated to reduce P concentrations from more than 1,000 parts per billion (ppb) to less than 100 ppb (Watershed Technologies, Inc., 2007).

Chemical treatment involves application of chemicals into stormwater runoff to aid in reduction of contaminant loads and concentrations, and of turbidity (suspended solids) in the water by promoting the coagulation and flocculation of suspended solids. Chemical treatment can be used in combination with wet detention of stormwater, treatment of runoff prior to storage, or with supplemental treatment associated with reservoirs or STAs. The specific technology that will work best at any given location will primarily depend upon influent water quality and the quantity of water to be treated.

The Platt's Creek Alum Enhancement and Hybrid Wetland Treatment System (SLE 07) is an example of this type of technology that is incorporated into the Preferred Plan.

9.1.3 Estuary Water Quality and Habitat Restoration Projects

Estuary water quality and habitat restoration projects are located within the St. Lucie Estuary and are anticipated to reduce N and P that have accumulated in the St. Lucie Estuary. These Preferred Plan projects include muck sediment removal and oyster habitat creation.

9.1.3.1 Muck Sediment Removal

Muck remediation involves the removal of muck within the St. Lucie Estuary that has accumulated due to suspended solids in runoff from the St. Lucie River watershed. Muck accumulation smothers substrate that once supported healthy submerged aquatic vegetation (SAV) and oyster communities. Removal of this sediment would expose this substrate, allowing for re-colonization of SAV and oysters. Muck removal will also improve water quality by improving the clarity and light attenuation of the water.

The Preferred Plan consists of several muck removal projects including the Manatee Pocket Dredging Project (SLE 30), the Danforth Creek Muck Removal Dredging Project (SLE 48), CERP-IRL South: Muck Remediation (SLE 27), the Warner Creek Muck Removal Dredging Project (SLE 49), and the Hidden River Muck Removal Dredging Project (SLE 50).

9.1.3.2 Oyster Habitat Creation

Established oyster reefs provide many ecological benefits including improvement to water quality. Oysters are a key indicator of the health of the St. Lucie Estuary system and are also very effective bio-filters of fine sediments and nutrients in the water column. Oyster habitat creation includes placing suitable substrates such as "oyster balls," limestone rocks, and relic shell bags under docks or on open slopes, and allowing oysters to naturally colonize on the substrate. Martin County has constructed one small demonstration project (2004-2005) and a subsequent one-half acre project in the Mid-Estuary in 2006. Oyster habitat creation in this SLRWPP will build upon existing efforts to create suitable oyster substrate in the St. Lucie Estuary using natural or man-made conditions.

The Preferred Plan incorporates the creation of suitable oyster substrate at various sites identified in IRL-South PIR (SLE 11).

9.1.4 Land Management and Restoration

Preferred Plan Management Measures (MMs) related to land management and restoration include creation and restoration of wetlands, land conservation, and incorporation of growth management techniques and initiatives that integrate environmental objectives into urban growth planning.

9.1.4.1 Wetland Restoration

Natural wetlands sequester surface water flows, recharge the aquifer, and provide water quality treatment through assimilation and sedimentation. Wetland restoration includes improving degraded wetlands and restoring areas that were historically wetlands.

There are four stand-alone wetland restoration projects within the Preferred Plan. These projects include: the CERP-IRL-S PalMar Complex-Natural Storage and Water Quality Area (SLE 09a); the CERP-IRL-S Allapattah Complex-Natural Storage and Water Quality Area (SLE 09b); the CERP-IRL-S Cypress Creek/Trail Ridge Complex-Natural Storage and Water Quality Area (SLE 09c); as well as the CERP-IRL-S North Fork Natural Floodplain (SLE 26).

9.1.4.2 Land Conservation

Conservation of natural areas in urban settings provides both natural and social benefits. The goal of land conservation programs is to protect coastal and estuarine lands considered important for their ecological, conservational, recreational, historical, or aesthetic values. There are programs that provide state and local governments with matching funds to purchase significant coastal and estuarine lands, or conservation easements on such lands, from willing sellers. The Coastal and Estuarine Land Conservation Program (LO 9), Florida Ranchlands Environmental Services Project (LO 87 revised), Alderman-Deloney Ranch (C-25 Basin) (LO 87a-1), and the Farm and Ranchland Partnership (SLE 56) are land conservation programs that are included in the Preferred Plan.

9.1.4.3 Integrated Growth Management and Restoration

This category includes programs and projects that integrate environmental restoration objectives with urban growth initiatives. Planning and economic incentives are typically provided to encourage the use of innovative and flexible planning, development strategies, and creative land use planning techniques that minimize the footprint of developments while conserving natural lands and open spaces.

The Comprehensive Planning & Growth Management (LO 68) and the Rural Land Stewardship Area Program are integrated growth management and restoration projects included in the Preferred Plan.

9.1.5 Preferred Plan Real Estate Requirements

Specific locations for some features in the Preferred Plan have already been identified. However, some project feature locations have only been identified on a sub-watershed level. Land acquisition needs will be developed over time through the Process Development and Engineering (PD&E) process. During the PD&E, conceptual planning will be conducted to further evaluate project siting and real estate acquisition requirements. The results of feasibility studies will help define the real estate requirements that will be reflected in future Preferred Plan updates.

To the extent possible, opportunities for less than fee acquisition, such as the Wetland Reserve Program, will be evaluated. It is expected that real estate acquisition for individual features will occur over a period of time. State and District-owned lands would be preferentially evaluated for siting Preferred Plan project features. However, many of the existing State- and District-owned acreages have already been targeted for specific features.

9.1.6 Preferred Plan Operations and Maintenance, Permitting, and Monitoring

The following sections describe the operations, maintenance, permitting, and monitoring needed for the Preferred Plan to the greatest extent possible. This section will be revised in future SLRWPP updates as more information becomes available. Appendix F, the Operations, Maintenance, Permitting, and Monitoring, provides greater detail on these items.

9.1.6.1 Operations and Maintenance

With very few exceptions, the majority of project features included in the Preferred Plan are likely to require some level of operation and maintenance (O&M). Consideration of O&M needs from the outset of planning is important to ensuring that the SLRWPP goals and objectives are achieved in the most efficient, effective, and safe manner. O&M collectively refers to the following five major elements:

- **Operations** – ongoing activities required to operate the management measure to achieve the project objectives, including water control, fuels and materials, monitoring, etc.
- **Maintenance** – ongoing activities required to maintain system in an operable condition, including machinery maintenance, mowing, inspections, etc.
- **Repair** – periodic repair of machinery or other structural elements as needed to restore complete operability of the management measure, including machinery repair, filling scour holes, repairing erosion, etc.
- **Replacement** – periodic replacement of project elements that have reached or exceeded their functional life, including pump replacement, stop-log riser replacement, etc.
- **Rehabilitation** – major rehabilitation of a project component may be required under the following circumstances:
  - When the component has exceeded its functional life and continued repair and replacement activities are no longer cost effective,
  - When there are substantive changes in conditions at the facility or associated components of the water management system that preclude meeting the project objectives or result in other undesirable impacts, or
  - Changes in design or safety standards.

9.1.6.2 Permitting

Construction and implementation of the SLRWPP features will require a variety of permits and regulatory approvals. The types of permits and approvals needed are likely to vary with feature type and location. Obtaining all required federal, state, and local permits for implementation and operation of a project often requires an intensive level of effort. Permitting can result in significant project delays if it is not adequately considered early in project development. However, specific permit requirements and/or issues may not be evident until a substantial level of detail has been developed during planning and design.

The types of permits and level of effort required during the permitting process may vary greatly for similar or identical measures depending on the physical conditions that exist at the project site and surrounding area. During the PD&E process, continuing consideration will be given to the types of permits required and the potential permitting issues that must be addressed. In this way, the level of effort and time requirements can be factored into the planning and design process to minimize the potential for significant permit-related project delays.

Federal and state permits that are likely to be required for the types of project features contained in the Preferred Plan are provided in Appendix F: Operations, Maintenance, and Permitting.

Local permit requirements will vary from site to site and will have to be addressed on a site-specific basis.

9.1.6.3 Monitoring

A comprehensive monitoring and information system will be utilized to provide the data necessary to measure the performance and effectiveness of the Preferred Plan in satisfying the restoration goals of the SLRWPP. The District will utilize the current monitoring base and monitoring proposed in the St. Lucie River Watershed RWQMP where appropriate and will implement additional project level monitoring as necessary to provide any project-specific resources needed to document the effectiveness of storage projects and nutrient control efforts in meeting any established Total Maximum Daily Loads (TMDLs) in the St. Lucie River watershed and to ensure compliance with all future permit requirements.

Monitoring is generally required to determine if individual project features and the plan as a whole are performing as intended. Typically, monitoring requirements for individual projects are established during the permitting process. Because the two primary objectives of the SLRWPP are storage and water quality improvements, it can be expected that performance of all structural and non-structural project features included in the plan will have to be monitored for flow and P and N load reduction.

Project-level assessments may also be needed that will focus on estimating the performances of both regional projects (i.e. STAs) and local projects (i.e. stormwater retrofits) located throughout the St. Lucie River watershed. Results of the project-level assessments will provide important water quality reduction information, including the assessment of the size of the sub-watershed vs. the size of the treatment facility, and residence time/pollution removal efficiencies. The results also will assist in evaluating specific nutrient reductions from different types of treatment systems. The overall temporal performance (life cycle) of these facilities over time will also be estimated through this effort. This information will ultimately be used in the Adaptive Management process to improve the overall performance of treatment facilities of various sizes (i.e. regional and local scale). In addition, safety monitoring will be required for features such as reservoirs and STAs. Best management practices (BMPs) will also need to be inspected periodically to ensure structural efficacy and that expected performance is achieved.

The District has established an Environmental Monitoring Coordination Team to critically review and evaluate all new monitoring requests to ensure permit compliance, scientific validity, and efficiency. Any future monitoring requirements associated with the SLRWPP will be subject to review and approval by this team. All current and future water quality data collection, analysis, validation, management, and storage will be conducted in accordance with in accordance with quality assurance in Chapter 62-160, Florida Administrative Code (F.A.C.), the *District Field Sampling Quality Manual* and/or the *CERP Quality Assurance Systems Requirements Manual*.

9.2 Watershed Pollutant Control Program

Pollutant source control is integral to the success of any water resource protection or restoration program. Source control programs in the St. Lucie River watershed are evolving and expanding through cooperative and complementary efforts by FDEP, Florida Department of Agriculture and Consumer Services (FDACS), and the SFWMD. The St. Lucie River Watershed Pollutant

Control Program is designed to be a multi-faceted approach to reducing pollutant loads that includes improving the management of pollutant sources within the St. Lucie River watershed through implementation of regulations and BMPs and development and implementation of improved BMPs focusing on N and P. This section provides an overview of the program. Please refer to Chapter 7 for the complete St. Lucie River Watershed Pollutant Control Program.

The main purposes of source control projects are to:

- Minimize the use of nutrients on site;
- Ensure the nutrients are applied in an effective manner; and
- Prevent nutrient-laden waters from leaving the site.

Regardless of how it is achieved, source control is integral to the success of any water resource protection or restoration program. BMPs or other treatments are often utilized in a series to improve water quality by controlling the introduction (source) of nutrients into the local runoff and the movement of off-site nutrients (loss) into the drainage system. This combination of treatment technologies is known as a treatment train, because BMPs and other treatments are implemented in a series, like cars on a train. Without BMPs as the first-stage technology utilized within water quality treatment trains, treatment and cost effectiveness of large, regional, capital projects such as reservoirs and STAs would be limited.

SFWMD, FDEP, and FDECS are currently planning and implementing numerous source control programs in the St. Lucie River watershed to reduce nutrient loads from both agricultural and urban land use practices. Most of these programs are expected to continue in the future and several of them are slated to be expanded to cover new geographic areas or revised to incorporate more stringent requirements.

9.2.1 Non-Point Source Best Management Practices

Nutrient source controls refer to activities and measures (also referred to as BMPs) that can be utilized on agricultural and non-agricultural lands to ensure that the amount of P and N in off-site discharge is minimized, thereby preventing nutrients from entering the St. Lucie River watershed. Implementation of BMPs is a relatively cost-effective pollutant reduction and prevention measure. BMPs include structural and non-structural measures. Structural measures include creating physical changes in the landscape to reroute discharges, installing water control structures, and erecting barriers. Non-structural source control measures include education and operational or behavioral changes.

There are at present several existing and proposed nutrient source control programs within the St. Lucie River watershed. These programs are developed and implemented cooperatively by FDEP, FDACS, and the SFWMD.

9.2.1.1 SFWMD Nutrient Source Control Programs

The Environmental Resource Permit (ERP) program regulates activities involving the alteration of surface-water flows, and it includes activities in uplands that alter stormwater runoff as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to

ensure that alterations do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems.

The ERP program only applies to new or modified development, and it operates on the assumption that permit requirements will result in adequate water-storage capacity and no increase in P loading. The SFWMD has initiated rule development for an ERP basin rule with specific supplemental criteria designed to result in no increase in total runoff volume from new development that discharges ultimately to Lake Okeechobee and/or the Caloosahatchee or St. Lucie Estuaries. The tentative date for rule adoption is July 2009.

Another existing SFWMD program, the Works of the District program under Chapter 40E-61, F.A.C., was adopted in 1989 as a result of the Lake Okeechobee Surface Water Improvement and Management (SWIM) plan to provide a regulatory source control program specifically for P. The NEEPP expanded the program boundary to the St. Lucie River watershed and included N in addition to P as the focus of nutrient source controls. The program applies to new and existing activities with the goal of reducing nutrients in off-site discharges.

The SFWMD plans to propose modifications to Chapter 40E-61, F.A.C. for consistency with the goals and objectives of NEEPP. To ensure consistency with the SLRWPP, rule development is expected to begin in 2009.

9.2.1.2 FDACS Nutrient Source Control Programs

Currently, FDACS has implemented three nutrient control programs that affect the St. Lucie River watershed. FDACS has adopted by administrative rule, agricultural BMPs addressing containerized nursery, vegetable, and agronomic crop and citrus land uses in the St. Lucie River watershed. FDACS is currently developing and will be adopting BMP programs for cow/calf, sod, and equine operations. BMPs for all agricultural land uses are expected to be adopted by early 2009.

In February 2008, FDACS initiated rule development to control the land application of animal wastes in the St. Lucie River watershed. The proposed rule includes minimum application setbacks from wetlands and all surface waters. Landowners who apply more than one ton per acre of manure must develop United States Department of Agriculture/National Resource Conservation Service (USDA/NRCS)-approved conservation plans specifically addressing the application of animal wastes, and conduct soil testing to demonstrate the need for manure application. All use of animal manure must be recorded and included in the operation's overall nutrient management plan. FDACS expects to complete rule making for this effort by the fall of 2008.

In August 2007, FDACS adopted a statewide Urban Turf Fertilizer Rule. The rule limits the P and N content in fertilizers for urban turf and lawns, thereby reducing the amount of P and N applied in urban areas and limiting the amount of those compounds reaching Florida's water resources. It requires that, by July 1, 2009, all fertilizer products labeled for use on urban turf, sports turf, and lawns be limited to the amount of P and N needed to support healthy turf maintenance. As a component of the Lake Okeechobee and Estuary Recovery (LOER) Plan established in October 2005, the new rule is an essential component to improve water quality through nutrient source control. See Sections 7.1.2 for a more in-depth description of FDACS nutrient source control programs.

9.2.1.3 FDEP Pollutant Source Control Programs

FDEP is responsible for several existing and planned source control programs primarily targeting urban and non-agricultural issues. These programs include initiatives to improve existing stormwater and wastewater infrastructure. As a result, local governments have constructed and continue to build stormwater retrofits, such as detention/retention facilities and swales, to improve the quality of urban stormwater runoff. Also included in these programs is the implementation of the Municipal Separate Storm Sewer Systems (MS4s) Permit Program, the purpose of which is to develop, to implement, and to enforce a stormwater management plan to reduce the discharge of pollutants to the maximum extent practicable, to protect water quality and comply with the water quality requirements of the Clean Water Act (CWA). Other FDEP initiatives include land development regulations to promote proper stormwater treatment, enhancement to existing regulations for the management of domestic wastewater residuals within the St. Lucie River watershed, coordination with applicable authorities on septage disposal to ensure that nutrient loadings are considered, and administering the National Pollution Discharge Elimination System (NPDES) permit program. For a more comprehensive description of the FDEP pollutant source control programs see Sections 7.1.3.

9.2.1.4 Other Pollutant Source Control Programs

Launched in October 2005, the Florida Ranchlands Environmental Services Project will design a program under which ranchers in the northern Everglades watersheds can sell environmental services of water retention, P load reduction, and wetland habitat expansion to agencies of the state and other willing buyers. To document the level of environmental services provided by ranch water-management projects, Florida Ranchlands Environmental Services Project will field test different methods of using monitoring and modeling of hydrology, water and soil chemistry, and vegetation change.

The Florida Yards and Neighborhoods Program is an excellent example of a non-structural program. It is a partnership of University of Florida Institute of Food and Agriculture Sciences (UF/IFAS), Florida's water management districts, FDEP, the National Estuary Program, the Florida Sea Grant College Program, concerned citizens, members of private industry, and numerous other non-governmental agencies. It is implemented through the counties' UF/IFAS Cooperative Extension Service. The program addresses the serious problems of pollution in stormwater runoff, water shortages and disappearing habitats by enlisting Floridians to preserve and to protect our natural resources.

9.3 Watershed Research and Water Quality Monitoring Program

The recommended research and monitoring plan has been formulated to fulfill the goals and reporting requirements of the SLRWPP and to support adaptive management. It builds upon the existing monitoring, research, and modeling components discussed above, and makes recommendations/modifications to these efforts to better achieve and assess the goals/targets of the SLRWPP.

9.3.1 Monitoring Program

The monitoring program consists of a watershed monitoring component and an estuarine monitoring component.

9.3.1.1 Watershed Monitoring- Water Quality and Flow

Existing water quality monitoring programs include monitoring at major water control structures (Water Quality Monitoring Program), and a monitoring network within smaller tributaries (St. Lucie Tributary Monitoring Program). The Water Quality Monitoring Program is a long-term program that measures both flow and water quality in the St. Lucie River watershed of the St. Lucie Estuary, while the St. Lucie Tributary Monitoring Program is a short-term monitoring program designed to measure BMP effectiveness, support adaptive management, and measure tributary loads.

It is recommended that the existing Water Quality Monitoring Program and the St. Lucie Tributary Monitoring Program continue. Recommendations also included optimization of the existing watershed network. Three new water quality parameters are recommended to be added to the monthly suite of water quality grab sample analytes in order to support the proposed TMDL. These parameters are: Dissolved Total Kjeldahl Nitrogen (DTKN), 5-day biological oxygen demand (BOD_5), and Total Organic Carbon (TOC). The sampling suite will be re-evaluated at the 3-year SLRWPP re-evaluation period.

In addition, the RWQMP recognizes that a District-sponsored source control monitoring program, to measure the success of the collective Source Control Program (SFWMD, FDEP, and FDACS) at the sub-watershed level, is under development and may refine the existing St. Lucie tributary monitoring program. At the sub-watershed level, monitoring activities associated with the program will assess the collective success of pollutant source control BMPs, compliance with pollution reduction targets, and the need for additional BMPs or optimization of existing BMPs. At the local level this monitoring will identify priority areas of water quality concern and provide data to enhance performance of downstream treatment facilities. This program also will provide data that can be used in adaptive management as well as modeling and tracking of progress towards TMDLs.

9.3.1.2 Estuary Monitoring- Water Quality, Salinity and Aquatic Habitat

Existing estuarine monitoring programs include monitoring of salinity, water quality, bacterial, and seagrass and oyster habitats.

Salinity Monitoring—Salinity monitoring is essential to supporting water quality modeling, refining salinity envelopes, and quantifying the goal of reducing undesirable salinity ranges. The long-term tide and salinity monitoring network in the St. Lucie Estuary was established in 1997. All tide and salinity monitoring stations take water level, temperature and conductivity measurements at 15-minute intervals. The current monitoring is sufficient for basic salinity monitoring needs.

Water Quality Monitoring—This program was established in 1990 to detect long-term spatial and temporal trends in the St. Lucie Estuary, and monitors multiple parameters. It is sufficient to measure progress towards targets or concentrations resulting from nutrient load reductions. The monthly frequency of data collection is adequate to quantify long-term trends, but may miss important episodic evidence such as algal blooms.

Bacteria Monitoring—Currently, the St. Lucie County and the Martin County Health Department monitor fecal coliform and Enterococci bacteria in the St. Lucie Estuary to

protect human health. St. Lucie County monitors 15 stations in the North Fork on a monthly basis, while Martin County monitors a station near SE03 on a weekly basis. Because impairments for bacteria have been determined, these monitoring programs are necessary to monitor progress towards any adopted TMDL.

Seagrass Monitoring—Seagrass monitoring includes monitoring seagrasses on both a landscape scale and patch scale. Monitoring is performed semi-annually for long-term data determining the health of seagrass in the lagoon; monthly for short-term (5-year) data to help document seasonal changes and associated macro-algae; and bi-monthly for multiple purposes including determining the CERP pre-condition and helping scientists better understand potential changes that the CERP may cause, increasing understanding of ecosystem dynamics and cause-and-effect relationships, and improving our abilities to interpret unanticipated results. The monitoring includes a mapping effort.

The bi-monthly seagrass monitoring will be sufficient to meet the goals of the SLRWPP and it is recommended that this program be continued. Specifically, results of this monitoring are critical for annual reporting requirements and documenting improvement in aquatic habitat as nutrient loads and stressful salinity fluctuations are curtailed.

Mapping of seagrasses through use of aerial photography should continue at its present frequency of 2 to 3 years. This sampling frequency should capture large-scale changes in seagrass distribution resulting from extreme unpredictable events such as droughts, hurricanes, and El Nino. Continued coordination with the St. Johns River Water Management District will allow quantification of lagoon-wide patterns of change. The Restoration Coordination and Verification Program (RECOVER) currently produces maps every 5 years. The 2- to 3-year preferred frequency can be achieved if the RECOVER mapping is supplemented through this or other programs on an alternating 2- to 3-year basis.

Oyster Monitoring—A long-term monitoring program of Eastern oysters (*Crassostrea virginica*) was established in 2004. It emphasizes spatial and size distribution patterns of adult oysters, distribution and frequency patterns of oyster diseases, reproduction and recruitment, and juvenile oyster growth and survival. This effort includes mapping the existing distribution of oyster reefs and the mean density of living oysters on each oyster bed. The current sampling regime is believed to be adequate.

The oyster monitoring conducted will be sufficient to meet the goals of the SLRWPP, and it is recommended that this program continue. Specifically, results of this monitoring are critical for: (1) annual reporting requirements, and (2) tracking progress towards the restoration goal of 890 acres of oysters as nutrient loads and stressful salinity fluctuations are curtailed.

The recommended RWQMP supports the existing salinity, water quality, and habitat monitoring programs. Recommendations also included optimization of the existing watershed network. Additionally, it is recommended that three new water quality parameters be added to the monthly suite of grab sample analytes. These parameters are DTKN, BOD_5 , and TOC. Data from the St. Lucie Estuary program is required to measure water quality improvements due to load reductions. A 30-month formal review of the data will be used to determine data sufficiency and whether any modifications to the existing monitoring are needed. This review will also help to refine numerical water quality models for predicting effects of changing freshwater inflows and

nutrient loads on estuarine water quality. It is also recommended that the current fecal coliform and *Enterococci* bacteria monitoring programs in the St. Lucie Estuary continue to monitor progress towards the proposed bacterial TMDL because impairments for bacteria in the St. Lucie Estuary have been determined.

9.3.2 Research Program

Research projects are intended to reduce or eliminate key uncertainties in the proposed TMDL and in flow and salinity envelopes, and optimize the operation protocols. The three research projects in the RWQMP are summarized below. Chapter 5 of the RWQMP provides a detailed description of these programs, and assesses their adequacy in achieving the SLRWPP goals/targets.

Estuarine Nutrient Budget—Over-enrichment with nutrients from urban and agricultural sources is a problem for the St. Lucie Estuary. This project will construct nutrient budgets of total nitrogen (TN) and total phosphorus (TP). Results of this project can be used to support water quality modeling efforts that will reduce the uncertainty of the proposed TMDL and increase the capability to predict effects of various MMs, including BMPs.

Dissolved Oxygen Dynamics—Low oxygen concentrations are often associated with excess nutrient loading (Gray, 1992) and have been a recognized problem in the St. Lucie Estuary. This project will identify the factors causing the DO impairment in the St. Lucie Estuary. Once causes are known, appropriate management solutions can be implemented. The results of this study will provide critical information that will guide the selection of these management solutions.

Low Salinity Zone—Much of the work that supports estimates of minimum and maximum freshwater inflow requirements to the St. Lucie Estuary is based on the salinity tolerances of freshwater and marine organisms that inhabit the system. This project examines elements of the estuarine food web. The ultimate goal is to understand the role of freshwater discharge and production of fish larvae in the St. Lucie Estuary. Results can be applied to establishing water reservations, to refining flow and salinity envelopes, and to providing guidelines for delivery of freshwater to the St. Lucie Estuary.

Each major research project (e.g., Nutrient Budget) can be broken down into several components. Examination of the components of each project shows that several projects may have common components. The major research projects and commonalities between components of these projects are summarized in **Table 9-1**. The source of data for each component is given (existing data, new measurements, model etc). Items funded in any given year may be prioritized according to the number of projects to which they belong.

512 **Table 9.1.** Components and Commonalities of Major Research Projects in the St. Lucie
513 Estuary and Watershed

Research Component	Research Projects			Source
	Nutrient Budget	Dissolved Oxygen Dynamics	Low Salinity Zone	
INPUTS				
Canal Loads (C-23,C-24,C-25)	√	√	√	Monitoring
Ungauged				
Surface Flow	√	√	√	
Groundwater	√	√	√	From Model
	√	√	√	Analysis of Data
Ocean Input	√	√		Concentration from Literature/Flow from model
Atmospheric Input	√			Literature/ Data Search
INTERNAL CYCLING				
Primary Productivity/Water Column Resp	√	√	√	New Measurements
Organic Matter Decomp/ Incl. DON	√	√		New Measurements
Benthic Flux	√	√		New Measurements
Dissolved Oxygen Time Series		√	√	New Contract In-house
OUTPUTS				
Export to Ocean	√			Model
Denitrification	√			Benthic Flux Project
North and South Fork Narrows:				
Larval /Juvenile fish (Species, size, number and gut content)				
Adult fish (movement and spawning				
Zooplankton (species, stage, and reproductive state)			√	New Measurements
Benthos (species, feeding type, number)				
Phytoplankton (species and size)				

514 ### 9.3.3 Modeling Needs and Recommendations

515 The three existing modeling efforts include the St. Lucie Watershed Hydrology and Water
516 Quality Models, the Estuary Hydrodynamic and Water Quality models, and the Ecological
517 Response Model (see **Table 9-2**).

Table 9-2. Existing Models in St. Lucie River Watershed and Estuary

Watershed Water Quality and Hydrology	Estuary Hydrodynamic and Water Quality Models	Ecological Response Model
Watershed Hydrology and Water Quality model (WaSh)	St. Lucie Estuary 2-D Hydrodynamic model	Oyster Salinity Stress Model
Reservoir Optimization model (OPTI)	St. Lucie Estuary 3-D Hydrodynamic and Water Quality model	
Northern Everglades Regional Simulation models (NERSM)		

9.3.3.1 Watershed Hydrology and Water Quality Modeling

Effective management that aims to protect water quality requires a big picture view of water resources at a watershed-scale. Watershed models provide the necessary links for this purpose, particularly when it comes to understanding how non-point sources of pollution interact with point sources, and how these jointly affect the downstream water quality.

Regarding watershed hydrology and water quality simulation, modeling tools are needed that are capable of (1) simulating the hydrologic interaction of the St. Lucie River watershed with other components of the Northern Everglades Program (Lake Okeechobee and Caloosahatchee River Watersheds); (2) simulating watershed loading; and (3) optimizing operations and sizing of features. Existing tools include the NERSM, SLE WaSh model (District's version and FDEP TMDL version), and OPTI6 model. The NERSM model can serve as a regional hydrological model to simulate the hydrologic interactions across the Northern Everglades watersheds but would require additional refinements and integration with a water quality component and optimization component. In order to use the SLE WaSh model for simulating watershed loading, the current model would need to be updated to reflect the recent sub-basin delineation and inter-basin transfers. The model would also need to be refined with additional calibration to better simulate nutrient cycling and DO dynamics in major canals. Data collected by the monitoring activities described in Section 4 can be used for this purpose. Once this update is completed, the modeling period of record would need to be extended.

9.3.3.2 Estuary Hydrodynamic and Water Quality Modeling

One of the major objectives of the St. Lucie River Watershed RWQMP is to identify and answer the priority science questions to reduce any uncertainties in the SLRWPP. One of the science questions is how the change in the quantity, quality, timing, and distribution of St. Lucie River watershed inflows will improve the water quality condition and aquatic habitats in the St. Lucie Estuary. The estuary hydrodynamic, water quality, and ecological models, when integrated with the watershed models, will serve as a critical tool to evaluate the many hydrodynamic and water quality issues such as stratification, nutrient cycling, and DO dynamics in response to the implementation of the SLRWPP.

Regarding estuary hydrodynamic and water quality simulation, modeling tools are needed that are capable of (1) simulating the impacts induced by the watershed loading; (2) estuary hydrodynamics; and (3) estuary water quality processes. Existing tools include SLE-CH3D hydrodynamic and water quality components, and a sediment transport model. The CH3D hydrodynamic/salinity model was successfully calibrated and verified with observed tidal and

salinity data for the period from 1997 to 2005. The model can be further enhanced by including seasonal groundwater seepage and refining turbulence schemes to better simulate stratification and mixing in the St. Lucie Estuary. Because wind-generated waves are considered to be important for sediment re-suspension and therefore have significant impact on turbidity, the wind-generated wave impact will be investigated using the sediment transport model. In order to establish a nutrient budget and understand the different pathways of nutrients and hence the impact on ecosystems, the water quality component/model will need to be updated with newly collected data including the benthic fluxes, diurnal DO concentrations, and sediment and turbidity. Calibration and refinements on nutrient cycling process, stratification, and DO dynamics need to be made when data are available.

9.3.3.3 Estuarine Ecologic Response Modeling

In addition to oysters in the Mid-Estuary, another valued ecosystems component in St. Lucie Estuary is the seagrass growing in the Indian River Lagoon near the St. Lucie Inlet. Studies have indicated that the seagrass in the area is sensitive to discharges of high flows. Unpublished data also suggest that there is a low flow requirement by fish larvae in the low salinity zone of the St. Lucie Estuary. Future efforts in the estuarine ecologic response modeling should simulate the habitats for seagrass, oyster, and fish larvae to represent the entire spectrum of the valued ecosystems in the St. Lucie Estuary. These Valued Ecosystems Components may serve as the performance measures for future environmental operation during different climatic and seasonal conditions. To achieve this goal, a set of ecological performance measures representing habitats for fish larvae in the low salinity zone, oyster in the mesohaline zone, and seagrass in the polyhaline zone will be needed by the operation model to direct operation for both the dry season and the wet season. These performance measures will also need to be integrated into an index-type model along with a graphic user interface to aid in future applications. Eventually, a community-level ecological response model should be developed to predict the ecosystem change with the anticipated improvement in the habitats.

9.4 Preferred Plan Implementation

The NEEPP legislation states the River Watershed Protection Plans shall be achieved through a phased program of implementation. Therefore, implementation of the Preferred Plan described in this chapter will occur through an iterative, adaptive, and phased implementation process. The Preferred Plan will be implemented in at least the following three phases.

Phase I—Phase I projects will be initiated or completed between 2008 and 2012 (**Table 9-3**). This phase will primarily focus on continued implementation of ongoing measures and initiatives. Projects were included in Phase I if current project schedules indicate the project will be initiated or completed by 2012. It is recognized that implementation of these projects is contingent upon funding from many different sources and that actual implementation timeframes may vary. Changes in project schedules will be reflected in annual reports and 3-year updates as appropriate (see Section 9.4.5.6 for more information regarding plan updates). Phase I includes the projects listed below:

- **Two CERP IRL-S PIR Regional Projects**: C44 Reservoir/STA (LO 14) and Allapattah Complex - Natural Storage and Water Quality Area (SLE 09b).
- **All Source Control Projects**: Owner-implemented and Cost Share BMPs (LO 1, 2 and 49), Land Application of Residuals (LO4), Additional Agricultural BMPs (LO 50), Urban

Turf Fertilizer Rule (LOER) (LO 3), Florida Yards and Neighborhoods (LO 5), NPDES Stormwater program (LO 8), Urban BMP Program (SLE 38), Environmental Resource Permit Program (LO 7), St. Lucie River Watershed 40E-61 Rule Regulatory Phosphorus Source Control Program (LO 15), Wastewater and Stormwater Master Plans (LO 63), Unified Statewide Stormwater Rule (LO 64), Comprehensive Planning-Land Development (LO 68), and LO and Estuary Watershed Basin Rule (LOER) (LO 21). (Note: The Pollutant Control Project features are accounted for in these source control projects.)

- **Local Stormwater, Wastewater, and Habitat Restoration Projects**: Old Palm City Phase 3 (SLE 29), Manatee Water Quality Retrofit Phase 1, 2, and 3 (SLE 44), Manatee Pocket Dredging (SLE 30), and North River Shores Vacuum Sewer System (SLE 22); Alternative Water Storage Projects (LO 12).
- **Land Management Projects:** Florida Ranchlands and Environmental Services Projects (LO 87), Farm and Ranchland Protection Program (SLE 56).
- **Innovative Nutrient Control Technologies**: HWTT (SLE 7).
- **RWQMP:** Monitoring, Research, and Modeling.

Table 9-3. Summary of Phase 1 Projects

		Initiated	Completed
Construction Project	Alternative Water Storage Facilities- Indiantown Citrus Growers Association Phase I and II		✓
	Florida Ranchlands and Environmental Services Projects (Alderman-Deloney complete)	✓	✓
	CERP-IRL South: C-44 Reservoir/STA	✓	
	CERP-IRL South: Allapattah Complex- Natural Storage and Water Quality Area	✓	
	Alternative Water Storage Facilities- Indiantown Citrus Growers Association- Phase III, Dupuis, Waste Management St Lucie Site, Caulkins	✓	
	Hybrid Wetland Treatment Technology Pilot Project	✓	
	Local-Stormwater Projects (e.g., retention/detention ponds, treatment wetlands, conveyance and structural improvements)	✓	✓
	Local-Wastewater Projects (e.g., sludge disposal management, sewage treatment and disposal systems)		✓
	Local-Habitat Restoration (e.g., muck removal, oyster balls)	✓	✓
	Florida Ranchlands and Environmental Services Project	✓	
	Farm and Ranchland Protection Program	✓	
Pollutant Control Program	Agricultural and Urban BMPs	✓	
	Revisions to Regulatory Programs (40E-61 Source Control Regulatory Program, ERP Basin Rule, Statewide Stormwater Rule)		✓
	Comprehensive Planning and Growth Management	✓	
Research and Water Quality Monitoring	Monitoring, Research, and Modeling	✓	✓

Phase II—Projects that will be initiated or completed between 2013 and 2018. Phase II projects will be identified in the 2012 SLRWPP 3-year update. The 2012 SLRWPP 3- year update will also provide a status update on Phase I projects. The 2015 and subsequent SLRWPP 3-year updates will provide status reports and any proposed refinements and revisions regarding Phase I and II.

Long-Term Implementation Phase—Projects that will be initiated subsequent to 2018. The Long-Term Implementation Phase will be further defined during the 2015 and 2018 SLRWPP 3-year updates.

9.4.1 Phase I Implementation Benefits

The following benefits are anticipated from implementation of the Phase I projects:

- Ongoing implementation of BMPs on 297,442 acres of agricultural lands by 2015;
- Ongoing implementation of BMPs on 83,861 acres of urban lands;
- Completing EEP and 40E-61 rule revisions;
- Completing design and initiating construction of an approximately 3,400 acres reservoir and 4,000 acres of STA, and multiple local stormwater retrofits;
- Restoring 42,348 acres of wetlands and natural areas within the St. Lucie River watershed;
- Providing approximately 50,000 acre-feet of water storage within the St. Lucie River watershed; and
- Removing approximately 250,000 cubic yards of silty muck sediment from Manatee Pocket in the St. Lucie Estuary, thereby improving water quality.

9.4.2 Phase I Implementation Cost Estimate

The Preferred Plan captures a wide array of projects and programs, so there will be a variety of implementation and funding strategies utilized to move the Preferred Plan projects forward. Many of these projects are already included in other planning or restoration efforts (e.g., CERP). This plan assumes that those projects will continue to be implemented through the existing mechanisms or programs as originally intended.

To provide a source of state funding for the continued restoration of the South Florida ecosystem, the 2007 Florida Legislature expanded the use of the Save Our Everglades Trust Fund to include Northern Everglades restoration and extended the State of Florida's commitment to Everglades restoration through the year 2020. Save Our Everglades Trust Fund appropriations are determined on an annual basis through the state's budget process. Opportunities for cost-sharing, partnering, and grant funding will be utilized to optimize use of resources, as required by section 373.4595(4), F.S.

For purposes of this planning effort, costs have been broken into three categories. It is recognized that there may be other alternative funding strategies for these projects in addition to those found below.

CERP—Costs for CERP projects are eligible for a 50 percent cost share with the federal government. The non-federal contribution may be provided by the state, SFWMD, or local sources.

Non-CERP—The costs for non-CERP features will primarily be borne by the SFWMD and the state, with potential for local cost sharing.

Local- Costs for local projects will be covered entirely by the local government or may be cost shared by the local government and state or SFWMD sources.

Cost estimates were calculated for Preferred Plan Phase I projects (projects initiated or completed between 2009 and 2012) (**Table 9-4**). Costs are presented for each component of the Protection Plan (i.e., Construction Project, Pollutant Control Program, and RWQMP) based on the cost categories described above.

Table 9-4. Preferred Plan Phase I Cost Estimates

		CERP	Non-CERP	Local
Construction Project		\$504 to 694 million		\$15 million *
Pollutant Control Program	**Agricultural**		\$1.64 to 2.0 million	
	Urban		\$393 to 479 million	
Research and Water Quality Monitoring			\$2.7 million	

*\$15 million captured under local costs for the construction project is based on \$5 million per year for 2009 to 2012, which is intended to cover local projects and AWSFs. The \$15 million estimate reflects only the state's contribution.

Cost estimates presented in **Table 9-4** are based on the following assumptions:

- Costs do not include dollars that have already been expended to date.
- Costs include the full cost to build a project completely even if construction period goes beyond Phase I.
- High cost estimates are based upon 10 percent annual-real estate inflation and 9 percent annual construction inflation.
- Low cost estimates are based upon6 percent annual real estate inflation and 2 percent annual construction inflation.
- Agricultural BMP costs assume that there will be 50 percent state contribution for capital costs only, , O&M costs will be covered by landowner, and all cost-share BMPs will be implemented by 2015.
- Urban BMP costs reflect total capital costs and assume that O&M costs will be covered by the landowner or appropriate entity. Total capital costs do not reflect any cost-sharing assumptions; however, most costs will be borne by the landowner and local and state programs. Therefore, only a fraction of these costs will likely be borne by the River Watershed Protection Plans. No phasing assumptions were utilized for urban BMPs, so all capital costs are captured as Phase I costs.
- RQQMP costs only reflect costs for additional monitoring (resulting from the recommendations) not current, ongoing monitoring costs.

9.4.3 Future Implementation Cost Estimate

Costs for each progressive stage of implementation will be developed as more detailed project designs and information from various projects and studies are available. It is anticipated that modifications and refinements in the methods used to reduce TP and TN loading to the St. Lucie Estuary will occur in the future as a result of model and technology refinements described in Sections 9.4.5.2 and 9.4.5.3, respectively. Factoring this type of information in will provide additional clarity regarding the scope and engineering and design specifics of projects that will be included in subsequent stages and reduce the uncertainty associated with cost estimates. Cost estimates for Phase II will be provided in the 2012 SLRWPP 3-year update.

9.4.4 Funding Sources and Cost Sharing Opportunities

The majority of funding for the implementation of this Preferred Plan will be from state, SFWMD, federal and local sources. The 2007 NEEPP legislation provides a dedicated state funding source for the Northern Everglades restoration by expanding the use of the Save Our Everglades Trust Fund to include the Lake Okeechobee Watershed Protection Plan and the St. Lucie and Caloosahatchee River Watershed Protection Plans. The legislation specifically states "There is created within the Department of Environmental Protection the Save Our Everglades Trust Fund. Funds in the trust fund shall be expended to implement the comprehensive plan defined in s. 373.470(2)(a), the Lake Okeechobee Watershed Protection Plan defined in s. 373.4595(2), the Caloosahatchee River Watershed Protection Plan defined in s. 373.4595(2), and the St. Lucie River Watershed Protection Plan defined in s. 373.4595(2)…" (Section 373.472, F.S.)(2007).

It also extends the state's commitment to provide funding for CERP and the Northern Everglades through the year 2020. Section 470(6)(a) F.S (2007) states "Except for funds appropriated for debt service, the department shall distribute funds in the Save Our Everglades Trust Fund to the district in accordance with a legislative appropriation and s. 373.026(8)(b) and (c). Distribution of funds to the district from the Save Our Everglades Trust Fund shall be equally matched by the cumulative contributions from the district by fiscal year 2019-2020 by providing funding or credits toward project components." This is intended to be a recurring source of funding from the state, but must be appropriated by the legislature annually. Funding from the state is to be matched by the SFWMD. Many of the local features will have cost sharing with landowners and local governments, as well as state and federal grant programs.

The rate of implementation for non-CERP projects will be dependent upon the level of funding from state, SFWMD, local, and select federal sources. The rate of implementation for CERP projects will depend upon federal, state, and SFWMD sources.

It is recognized that multiple sources of funding beyond the recurring annual state and SFWMD appropriations will be required to complete the implementation of the Preferred Plan (Appendix G). These sources may include funding from federal government agencies (United States Army Corps of Engineers [USACE], United States Department of the Interior [DOI], USDA, etc.) local governments, tribal communities, and private landowners.

9.4.5 Plan Refinement and Revision

The Preferred Plan provides a framework and road map for progressive water quality and quantity improvements to benefit the lake and downstream estuaries.

Throughout implementation, it is fully expected that hydrologic and water quality conditions in the St. Lucie River watershed will continue to change as land uses in the St. Lucie River watershed are modified, and as restoration projects become operational. Performance will be periodically assessed and revisions made as necessary. In addition, NEEPP requires protection plan updates every 3 years and annual progress reports..

Portions of this SLRWPP have already been implemented or are in the process of being implemented. More detailed planning and design of other features will begin in 2009 and continue throughout the SLRWPP implementation stages. During implementation, the hydrologic and water quality conditions in the St. Lucie River watershed will continue to change as land use changes and individual projects affecting the quality and quantity of water become operational. It is therefore important to have a procedure in place to:

- Provide a process for more detailed planning and design to project implementation;
- Monitor plan performance adequately and appropriately over time;
- Revise the SLRWPP periodically, as necessary, based on evaluation of monitoring data; and
- Report progress to the legislature, regulatory agencies and the public as required by NEEPP.

Similar to other state initiatives (e.g., Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals), it is anticipated that this procedure will be borne out through Process Development and Engineering (PD&E). The recommendations for PD&E are described in this section. A description of the strategy for plan refinement, revision, and reporting is also provided.

9.4.5.1 Process Development and Engineering

The primary objective of the PD&E is to provide a roadmap for further refinement of the design of individual plan components. The PD&E will also identify additional measures that, if implemented, will increase certainty that the overall plan objectives for improving water quality and quantity are met. The PD&E procedure recognizes that:

- Achieving improvements in the quality, quantity, timing, and distribution of water and achievement of water quality standards will involve an adaptive management approach, whereby the best available information is used to develop and expeditiously implement incremental improvement measures in a cost-effective manner;
- Continued engineering evaluations will be necessary to increase certainty in the overall operation and performance of integrated hydrology and water quality improvement strategies;
- Significant technical and economic benefits can be realized by integrating the Construction Project Preferred Plan water quality and water quantity management measures with CERP projects; and
- As TMDLs are established for the St. Lucie River watershed, additional types of projects may need to be added to the suite of Preferred Plan components.

Key elements of the PD&E procedure include model refinement, technology refinement, sub-watershed conceptual planning, adaptive management (resulting from research and water quality monitoring), and plan updates and revisions. These elements are further described in the following sections.

9.4.5.2 Recommended Model Refinement

An integrated modeling approach is recommended to provide the technical support for implementation and adaptive management of the SLRWPP. In addition, several modeling needs have been identified to refine or update the existing models. These continuous improvements are further described in the RWQMP (Appendix E).

9.4.5.3 Technology Refinement

Technology refinement efforts likely to be required to support implementation of the Preferred Plan include existing technology refinements, and identification of new technologies that can be used either to accelerate achievement of plan objectives or increase cost-effectiveness of implementation (including innovative nutrient control technologies).

Existing technology refinement efforts will play an important role in optimizing and refining the implementation of many features that make-up the Preferred Plan and currently include BMP research and refinement; STA integration and refinement; and further research on innovative nutrient control techniques, chemical treatment, and hybrid wetland treatment technologies.

BMP Research and Refinement—Several uncertainties exist in estimating BMP performance. Some uncertainties associated with the performance of BMPs include the impacts of different soils and hydrologic conditions, the quantity of water that can be held on a parcel without impacting an agricultural operation, and legacy P currently within the St. Lucie River watershed. The BMP performance estimates utilized in this SLRWPP were based on best professional judgment and take into account the uncertainties described above, information available from literature, as well as actual performance data observed within the St. Lucie River watershed to date. These estimates will continue to be refined over time as ongoing and future research provides additional information through the technology and model refinement efforts.

Stormwater Treatment Area Integration and Refinement—The Preferred Plan establishes a technical framework through PD&E for the refinement and integration of water quality projects for the purpose of meeting water quality goals for the watershed and estuary. The goal of water quality project refinement and integration is to apply adaptive management analyses that will assist in determining how to optimize nutrient removal in individual projects and how to integrate multiple water quality projects throughout the watershed.

Innovative Nutrient Control Technologies—Evaluation and testing of technologies, such as chemical treatment and hybrid wetland treatment technologies that have the potential to remove nutrients in a cost-effective manner to meet any adopted TMDLs in the St. Lucie River watershed will be conducted. The results of these and other testing and evaluations in the future will play a role in refining and optimizing the SLRWPP.

Hybrid Wetland Treatment Technology—This technology combines the strengths of the two top-ranked nutrient removal technologies, namely treatment wetlands and chemical injection system. This synergy results in nutrient removal efficiencies beyond attainable by either separate technology with lower capital and operating costs. Optimization of system performance is achieved by adjusting hydraulic retention time (area of facility) and/or chemical dosing rates. Hybrid Wetland Treatment Technology has been previously demonstrated to reduce P concentrations from over 1,000 ppb to less than 100 ppb. Preliminary data from the existing pilot facilities in Lake Okeechobee and St. Lucie River watersheds show P concentration reductions in the range of 84 to 94 percent. Based on the results of the ongoing pilot projects, additional Hybrid Wetland Treatment Technology projects may be located within the St Lucie watershed.

Nitrogen Reduction Technology: The treatment efficiency of most of the included water quality features is well documented with regards to TP reductions. Unfortunately, there is not as much existing information regarding how well these facilities address reductions of TN in the South Florida region. Additional investigations to determine the most efficient and effective methods of reducing TN loads and concentrations will be included in future efforts.

9.4.5.4 Sub-watershed Conceptual Planning

The Preferred Plan has provided a general framework and road map to follow that will result in progressive improvements in nutrient loading to the St. Lucie Estuary and additional storage that will reduce undesirable St. Lucie River watershed discharges. However, due to the general nature of many of the projects identified in this planning process a significant amount of more detailed PD&E will be necessary prior to project implementation.

In addition, the results of other feasibility efforts will be used to help meet the Preferred Plan's objectives in as cost effective a manner as possible. Studies and pilot projects that test and evaluate various water quality treatment technologies will be used to refine and optimize nutrient removal.

Level 4 and 5 features of the Preferred Plan are those that have the least detail and have not been sited at this time. For these features, the initial stages of more detailed planning and design prior to more detailed engineering will be an evaluation of lands that are currently in District ownership and how best to maximize their utilization for water quality and surface storage and minimize the need for additional lands. This conceptual planning may be performed on a site-specific basis; however, most initial planning will be conducted on a broader sub-watershed scale. In compliance with the NEEPP requirements, the siting analyses will consider potential impacts to wetlands and threatened and endangered species. After siting of features is completed, more detailed design and engineering will follow.

9.4.5.5 Adaptive Management

In order to improve environmental conditions in both estuaries, protection plans will call for the construction of facilities designed to help meet any adopted TMDLs and flow/salinity targets by attenuating and storing stormwater runoff, and reducing nutrient loads. Operation of these facilities will be vital to their success. Monitoring and short-term studies will be required to adaptively manage these facilities to meet environmental objectives.

Research conducted within the context of an environmental protection program supports and informs adaptive management. Adaptive management is the iterative and deliberative process of applying the principles of scientific investigation to the design and implementation of a program to better understand the ecosystem and predict its response to implementation and to reduce key uncertainties. The basis of adaptive management is the use of feedback loops that iteratively feed new information into the decision-making process for planning, implementation, and assessment of project components. The 3-year assessment, specified in the legislation, provides this feedback loop and ensures the incorporation of adaptive management in the River Watershed Protection Plans.

Research for adaptive management uses a combination of models (conceptual to numeric) and observational and experimental studies to reduce uncertainty in the proposed TMDL and salinity /flow targets, improve the operations of water storage and water quality projects and increase predictive capability. The role of modeling is to provide a mechanism for synthesis, hypothesis specification, and preliminary testing, and to enhance predictive capability.

9.4.5.6 Plan Updates and Revisions

The coordinating agencies will prepare SLRWPP updates and revisions that may be necessary based on new information from PD&E, updated water quality and hydrologic data, and adaptive management. In addition, other agencies and the public will have the opportunity to provide input to the coordinating agencies in developing proposed changes through numerous public forums. A process for updating and revising the SLRWPP throughout the various implementation stages is described below.

9.4.5.6.1 Types of Updates and Revisions

Revisions to the SLRWPP will be classified as minor or major, based on the following criteria:

- Magnitude and nature of the proposed revisions (i.e., scope, schedule, budget);
- Potential for the proposed revision to have environmental impacts that are significantly different from those previously considered by the coordinating agencies for the project;
- Potential for the revision to impact the intent and purpose of the Preferred Plan; and
- Whether the revision requires SFWMD Governing Board approval.

The classification of the revision will not necessarily determine the nature of any accompanying permit requirements that may be necessary.

9.4.5.6.2 Process for Updates, Revisions, and Reporting

The following process is proposed for updating the SLRWPP and reporting:

- **Monthly/Bi-monthly Coordinating Agency Meetings—**This forum is used to discuss progress of implementation, review new information and data, present proposals for revisions (minor and major) along with supporting documentation, and seek review and comments.

- **Semi-annual Coordinating Agency Review**—New information compiled as a result of the Interagency Coordinating Meetings and other agency and public input will be reviewed by the SFWMD, FDEP, and FDACS.
- **Annual Report in the South Florida Environmental Report (SFER)**—The SFWMD will submit the required Annual Report in the SFER (also known as the Consolidated Water Management District Annual Report) to FDEP, the Governor, the President of the Senate, and the Speaker of the House of Representatives. This annual report will summarize the status of research and monitoring, project implementation, and recommended revisions to the SLRWPP. In addition, major updates and revisions to the SLRWPP will be identified and described in the annual report. The discussion will include a description of the need for the revision and its impacts on the SLRWPP's scope, schedule, budget, and objectives. Public comments received during the coordination of the proposed plan revision will also be noted in the annual report.
- **Annual Work Plan**—The Annual Work Plan will be submitted for each fiscal year to FDEP identifying the projects and funding necessary to implement those projects.
- **SLRWPP Update** - Every 3 years, the SFWMD in cooperation with the coordinating agencies, will formally update, revise, and submit the SLRWPP to the State Legislature.

9.4.5.7 Public Involvement

Public involvement will be sought regarding proposed updates and revisions to the SLRWPP through discussion with the groups listed below.

- **Northern Everglades Interagency Coordinating Meetings**—This forum is used to discuss progress of implementation; review new information and data; present proposals for revisions (minor and major) along with supporting documentation; and seek review and comments from the coordinating agencies, stakeholders, and the general public.
- **Water Resources Advisory Commission and Lake Okeechobee Committee Meetings**—Regular updates will be provided to the WRAC and Lake Okeechobee Committee, which advises the SFWMD Governing Board on a variety of environmental restoration and water resource management issues. The WRAC also serves as a forum for improving public participation and decision-making on water resource issues. These meetings will be used to discuss progress of implementation and seek input from stakeholders as well as the general public.
- **SFWMD Governing Board Meetings**—Updates on progress of implementation and proposals for major revisions will be discussed as appropriate. This forum provides an opportunity for input from stakeholders as well as the general public.
- Other public meetings will be held as necessary.

9.4.6 Force Majeure

Extraordinary events or circumstances beyond the control of the coordinating agencies may prevent or delay implementation of SLRWPP projects. Such events may include, but are not limited to, acts of nature (including fire, flood, drought, hurricane, or other natural disaster) as well as unavoidable legal barriers or restraints, including litigation of permits for individual SLRWPP projects.

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CHAPTER 10.0

LITERATURE CITED

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10.0 LITERATURE CITED

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