Lower East Coast
Regional Water Supply Plan

Planning Document

prepared by

South Florida Water Management District

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Water Supply Planning and
Development Department
West Palm Beach, Florida

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The Lower East Coast Regional Water Supply Plan was a large-scale planning effort to ensure future water supplies for 75 percent of the South Florida Water Management District's population through 2020. A large multidiscipline team with extensive technical support was required to perform the detailed analysis using state-of-the-art computer modeling tools.

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EXECUTIVE SUMMARY

Introduction

The *Lower East Coast Regional Water Supply Plan* (LEC Plan) provides a blueprint to help meet the water resource needs of a rapidly growing South Florida between now and 2020. Technical analyses of this area's future water needs and the availability of water supplies indicate that extensive actions are required to ensure that a sustainable water supply is available to fulfill future urban, agricultural, and natural systems water needs. The actions recommended in this plan will meet these needs. Analyses show that the recommended projects must be built on schedule or the region will face a significant increase in the risk of water shortages and environmental decline.

The Lower East Coast (LEC) Planning Area is expected to experience substantial growth between now and 2020, increasing by almost 58 percent from 1995. Most of this increase in population will occur in the coastal area, which is projected to have almost seven million residents in 2020. This growth will create additional water demands for potable and irrigation water. Agricultural water demand, primarily for irrigation of row crops, ornamental horticulture, and sugarcane, is projected to decrease by seven percent reflecting a reduction in the area cultivated to approximately 480,000 acres. The overall water demands of consumptive users is projected to increase by 20 percent, to 2.52 billion gallons per day on average. In addition, significant increases in water supply deliveries will be needed to sustain and restore the natural systems of South Florida.

Development of proactive water resource and water supply development projects is imperative to both meet water demands and restore critical ecosystems in the coastal estuaries, Lake Okeechobee, the Everglades, and the Biscayne Bay. The South Florida Water Management District (District) is primarily responsible for water resource development. Local governments, water users, and water utilities are primarily responsible for implementing water supply development. When appropriate, and resources are available, the District will also assist water supply development efforts at the local level.

Purpose

The purpose of this plan is to fulfill the requirements of Section 373.0361, Florida Statutes (F.S.), for regional water supply plans. Implementing this plan, which complies with the statutory requirements, will ensure significant benefits to the people in South Florida and the natural systems by providing guidance, funding, and resources needed to develop regional and local water supplies.

Achievements

Implementation of the LEC Plan will do the following:

- Create a water supply that fully meets the future (2020) needs of almost seven million people, agriculture and industries during a 1-in-10 year drought
- Reduce the number and severity of violations of Minimum Flow and Levels (MFL) criteria for the Everglades, Lake Okeechobee, and the Biscayne aquifer by 2020
- Reserve from allocations sufficient water to allow for the restoration of the Everglades and enhancement of other significant natural systems
- Reduce the uncertainty for issuing long-term permits for water users as they invest in tomorrow's water supply infrastructure
- Provide public forums to modernize District operational procedures and promote greater flexibility in the operation of the regional water management system

Relationship with Comprehensive Everglades Restoration Plan

In 1997, the District merged its LEC regional water supply analyses of major water storage facilities into the Central and Southern Florida Project Comprehensive Review (Restudy) process. The Restudy was a multiyear planning effort by the U.S. Army Corps of Engineers and the District, which was completed in April 1999 with publication of the *Central and Southern Florida Comprehensive Review Study Final Feasibility Report and Programmatic Environmental Impact Statement*. The water supply planning efforts completed from 1992 to 1997 for the LEC Plan provided the foundation, in the form of analytical tools, evaluation techniques, and storage projects for the Restudy. The Restudy is being refined and implemented through the Comprehensive Everglades Restoration Plan (CERP). This LEC Plan incorporates the CERP construction and operational features into the state planning process to determine how much water can be made available from the regional system through the state regulatory program. The water supply planning process also verified that the sequencing of proposed Restudy components at five-year increments through 2020 would protect existing legal water users, protect water resources from significant harm, and balance the future water needs of the region. The LEC Plan also identified improvements to that should be considered as the CERP moves forward.

Statutory Requirements

The LEC Plan integrates the federal water management process (CERP) into the state process, described in Section 373.0361, F.S., and other pertinent sections of Chapter 373, F.S., by including the following:

- Analyses based on at least a 20-year planning period
- Estimated water supply demands for all existing and future users and the environment up to a 1-in-10 year level of certainty
- Water resource development projects, implementation schedules, costs, and funding strategies
- Descriptions of water supply development options, their effectiveness, and estimated cost to implement
- Minimum Flows and Levels (MFL) recovery and prevention strategies for four priority water bodies and recommendations for development of MFLs for other water bodies
- Technical data and information to support the plan

Process

This planning document is the product of a public process, which relied heavily on an advisory committee representing federal, state, tribal, agricultural, urban, and environmental interests. The LEC Regional Water Supply Plan Advisory Committee was initiated in 1992. The committee participated in development of both the *Interim Plan for Lower East Coast Water Supply* (LEC Interim Plan) (SFWMD, 1998b) and this 20-year plan.

Two existing hydrologic models, the South Florida Water Management Model and the Natural System Model, and five recently developed, high resolution, ground water models were applied to analyze how the hydrology of South Florida performs under future conditions. Projections for urban and agricultural water demands and sources were incorporated, as well as future land use projections, construction of water management features, such as the Everglades Construction Project, and operational features, such as the Water Supply and Environmental schedule for Lake Okeechobee. Performance measures were applied to evaluate the computer simulations. The performance measures relate to the goals of the plan, provide water to meet a 1-in-10 year level of certainty, and provide for hydrologic restoration of the Everglades through 2020.

Other planning efforts are linked to the LEC Plan and are important to meeting its objectives. Three District plans, the *Lower West Coast Water Supply Plan* (SFWMD, 2000b), the *Kissimmee Basin Water Supply Plan* (SFWMD, 2000c), and the *Caloosahatchee Water Management Plan* (CWMP) (SFWMD, 2000d) were approved by the Governing Board in April 2000. Two federal planning projects, the Water Preserve Areas and Southwest Florida feasibility studies, are under way. These other efforts were integrated to the greatest degree possible with the LEC planning process. The *Caloosahatchee Water Management Plan* evaluated water supply in an area linked to the LEC Planning Area by virtue of its dependence on Lake Okeechobee. Its recommendations are included as part of the LEC Plan. Additional integration of the plan will occur as part of related implementation efforts or as water supply plans are periodically updated. This plan will be reviewed and updated at least every five years to ensure that future water needs of LEC Planning Area continue to be met.

Conclusions of Analysis

It was concluded that construction and implementation of the CERP components and appropriate management and diversification of water supply sources will ensure sufficient water to meet the needs of the LEC Planning Area up to and including a 1-in-10 year drought condition. Urban areas may reach a 1-in-10 year level of certainty by 2010. Agricultural users that depend on Lake Okeechobee may reach a 1-in-10 year level of certainty by 2015 if the construction and operational features in the LEC Plan are implemented. The proposed MFLs will also be achieved in Lake Okeechobee, the Everglades, and the Biscayne aquifer by 2020. Also, a majority of restoration targets for the Everglades can be met by 2020 if this plan is implemented, although CERP features will not be fully implemented until 2037.

Recommendations for Water Resource Development

The LEC Plan recommends water resource development projects and lists water supply development options available to public and private water suppliers. The primary water resource development projects will be completed as part of the CERP. The District and local sponsor costs for the first five years of implementation are expected to be $922,491,000 and the 20-year costs are estimated at $3,395,470,000. The recommendations fall into eight categories which are listed in **Table 1** along with the District and local five-year and 20-year costs.

Table 1. Summary of District Five-Year and 20-Year Costs of the Water Resource Development Projects Recommended in the LEC Plan.

Category	Five-Year Cost (FY2001-FY2005)	20-Year Cost[a] (FY2001-FY2020)
Ongoing projects from the LEC Interim Plan	$19,509,000	$33,789,000
Other federal, state, and District projects	$4,245,000	$4,245,000
CERP projects	$893,417,000	$3,352,116,000
Operational recommendations	$750,000	$750,000
Consumptive Use Permitting and Resource Protection Projects	$1,920,000	$1,920,000
Other Water Resource Development Project	$2,650,000	$2,650,000
TOTAL	$922,491,000	$3,395,470,000

a. 20-year costs may be updated in the 2005 Update to the LEC Plan

Implementation of the CERP is critical to meeting the state mandates to achieve a 1-in-10 year level of certainty, provide MFLs, and meet restoration targets for natural systems. Implementation of the LEC Plan, in conjunction with the CERP, the CWMP, and the Southwest Florida Study, should avert water shortages and harm to the environment during a 1-in-10 year drought. However, successful implementation of the LEC Plan is dependent on completing the rule development for MFLs, reservations of water for the environment, and consumptive use permits.

The CWMP determined that projected surface water needs of the Caloosahatchee River basin and estuary can be met based on recommended water management and storage infrastructure that effectively capture and store surface water flows in the basin. The CWMP recommendations for modifications to demand projection methodology, the Aquifer Storage and Recovery (ASR) Pilot Project, and the C-43 Storage Project will be referred to the CERP and the Southwest Florida Study. As in the LEC Planning Area, meeting the 1-in-10 year level of certainty for the Caloosahatchee Basin depends on completing the CERP projects.

Recommendations for Water Supply Development

Use of the traditional source for public water, the Surficial Aquifer System, can be expanded with completion of proposed water resource development projects and more efficient use of regional and local water supplies. The Surficial Aquifer System is limited in some areas due to increased potential for impacts on wetland systems and for saltwater intrusion in coastal areas in the vicinity of public water supply wellfields. Coastal areas with limited access to regional water are more likely to require implementation of the water supply development options described in the LEC Plan.

Eight water source options were identified to address water supply needs of the LEC Planning Area. These options either make additional water available from historically used sources or other sources, or provide additional management through conservation and storage of water. The options are as follows (no implied priority):

- Conservation
- Surficial Aquifer System
- Floridan Aquifer System
- Reclaimed Water
- Seawater
- ASR
- Reservoirs
- Surface Water

Strong emphasis is placed on implementation of a comprehensive water conservation program. Conservation will be encouraged through cooperative efforts among water users, utilities, local governments, and the District. These efforts will incorporate many initiatives, including continued development and compliance with water conservation ordinances, development and implementation of public education programs, use of alternative water sources, continued emphasis on water conservation in the District’s surface water and consumptive use permitting programs, and other means. Local governments and users will play a key role in making these strategies a success, through adoption of conservation ordinances, homeowner awareness programs, land use decisions, and development of water supply options by local governments, utilities, and water users.

The Floridan aquifer appears to be a promising source for additional potable water in areas with limited access to regional supplies, but little is known about long-term water quality impacts of sustained withdrawals from this aquifer. As a result, the District is currently refining the Floridan aquifer ground water model and the Floridan aquifer water quality and water level monitoring networks. Several public water utilities already use reverse osmosis technology to remove salt from the saline water in the Floridan aquifer.

From a regional perspective, the use of ground water sources, reclaimed water, surface water, and storage through development of a regional or subregional irrigation water distribution system(s) will be sufficient to meet the urban and irrigation demands. Water from the Surficial Aquifer System and reclaimed water have been used historically to meet such demands. However, in some areas of the LEC Planning Area, these sources will need to be augmented. The feasibility of developing a regional irrigation water distribution system using reclaimed water is being considered in northern Palm Beach County.

In the southeastern portion of the LEC Planning Area, it was concluded that existing surficial aquifer and Floridan aquifer system ground water sources are sufficient to meet the 2020 projected urban demands with minimal potential impacts. Some modifications to wellfield configurations and well operations will be needed at the local level to meet a 1-in-10 year level of certainty and avoid potential impacts to water resources and other existing legal users.

Improved management of surface water through storage could increase freshwater availability in the region and reduce potential impacts resulting from water use. ASR technology shows promise both for treated and untreated water by providing capacity to capture and store excess water when it is available. This technology is currently being used by several utilities at the local level. In addition to continued use and development at the local level, application of ASR on a regional scale has been identified as an option to capture excess surface water in several basins including Lake Okeechobee. Regional and local retention projects will reduce excess water discharged to estuarine systems and increase water availability inland by increasing water levels in canals and providing additional ground water recharge.

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2005 SSM	2005 Supply-Side Management Scenerio (SFWMM)
2005R	2005 incremental simulation (SFWMM)
2010R	2010 incremental simulation (SFWMM)
2020R	2020 incremental simulation (SFWMM)
20Base	2020 Base Case (subregional models)
20BSR	2020 Base Case (SFWMM)
2020WR	2020 with Restudy (SFWMM)
20wres	2020 with Restudy (subregional models)
95Base	1995 Base Case (subregional models)
95BSR	1995 Base Case (SFWMM)
95BSRR	1995 Revised Base Case (SFWMM)
ac-ft	acre-feet
ADAPS	Automated Data Processing System
AFSIRS	Agricultural Field Scale Irrigation Requirements Simulation
APT	Aquifer Performance Test
ASCII	American Standard Code for Information Interchange
ASR	Aquifer Storage and Recovery
AWWA	American Water Works Association
AWT	Advanced Water Treatment
BMPs	Best Management Practices
BOR	Basis of Review
C&SF Project	Central and Southern Florida Project for Flood Control and Other Purposes
CERP	Comprehensive Everglades Restoration Plan
CLBSA	Central Lake Belt Storage Area
cfs	cubic feet per second
CUP	Consumptive Use Permitting
CWMP	Caloosahatchee Water Management Plan
DAO	District Administrative Order

DERM	Department of Environmental Resource Management
District	South Florida Water Management District
DRI	Development of Regional Impacts
DWMP	District Water Management Plan
DWSA	Districtwide Water Supply Assessment
EAA	Everglades Agriculture Area
ERP	Environmental Resource Permitting Program
ET	Evapotranspiration
F.A.C.	Florida Administrative Code
FAU	Florida Atlantic University
FAS	Floridan Aquifer System
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FFWCC	Florida Fish and Wildlife Conservation Commission
FGS	Florida Geological Survey
F.S.	Florida Statutes
FTE	Full-Time Equivalent
FWC	Florida Wildlife Commission
FY	Fiscal Year
GIS	Geographic Information System
GPD	gallons per day
GPCD	gallons per captia daily
GRR	General Reevaluation Report
IFAS	Institute of Food and Agricultural Sciences
IR	Indicator Region
ISGM	Intergrated Surface Water Ground Water Model
IWR	Institute of Water Resources
IWRP	Integrated Water Resource Plan
LEC	Lower East Coast
LEC-1R	LEC-1 Revised simulation
LECSA	Lower East Coast Service Area

LOSA	Lake Okeechobee Service Area
LOVFMT	Lake Okeechobee Vegetation and Fire Management Team
LWC	Lower West Coast
MDS	Modified Delta Storage
MFL	Minimum Flows and Levels
MGD	million gallons per day
mg/L	milligrams per liter
MGY	million gallons per year
MIL	Mobile Irrigation Laboratory
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NGVD	National Geodetic Vertical Datum
NLBSA	North Lake Belt Storage Area
NPBCSA	North Palm Beach County Service Area
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSM	Natural Systems Model
NWI	National Wetlands Inventory
O&M	Operations and Maintenance
OPEs	Other Project Elements
P2000	Preservation 2000
PDE	Partial Differential Equation
PIR	Project Implementation Report
P-M	Penman-Monteith
ppt	parts per thousand
PWS	Public Water Supply
RECOVER	Restoration, Coordination, and Verification
REDI	Real Estate Data Information
Restudy	Central and Southern Florida Project Comprehensive Review Study
RO	Reverse Osmosis
RTA	Reduced Threshold Area

SAS	Surficial Aquifer System
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SFWRMS	South Florida Water Resource Management System
SOW	Statement of Work
SSM	Supply-Side Management
STA	Stormwater Treatment Area
SWCD	Soil and Water Conservation District
SWFRPC	Southwest Florida Regional Planning Council
SWFS	Southwest Florida Study
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement Management
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Loads
UEC	Upper East Coast
USACE	United States Army Corps of Engineers
USACE-WES	U.S. Army Corps of Engineers - Waterways Experiment Station
USDA	United States Department of Agriculture
USDW	Underground Sources of Drinking Water
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WASD	Water and Sewer Department
WATBAL	Water Balance Component
WCA	Water Conservation Area
WMA	Water Management Area
WRCA	Water Resource Caution Area
WSE	Water Supply and Environmental

Chapter 1
INTRODUCTION

BACKGROUND

The Lower East Coast (LEC) Planning Area is one of four regional planning areas in the South Florida Water Management District (District, SFWMD). The planning area covers approximately 1,200 square miles and includes essentially all of Miami-Dade, Broward, and Palm Beach counties, most of Monroe County, and the eastern portions of Hendry and Collier counties (**Figure 1**). The entire Lake Okeechobee Service, which includes part of four additional counties, Martin, Okeechobee, Glades and Lee, were incorporated into the analyses because of their reliance on the Lake Okeechobee for a portion of their water supply. Land use within the LEC region ranges from urban in the east to undeveloped natural landscapes in the west, with some areas in between having intense agricultural use. In the future, urban land use is expected to intensify and increase spatially and agricultural land use is expected to decline slightly. The ability to provide more water to the LEC planning area in the future also depends on activities in other areas of the District that depend on Lake Okeechobee for water supply, such as the Caloosahatchee and St. Lucie river basins.

The planning area faces many challenges to provide adequate water supply to meet growing urban demands, changing agricultural demands, and needs of the environment through 2020. To some extent, these trends may offset each other in some basins and service areas. Nevertheless, overall water demand is expected to increase by 20 percent for urban and agricultural users (**Table 2**). The costs of implementing the options necessary to meet the projected increases in demand are substantial, but these costs will be spread over a number of years and will be funded from various local, regional, state, and federal sources.

This plan builds on analyses described in previous documents, including the *LEC Working Document* (SFWMD, 1993), the *Interim Plan for Lower East Coast Regional Water Supply* (SFWMD, 1998b), and the *Central and Southern Florida Project Comprehensive Review Study Final Feasibility Report and Programmatic Environmental Impact Statement* (Restudy) (USACE and SFWMD, 1999), and ongoing efforts such as the Comprehensive Everglades Restoration Plan (CERP). The CERP is being developed by the District, the United States Army Corps of Engineers (USACE), and other agencies to refine and implement the recommendations from the Restudy. The time frame for this plan is from the present to the future (2020). The computer modeling analysis for this plan originally used population, agricultural production, and water use projections through the year 2010, based on data provided from local governments. In order to comply with statutory changes to Chapter 373, F.S., that were made in 1997, these projections were reviewed and updated to create new projections for 2020.

The District has established a planning goal to meet regional water needs, consistent with Florida statutes and ensure that sufficient water is available to avoid water

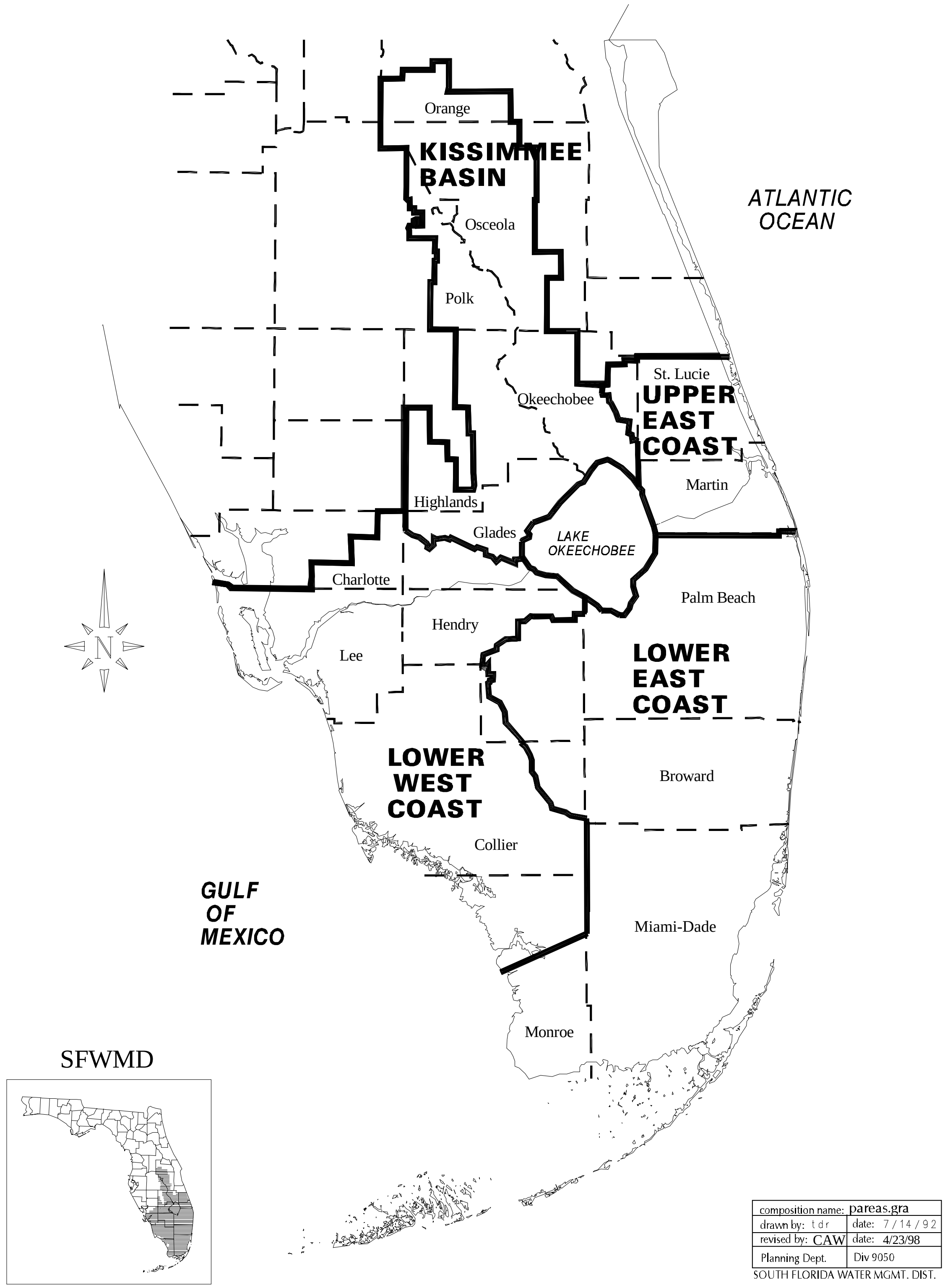

Figure 1. Water Supply Planning Areas within the SFWMD.

Table 2. Current and Projected Water Demands for each Water Use Category by County within the LEC Planning Area.

County	1995 Average Annual Demand (BGY)[a]				2020 Average Annual Demand (BGY)			
	PWS/DSS	Recreational	Commercial and Industrial	Agricultural	PWS/DSS	Recreational	Commercial and Industrial	Agricultural
Palm Beach	76.9	24.0	10.9	256.6	117.3	35.8	12.2	225.3
Broward	83.0	21.9	1.3	3.2	116.6	27.6	1.8	2.6
Miami-Dade	145.4	5.1	10.6	39.9	230.3	6.9	13.3	41.7
Monroe	0.2	0.8	0.03	0	0.2	0.8	0.03	0
Eastern Hendry	0.1	0	0	85.3	0.2	0	0	87.0
Total for the LEC Planning Area	305.6	51.8	22.9	385.0	464.5	71.1	27.3	356.4

a. BGY is Billions of Gallons per Year

shortages and meet demands during a 1-in-10 year drought condition. This plan achieves that goal. Even though enough water is available to meet demands on a regional scale, local conditions and circumstances may make it impossible or impractical to deliver regional water to particular individual supply systems. To address this issue, this plan presents regional water resource development projects, as well as a menu of strategies and local options that are available for more localized water supply development projects.

OVERVIEW

The *Lower East Coast Regional Water Supply Plan* (LEC Plan) was developed to include the areas in South Florida shown in **Figure 2**, covering all or part of ten of the 16 counties in the SFWMD. Documentation of the plan includes the final Planning Document (this document) and the Appendices. This chapter, Chapter 1, provides an introduction that emphasizes the purpose and general goals of the LEC Plan. **Chapter 2** gives an overview of the LEC water supply planning process. **Chapter 3** describes the LEC Planning Area boundaries and major features, the primary and secondary water management systems, and the various basins and service areas. **Chapter 3** also includes a description of the areas within the LEC where Minimum Flows and Levels (MFL) have been proposed, pursuant to provisions in Chapter 373, F.S. **Chapter 4** presents the findings of the LEC Plan in terms of the performance of the regional and subregional water supply systems under present and future conditions with various water management features in place. **Chapter 4** focuses on use of the regional and subregional models to evaluate current (1995) and future (2020) conditions without the major features proposed in the Restudy and future conditions with the major features proposed in the Restudy in place. **Chapter 4** also describes performance of the regional and subregional water supply systems with various combinations of water resource and supply options in place. **Chapter 5** provides the conclusions from the analysis and lays out implementation strategies for projects

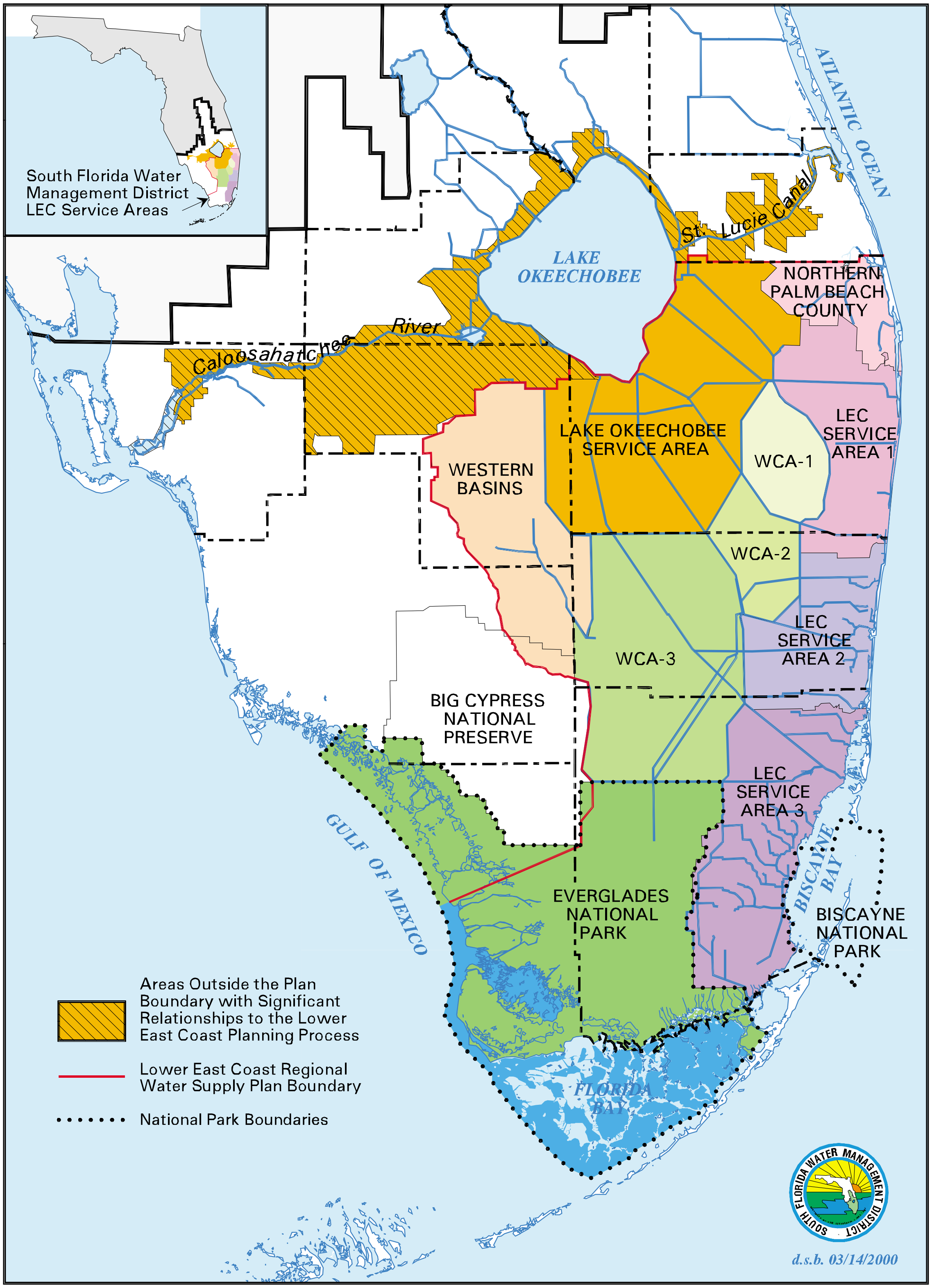

Figure 2. Major Features of the Lower East Coast Planning Area.

construction, recovery and prevention strategies to meet MFLs, reservations of water, and rule development. **Chapter 6** presents the plan's recommendations, based on all evaluations conducted as part of the LEC planning process.

Appendices to the LEC Plan document include the legal statutes pertaining to the water supply plans (**Appendix A**), water demand analyses and projections (**Appendix B**), descriptions of water resource projects development (**Appendix C**), performance measures and indicators (**Appendix D**), hydrologic modeling tools (**Appendices E** and **F**), engineering designs and cost estimates (**Appendix G**), results of the SFWMM and ground water model runs (**Appendix H**), related planning materials (**Appendix I**), and documentation for the establishment of MFLs (**Appendix J**).

LEGAL BASIS

The LEC Plan provides strategies that are cost-effective, can be implemented, and assure that adequate water is available to meet future urban and agricultural, and natural system demands within the planning area through the year 2020. In accordance with recent changes to Chapter 373, F.S., a combination of water resource and water supply development projects is proposed. The plan has been evaluated to determine how well the proposed facilities and operational changes meet reasonable-beneficial water demands during a 1-in-10 year drought condition, while protecting the natural system from harm.

Currently, the regional water supply system meets the urban and agricultural needs fairly well. However, large portions of the Everglades and important estuary systems do not receive adequate quantities, timing, or distribution of water. Meeting the water supply needs for restoration of the environment is explicitly recognized as a responsibility of equal importance to meeting urban and agriculture demands and is specifically addressed in the Restudy and the subsequent CERP. Although this LEC Plan is not intended to achieve full restoration, appropriate attention has been given to improving hydropatterns within natural systems, particularly within the Everglades ecosystem. Furthermore, the plan incorporates proposed MFLs for Lake Okeechobee, the Everglades, and the Biscayne aquifer and outlines recovery and prevention strategies, where appropriate, to ensure that minimum water levels, and the durations and frequency of wetland flooding are achieved and maintained.

All of the policies developed for the LEC Regional Water Supply Plan Advisory Committee are governed by the general regional water supply planning requirements and policies as stated in the Florida Water Resources Act, Chapter 373, F.S. The purpose and scope of this plan are based on a hierarchy that progresses from law to more specific policy direction, and expressed District goals and objectives.

Regional Water Supply Plan Legal Requirements and Implementing Policies

Chapter 373 Planning Framework

Florida law provides several layers of legal requirements and policy direction to water management districts that impact regional water supply plan development. The relationship among three primary levels of legal and policy direction that affect regional water supply planning is shown in **Figure 3**.

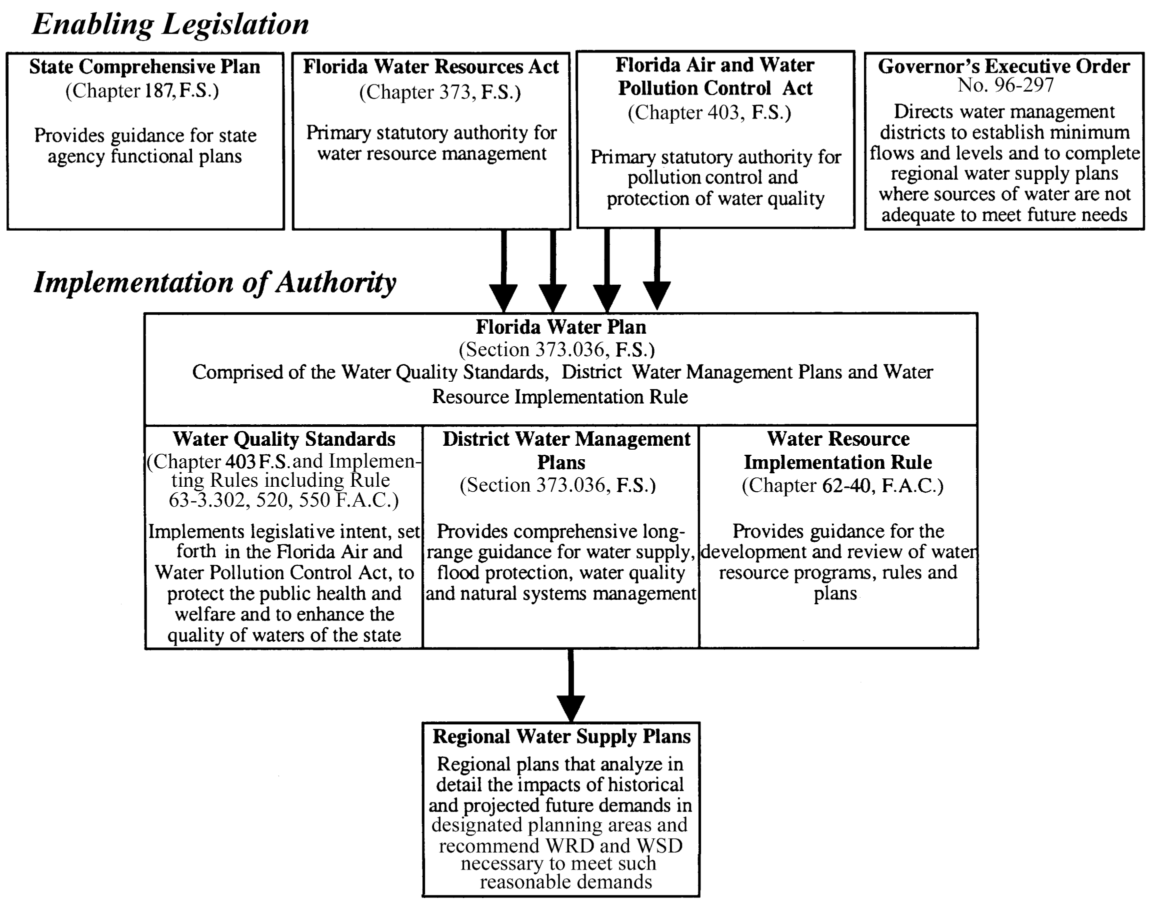

Figure 3. Legal Framework for the LEC Plan.

The Water Resource Implementation Rule (Chapter 62-40, F.A.C.), The Water Resources Act (Chapter 373, F.S.), the State Comprehensive Plan (Chapter 187, F.S.), the Florida Air and Water Pollution Control Act (Chapter 403, F.S.), and delegation of authority from Florida Department of Environmental Protection (FDEP) provide overall directives and policies that guide water management district water supply planning efforts. The Water Resource Implementation Rule stems from requirements in Chapter 373, F.S., (principally Sections 373.036 and 373.039). In addition, new legislative directives were monitored throughout the development of this plan, keeping it current and consistent with the 1996 Governor's Executive Order (96-297) and the 1997 legislative water supply amendments to Chapter 373, F.S. The LEC Plan was developed by the SFWMD based on guidelines developed in the *Regional Water Supply Assessment* (SFWMD, 1998e) and to fulfill commitments made in the approved *District Water Management Plan* (SFWMD, 2000a).

Key Direction for Regional Water Supply Plan Development

Within the three levels (enabling legislation, implementation of authority, and plan development) there are three key provisions discussed below. They are 1) overall Chapter 373, F.S., “Florida Water Resources Act” requirements; 2) district water management plan policies, goals, and objectives; and 3) regional water supply plan policies, goals, and objectives. These policies and legal requirements must be taken as a whole when balancing the often competing missions of the District.

Overall Chapter 373 Policies

Section 373.016, F.S., contains policy direction for the water management districts to implement all of the programs authorized by the law, including the development of regional water supply plans. It declares that the waters in the state are among its basic resources and they have not been conserved or fully controlled so as to realize their full beneficial use. It directs the FDEP and the District to take into account cumulative impacts on water resources and manage those resources in a manner to ensure their sustainability. The section then lists detailed policies which must be applied as a whole:

- Provide for the management of water and related land resources
- Promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of surface and ground water
- Develop and regulate dams, impoundments, reservoirs, and other works
- Provide water storage for beneficial purposes
- Promote the availability of sufficient water for all existing and future reasonable-beneficial uses and natural systems
- Prevent damage from floods, soil erosion, and excessive drainage
- Minimize degradation of water resources caused by the discharge of storm water
- Preserve natural resources, fish, and wildlife
- Promote the public policy set forth in Section 403.021, F.S.
- Promote recreational development, protect public lands, and assist in maintaining the navigability of rivers and harbors
- Otherwise promote the health, safety, and general welfare of the people of Florida

District Water Management Plans Policies, Goals and Objectives

General Direction

Pursuant to Section 373.036, F.S., each water management district must develop an overall planning document for all of the programs implemented under Chapter 373, F.S. The district water management plans provide another layer of policy direction for the development of regional water supply plans. District water management plans are to be formulated with consideration to the following:

- Attainment of maximum reasonable-beneficial use of water resources
- Maximum economic development of water resources consistent with other uses
- Management of water resources for such purposes as environmental protection, drainage, flood control, and water storage
- Quantity of water available for application to a reasonable-beneficial use
- Prevention of wasteful, uneconomical, impractical, or unreasonable uses of water resources
- Presently exercised domestic use and permit rights
- Preservation and enhancement of the water quality of the state
- State water resources policies expressed by Section 373.036, F.S.

The *District Water Management Plan* (DWMP) (SFWMD, 2000a) represents the District's overall strategy for future planning and implementation activities and provides a comprehensive examination of a myriad of issues related to water supply, flood protection, water quality, and natural systems management in South Florida. This plan also establishes schedules for future District planning activities, including the LEC Plan. The DWMP was published first in April 1995 (SFWMD, 1995c). Annual progress reports were published over the next four years (SFWMD, 1996a, 1997, 1998a, 1999). In 2000, the five-year update of the DWMP was published and incorporates major features of the LEC Plan.

Goals and Objectives

The DWMP sets forth the following and objectives for water supply, that apply to development of regional water supply plans. The goals and objectives are listed below.

Goals:

- Increase available water supply

- Promote the use of alternative water supply sources and conservation
- Protect the quality of source water from degradation and natural systems from significant harm, which could result from water use

Objectives:

- Increase available water supplies and maximize overall water use efficiency to meet identified existing and reasonable-beneficial future needs
- Prevent contamination of water supply sources.

These goals and objectives must work in concert with the Chapter 373, F.S., policies discussed above.

Districtwide Water Supply Assessment

Each District must also produce a districtwide water supply assessment which identifies areas where development of regional water supply plans is required. Section 373.036, F.S., requires the districtwide water supply assessment to include an analysis of the following:

- Existing legal uses, reasonably anticipated future needs, and existing and reasonably anticipated sources of water and conservation efforts
- Whether existing and reasonably anticipated sources of water and conservation efforts are adequate to supply water for all existing legal uses and reasonably anticipated future needs and to sustain the water resources and related natural systems

The SFWMD *Districtwide Water Supply Assessment* (DWSA) was completed in 1998 (SFWMD, 1998c). It recommends that water supply plans should be prepared for four regions within the SFWMD that are anticipated to have the potential for demands to outstrip available supplies by 2020. The assessment identified demands for the following water use categories:

- Public Water Supply
- Domestic Self-Supplied (and small public supply systems)
- Commercial/Industrial Self-Supplied
- Recreational Self-Supplied
- Thermoelectric Power Generation Self-Supplied
- Agricultural Self-Supplied

Projections for 2020 contained within the DWSA include demand levels associated with average rainfall conditions, as well as demands that would be anticipated during a drought that could be expected to occur once in every ten years (as required by Section 373.036, F.S.). The water resource and demand analyses presented in the DWSA will be refined every five years as part of each region's water supply planning process. Environmental demands are not quantified in the DWSA. These needs are addressed in the water supply planning process through the incorporation of restoration goals and targets, MFLs, performance measures, reservations of water, and resource protection criteria.

The DWSA provides demands for 1995 and projections for 2020 for each Public Water Supply (PWS) utility in the SFWMD with projected pumpage of 0.5 million gallons per day (MGD) or greater in 2020. Source locations for each of these utilities are also provided. The DWSA also includes descriptions of agricultural, commercial/industrial, and recreational self-supplied uses; surface water and ground water resources; and the availability and limits of water resources in each of the District's four regions.

Regional Water Supply Plans

The District will continue to prepare water supply plans for each of its four planning regions, that cover the entire District. Regional water supply plans provide more detailed, region-specific information than the DWSA. Water supply plans are based upon data that are related to the specific water needs, sources, and environmental features of the regional planning areas, and are updated every five years. Area-specific goals and objectives were developed for the LEC Plan during the water supply planning process.

The preparation of water supply plans for the planning regions has been sequenced based on the history of water shortage problems. The water supply plan for the Lower West Coast Planning Area was the first to be initiated, followed by the LEC, Upper East Coast, and finally the Kissimmee Basin. The District's water supply planning status for the four regions is as follows:

- The *Interim Plan for Lower East Coast Regional Water Supply* was completed in 1998 (SFWMD, 1998b). This plan described various options that were under investigation, provided preliminary recommendations, and laid out the process for completing the regional plan. The analyses in that document were subsequently expanded to produce the present document.
- The *Lower West Coast Water Supply Plan* was completed in 1994 (SFWMD, 1994), and was updated in 1999-2000. This updated plan was approved by the Governing Board in April 2000 (SFWMD, 2000b).
- *The Upper East Coast Water Supply Plan* was completed in 1998 (SFWMD, 1998d), is currently being implemented, and will be updated in 2003.
- The *Kissimmee Basin Water Supply Plan Background Document and Appendices* were completed in 1996 (SFWMD, 1996b), and the water supply plan for this region was developed in 1999-

2000. This plan was approved by the Governing Board in April 2000 (SFWMD, 2000c).

Statutory Requirements for Regional Water Supply Plans

Section 373.0361, F.S., requires that each regional water supply plan be based on at least a 20-year planning period and include water supply and water resource development components, a funding strategy for water resource development projects, MFLs established within the planning region, an MFL recovery and prevention strategy, and technical data and information supporting the plan.

The water supply development component must include the a quantification of the water supply needs for all existing and projected future uses within the planning horizon, with a level-of-certainty planning goal for meeting needs during a 1-in-10 year drought event. It must also include a list of water source options for water supply development, including traditional and alternative sources, from which local government, government owned and privately owned utilities, self-suppliers, and others may choose. For each option, the amount of water available, the estimated cost of the project, and sources of funding must be identified.

The water resource development component must include a list of water resource development projects that support water supply development. For each water resource development project the following must be provided: an estimate of the amount of water to become available through the project; the timetable for implementing or constructing the project; the estimated costs for implementing, operating, and maintaining the project; sources of funding; the entities or agencies who will implement the project; and a description of how the project will be implemented. The funding strategy for water resource development projects must be reasonable and sufficient to pay the cost of constructing or implementing all of the listed projects.

The recovery and prevention strategy must be implemented if the flow or level in a water body is below, or within 20 years is projected to fall below, its established MFLs (Section 373.0421(2), F.S.). The strategy must include the development of additional water supplies and other actions to achieve recovery to the established MFLs or to prevent the existing flow or level from falling below the established minimum flow or level. It must also include a timetable which will allow for the provision of sufficient water supplies for all existing and projected reasonable-beneficial uses.

The plan must also take into consideration how the water supply and water resource development options serve the public interest or save costs overall by preventing the loss of natural resources or avoiding greater future expenditures for water resource development, water supply development, or resource restoration. However, unless adopted by rule, these considerations do not constitute final agency action.

LEC Plan Goals and Objectives

Goal. The following provision from the State Comprehensive Plan (Section 187.201(8a), F.S.) was adopted as the primary goal of the LEC Plan:

> Florida shall assure the availability of an adequate supply of water for all competing uses deemed reasonable and beneficial and shall maintain the functions of natural systems and the overall present level of surface and ground water quality. Florida shall improve and restore the quality of waters not presently meeting water quality standards.

This statewide policy is consistent with the water management policies in Chapter 373, F.S., and the *Water Supply Policy Document* (SFWMD, 1995).

Objectives. The LEC Regional Water Supply Plan Advisory Committee also developed several specific objectives and associated strategies for the plan:

1. Protect and enhance the environment including federal, state, and locally identified natural resource areas
2. Protect and conserve the water resources of South Florida to ensure their availability for future generations
3. Provide for the equitable, orderly, cost-effective, and economical development of water supplies to meet South Florida's environmental, agricultural, urban, and industrial needs
4. Improve resource management through the integration of regional and local water supply plans and land use planning

Statutory Requirements. In addition to the above general goals and objectives, results of model simulations were analyzed to determine the ability of proposed projects and actions to achieve other statutory requirements of water supply plans:

- Provide for 1-in-10 year Level of Certainty without causing harm
- Protect water resources from significant harm
- Restore natural systems
- Reserve water needed to protect fish and wildlife and public health and safety

These objectives and statutory requirements were used in the planning process to develop water supply performance measures, resolve competing use issues, and identify recommendations.

Strategies. The plan identifies 14 general strategies and associated recommendations to achieve these objectives (**Table 3**).

Table 3. Summary of Strategies and Recommended Actions Developed to Meet the Objectives of the LEC Plan.

General Strategy	Objective(s) Addressed	Implementing Recommendation (see Chapter 6)
Implement CERP, Water Resource Development, and Water Supply Development Projects	all	all
Refine regional/subregional models and conduct additional simulations	all	**1**, **2**, **6**, **11**, **19**, **30**, **37**, **40**
Implement a resource monitoring and adaptive management process	all	**1**, **3**, **6**,**17**, **39**
Recognize tribal water rights	3	**8**, **17**
Implement actions described in the *Caloosahatchee Water Management Plan* (CWMP) (SFWMD, 2000d)	all	**13**,**14**, **28**, **29**, **30**, **35**
Resolve permitting issues associated with ASR	3	**15**
Develop and implement a water conservation program	2,3,4	**16**, **17**, **38**, **41**
Implement actions recommended in this plan and the CWMP to improve performance of CERP projects	all	**18-30**
Improve management and operations of District and local facilities	all	**26-27**, **31**, **32**
Improve water shortage/supply-side management plans and practices	1,2,3	**31**, **32**
Establish reservations of water	1,2	**9**, **34**, **35**, **36**, **37**
Establish MFL criteria and MFL recovery and prevention plans	1,2	**11**, **35**, **36**, **37**, **38**, **39**
Consumptive Use Permitting	2,3	**2**, **8**, **40**

Recommendations to achieve the goal, its associated objectives, and plan requirements through implementation of the listed strategies are discussed in **Chapter 6** of this document.

Regional and Local Components

The design of the LEC Plan provides guidance for local government and other users (e.g., private utilities, agriculture, etc.) to implement water supply development projects. These projects will be financed primarily at local expense to use alternative sources to supplement water supplies available from the regional system and provide greater reliability. In conjunction with the CERP, the LEC Plan also supports water resource development activities that are designed to increase the amounts of water that can be stored in, and delivered from, the regional system. These options provide additional water to meet a broad range of environmental, urban, and agricultural needs and will be financed primarily at public expense.

In addition, the LEC Plan calls for the establishment of boundary conditions that will define the amount of regional system water available within a particular basin or service area. This amount depends on the specific system components in place at any point in time. If recommendations of this plan are implemented within appropriate time frames, sufficient water will be available to meet urban, agricultural and environmental demands through 2020. Although investment in significant public infrastructure will be required to meet the demands of future growth, the costs of developing the needed supplies will be distributed among many users and should not overly burden the regional economy.

The LEC Plan has been constrained to include options and components that can reasonably be expected to be in place by 2020. These include water supply planning activities, projects within the purview of the CERP, and additional structural and operational features. Additional research may be required within the region to identify and meet long-term water supply needs, environmental restoration goals, and appropriate minimum water levels.

RELATIONSHIP TO OTHER PLANS AND PROGRAMS

Comprehensive Everglades Restoration Plan

The Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project), which was first authorized by Congress in 1948, is a multipurpose project that provides flood control, water supply for municipal, industrial, and agricultural uses, prevention of saltwater intrusion, water supply for Everglades National Park, and protection of fish and wildlife resources. The primary system includes about 1,000 miles each of levees and canals, 150 water control structures, and 16 major pump stations. The C&SF Project was designed in the 1950s to encompass a 50-year planning horizon The design was based on forecasts that significantly underestimated the intensity of land uses and future population growth. Increased population and more intense land use have resulted in higher than anticipated demands on the system's flood protection and water supply capabilities.

In 1994, Congress authorized the U.S. Army Corps of Engineers (USACE) to reevaluate the C&SF Project and make recommendations to improve the project for multiple benefits, including the restoration of the Everglades system. The final report of this effort, the *The Central and Southern Florida Flood Control Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement* (Restudy), was submitted to Congress in July 1999. The Restudy was developed by a multiagency, multidisciplinary team which formulated and evaluated alternative comprehensive plans based on computer simulations, field observations, and professional judgement. The purpose of this study was to reexamine and determine the feasibility of modifying the C&SF Project to restore the South Florida ecosystem and to provide for the other water related needs of the region, including flood control, the enhancement of water supplies, and other objectives served by the C&SF Project. Specifically, as required by the authorizing legislation, the study investigated making structural or operational modifications to improve the quality of the environment; improve protection of the aquifer; improve the integrity, capability, and conservation of urban and agricultural water supplies; and improve other water related purposes. The recommendations made in the Restudy will be refined and implemented in the Comprehensive Everglades Restoration Plan (CERP).

In 1997, the LEC Regional Water Supply Plan Advisory Committee agreed to have major storage concepts developed by the District for the LEC Plan incorporated into the Restudy analysis. As a result, much of the Restudy's recommended course of action is based on concepts that were developed and refined in the LEC water supply planning process. Therefore, the Restudy and the LEC Plan are closely integrated, and key storage components for this plan are eligible for federal funding.

The Restudy includes recommendations for structural and operational changes to the existing C&SF Project that will capture and store much of the water that is now lost to tide, in order to provide enough water in the future for the ecosystem, as well as urban and agricultural users. Water management options developed in the Restudy provide a template and basic infrastructure for Everglades restoration, regional water resource development, and local water supply development efforts. The hydrologic management goals developed in the Restudy were also used as a basis to define the various harm standards that are used in the Consumptive Use Permitting (CUP) process and to develop MFLs.

The components identified in the Restudy will be refined and implemented in the CERP. The CERP will address modifications to improve the performance of the C&SF Project and restore the South Florida ecosystem, while providing for other water related needs of the region. Proposed locations of the major features of this plan are shown in **Figure 4.**

Water Preserve Areas Feasibility Study

As part of the overall CERP effort, multipurpose water management areas are planned in Palm Beach, Broward, and Miami-Dade counties between urban areas and the eastern Everglades. These Water Preserve Areas (WPAs) will have the ability to store and treat urban runoff, reduce seepage, provide flood protection, and improve existing wetland areas. The study area for the WPAs is shown in **Figure 5**.

The Water Preserve Areas Feasibility Study, scheduled for completion in 2001, is investigating methods to capture and store excess surface waters that are normally released to tide via the C&SF Project canal system. This would be accomplished by backpumping a portion of these surface waters to the WPAs. The regional and local benefits associated with the WPAs include the following:

- Prevent overdrainage of the Everglades and reestablish natural hydropatterns within existing natural areas
- Provide for the re-creation of natural storage systems lost due to the impacts of development

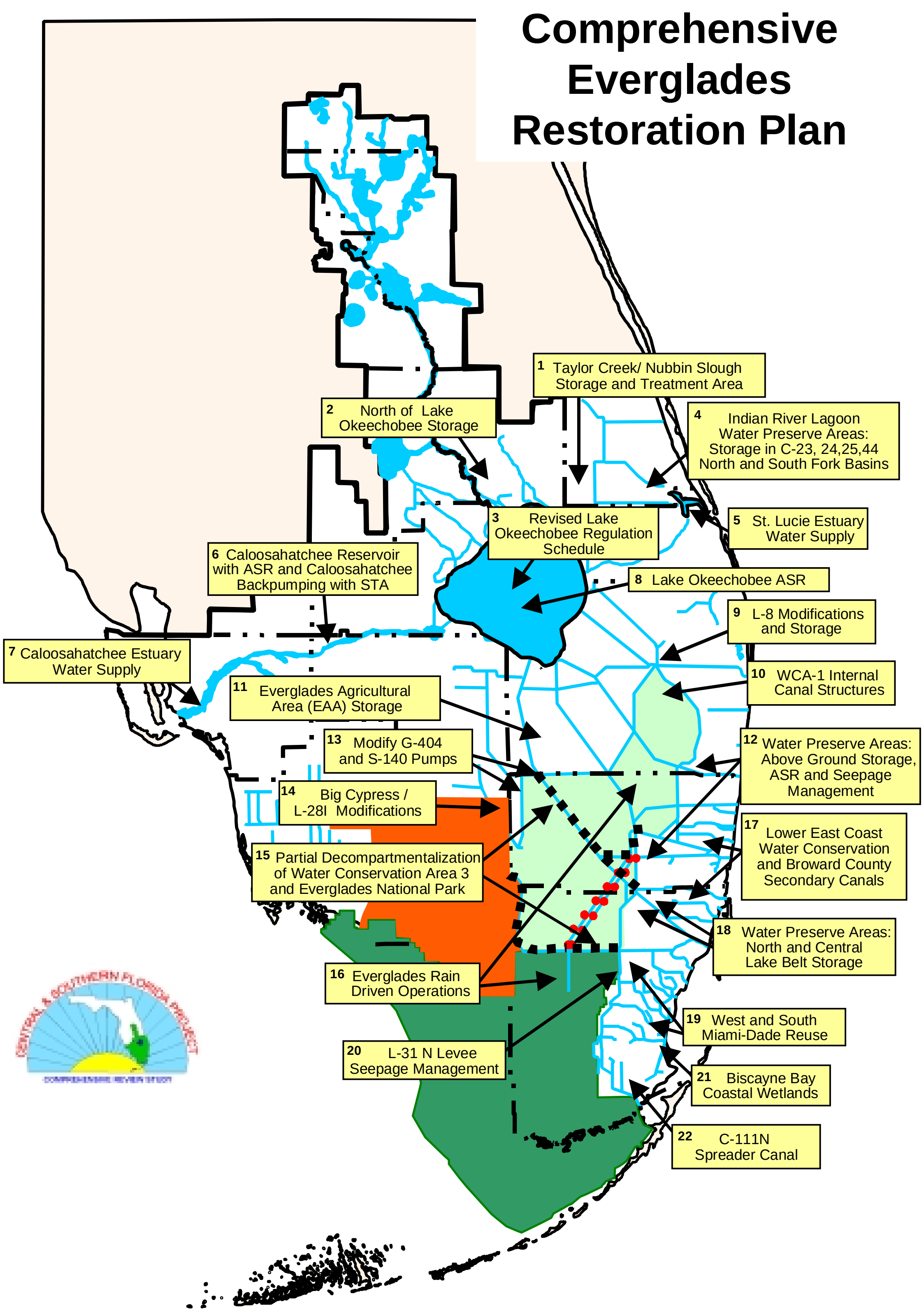

Figure 4. Major Components of the Comprehensive Everglades Restoration Plan.

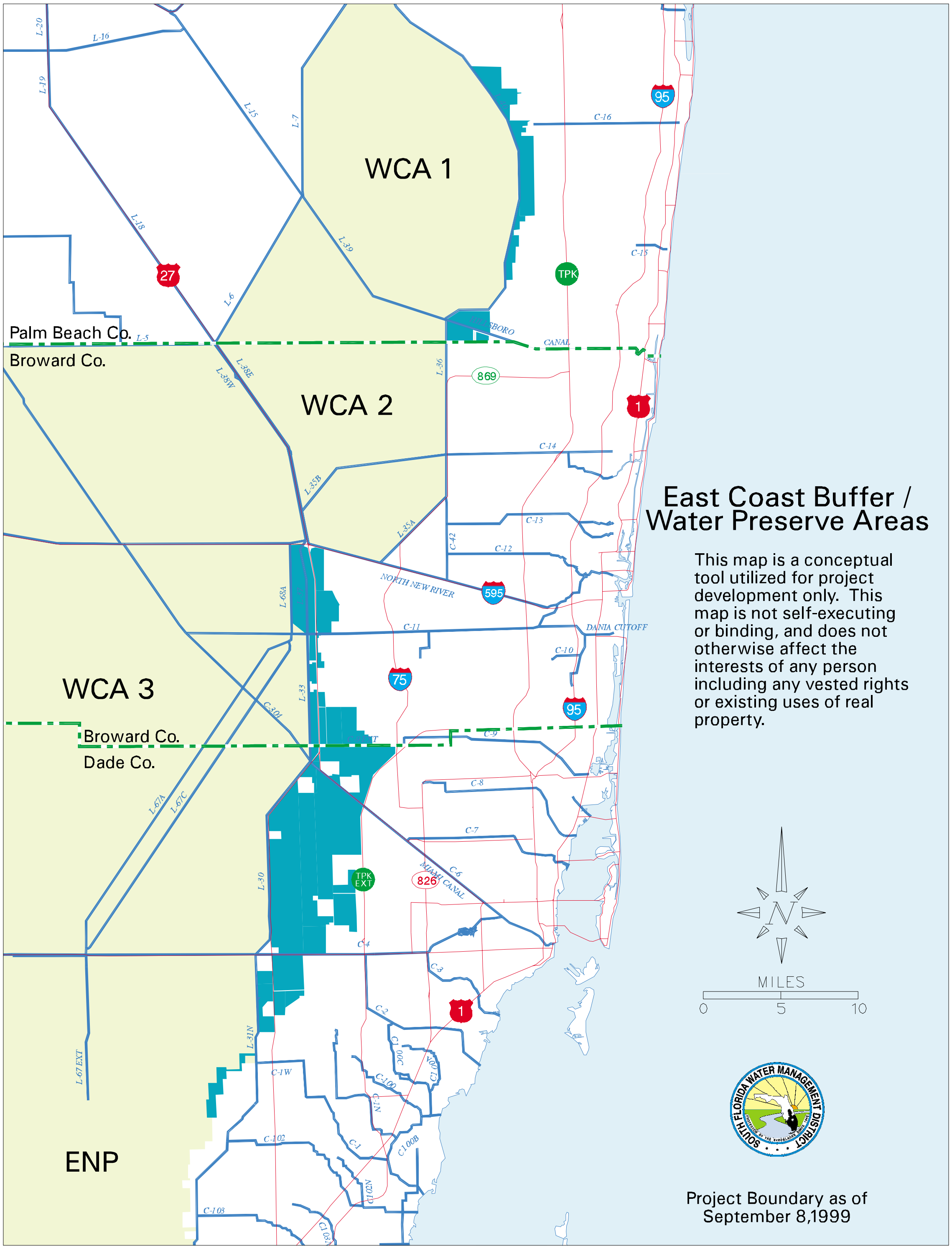

Figure 5. The Study Area for the Water Preserve Area Components.

- Provide for the increased spatial extent of short hydroperiod wetlands
- Provide a buffer between the Everglades and the urbanized LEC planning area
- Provide for an improved water supply to the LEC planning area
- Maintain flood protection to urban and agricultural lands

Integrated Water Resource Plans

Other efforts include the development of more location specific, LEC subregional plans that are derived from the overall LEC regional water supply planning effort. These include the *Northern Palm Beach County Comprehensive Water Management Plan*, the *Southeast Palm Beach County Integrated Water Resource Strategy, the Broward County Integrated Water Resource Plan*, and the *South Miami-Dade County Integrated Water Resource Plan*. While the planning processes are in different stages of development, efforts will be made to complete these works, where appropriate, as quickly as possible. Results of these ongoing subregional efforts were incorporated into the LEC Plan. The District has shifted its emphasis toward implementation of regional water supply plans and the CERP. In cases where local governments decide to continue their own local water supply planning processes, the District will attempt to remain supportive as long as resources are available and there is no conflict with the implementation of the water supply plans or the CERP.

Other Regional Water Supply Plans

Three other water supply plans, the *Upper East Coast Water Supply Plan* (SFWMD, 1998d), the *Lower West Coast Water Supply Plan* (SFWMD, 2000b), and the *Kissimmee Basin Water Supply Plan* (SFWMD, 2000c) are linked to the LEC Plan because Lake Okeechobee serves as a common source of water for all of these areas. For example, the Caloosahatchee Basin, Lee County, and the City of Fort Myers rely on water from Lake Okeechobee as a source of supply during dry periods. In addition, the St. Lucie Canal, in the UEC Planning Area, and the Caloosahatchee River, in the LWC Planning Area are outlets for discharge of excess water from Lake Okeechobee when water levels in the lake exceed its regulation schedule. For this reason, these areas within the other water supply planning regions were analyzed in the LEC planning process.

The *Upper East Coast Water Supply Plan* was the first water supply plan developed under this new statutory direction. The *Lower West Coast Water Supply Plan* was developed at the same time as the LEC Plan and was completed in 2000. The LEC Plan follows the format established by these efforts, with modifications as needed to address specific features and issues that are unique to the LEC Planning Area. As other water management districts develop their water supply planning initiatives, the SFWMD and the FDEP will work with them to develop a compatible statewide approach. Aspects that may be reviewed for compatibility include application of the 1-in-10 year level of certainty goal and development of associated water demands. Any results of such efforts will be reflected in the five-year update to this plan.

Caloosahatchee Water Management Plan

Due to the special problems associated with providing water for irrigation to agricultural interests in the Caloosahatchee River Basin (**Figure 6**) and to public water supply facilities in Lee County, a special management plan was developed for the Caloosahatchee River (SFWMD, 2000d). The Caloosahatchee Planning Area spans two regional water supply planning areas, the Lower West Coast and the Lower East Coast. The *Interim Plan for Lower East Coast Regional Water Supply* (SFWMD, 1998) recommended that a water management plan be developed for the Caloosahatchee River Basin, in recognition of the unique features of this geographic area and its relationship to the regional water management system. This plan was completed in 2000 and addressed the long-term water supply needs from the regional system, and alternative methods to improve management of available water within the watershed. The relevant conclusions and recommendations of the *Caloosahatchee Water Management Plan* (SFWMD, 2000d) have been incorporated directly into **Chapter 6** of the LEC Plan. The remaining portions of the plan are incorporated by reference.

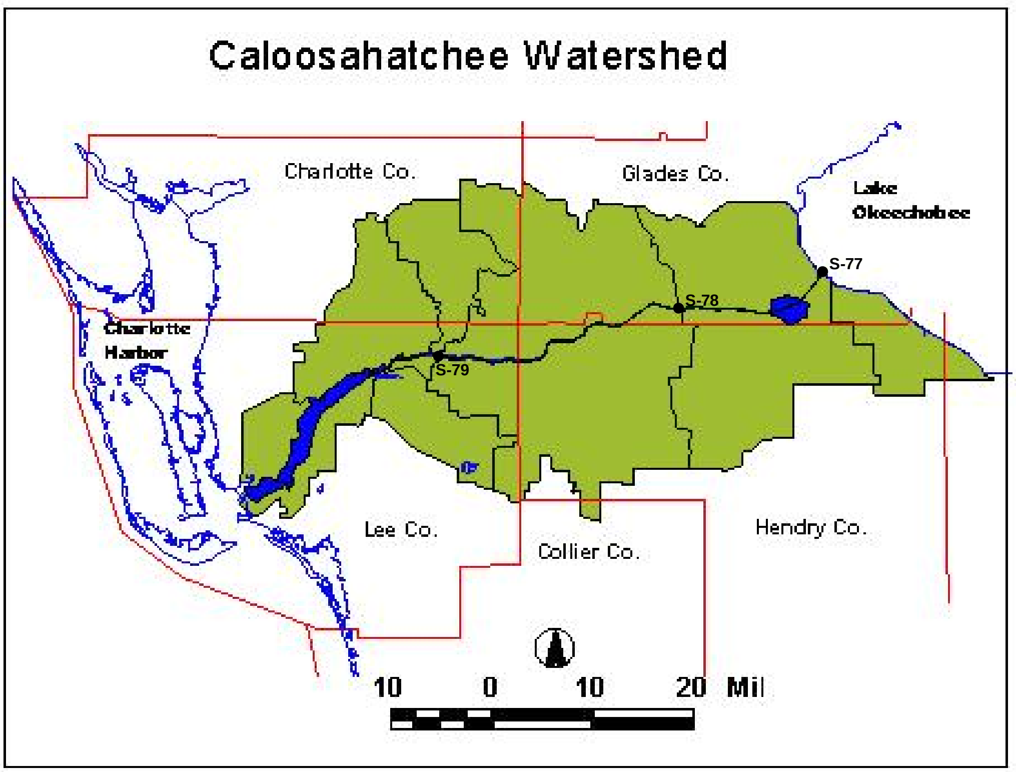

Figure 6. Caloosahatchee Watershed Management Planning Area.

Ecosystem Restoration

In addition to the CERP, restoration is under way in a number of other major South Florida ecosystems and watersheds. Some examples are the Indian River Lagoon/St. Lucie River, Caloosahatchee River, Loxahatchee Slough and River, the Lake Worth Lagoon, Biscayne Bay, Estero Bay, Kissimmee River Basin, Lake Okeechobee, and the Everglades. Everglades restoration projects include improvements to the C-111 Basin, the Everglades Construction Project, Modified Water Deliveries to Everglades National Park, and restoration of Florida Bay. These efforts are designed to avoid further degradation and ultimate loss of the desirable characteristics of these ecosystems and to restore these systems to more closely resemble pre-impact conditions.

Rulemaking and Regulation

The District implements two main permitting programs for water resource allocation and protection: the Consumptive Use Permitting (CUP) Program and the Environmental Resource Permitting (ERP) Program. Both require an evaluation of source impacts, including flood protection, wetland protection, water quality, and water supply. Permits are required to withdraw ground water or modify surface water drainage characteristics and are issued after careful review of the applicant’s request. The District also implements a water well construction permitting program.

Consumptive Use Permitting

Chapter 373, F.S., enables and directs the District to regulate the consumptive use of water within its jurisdictional boundaries. Consumptive use is any use of water which reduces the supply from which it is withdrawn or diverted (SFWMD, 1997d). The purpose of the consumptive use regulatory program is to ensure that those water uses permitted by the District are reasonable-beneficial. For consumptive uses to be considered reasonable-beneficial they must be efficient, consistent with the public interest, and not interfere with other presently existing legal uses. Reasonable assurances must be made that proposed water uses meet these requirements on an individual and cumulative basis, as well as meet specific water resource protection criteria.

Water Well Construction Permitting

The District implements a well construction permitting program which reviews the location, construction, repair, and abandonment of water wells, and the licensing of water well contractors. As of January 1999, the District had five well construction delegation agreements with local governments. The District intends to pursue delegation agreements with other local governments.

MEETING PRESENT NEEDS AND THE NEEDS OF FUTURE GENERATIONS

An important part of the planning process has been to identify constraints that are needed to protect water supplies while exploring opportunities to maximize reasonable-beneficial use of the resource. Balancing these two requirements involved extensive public input from the LEC Regional Water Supply Plan Advisory Committee, whose members represent a variety of disciplines and interests, such as local governments, public water supply utilities, environmental interests, agriculture, Native American tribes, and the general public.

Water management in South Florida is multifunctional, reflecting the District's four main areas of responsibility: water supply, flood protection, water quality, and natural systems management. Due to the interrelationships of these areas of responsibility, the water supply plan was coordinated with other planning, restoration and construction efforts in the region. For example, other related studies are addressing freshwater inflows to Biscayne Bay, Everglades National Park, and Florida Bay. The CERP and Everglades Construction Project are addressing needs of the Everglades regional ecosystem. The results of these and other investigations may further enhance regional water supply by increasing surface water availability and improving water quality. This comprehensive, coordinated approach, combined with extensive public input throughout the planning process, ensures that solutions are balanced and consider all aspects of water management.

Chapter 2
THE WATER SUPPLY PLANNING PROCESS

PROCESS OVERVIEW

This section describes the planning process that was undertaken to develop the *Lower East Coast Regional Water Supply Plan* (LEC Plan). The structure of the iterative process used is summarized in the following steps that are described in this plan:

1. Define goals and objectives (**Chapter 1**, **Chapter 2**, and **Appendix A**)
2. Develop evaluation tools (**Chapter 2**, **Appendix E**, and **Appendix F**)
3. Develop performance measures (**Chapter 2**, **Chapter 4**, and **Appendix D**)
4. Estimate current and future base case (without action) conditions (**Chapter 4** and **Appendix B**)
5. Identify problems and issues, including quantification of supplies, demands, and projected shortfalls (**Chapter 4**)
6. Identify options for inclusion in an alternative (**Chapter 4**)
7. Evaluate water management systemwide performance of the alternative(s); identify demands met and not met (**Chapter 4** and **Appendix H**)
8. Develop and analyze solutions and water supply options (**Chapter 5** and **Appendix H**)
9. Develop recommendations based on the results of evaluations (**Chapter 6**)
10. Develop action plans and funding plans to implement the recommendations (**Chapter 6**)

To implement this process for the LEC Plan, staff first worked with the LEC Regional Water Supply Advisory Committee to develop an overall goal and objectives for the plan. These were presented and discussed in **Chapter 1**. Particular attention was paid to ensure that the water supply goal and objectives gave balanced consideration to meeting urban, agricultural, and natural system needs.

At the same time, steps were taken to develop or improve the hydrologic modeling tools that would be used to test and evaluate systemwide performance under various alternatives. Key hydrologic modeling tools include the South Florida Water Management Model (SFWMM) and a series of subregional ground water models that were developed to address localized geographic areas.

Performance measures were developed based on outputs from the hydrologic modeling tools and results of related investigations. The performance measures are used as indicators of the degree to which the water supply objectives are being met. The performance measures identify whether the proposed alternative system is providing water with appropriate timing, frequency, and duration; in sufficient quantities; and at the proper locations to meet the objectives of the plan.

Next, the systemwide performance of the water management system was assessed under conditions that presently occur, or that will occur in the future, without any actions being taken based on the LEC Plan. These two without-action conditions are called the 1995 (current) base case and the 2020 (future) base case. The year 1995 was selected as one anchor year because it represented the latest year for which complete historical dates could be incorporated into the plan. The year 2020 was selected as the other anchor because it represented the end point of a 20-year planning horizon (as stipulated in Chapter 373, F.S.), based on the completion date of this plan (May 2000). The 1995 and 2020 dates are also consistent with the time frames of the *Districtwide Water Supply Assessment* (SFWMD, 1998c) and other regional water supply plans.

The 1995 base case includes land use, population, and water demands, as well as the water management system and operating rules that applied at the time of the analysis (1999). The 2020 base case includes projections of 2020 land use, population, and water demands. It also includes modifications to the water management system, such as the Everglades Construction Project and the Kissimmee River Restoration, that are scheduled to be implemented by 2020.

Analyses of these baseline conditions, which are described in subsequent chapters, show that significant water resource problems can be expected to occur throughout the region unless actions are taken to improve water supplies, redistribute flows, or reduce expected demands. Results of the model simulations indicate that frequent water restrictions may occur within the coastal urbanized and interior farming areas. Serious environmental concerns were also identified as likely to occur in Lake Okeechobee, the Everglades Protection Area, and the St. Lucie and Caloosahatchee estuaries.

Having defined the type and severity of potential future problems the planning process then began to develop and analyze alternative solutions. The first solution was to incorporate features of the *Interim Plan for Lower East Coast Regional Water Supply* (SFWMD, 1998b) and implement the various projects and activities recommended by the *Central and Southern Florida Project Comprehensive Review Study Final Feasibility Report and Programmatic Environmental Impact Statement* (Restudy) (USACE and SFWMD, 1999) that would be in place by 2020. Results of this analysis indicated that many of the problems identified to occur in the future were resolved. The most promising methods available to enhance water supply was to implement options that have been identified in previous LEC planning documents and additional new options.

The recommendations of this plan are based on the results of the alternatives analyzed and provide a blueprint to address the future water needs of the region. Recommendations of the *Caloosahatchee Water Management Plan* (CWMP) (SFWMD, 2000d) also have been included. The analysis of the Restudy components and the water supply planning alternative provided insight into how the options functioned together and how an integrated system could be designed. Some of the proposed recommendations will be implemented as part of the Comprehensive Everglades Restoration Plan (CERP), its associated critical projects, feasibility studies, and project implementation reports. Other recommendations suggest actions to address regional and local water supply needs that should be implemented via the LEC Plan and the MFL recovery and prevention plans. More detailed implementation strategies, funding, and five-year water resource development work plans will be prepared based on recommendations contained herein.

IMPLEMENTING THE PROCESS

Goal Clarification (Step 1)

The overall goal of Chapter 373, F.S., is to ensure the sustainability of water resources of the state (Section 373.016, F.S.). Chapter 373, F.S., provides the District with several tools to carry out this responsibility. These tools have various levels of resource protection standards. Water resource protection standards in Chapter 373, F.S., must be applied together as a whole to meet this goal. Pursuant to Parts II and IV of Chapter 373, F.S., surface water management and Consumptive Use Permitting (CUP) regulatory programs must prevent **harm** to the water resource. MFLs must be set at the point at which further withdrawals could cause **significant harm** to the water resources or ecology of the area. Water shortage statutes, on the other hand, dictate that permitted water supplies must be restricted in a manner that prevents **serious harm** from occurring to the water resources. Other protection tools include reservation of water for fish and wildlife, or health and safety (Section 373.223[3], F.S.), and aquifer zoning to prevent undesirable uses of the ground water (Section 373.036, F.S.).

The levels of impacts cited above, harm, significant harm, and serious harm, are relative resource protection terms. Each plays a role to help achieve the ultimate goal, which is a sustainable water resource. The role of MFLs is shown conceptually in **Figure 7**.

Consumptive Use Permitting Role - Harm Standard and Level of Certainty

Harm Standard

The resource protection criteria used for CUP are based on the level of impact that is considered harmful to the water resource. These criteria are applied to various resource functions to establish the range of hydrologic change that can occur without incurring harm. The hydrological criteria include water level, duration, and frequency components and are used to define the amount of water that can be allocated from the resource. Saltwater intrusion, wetland drawdown, aquifer mining, and pollution prevention criteria in Chapter 40E-2, F.A.C., together define the harm standard for purposes of consumptive use allocation. These harm criteria are currently applied using climate conditions that represent an assumed 1-in-10 year level of certainty.

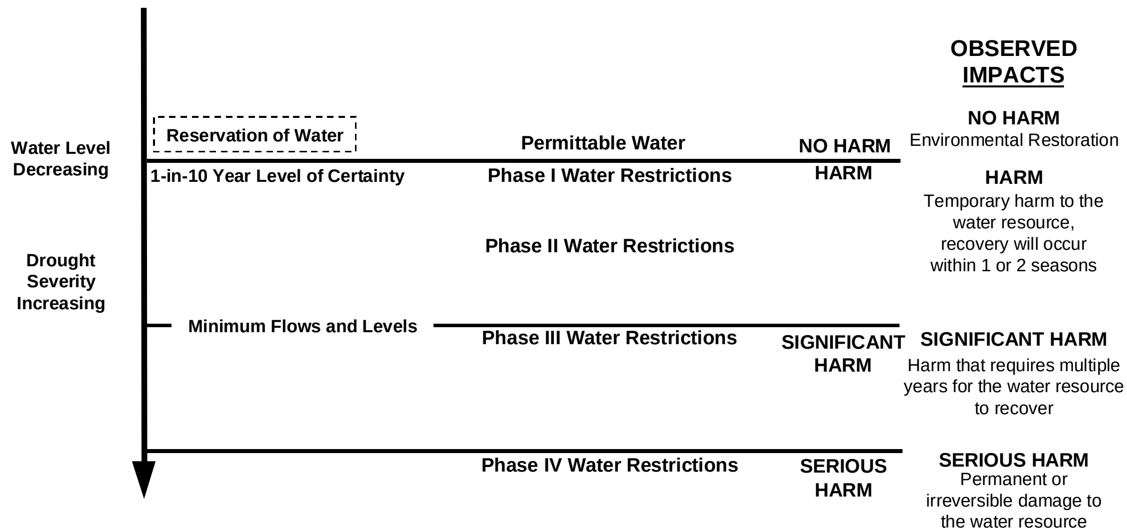

Figure 7. Conceptual Relationship Among the Harm, Serious Harm, and Significant Harm Standards

Level of Certainty

The level of certainty may be characterized as the point to which ground water or surface water can be drawn down on a reoccurring basis, based on the severity of a drought event, without harming the water resources. The regulatory level represents the point of maximum resource development that protects the water resources from harm and provides some degree of certainty to water use permittees. Another implication of the level of certainty in the planning process is that it defines where water resource development projects need to be implemented to meet projected reasonable demands (Section 373.0361, F.S.).

Wetlands Protection

Section 3.3, Environmental Impacts, of the District's Basis of Review for Water Use Permit Applications (SFWMD, 1997d) requires that withdrawals of water must not cause adverse impacts to environmental features that are sensitive to magnitude, seasonal timing, and duration of inundation. Maintaining appropriate wetland hydrology (water levels and hydroperiod) is scientifically accepted as the single most critical factor in maintaining a viable wetland ecosystem (Duever, 1988; Mitch and Gosselink, 1986; Erwin, 1991). Water use induced drawdowns under wetlands potentially affect water levels, hydroperiod, and the areal extent of the wetland. A guideline of no greater than one foot of drawdown at the edge of a wetland after 90 days of no recharge and maximum day withdrawals is used currently for CUP purposes to indicate no adverse impacts. For CUP purposes, wetlands are delineated using the statewide methodology as described in Chapter 62-340, F.A.C.

The wetland protection criterion used in the modelling performance measures is defined as follows: ground water level drawdowns induced by cumulative pumping withdrawals in areas that are classified as wetlands should not exceed one foot at the edge of the wetland for more than one month during a 12-month drought condition that occurs as frequently as once every 10 years.

The District began a research project in 1995 to support development of wetland drawdown criteria. This project involves long-term monitoring of wellfields and wetland systems. The wetland protection criterion regarding the relationship between water use drawdowns and impacts to specific wetland types will be reviewed in the future as these field data become available.

Projects Needed to Meet Demands

This plan defines the water resource and water supply development projects that are needed to assure reasonable-beneficial demands will be met. The regulatory process is one of several plan implementation tools. In order to be consistent with the plan, CUP applications are reviewed by using the same level of certainty that was used for the planning analysis, and similar resource protection constraints, on a smaller scale.

1-in-10 Year Level of Certainty

This plan must also meet the water demands for a 1-in-10 year drought event (Section 373.036, F.S.). This level of certainty planning criterion is incorporated into the modeling targets for the LEC Plan. The level-of-certainty planning criteria are designed to prevent harm to the resources up to a 1-in-10 year drought event. These criteria are not intended to be a minimum flow and level. For drought conditions greater than a 1-in-10 year event, it may be necessary to decrease water withdrawals to avoid causing significant harm to the resource. Water shortage triggers are water levels at which phased restrictions will be declared under the District's water shortage program. The District can use these triggers to curtail withdrawals and help prevent water levels from declining to and below a level where significant harm may occur to the resource could potentially occur.

Water Shortage Role - Serious Harm Standard

Pursuant to Section 373.246, F.S., water shortage declarations are designed to prevent serious harm from occurring to water resources. Serious harm, the ultimate harm to the water resources that was contemplated under Chapter 373, F.S., can be interpreted as long-term, irreversible, or permanent impacts to the water resource. Declaration of water shortages by the Governing Board can thus be used as a tool to prevent serious harm.

When droughts occur, water users increase the amount of withdrawals, typically for irrigation or outside use, to supplement water not provided by rainfall. In general, the more severe the drought, the more supplemental water is needed, and the more likely it becomes that water shortage restrictions will be imposed. These increased withdrawals also increase the potential for serious harm to the water resource.

By basing the CUP criteria on a specific and uniform level of certainty, it is possible to estimate how often water may be restricted by water shortage declaration. Water shortage restrictions may be imposed due to climactic events, continued decline in water levels, and/or saltwater intrusion and provide a means to curtail human use in the face of decreasing supplies. Each water level trigger corresponds to a particular level of water shortage restriction. These restrictions act to apportion the available resource among uses, including the environment, in a manner that shares the adversity resulting from a drought event. Adoption of resource protection criteria as water shortage trigger indicators also reminds users of the risks of damage and potential for loss due to water shortages.

The District has implemented its water shortage authority by restricting consumptive uses based on the concept of shared adversity between users and the water resources (Chapter 40E-21, F.A.C.). Under this program, different levels or phases of water shortage restrictions with varying levels of severity are imposed relative to the severity of drought conditions. The four phases of current water shortage restrictions are based on progressively increasing resource impacts, leading up to serious harm. Under the District program, Phase I and II water shortages primarily reduce water use through conservation techniques and minor use restrictions, such as restrictions on car washing and lawn watering. Phases III and IV, however, require use cutbacks that are associated with some level of economic impact to the users, such as the potential for crop damage due to agricultural irrigation restrictions.

Determining Environmental Water Needs

Water demands for urban and agricultural users are better established and known than environmental water demands. Urban and agricultural water uses are considered in the plan based on historical data and irrigation practices. These are projected into the future considering changes in conservation practices, population, land use, and irrigation systems. Urban, agricultural, and industrial uses of water are protected through the CUP process.

On the other hand, environmental demands have not historically been explicitly defined as a component in the management of the regional water system, with the possible exception of the rainfall-based operational plans being developed for Modified Water Delivery Project for Everglades National Park. To clarify the LEC Plan's objective of protecting and enhancing the environment and translate it into operational terms, two processes were implemented during plan development. The first was a process to determine appropriate MFLs for Lake Okeechobee, the Everglades Protection Area, and the Biscayne aquifer. The second was the effort undertaken during development of the Restudy to define restoration. Results of these efforts are briefly discussed below. The state provides an explicit tool to ensure availability of water for natural systems.

Reservations of Water

Chapter 373, F.S., gives the District authority to reserve water for environmental purposes:

> The governing board or the department, by regulation, may reserve from use by permit applicants, water in such locations and quantities, and for such seasons of the year, as in its judgment may be required for the protection of fish and wildlife or the public health and safety (Section 373.223(3), F.S.).

Water reserved under this statute cannot be allocated for use under the CUP program. The reservation statute may be used effectively as the standard for the restoration of water resources. It is construed to offer a higher level of protection for fish and wildlife than the significant harm standard that applies to MFLs.

One of the most explicit protections of water supplies for natural systems in the LEC Planning Area is set forth in the Everglades Forever Act. In addition to its water quality components, the Everglades Forever Act requires establishment of “programs and projects to improve the water quantity reaching the Everglades Protection Area at optimum times and improve hydroperiod deficiencies in the Everglades ecosystem” (Section 373. 4592(4)(b), F.S.). Although the Everglades Forever Act mandates this broad reaching goal, it explicitly directs the District to utilize existing legal mechanisms in Chapter 373, F.S., to implement the hydroperiod enhancement program. The Everglades Forever Act generally refers to the District's other authority to reserve water for environmental purposes. The use of reservations may also be appropriate for setting aside water from allocation necessary to ensure adequate flows to estuaries such as the Caloosahatchee Estuary, and water needed to prevent saltwater contamination, such as occurs in the Caloosahatchee River in the vicinity of public water supply intakes in Lee County.

Minimum Flows and Levels - Significant Harm Standard

The District is responsible for the implementation of statutory provisions in Chapter 373, F.S., including Section 373.042, F.S., which requires that the District establish MFLs for watercourses and aquifers. Generally stated, the MFLs for a given watercourse or aquifer shall be the limit at which further withdrawals would be significantly harmful to the water resources of the area. As a step toward meeting the statutory requirement, a technical document was developed (SFWMD, 2000e) to identify proposed minimum level depth, duration, and frequency criteria for Lake Okeechobee, the Everglades and the Biscayne aquifer The remaining Everglades include the Water Conservation Areas (WCAs), the Holey Land and Rotenberger Wildlife Management Areas (WMAs), and the freshwater regions of Everglades National Park. The District is also proceeding with efforts to develop MFLs for associated areas, such as the Caloosahatchee River and Estuary, by 2000, the Loxahatchee and St. Lucie estuaries by 2001, Florida Bay by 2003, and Biscayne Bay by 2004.

Technical Criteria

As a first formal step to meet the deadlines for Lake Okeechobee, the Everglades and the Biscayne aquifer, the MFL report includes the following:

- A conceptual framework for determining MFLs based on the best scientific information and ecological criteria available (this approach may be applied to other surface and ground waters within the District)
- A proposed definition of significant harm to water resources; i.e. a loss of specific water resource functions that takes multiple years to recover, which results from a change in surface water or ground water hydrology
- Proposed minimum water levels (depth, duration, and frequency) that should be met to protect water and related resources in Lake Okeechobee, the Everglades, and the Biscayne aquifer
- Proposed technical criteria that provide the basis for determining what actions should be taken to reduce the number of times the MFL criteria for Lake Okeechobee, the WCAs, Everglades National Park, and the Biscayne aquifer are not met

The proposed MFL criteria for Lake Okeechobee, the Everglades, and the Biscayne aquifer were based on a review of available scientific literature, historical water level and spatial (geographic) data, modeling results, expert opinion, and the results of recent water resource investigations. This information was compiled and analyzed to develop criteria that could be applied to Lake Okeechobee, Everglades peat and marl soils, and the Biscayne aquifer. Work to define the freshwater needs of coastal estuaries such as the Caloosahatchee, Loxahatchee, and St. Lucie estuaries, Biscayne Bay, and Florida Bay is ongoing.

Continuing technical review by additional scientists and concerned interests is an integral part of the MFL development process. The *Draft Minimum Flows and Levels for Lake Okeechobee, the Everglades, and the Biscayne Aquifer* (SFWMD, 2000e) was formally peer reviewed by numerous impartial scientists and technical experts who provided substantive comments concerning all aspects of the document. The document was expanded and rewritten and the final report is referenced in this plan. Further refinements of these documents are anticipated through time.

Recovery and Prevention Strategy

Once the MFL technical criteria have been established, the District must develop a recovery and prevention strategy for those water bodies that do not meet the proposed criteria now or in the future (Section 373.0421, F.S.). The actions required to achieve MFLs will be laid out in this recovery and prevention strategy. This recovery and prevention strategy must be expeditiously implemented and include water resource development projects, development of additional water supplies, and implementation of conservation and other efficiency measures. The recovery or prevention strategy must include phasing or a timetable for development of sufficient water supplies for all existing and projected reasonable-beneficial uses. Development of additional water supplies "concurrent with, to the extent practical, and to offset, reductions in permitted withdrawals . . ." (Section 373.0421, F.S.) must occur pursuant to the recovery and prevention strategy. The recovery and prevention strategy is included in the LEC Plan (**Appendix J**). This strategy includes implementation of the MFL criteria through rulemaking, which will occur subsequent to the planning process.

Comprehensive Everglades Restoration Plan Restoration Targets

The recommendations made in the Restudy will be refined and implemented within the Comprehensive Everglades Restoration Plan (CERP). While one goal of the CERP is the ecological restoration of the Everglades, this plan, as well as the broad scientific community, recognize that complete ecological restoration in this region is not possible. Traditionally, restoration has been defined as the recovery of a natural system to a condition that existed during some prealtered period. For the Everglades, this goal may require the creation of a system that mimics natural conditions that existed prior to construction of the first drainage canals and levees in the 1880s.

For at least two overwhelming reasons this goal is challenging. First, there have been substantial and irreversible reductions in the spatial extent of the wetland systems in South Florida (including an approximately 50 percent reduction in the extent of the true Everglades), and in the total water storage, timing, and flow capacities of these systems. The second major hurdle is that few of the quantitative, ecological characteristics of the predrainage wetlands of South Florida are known.

Because the predrainage Everglades cannot be recreated in its original form, the restoration goal for the CERP is to create a new Everglades that will be different from any system that existed in the past but will be substantially healthier than the current system. For this restoration project to be successful, it must recover important ecological indicators and patterns which are thought to have characterized the predrainage system, and it must be able to sustain these recovered ecological attributes over the long term.

It is too early in the South Florida ecosystem restoration process to state with certainty exactly what the endpoint for the restored Everglades should become. It is likely that the length of time required to implement the restoration projects, and the varying time lags in ecological responses, will mean that the current, managed system will evolve into a new Everglades. Thus, the point at which restoration is achieved, and the precise characteristics of that restored system, are unknown at present.

Because of these considerations and uncertainties, ecosystem restoration in South Florida is viewed as an open-ended process. Restoration planning is a balancing act among directions of change, general features that should be present in a restored system, flexibility concerning how and when certain objectives are achieved, and what the restored system should look like.

More importantly, the realistic perspective at present is that it is premature to force the debate over the question of, "what constitutes restoration?" At this point there is broad agreement that water management and development practices have caused much of the ecological damage to the South Florida ecosystem and that restoration projects to correct hydrological stresses should produce strong improvements in the health of these existing ecosystems.

Evaluation Tools (Step 2)

Computer models were used extensively to help in develop this plan. Modeling efforts for the LEC Plan included same basic tools that were used for the Restudy. The models produce a simplified version of the real world that may be used to predict the behavior of the natural system under various conditions. The models do this through a series of equations which simulate major components of the hydrologic cycle in South Florida. These components include rainfall, evapotranspiration, infiltration, overland and ground water flow, canals, canal-ground water seepage, levee seepage, and ground water pumping. The models incorporate current or proposed water management control structures and current or proposed operational rules. Information from local comprehensive plans, utilities, the University of Florida Institute of Food and Agricultural Sciences (IFAS), and the District's permitting data base was used to support this analysis. Where specific information was not available, conservative professional judgement was used. While results of these model runs and analyses are an important part of the LEC planning efforts, the model runs do not constitute a plan. Instead, the analyses provide support for many of the plan's recommendations.

These analyses were conducted using both regional surface water and high-resolution ground water computer models. The regional South Florida Water Management Model (SFWMM) was used to understand how changes in the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project), Lake Okeechobee, and WCA schedules and other factors might affect the hydrology of the region and its ability to supply water. The regional Natural System Model (NSM) was used to simulate conditions that may have existed in South Florida before water management features were constructed. The subregional. high-resolution ground water models were used to identify potential impacts of water use on the environment and ground water resources in the urban and agricultural areas along the lower east coast of Florida. Outputs from these models were also analyzed to identify areas where the potential for future saltwater intrusion exists in the Surficial Aquifer System.

South Florida Water Management Model Version 3.7

The South Florida Water Management Model version 3.7 (SFWMM v3.7) is a regional-scale computer model that simulates the hydrology and the management of the water resources system from Lake Okeechobee to Florida Bay. It covers an area of 7,600 square miles using a mesh or grid of two mile by two mile cells. The model boundaries include Lake Okeechobee, the Everglades Agricultural Area (EAA), the WCAs, Everglades National Park, the LEC urban areas, and parts of the Big Cypress National Preserve (**Figure 8**). Inflows from Kissimmee River, and runoff and demands in the Caloosahatchee River and St. Lucie Canal basins are considered. The model simulates

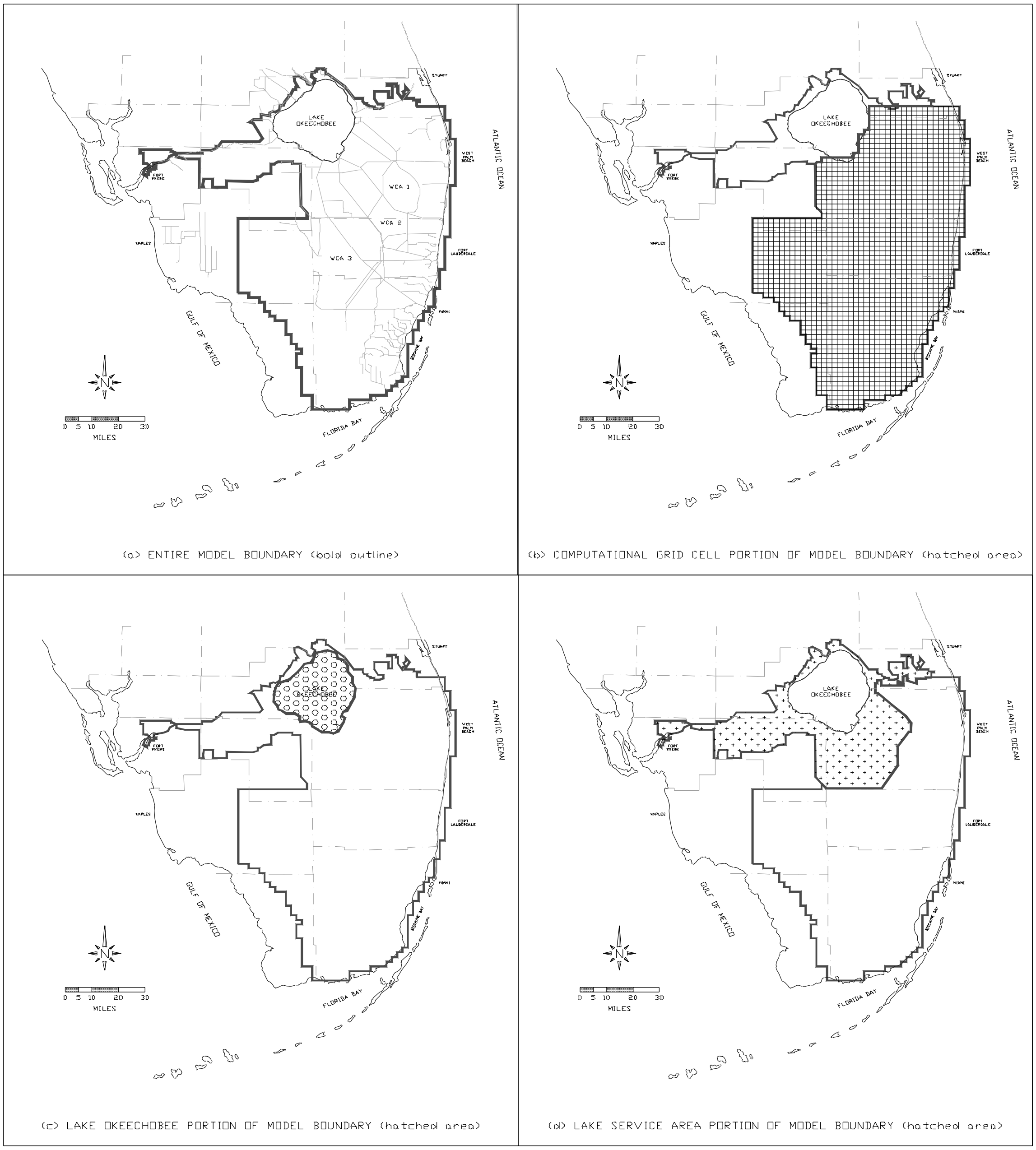

Figure 8. Boundaries and Grid Used for the SFWMM Simulations.

major components of the hydrologic cycle in South Florida including rainfall, evapotranspiration, infiltration, overland and ground water flow, canal flow, canal-ground water seepage, levee seepage, and ground water pumping. It incorporates physical and operational features for current or proposed water control structures, pump stations, and canals. The ability to simulate water shortage policies affecting urban, agricultural, and environmental water uses in South Florida is a major strength of this model.

The SFWMM is an integrated surface water-ground water model that simulates hydrology on a daily basis using climatic data for the 1965-1995 period, which includes droughts and wet periods. The model has been calibrated and verified using water level and discharge measurements at hundreds of locations distributed throughout the region within the model boundaries. Output of the model includes Lake Okeechobee stages and discharge information, surface and ground water levels, overland flow, and evapotranspiration at any of the 1,700 four-square-mile model grid cells located within the LEC Planning Area. The SFWMM was developed in the early 1980s by the District for the USACE and has been extensively modified and improved during the past 14 years. The model has been used for a number of applications to evaluate proposed structural or operational changes to regional water management facilities. The SFWMM was used to help identify water supply problem areas in the LEC Planning Area and to assist staff in the evaluation of the five proposed water supply plan alternatives. Technical staffs of many federal, state, and local agencies, and public and private interest groups have accepted the SFWMM as the best available tool for analyzing regional-scale structural and operational changes to the complex water management system in South Florida.

The SFWMM was used in this plan because the hydrology of South Florida is complex, due to the flat topography, high water table, sandy soils, and high conductivity of the aquifer system. With the rapid population growth, the water control system in South Florida has been expanded and its operation has become increasingly automated, resulting in a unique system. Federal and state agencies, local governments, and private interests are presently involved in numerous environmental restoration and water resource development projects that are necessary to sustain the quality of life in this rapidly growing region. These projects can potentially cost billions of dollars, so that accurate estimation of their benefits and costs is extremely important. Simulation models have become the preferred means to assess systemwide impacts of the proposed modifications to the water resources system in South Florida. The SFWMM, developed specifically for this region, is probably the best available tool that can simulate the complex system features and operational rules of proposed regional water management alternatives and provide adequate information for making water management decisions.

Natural System Model Version 4.5

The Natural System Model (NSM) was created primarily to estimate natural predrainage flows and stages throughout the region, prior to significant human influence on the landscape. The current NSM (version 4.5) uses the same calibrated algorithms as those implemented by the SFWMM to represent surface and ground water flows, but the canals and structures of the C&SF Project, as well as all of the water supply wellfields, were removed. Data (where available) and estimates of presubsidence topography and an approximation of historical vegetation cover are used in lieu of the SFWMM data sets. Output from the NSM includes surface water and ground water levels, overland flow, ground water flow, and evapotranspiration.

The NSM uses recent rainfall data (1965-1995) to predict how water would move through an unmodified South Florida hydrologic system. The NSM is the most comprehensive tool available that describes the hydrology of South Florida prior to human influence. The NSM provides a reasonable estimate of hydrologic patterns that should be used as restoration targets. The model was especially useful for Everglades ecosystems in the Holey Land and Rotenberger WMAs, WCA-1, WCA-2, WCA-3, Everglades National Park, and Big Cypress National Preserve. Many improvements have been made since the NSM was first developed. These improvements were based on comments and suggestions received from scientific and technical peer reviewers, and improved information, such as better topographic data. The District has elected to use the improved versions of the model as they became available. Outputs from the most recent version of the model provided a basis for the Everglades performance measures used in the LEC Plan.

In this study, NSM results were used in three ways. First, NSM predictions of hydropattern conditions were used to identify when deliveries of water should be made to the Everglades for environmental enhancement. Second, NSM hydropattern predictions were incorporated into the rainfall driven schedules. Finally, NSM hydropatterns were used in performance measures as reference points to estimate the degree to which the various alternatives achieve hydropattern restoration goals. NSM results have become accepted by the scientific community as reasonable estimates of natural hydrologic patterns that can be used as restoration targets, for the Holey Land and Rotenberger WMAs, the WCAs, and Everglades National Park.

The SFWMM and the NSM computer models perform, on a daily time step, a continuous simulation of water conditions based on 31 years of historic rainfall and evaporation data. The NSM covers an additional 1,576 square miles of portions of Glades, Hendry, and Highlands counties that were tributary to the original Everglades (**Figure 9**). Because of the limited amounts of historical predrainage hydrologic data available, NSM results cannot be directly calibrated to, or validated against, predrainage hydrologic conditions. As a result, NSM results are somewhat less certain than the SFWMM results. However, the NSM is considered the best tool available, combined with good scientific judgment, to estimate the hydrologic patterns needed to restore the remaining Everglades.

Subregional Models

Ground water models used in the development of the LEC Plan include six subregional models: five overlapping ground water models that extend from Palm Beach County's northern border to the tip of Florida and an integrated surface and ground water model that simulates the Caloosahatchee River Basin. These models were integral to development of the recommendations of the LEC Plan. They provided the initial design and local evaluation to support several recommendations of this plan. Specifications of the various models are summarized in **Table 4**.

The basins most dependent on ground water withdrawals to meet urban and agricultural demands require a higher-resolution model than the SFWMM's two-mile by two-mile grid to more precisely simulate the effects of withdrawals from the surficial aquifer system. The existing and proposed withdrawal facilities, may potentially impact the environment or aquifer or may not be able to meet the demands during a 1-in-10 year drought condition. In locations where potential impacts were most likely to occur, more detailed analyses were conducted.

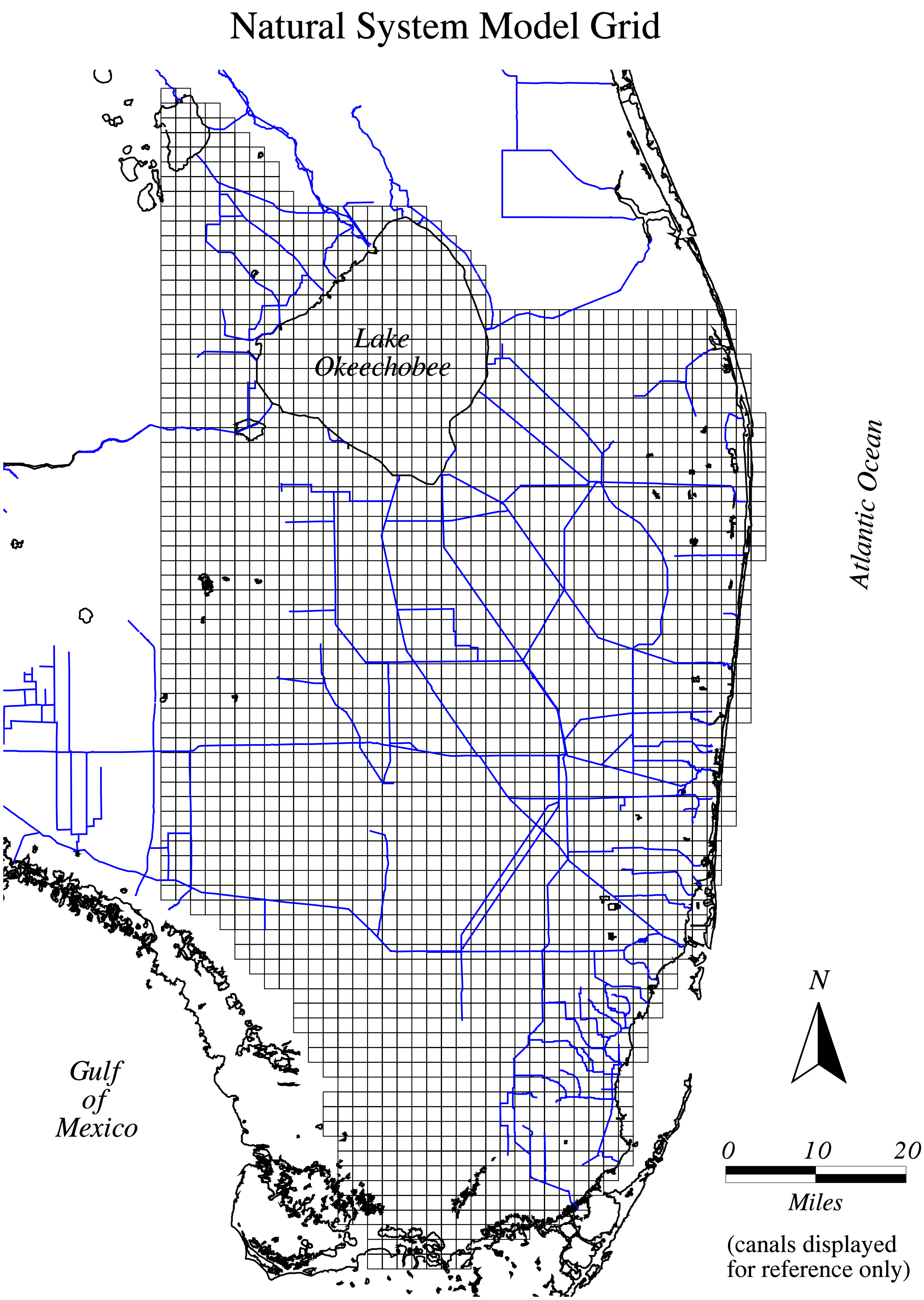

Figure 9. Boundaries and Grid Used for the NSM Simulations.

Table 4. Specifications of the High-Resolution Ground Water Models.

Model	Resolution	Calibration period(s)	Primary Developers
North Palm Beach (expanded)	1/4 mile	1987-1995	SFWMD
South Palm Beach	500 ft.	July 1988-June 1989 (dry) July 1994-June 1995 (wet)	SFWMD
Broward	500 ft.	1988-1992	Jointly by Florida Atlantic University (FAU) and SFWMD
North Miami-Dade	500 ft.	July 1988-June 1989 (dry) July 1993-December 1994 (wet)	SFWMD
South Miami-Dade	500 ft.	1988-1992	Jointly by FAU and SFWMD
Caloosahatchee MIKE-SHE	1500 ft.	1986-1990 1994-1998	Contracted to Danish Hydraulic Institute (DHI)

Five regional ground water models were used to simulate the potential impacts of water use in the LEC Planning Area: the North Palm Beach Ground Water Model, the South Palm Beach Ground Water Model, the Broward Ground Water Model, the North Miami-Dade Ground Water Model, and the South Miami-Dade Ground Water Model. These models use the United States Geological Survey (USGS) modular three-dimensional finite difference ground water flow model, commonly known as MODFLOW. The area encompassed by each model is divided into cells by a model grid (defined by a system of rows and columns). Each cell is 500 feet by 500 feet. (The Northern Palm Beach model which has a grid size 1/4 mile by 1/4 mile.) The higher resolution of the MODFLOW models is captured by the fact that approximately 450 ground water model cells can fit into one SFWMM cell. The grid also has a third-dimension, depth. The number of layers and thickness of each layer vary within the models and between the models depending on the characteristics of the aquifer. The ground water models generate two principal types of output: computed head (water levels) which result from the conditions simulated, and water budgets for each active cell. The water budget shows the inflows and outflows for each cell. More detailed information on these models is available in **Appendix F**.

Due to the integrated nature of the surface water and ground water resources in the Caloosahatchee River Basin, an integrated approach has been adopted using MIKE-SHE. The integrated surface-ground water model includes the freshwater portion of the basin, which stretches from Lake Okeechobee upstream, to the Franklin Lock (S-79) downstream. The model area encompasses approximately 1,050 square miles (2,720 square kilometers). Details of Caloosahatchee Basin modeling efforts are described in the CWMP (SFWMD, 2000d).

An important component of the evaluation process for the LEC Plan is the analysis of the estimated costs associated with each option and each alternative. While hydrologic modeling is used primarily to evaluate the relative performance of options and alternatives in meeting the water resource management goals, the cost analyses specify, at a planning level, the present and future costs of the resources needed to achieve that performance. Cost estimates for the LEC Plan were mainly developed using analyses completed for the Restudy. The planning level costs developed for the LEC Plan were based on the options presented in the appendices to this document that identify major cost components. These components, such as acres of land, miles of levees of certain height, pump stations of certain capacity, or wells of certain depths and sizes, were then used to estimate the costs of options. These procedures are only designed to provide planning level costs that are useful to compare relative costs among options or alternatives. More detailed designs and analyses of site specific factors will be needed before costs suitable for actual construction can be developed.

Categories of costs in the analyses include land purchases, construction of structures and facilities, and operation and maintenance. The estimated costs and cost savings resulting from the implementation of any option represent differences from the future base condition. No costs for existing programs, such as the Everglades Construction Project, are included as costs in the LEC Plan.

Performance Measures (Step 3)

Establishing Performance Measures

Once the goals, objectives, and modeling procedures were established for the LEC Plan, measures were defined to assess performance of the water supply system. A comprehensive set of performance measures was developed by District staff with review and input from the LEC Regional Water Supply Plan Advisory Committee. The performance measures indicate the degree to which the options and alternatives are likely to meet the goals and objectives of the plan. The performance measures are represented by specific, selected outputs of the NSM, SFWMM, the ground water models, and their postprocessing.

Certain specific performance measures are considered key measures because they best summarize the overall performance of alternatives. They are presented along with the discussion of the results in **Chapter 4**. A more complete description of performance measures is provided in **Appendix D** and results of those measures for the various model runs are presented in **Appendix H**.

Categories of Performance Measures and Indicators

The main categories of performance measures and indicators include water budget summaries, inflow measures, outflow measures, water level measures, demands met (or not met) measures, and measures that compare projected water levels with MFLs and NSM predicted hydroperiod (depth, duration, and frequency) targets. A summary of each of these categories and their importance is provided below.

Water Budget Measures

Water budgets are summaries of the major inflows and outflows of water in a basin. Rainfall, evapotranspiration, and inflows and outflows of surface and ground water across basin boundaries are the major components. Water budgets provide an important basis for comparing the sources and uses of water in different water management alternatives. For instance, the water budgets for Lake Okeechobee provide an important basis for evaluating use of lake water.

Inflow Measures

Inflow measures are summaries of the timing (frequency and duration), amount, and location of water flowing into a basin. These measures are important because the timing, amount, and location of inflows into natural areas affect the degree to which desired hydroperiods, MFLs, and restoration can be achieved. For example, the proportion of inflows that enter Everglades National Park through eastern and western portions of Shark River Slough is a major indicator of the ability to restore sheetflow through Everglades National Park. Inflows are also important performance measures because they can measure demands. Inflows to the coastal basins during drought periods indicate the demands of the coastal basins for regional system water.

Outflow Measures

Outflow measures are summaries of the timing (frequency and duration), amount, and location of water flowing out of a basin. Outflow measures from wetland basins are important because releases of water affect the ability to meet hydroperiod goals in those basins that supply the water. For instance, seepage out of the Everglades to the coastal basins has a major impact on the ability to achieve desired hydroperiods in the Everglades. Outflows from reservoirs to meet demands are key measures of the performance of the reservoirs.

Water Level Measures

Water level measures are summaries of water elevations. In wetlands, the depth, frequency, and duration of inundation (hydropattern) are particularly important performance measures. Stage hydrographs and stage duration curves are two important means that are used to present water level measurements. Water level measures are also used to determine how much water is in the system. Such data indicate if problems may be occurring due to excessively wet or dry conditions.

Measures of Demands Met and Demands Not Met - Level of Certainty

Measures of demands compare the amounts of water supplied to users with the amount of water that is desired or normally used. Measures of demands that are met and demands that are not met are particularly important as a means to assess the performance of the option or alternative relative to meeting urban and agricultural water demands. The present water management response to anticipated water supply deficits is to declare water shortages, shift supplies, limit deliveries, and reduce demands. The intent of District planning efforts is to implement long-term water resource development projects that will eventually provide enough additional water to meet demands during a 1-in-10 year drought condition. Therefore, the frequency and duration of declared water shortage restrictions are used as performance measures. The District has the ability to impose several different levels of water restrictions. Phase 1 and Phase 2 shortages are less severe and unlikely to cause economic loss or damages to crops or vegetation. Phase 3 and 4 restrictions are more severe and may reduce irrigation to the extent that crop and vegetation damages would be significant if rainfall cannot compensate for the lack of irrigation water.

The level of certainty planning goal that the districts need to achieve in their water supply plans is to provide sufficient water to meet the 1-in-10 year level of certainty criteria (Section 373.0361, F.S.). This criterion was applied as an additional performance measure to evaluate the adequacy of water deliveries to utilities and agricultural water users.

Measuring MFLs

Specific quantitative targets have been proposed for minimum levels in Lake Okeechobee, the Everglades, and the coastal Biscayne aquifer. Comparison of projected water levels for an alternative to these targets is an important performance measure to determine where and when significant harm may occur.

Natural System Model Hydroperiod Targets

Similarly, the NSM was used in many areas to define restoration and management goals. Generally these targets were considered to provide the harm standard that is used to establish limits for issuing consumptive use permits. Many such comparative performance measures are used for evaluation of the LEC Plan options and alternatives.

Estimate Current and Future Base Case Conditions (Step 4)

Current base case conditions consisted of 1995 land use patterns and populations, as well as actual water use data provided by local utilities. This model run was the 1995 Base Case. Two future base case conditions were considered.

In the first future condition, projected 2020 land use patterns, population distributions, and water use data were developed based on input from local governments, utilities, and the state. Ongoing efforts such as the Everglades Construction Project, C-111 Project and Modified Water Deliveries to Everglades National Park are assumed to be complete. This constituted the 2020 Base Case, which does not include Restudy projects.

In the second future condition, projected 2020 land use, population, and ongoing project conditions were also used. Water supply and environmental restoration components recommended in the Restudy were then added to the extent that such facilities or features would be in operation by 2020 to create the LEC 2020 with Restudy.

This second future condition was also evaluated using the subregional ground water models. Outputs from the 2-mile by 2-mile grid SFWMM were used to establish boundary conditions for the finer scale subregional models. Outputs from the subregional models were expressed and evaluated in terms of the same performance measures that were used for the larger models

Problem and Solution Identification and Evaluating Alternatives (Steps 5 Through 8)

Having identified the problems based on historical experience and the base case evaluations, the next step was the identification of potential solutions that would provide the water needed to meet the projected demand. In the LEC planning process, individual actions that may contribute to an improvement in water supply are called options. When selected options are combined to improve the overall performance of the water supply system, they are referred to as an alternative.

Results of the Restudy and input from the LEC Regional Water Supply Plan Advisory Committee were used as the primary basis to identify options and develop alternatives. Options were identified based on performance problems discovered in the base case analyses or from evaluation of previous or parallel planning efforts. Also considered was the potential or opportunity that exists for the option to solve the problem, the technical feasibility, ability to obtain permits, and the cost of the option.

The identification of an option within a particular area is based on the recognition that there is an opportunity to improve on the management of the regional water system. It does not imply that a problem is or is not caused by water demands in that area or that a special funding responsibility will or will not be assigned in the area where a facility is located. Many of the options included in this plan have been identified as components of the Restudy. To the extent possible, the methods and procedures that were used to analyze options for the LEC Plan were the same as were used for the Restudy. Examples of water resource development opportunities that will improve the regional water management system include the following:

- Facilities or operating procedures to modify storage in Lake Okeechobee
- Facilities to capture and use runoff from the Caloosahatchee Basin
- Aquifer Storage and Recovery (ASR wells) and reservoirs to capture and use runoff from the EAA
- Water Preserve Areas (WPAs) to capture and use seepage from the Everglades and runoff from coastal basins
- Facilities and operating procedures to improve the timing and location of releases into the Everglades and between locations within the Everglades
- Operational procedures to improve timing and location of releases to estuaries

In addition to the regional elements that were considered in the Restudy, a number of more site-specific features were analyzed to help meet urban and agricultural needs in coastal watersheds and the EAA:

- Wellfield relocation to protect and make better use of water resources available in the coastal basins
- Local ASR to capture and use excess water
- Alternative sources to meet new water demands in the EAA and coastal basins

Options considered in the LEC Plan are discussed in **Chapter 5** and detailed explanations are included in the appendices to this report.

Recommendations (Step 9)

Initial draft recommendations were developed by District staff based on all the analyses conducted in support of the LEC planning process, discussions with the LEC Regional Water Supply Plan Advisory Committee, and comments and input provided by the committee and the public throughout the planning process. The Restudy components primarily address environmental restoration goals, but also provide significant regional urban and agricultural water supply benefits. The final recommendations were also based on results of model runs and the findings and insights gained throughout the entire LEC planning process.

Implementation Plans and Funding Analyses (Step 10)

Detailed funding analyses and schedules to implement the recommendations in the LEC Plan were developed as a component of this plan. Planning level implementation steps and costs were developed in concert with the Restudy and were based on results of model runs and staff analysis. Funding strategies for the LEC Plan are being coordinated with other Districtwide activities, efforts of other agencies, local governments, and utilities.

PUBLIC AND GOVERNMENT PARTICIPATION

The LEC Regional Water Supply Plan Advisory Committee was created in January 1992 to allow extensive public participation in the plan development process. The committee has played a key role throughout the planning process, especially in assisting with the development of objectives and design solutions to meet the objectives. Committee participants include representatives from urban, agricultural, environmental interest groups, government agencies, Native American tribes, and others. A continuing role of the LEC Regional Water Supply Plan Advisory Committee is to represent the public in the implementation of the regional water supply plan.

To encourage and ensure a high level of public participation, the SFWMD has met with many groups and organizations to discuss this plan. Participants included utility, environmental, and agricultural advisory committees, the Governor's Commission for a Sustainable South Florida, the Southeast Florida Utilities Council, and the Florida Section of the American Water Works Association (AWWA). The SFWMD also contributed significant support and technical information derived from the LEC planning effort to the Governor's Commission for a Sustainable South Florida, the Northwest Dade County Freshwater Lake Plan Implementation Committee, the planning effort for the WPAs, and the Restudy.

Chapter 3
PLANNING AREA DESCRIPTION

INTRODUCTION AND OVERVIEW

The Lower East Coast (LEC) Planning Area covers approximately 1,200 square miles and includes essentially all of Miami-Dade, Broward, and Palm Beach counties, most of Monroe County, and eastern portions of Hendry and Collier Counties (**Figure 1**). The entire Lake Okeechobee Service Area, which includes parts of four additional counties, Martin, Okeechobee, Glades, and Lee, was incorporated into the analyses because of its reliance on Lake Okeechobee for water supply. This area encompasses a sprawling, fast-growing urban complex that, according to the 1990 census, provided homes for 6.3 million people, primarily along the coast. The planning area has extensive, economically significant agricultural lands and world renowned environmental resources such as the Everglades ecosystem and Lake Okeechobee, the largest freshwater lake in the southern United States. Highly productive coastal estuaries such as Biscayne Bay and Florida Bay occur along the shores.

Natural Features

The LEC Planning Area has many significant and unique natural resources and features that make this area especially worthy of protection, as well as desirable for human use and settlement. The region has a very suitable climate with mild temperatures and ample amounts of rainfall. The topography is low and flat, with numerous, extensive wetlands, and significant lakes and rivers. Many areas are covered with rich organic soils that support lush natural plant communities and highly productive farms. Undeveloped areas of the region support a broad diversity of native subtropical plant and animal communities, including many threatened and endangered species.

Historically, the watershed of the LEC Planning Area began in Central Florida, south of Orlando. Water from lakes and wetlands in that region overflowed natural drainage divides during wet periods and moved slowly southward, through Lake Kissimmee and into the Kissimmee River. The Kissimmee River, in turn, then meandered slowly southward for about 90 miles to flow into Lake Okeechobee. Lake Okeechobee was much larger than it is today and was bordered by extensive freshwater marshes and forests, especially along its southern border. When the water level in the lake was high, water flowed south into the extensive wetlands of the Everglades, moving slowly southward through this “River of Grass” to Florida Bay and the Ten Thousand Islands.

The quality of water that historically existed in South Florida is unknown, but analyses of remaining areas that are relatively undisturbed, suggest that most natural surface waters were extremely pure, containing very low levels of dissolved solids and nutrients.

Man-Made Features

The Kissimmee River was channelized and degraded, beginning in the late 1800s and culminating with completion of the Kissimmee River Project in the 1970s. Lake Okeechobee is especially important to the LEC Planning Area because it forms the headwaters of the planning area. The lake has been diked around its borders and structures and gates have been constructed to regulate the flow of water to and from the lake. Today, Lake Okeechobee provides a multifunctional reservoir from which the South Florida Water Management District (District, SFWMD) has the ability to move water to the Everglades, to coastal communities, to agricultural interests in the Everglades Agricultural Area (EAA), and to the St. Lucie Canal and Caloosahatchee River basins. Much of the historic Everglades has been developed for urban and agricultural use. These regional wetlands are crossed by large canals that are designed to provide drainage and convey water to coastal communities and to tide. Protective levees were constructed around the remaining northern Everglades to create multipurpose Water Conservation Areas (WCAs). Everglades National Park was created at the southern end to protect and restore natural plant and animal communities

South Florida today is characterized by highly productive agricultural regions and rapidly growing urban areas that lie directly adjacent to extensive aquatic and wetland ecosystems. Many of these natural systems are threatened as a result of water management activities that were designed to support agricultural and urban development. Urban landscapes occupy most of the higher elevation areas. Extensive agricultural areas cover much of the interior of the peninsula north and south of Lake Okeechobee and along the interior margins of the coastal urban areas. Both urban and agricultural land uses require increasing levels of water supply and flood control and produce degraded runoff that needs to be treated or stored prior to release back into natural systems.

Resource Concerns

The Kissimmee River is currently undergoing ecological restoration. Diking and management of water levels in Lake Okeechobee have reduced the surface area of the lake and eliminated most of the surrounding littoral wetlands. The lake now requires frequent regulatory water releases to avoid flooding and to maintain lowered water levels. Large regulatory releases can severely damage the St. Lucie and Caloosahatchee estuaries.

Lake Worth Lagoon and Biscayne Bay are located along the highly urbanized east coast in central Palm Beach and Dade counties, respectively. These urban estuaries historically received significant freshwater inflows from adjacent rivers and springs, but have become increasingly saline since the beginning of the twentieth century, when water tables were lowered, major rivers were channelized, salinity control structures were installed, and permanent inlets were opened to the Atlantic Ocean. Today, these largely saline systems are periodically impacted by excessive freshwater discharges from the primary drainage canals. In addition, they have been degraded by development activities such as channel dredging, bulkhead construction, industrial and sewage waste disposal, marina and dock development, and storm water runoff. Although these cumulative impacts have diminished their value as healthy estuarine ecosystems, both areas still support a number of important natural resource and recreational values that should be protected. Efforts by local interests and state agencies to restore Biscayne Bay have been ongoing for many years. In January 1997, the Florida Department of Environmental Protection (FDEP) and Palm Beach County became cosponsors for the Lake Worth Lagoon restoration efforts. The SFWMD is also contributing funds and staff support to restoration projects in these systems.

The Everglades have been reduced in area by half due to agricultural and urban expansion. The remaining Everglades ecosystem is declining largely as a result of altered water regimes, drainage, compartmentalization, and degraded water quality. This degradation is evidenced by vegetation change, decreasing wildlife populations, and loss of organic soils. At the downstream end, the Florida Bay ecosystem experiences altered salinities due to decreased freshwater heads and inflows from the Everglades. The altered salinities have impacted habitats, nursery grounds, plants, and animals.

The environmental problems in South Florida today can be attributed largely to a diminished capacity to retain the huge volumes of water that once pooled and sheetflowed across the predrainage landscape. Loss of this capacity to store fresh water on the surface and underground has led to a decline in ground water levels. This has caused inland migration of salt water in coastal aquifers. Today, surface water that comprised an essential feature of South Florida ecosystems is considered a threat to coastal development and is either discharged to tide through canal systems or is stored at unnaturally high levels in remnant diked wetlands of the Everglades. Many of these problems are recognized to be unanticipated effects of the existing Central and Southern Project for Flood Control and Other Purposes (C&SF Project). They are exacerbated by the continually increasing population in South Florida. The result is a currently nonsustainable system of urban, agricultural, and natural systems that exceeds the capacity of, or is hampered by, existing water management facilities.

The following discussion is a brief summary of existing physical, ecological, and socioeconomic conditions within the study area. It does not attempt to provide comprehensive coverage of all resources or concerns. Instead, it summarizes baseline resources that are present in the study area and may be affected by implementation of this water supply plan.

TOPOGRAPHY

The surface features of central and southern Florida are largely of marine or coastal origin with subsequent erosion and modification by nonmarine waters. The features include flat, gently sloping plains; shallow water-filled depressions; elevated sand ridges; and a limestone archipelago. The elevations of the ridges and plains are related to former higher stands of sea level. Some ridges were formed above the level of these higher seas as beach ridges while the plains developed as submarine shallow sea bottoms.

The topography of the District has low elevation and wide areas of very low relief. Nearly all of the District is less than 200 feet above sea level and nearly half its area is less than 25 feet above sea level. Elevations within the District generally decline from north to south.

The bottom of Lake Okeechobee is approximately at sea level. Water levels in the lake generally range from 11 to 18 ft NGVD The land immediately surrounding Lake Okeechobee is at an elevation of about 20 to 25 ft NGVD. The coastal regions and most of the peninsula south of the latitude of Lake Okeechobee lie below 25 ft NGVD in elevation. From Lake Okeechobee southward, an axial basin, occupied by the lake and the Everglades, occurs near the longitudinal center of the peninsula with slightly higher ground to the east and west. A small area near Immokalee and parts of the Atlantic Coastal Ridge are higher than 25 ft NGVD. Except for the coastal and beach ridges, this southern region is very flat in appearance and slopes vary gradually from approximately 25 ft NGVD in the vicinity of Lake Okeechobee to sea level at the coasts.

Land elevations in the WCAs generally range from about 16 ft NGVD at the northern end of WCA-1 to about 9 to 10 ft NGVD at the southern end of WCA-3. Within Everglades National Park, the land surface generally slopes from 8 to 9 ft NGVD at the northern end to below sea level as the freshwater wetlands of the Everglades merge with the saltwater wetlands of Florida Bay.

Because changes in elevation are very gradual, and because much of South Florida is difficult to access, detailed topographic data are not available for much of the region, especially within the remaining Everglades. Accurate topographic information is an essential requirement for both surface and ground water modeling efforts.

GEOLOGY AND SOILS

The geology and soils of South Florida represent many of the opportunities, constraints, and impacts of regional water management. The high transmissivity of the Biscayne aquifer allows rapid recharge of LEC Planning Area wellfields, increases the tendency for flooding to occur in low-lying lands east of the Everglades, and has set the stage for the issue of seepage control. Loss of peat soils of the Everglades, as a result of drainage, has reduced the capacity of the system to retain water and is an indicator of ecosystem change.

Lake Okeechobee and much of the Everglades are underlain by peat and muck soils that developed in a shallow basin with poor natural drainage under prolonged conditions of flooding. Beneath these surface layers of organic material lies the Fort Thompson formation of interbedded sand, shell, and limestone. Bedrock in the Everglades is almost entirely limestone.

The Atlantic Coastal Ridge along the lower east coast is mostly underlain by thin sand and Miami Limestone that are highly permeable and moderately-to-well drained. West of the coastal ridge, soils contain fine sand and loamy material and have poor natural drainage. Rockland areas on the coastal ridge in Miami-Dade County are characterized by weathered limestone surfaces and karst features such as solution holes and sinkholes. Higher elevation marshes of the southern Everglades on either side of Shark River Slough are characterized by calcitic marl soils deposited by algal mats and exposed limerock surfaces with karst features. A generalized soils map of the region is shown in **Figure 10**.

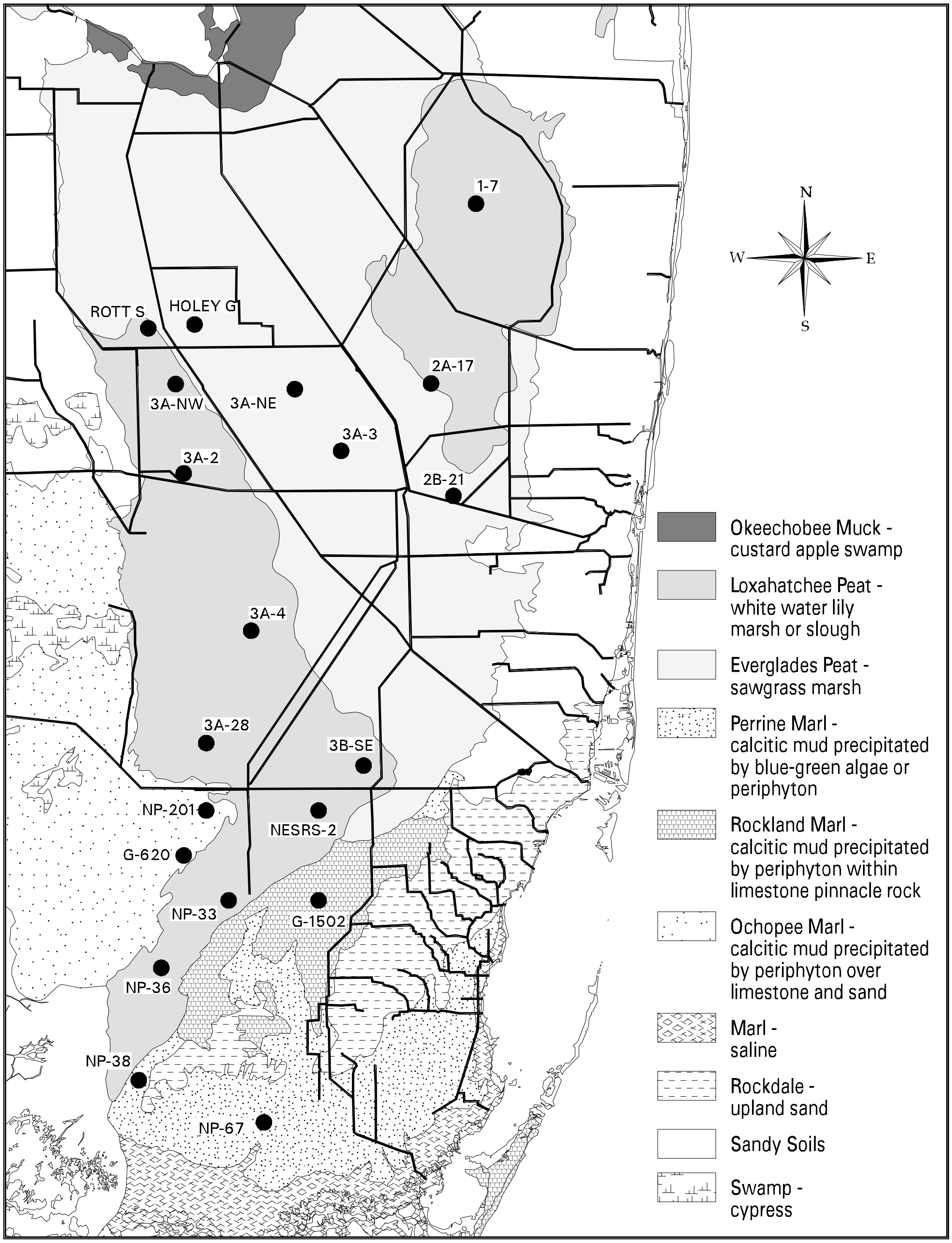

Figure 10. Generalized Soils Map of Lower East Coast Planning Area.

Florida Bay is underlain by Miami Limestone with variable sediment cover of sand, exposed bedrock, and mudbanks. The Ten Thousand Islands consist of sandy barrier islands underlain primarily by the Tamiami formation. Because of the low relief, numerous marshy back bays or lagoons, such as Whitewater Bay, occupy exposed limestone surfaces behind the slightly higher buildup of sand and mangrove peat on beaches along the Gulf of Mexico. The Florida Keys are made up of highly permeable Key Largo Limestone in the Upper Keys and less permeable Miami Oolite on the Lower Keys.

South Florida contains three major carbonate aquifer systems. These systems are the Surficial Aquifer System, the Intermediate Aquifer System, and the Floridan Aquifer System.

The Surficial Aquifer System is comprised of rocks and sediments from the land surface to the top of an intermediate confining unit. The discontinuous and locally productive water bearing units of the Surficial Aquifer System include the Biscayne aquifer, the undifferentiated surficial aquifer, the coastal aquifer of Palm Beach and Martin counties, and the shallow aquifer of southwest Florida. Practically all municipal and irrigation water is obtained from the Surficial Aquifer System.

The Intermediate Aquifer System consists of beds of sand, sandy limestone, limestone, and dolostone that dip and thicken to the south and southwest. In much of South Florida, the Intermediate Aquifer System represents a confining unit that separates the Surficial Aquifer System from the Floridan Aquifer System.

The Floridan Aquifer System is divided by a middle confining unit into the upper and Lower Floridan aquifers. In the LEC Planning Area, from Jupiter to south Miami, the Upper Floridan aquifer is being considered for storage of potable water in an Aquifer Storage and Recovery (ASR) system. In the Lower Floridan aquifer there are zones of cavernous limestones and dolostones with high transmissivities. However, these zones contain saline water, and are primarily used for injection of treated effluent wastewater.

CLIMATE

The subtropical climate of South Florida, with distinct wet and dry seasons, high rates of evapotranspiration, and climatic extremes of floods, droughts, and hurricanes, represents a major physical driving force that sustains the Everglades while creating water supply and flood control issues in the agricultural and urban segments. South Florida's climate, in combination with low topographic relief, delayed the development of South Florida until the twentieth century, provided the main motivation for the creation of the C&SF Project 50 years ago, and continues to drive the water management planning of the Comprehensive Everglades Restoration Plan (CERP) and the *Lower East Coast Regional Water Supply Plan* (LEC Plan) today.

Seasonal rainfall patterns in South Florida resemble the wet and dry season patterns of the humid tropics more than the winter and summer patterns of temperate latitudes. Of the 53 inches of rain (average) that South Florida receives annually, 75 percent falls during the wet season months of May through October. During the wet season, thunderstorms that result from easterly trade winds and land-sea convection patterns occur almost daily. Wet season rainfall follows a bimodal pattern with peaks during May-June and September-October. The amount of rainfall varies regionally within the District (**Figure 11**).

Tropical storms and hurricanes also provide major contributions to wet season rainfall with a high level of interannual variability and low level of predictability. During the dry season, rainfall is governed by large-scale winter weather fronts that pass through the region approximately weekly. High evapotranspiration rates in South Florida roughly equal annual precipitation. Recorded annual rainfall in South Florida has varied from 37 to 106 inches, and interannual extremes in rainfall result in frequent years of flood and drought. Multiyear high and low rainfall periods often alternate on a timescale approximately on the order of decades.

NATURAL SYSTEMS

Vegetation

The location of South Florida between temperate and subtropical latitudes, the proximity to the West Indies, the expansive wetland system of the greater Everglades, and the low levels of nutrient inputs under which the Everglades evolved, all combine to create a unique and species-rich flora and vegetation mosaic. Today nearly all aspects of South Florida's native vegetation have been altered or eliminated by the development, altered hydrology, nutrient inputs, and spread of exotics that have resulted directly or indirectly from a century of water management. **Figure 12** indicates the nature and extent of changes in natural systems from 1900 to 1973.

Riparian plant communities of the Kissimmee River and its floodplain are recovering from channelization and drainage. The macrophyte communities of the diminished littoral zone of Lake Okeechobee are now contained within the Hoover Dike. They remain essential for the ecological health of the lake but are stressed by extreme high and low lake levels and by the spread of exotics.

Below the lake, all of the pond apple swamp forest and most of the sawgrass plain of the northern Everglades have been converted to the EAA. Also, eliminated is the band of cypress forest along the eastern fringe of the Everglades that was largely converted to agriculture after the eastern levee of the WCAs cut off this community from the remaining Everglades. The mosaic of macrophytes and tree islands within the WCAs and Everglades National Park is altered by changes in hydrology, exotic plant invasion, and nutrient inputs.

The problems of the Everglades extend to the mangrove estuary and coastal basins of Florida Bay, where the forest mosaics and submerged aquatic vegetation show the effects of diminished freshwater heads and flows upstream that are exacerbated by a rise

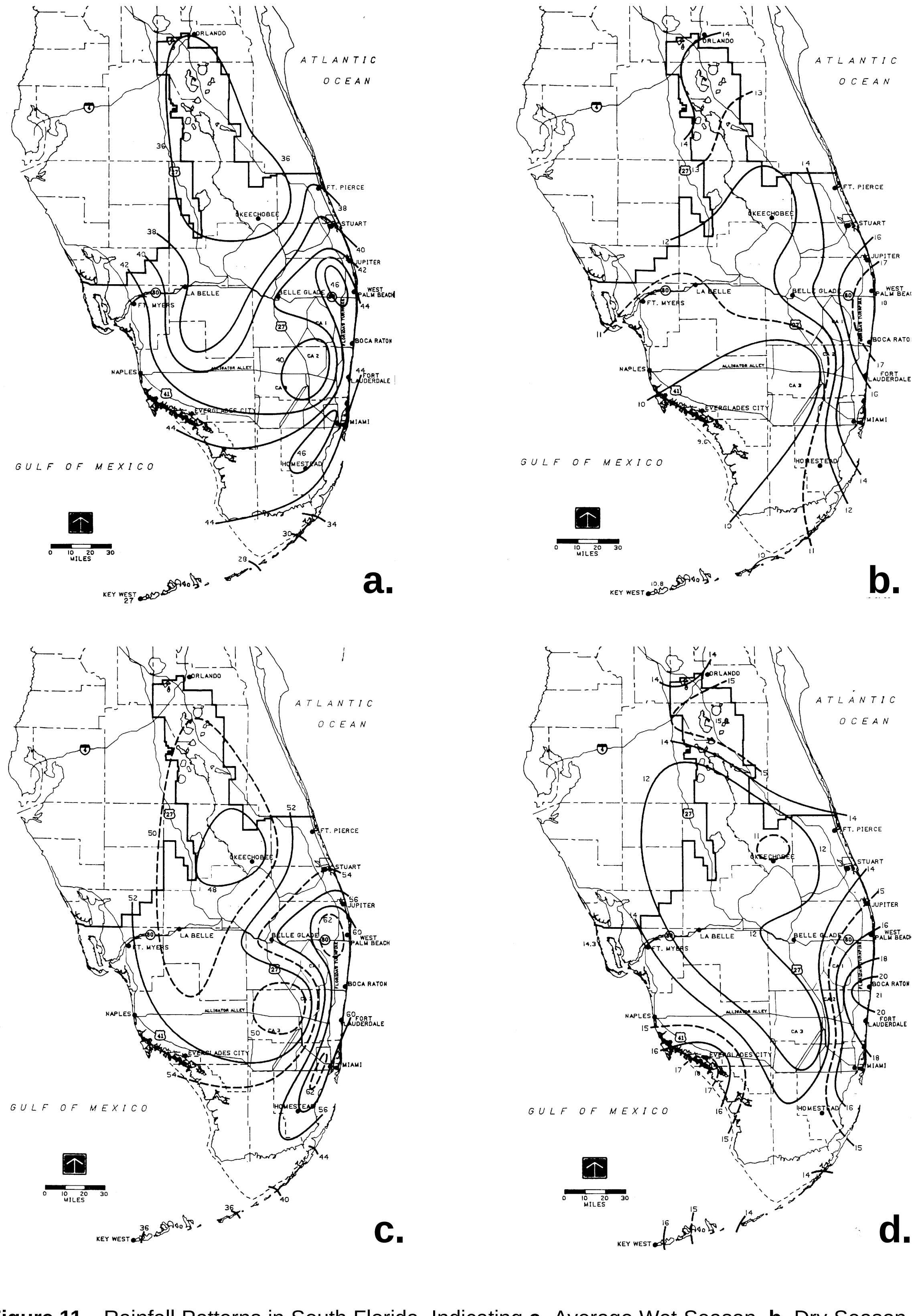

Figure 11. Rainfall Patterns in South Florida, Indicating **a.** Average Wet Season, **b.** Dry Season, **c.** Annual Rainfall Amounts (inches), and **d.** Expected Rainfall During an Extreme Three-Day Rainfall for a 100-Year Return Period.

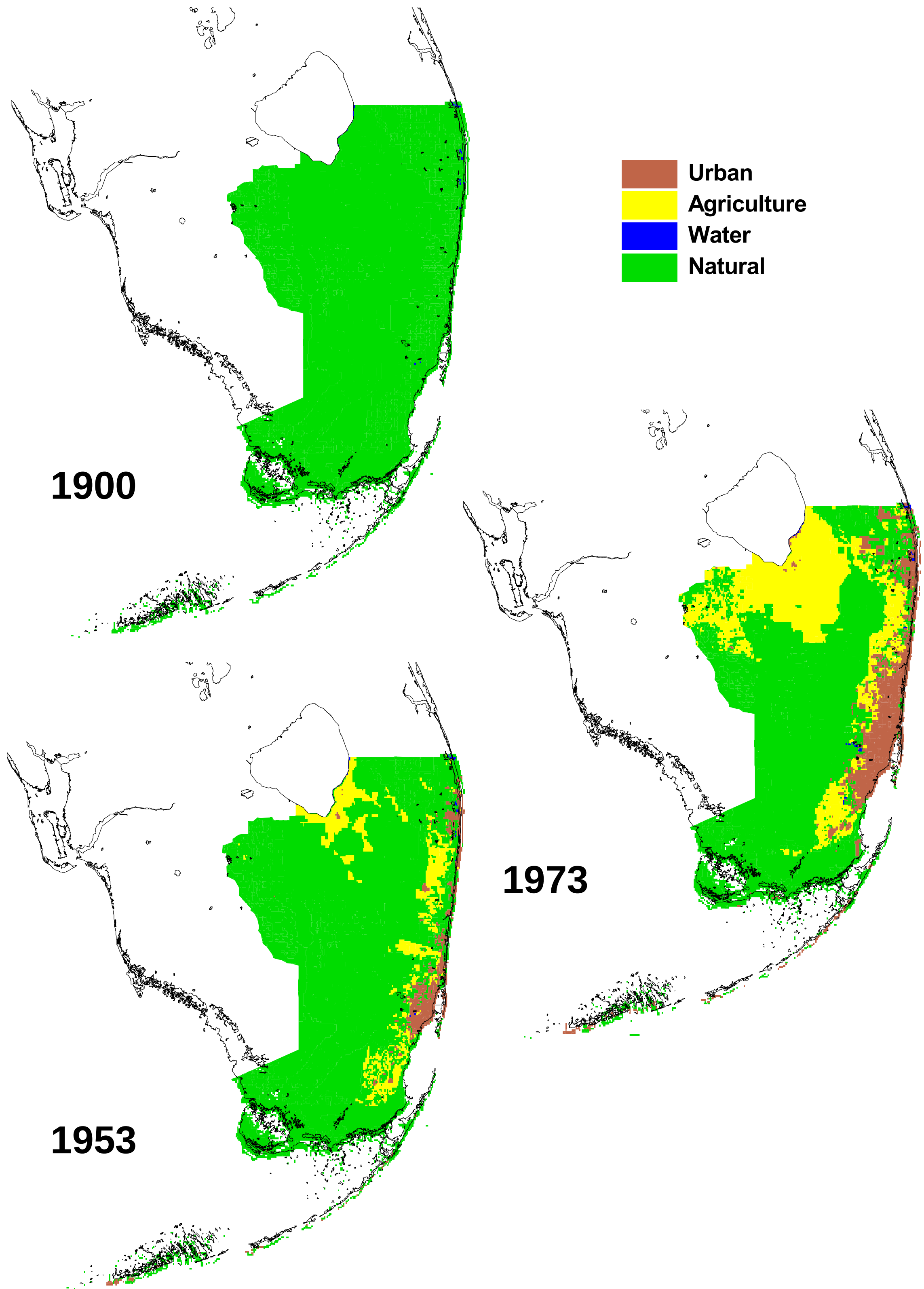

Figure 12. Changes in Natural Systems in the Lower East Coast Planning Area, 1900 to 1973.

in sea level. The upland pine and hardwood hammock communities of the Atlantic coastal ridge were historically interspersed with wet prairies and cypress domes and dissected by “finger glades” watercourses that flowed from the Everglades to the coast. These remain only in small and isolated patches that have been protected from urban development.

More detailed documentation of existing vegetation focuses on wetland systems that have been most seriously degraded and that will receive the most benefits from the implementation of the components recommeded in the *Central and Southern Florida Project Comprehensive Review Study Final Feasibility Report and Programmatic Environmental Impact Statement* (Restudy) (USACE and SFWMD, 1999). Those systems include the Everglades peatland, the Everglades marl prairie and rocky glades, and the mangrove estuaries and coastal basins of Florida Bay. Other natural systems in South Florida already have restoration plans and have had lesser impacts from man. These systems include the Kissimmee River, where restoration is already in progress; Lake Okeechobee for which a revised regulation schedule is planned to protect littoral, macrophyte communities; and the Big Cypress National Preserve where vegetation impacts and fixes are relatively minor compared to the Everglades. The Atlantic coastal ridge pinelands and hardwood hammocks, and the hammock and dune communities along the beaches are unique subtropical ecosystems that have very little protection and are rapidly disappearing.

Fish And Wildlife

The life cycles, community structures, and population densities of the fauna of South Florida are intricately linked to regional hydrology. The current status of fish and wildlife has been strongly influenced by the cumulative effects of drainage activities early this century, the C&SF Project, and the ensuing agricultural and urban development. The major emphasis in this section is on those faunal groups that appear to have declined as a result of hydrologic changes caused by the C&SF Project. The major linkages between hydrologic alterations and fauna that are emphasized here include the decline of aquatic food webs and populations, higher level consumers that depend upon them, shifts in habitats to those less favorable to faunal communities, and the reduction in the spatial extent of the Everglades wetland system.

A critical link in the aquatic food webs, and one that appears to have been impacted by hydrologic alterations, is the intermediate trophic level of the small aquatic fauna. The small marsh fishes, macroinvertebrates, amphibians, and reptiles, which form the link between the algal and detrital food web bases of the Everglades and the larger fishes, alligators, and wading birds that feed upon them, are currently diminished due to loss of habitat and changes in hydrology.

Included in the freshwater aquatic community of South Florida are the larger sport species such as the largemouth bass (*Micropterus salmoides*), sunfishes, and black crappie (*Lepomis nigromaculatus*). Lake Okeechobee is renowned for the trophy bass from its littoral zone and for an abundant black crappie fishery. Largemouth bass also naturally inhabit the deep water sloughs and wet prairies of the Everglades, where they grow at a rate of one pound per year of uninterrupted flooding.

Shortened hydroperiods in much of the LEC Planning Area presently confine larger bass mostly to canals, which provide a popular recreational fishery. Unfortunately, Everglades bass contain high body burdens of mercury, which make them unsuitable for frequent human consumption. Prolongation of hydroperiods that will be provided by an increase in water supply to the Everglades, should revitalize and expand the fishery for the largemouth bass to the sloughs and wet prairies and create new fisheries in reservoirs. Bass fisheries in remaining canals should also be substantially improved.

The American alligator (*Alligator mississippiensis*) is a keystone species in the Everglades. Holes that are created by alligators form ponds where aquatic fauna survive droughts. Mounds of sediment that are excavated from the holes create higher-elevation habitat for willow and other swamp forest trees. In addition to modifying topography, the American alligator is the top predator in the Everglades and feeds on every level of the food chain, from small fishes to wading birds, at various stages in its life.

The most conspicuous indicators of ecosystem health in the Everglades are the plummeting populations of wading birds. At present, nesting birds have declined to only ten percent of their historical number and they continue to decline. The food bases for these species are mostly contained in the freshwater marsh fish assemblage of the Everglades and the low salinity mangrove fish assemblage of the estuarine transition zone.

Due to diminished freshwater heads and flows upstream, habitats for the American crocodile (*Crocodylus acutus*) and migratory waterfowl, and nursery grounds of estuarine and marine sport fishes and pink shrimp (*Penaeus duorarum*) were also degraded.

The deer population has benefited from lower water levels. More white-tailed deer (*Odocoileus virginianus*) presently live in the Everglades than occurred under predrainage conditions. However, during high water periods, large-scale mortality can occur when the deer are stranded on overbrowsed tree islands.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service (USFWS), has identified 18 federally-listed plant and animal species that would likely be affected by changes in water management practices (**Table 5**). Of the listed species, critical habitat has been designated for the West Indian manatee (*Trichechus manatus*), the snail kite (*Rostrhamus sociabilis plumbeus*), the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), and the American crocodile. For a description of these critical habitat geographic designations and a complete species description, taxonomy, distribution, habitat requirements, management objectives, and current recovery status, see the USFWS web site (http://www.fws.gov). A complete listing of all the federally-listed threatened and endangered plant and animal species occurring or thought to occur within the study area is also available from this web site. The Florida Wildlife Commission (FWC) provides information on state-listed species (**Table 5**).

Table 5. Threatened and Endangered Plant and Animal Species Found in the Lower East Coast Planning Area.

Scientific Name	Common Name	USFWS[a]	FWC[a]
Mammals			
Trichechus manatus	West Indian Manatee	E[b]	E[b]
Felis concolor coryi	Florida panther	E	E
Mustela vison evergladensis	Everglades mink		T
Birds			
Rostrhamus Sociabilis plumbeus	snail kite	E[b]	E
Mycteria americana	wood stork	E	E
Ammodramus maritimus mirabilis	Cape Sable seaside sparrow	E[b]	E
Ammodramus savannarum floridanus	Florida grasshopper sparrow	E	E
Picoides borealis	red-cockaded woodpecker	E	T
Haliaeetus leucocephalus	bald eagle	T	T
Polyborus plancus (borealis)	Audubon's crested caracara	T	T
Aphelocoma coerulescens	Florida scrub jay	T	T
Grus canadensis pratensis	Florida sandhill crane		T
Ajaia ajaia	roseate spoonbill		SSC
Aramus guarauna	limpkin		SSC
Egretta caerula	little blue heron		SSC
Egretta thula	snowy egret		SSC
Egretta tricolor	tricolored heron		SSC
Eudocimus albus	white ibis		SSC
Falco peregrinus tundrius	Arctic peregrine falcon		SSC
Speotyto cunicularia	burrowing owl		SSC
Reptiles and Amphibians			
Crocodylus acutus	American crocodile	E[b]	E
Drymarchon corais couperi	Eastern indigo snake	T	T
Gopherus polyphemus	gopher tortoise		SSC
Pituophis melanoleucus mugitus	Florida pine snake		SSC
Tantilla oolitica	Miami black-headed snake		SSC
Rana capito	gopher frog		SSC
Invertebrates			
Liguus fasciatus	Florida tree snail		SSC
Heraclides aristodemus ponceanus	Shaus' swallowtail butterfly		E
Plants			
Cucurbita okeechobeensis	Okeechobee gourd	E	
Amorpha crenulata	crenulate lead plant	E	
Euphorbia deltoidea	deltoid spurge	E	
Galactia smallii	Small's milkpea	E	
Polygala smallii	tiny polygala	E	
Euphorbia garberi	Garber's spurge	T	

a. E= Endangered; T= Threatened; SSC= Species of special concern
b. Designated critical habitat

WATER QUALITY

Generally, water quality conditions in South Florida are assessed on a biannual basis by the FDEP. The *Florida Water Quality Assessment 1998 305 (b) Report* (Paulic and Hand, 1998) provides an overall view of water quality in South Florida, including much of the LEC Planning Area.

Pollutants of Concern

Water quality conditions in the study area are significantly influenced by development related activities. Hydrologic alterations have led to significant changes in the landscape by opening large land tracts for urban development and agricultural practices, and by the construction of extensive drainage networks. Natural drainage patterns in the region have been disrupted by the extensive array of levees and canals such that nonpoint source (storm water) runoff and point sources of pollution (wastewater discharges) are now part of the normal hydrological regime in many areas. Several pollutants of concern in the study area have been identified, including nutrients, pesticides, mercury, other metals, biologicals (fecal coliforms and pathogens), physical parameters, and other constituents. Of this list, phosphorus, pesticides, and mercury are considered to be the most problematic water quality pollutants of the region and are discussed below.

Phosphorus

Historically, South Florida waters were low in nutrients (oligotrophic). Due to human activities including the ditching and draining of wetlands and the expansion of agricultural practices, water bodies from the Kissimmee River southward have become nutrient enriched to various degrees. The nutrient that has the greatest impact on the health of South Florida ecosystems, is phosphorus. Farming areas surrounding Lake Okeechobee have contributed to elevated phosphorus levels in the Kissimmee River, Lake Okeechobee, Caloosahatchee River, and the Everglades. Urban storm water runoff is another source of phosphorus to the Everglades and South Florida coastal systems. In general, the trend for phosphorus concentrations is a decrease from north (Kissimmee River and EAA) to south (Everglades National Park). Nutrient removal occurs naturally in lakes and wetlands, due to the water quality treatment provided by plants and bacterial processes. Elevated nutrient levels occur when loading rates exceed the natural removal capacity. The resulting increased concentration of nutrients is termed eutrophication and may have various ecological impacts that include increased primary productivity, loss of water column dissolved oxygen, algal blooms, and changes in vegetation and biodiversity. Such effects of phosphorus loadings may ultimately reduce or destroy a water body’s habitat and/or recreational value.

Pesticides

Many types of pesticides are applied to or persist in South Florida waters, sediments and soils. The South Florida region is unique in that large and sensitive ecosystems exist in the midst of intensively developed urban and agricultural areas. Major amounts of pesticides are used in ground/aerial applications related to agricultural production, mosquito control, control of aquatic plants in local waterways, and maintenance of golf courses, lawns, and yard vegetation. Pesticides used in these ways threaten sensitive ecosystems and humans due to the intense year-round use, coupled with the shallow water tables and large-scale consumption of ground and surface waters.

Mercury

Mercury is a toxic heavy metal. Levels of mercury in water, animal tissue, sediments, periphyton, air, and soil are elevated in certain areas of South Florida. However, the sources, distribution, magnitude, transport, transformations, and pathways of mercury through the Everglades ecosystem are poorly understood. Among the possible mercury sources in South Florida are natural mineral and peat deposits and atmospheric deposition from global, regional, and local sources. Local sources include generating plants and waste incinerators. Mercury is now believed to primarily come from atmospheric deposition. Once elemental mercury is methylated by microbial action, it becomes biologically available in the food chain and concentrations increase as it moves up the food chain to top carnivores such as the Florida panther.

Surface Water Quality Conditions

Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Loads (TMDLs) for their water bodies that are not meeting designated standards. For the study area, FDEP listed over 118 priority water bodies/segments. The number of these priority water bodies/segments occurring in each basin is as follows:

- Lake Okeechobee (12)
- Caloosahatchee River Basin (11)
- Southeast Florida Basin (95)
- Florida Keys (0)

A map summarizing information available for the Southeast Florida Basin and Lake Okeechobee is provided in **Figure 13**.

Lake Okeechobee is at the center of the South Florida drainage system, receiving flow from the Kissimmee River Basin, and, to a lesser extent, from EAA backpumping. The lake may be considered an historically eutrophic water body that is becoming degraded, due primarily to nutrient inputs from the Kissimmee River and the Taylor Creek/Nubbin Slough basins. Despite extensive pollutant abatement programs implemented during the past 15 years, recent lake data indicate that nutrient concentrations and loads have shown no substantive improvement. Further, because the

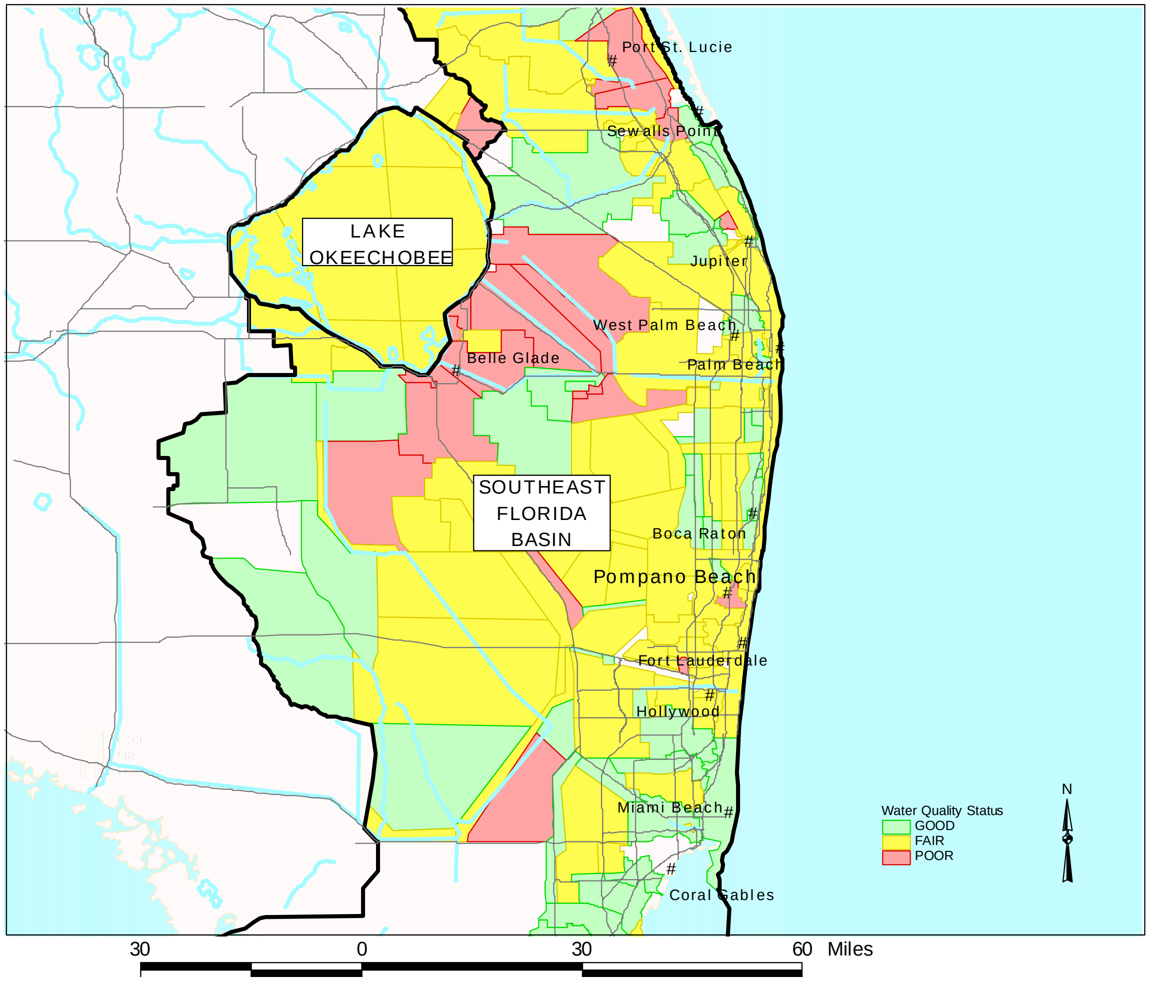

Figure 13. Results of FDEP Water Quality Assessment for Portions of the LEC Planning Region.

lake's phosphorus is internally recycled and large amounts of phosphorus are stored in watershed canal sediments, phosphorus levels in lake waters may not reach acceptable levels for many decades.

Water quality in the Caloosahatchee River is degraded in the upper and lower areas of the basin, due to agricultural and urban runoff, respectively. Problems associated with the degraded areas are typified by low dissolved oxygen levels, elevated conductivity, and decreased biodiversity. In urban sections of the basin, nonpoint storm water flows are associated with periodic algal blooms, fish kills, and low dissolved oxygen levels.

Extensive agricultural Best Management Practices (BMPs) have been applied in the EAA in the past several years to reduce the phosphorus load leaving the EAA. However, this area remains a primary source of pollutants for the WCAs. Drainage of muck soils for crop production causes soil oxidation and the release of nutrients into EAA runoff waters. During the wet season, growers commonly pump large volumes of nutrient enriched water off their land to protect crops against flooding. These waters also are contaminated with chlorides, dissolved minerals, iron (derived from EAA ground water), nutrients and trace levels of pesticides. The highly altered hydroperiod, resulting from the levees and pump operations, may exacerbate water quality conditions in the WCAs, as evidenced by a general degradation of water quality in the areas along the canals and adjacent to pump stations. Construction of upstream Stormwater Treatment Areas (STAs) currently under way is expected to improve water quality conditions in the WCAs through time.

In the central Everglades, phosphorus concentrations entering the Everglades National Park were lower in 1997 than the interim and long-term limits established by the 1991 Settlement Agreement (USA v. SFWMD, 1991). No significant trends in annual average mercury concentrations in water, sediment, or fish have been observed for the past five years. The best water quality conditions in the Everglades National Park were found in central Shark River Slough and along the coastal regions of the basin.

Some parts of Florida Bay experienced massive seagrass and mangrove die-offs during the 1980s and 1990s that likely stem from a lack of circulation, high water temperatures, and increased levels of salinity. Water diverted into the lower east coast canals has reduced freshwater flows to the bay resulting in recorded salinities as high as 70 parts per thousand.

Water bodies in the LEC Planning Area are seriously degraded in the heavily urbanized areas, including the numerous man-made canals. For example, water quality in Lake Worth Lagoon is good near the inlets and poor in the area between the inlets. Canals and water bodies in and around Fort Lauderdale are degraded by urban runoff and historical wastewater discharges, and by agricultural runoff in western portions of the canals. The New River and Miami River canals are polluted by improperly functioning septic tanks, discharges from vessels, industrial activities, improper sewer connections, and storm water runoff. Problems associated with these pollutants vary, but may include high nutrient concentrations, high bacteria counts, dense growth of undesirable aquatic vegetation, low biological diversity, low dissolved oxygen concentrations, and the occurrence of exotic plants and animals.

Water quality is good in open water areas of central and southern Biscayne Bay, and degraded in the area north of the Miami River Canal. High concentrations of heavy metals such as tin, copper, zinc, and chromium occur in sediments at marina sites.

Water quality conditions in the Florida Keys are generally good in areas open to the Atlantic or Gulf of Mexico. However, many man-made canals and marinas have water quality problems that are exacerbated by storm water runoff, seepage from septic tanks, and poor circulation.

Ground Water Conditions

The principal ground water resources for the LEC Planning Area are the Surficial Aquifer System (SAS), including the Biscayne aquifer, and the Floridan Aquifer System (FAS). Both are critical to the local ecology and economy. A cross-section of the geology of South Florida, depicting the aquifers, is shown in **Figure 14**.

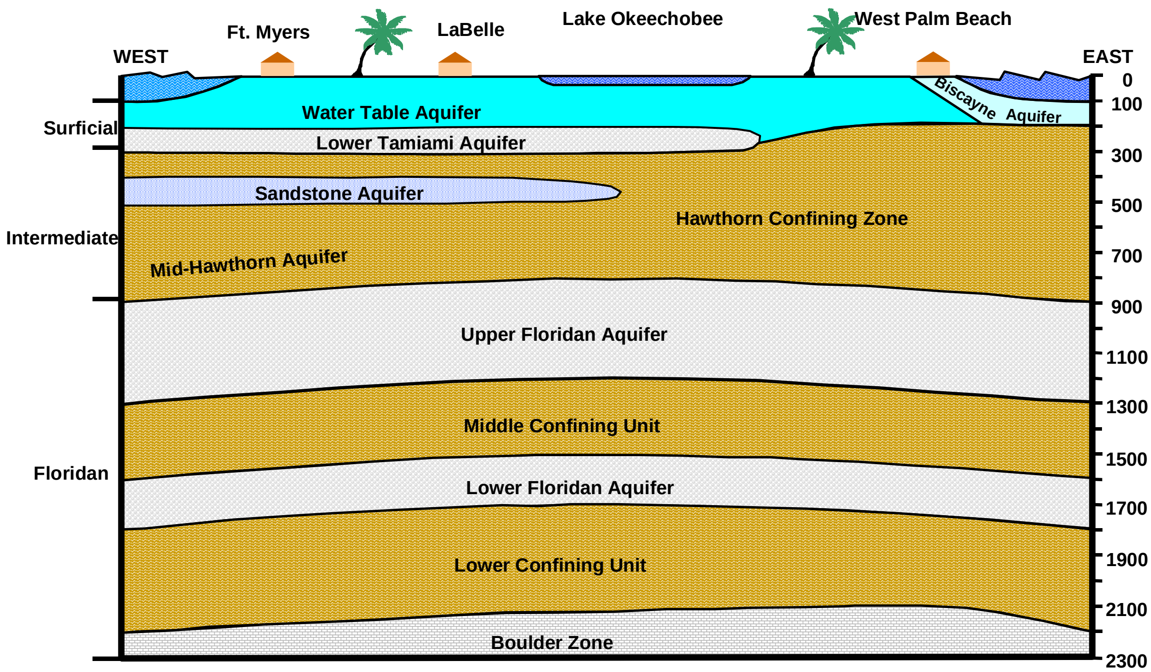

Figure 14. Geologic Cross-Section of South Florida Showing the Location of the Aquifers.

Surficial and Biscayne Aquifers

The surficial and Biscayne aquifers provide most of the fresh water for public water supply and agriculture within the LEC Planning Area. Both are critical to the local ecology and economy. The SAS is unconfined and extends throughout southeast Florida. A portion of the SAS has distinctive geological characteristics, is highly productive, and has been designated as the Biscayne aquifer. Location, depth, and water levels in the Biscayne aquifer are shown in **Figure 15**. The SAS provides major sources of water for the following uses:

- Meeting drinking water requirements for more than four million people living in urban areas along Florida's lower east coast
- Maintaining water levels in local wells, canals, and lakes
- Irrigating agricultural crops
- Replenishing regional wetlands and providing base flow to estuaries such as Biscayne Bay and Florida Bay

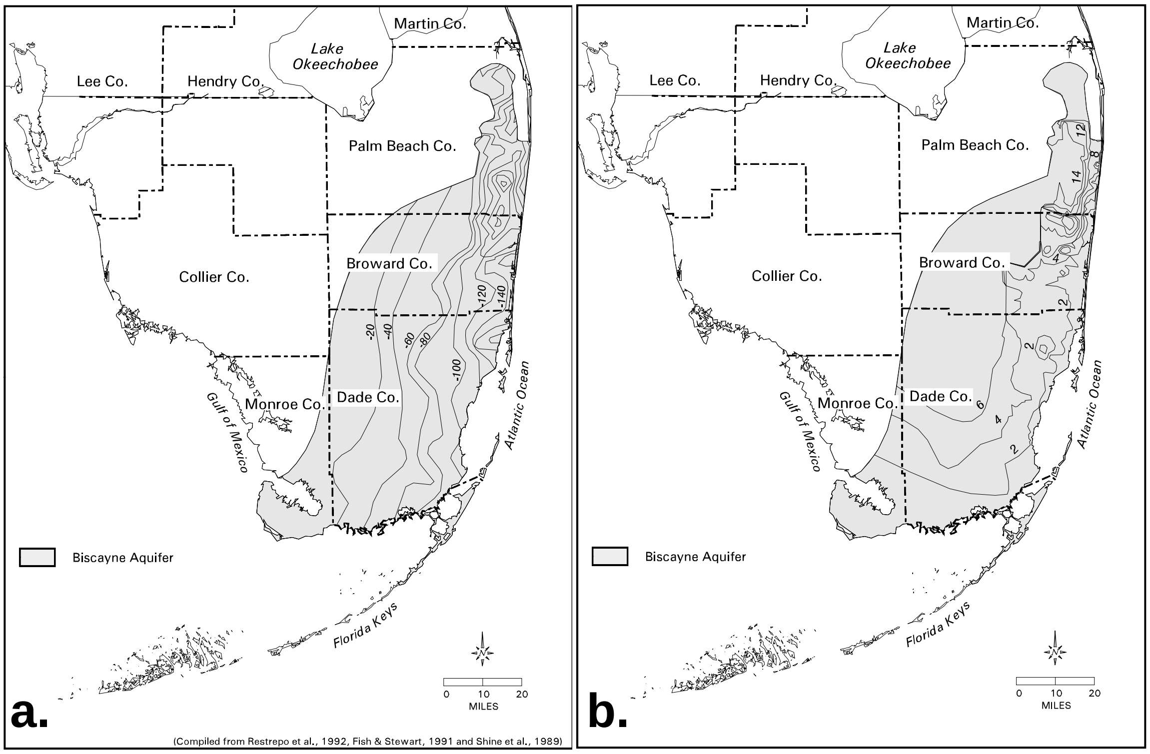

Figure 15. Location of the Biscayne Aquifer in Eastern Miami-Dade, Broward, and Palm Beach Counties with **a.** Average Aquifer Depth and **b.** Elevation of the Surface of the Aquifer. Contour lines are ft NGVD.

The Biscayne aquifer is composed of units and formations principally deposited during the Pleistocene Epoch, or Great Ice Age. This interval of geologic time was a period of climatic instability where great glaciers would advance and retreat across the continents. As the glaciers advanced, sea level declined and large areas of South Florida became exposed as dry land. Deposition during this time occurred due to dune building and formation of freshwater limestones. As the glaciers melted, sea levels increased and eventually submerged the southern peninsula, creating a highly productive, shallow marine environment. During this time period, marine deposits dominated the composition of the Biscayne aquifer. Typical marine deposits from these high sea level stands occur throughout South Florida and include the coral limestones on Key Largo and the oolitic ridge along the coast (Hoffmeister, 1974).

The major geologic deposits that comprise the Biscayne aquifer include Miami Limestone, the Fort Thompson Formation, the Anastasia Formation, and the Key Largo Formation. The base of the Biscayne aquifer is generally the contact between the Fort Thompson Formation and the underlying Tamiami Formation of Plio-Miocene Age. However, in places where the upper unit of the Tamiami Formation contains highly permeable limestones and sandstones, the zones would also be considered part of the Biscayne aquifer if the thickness exceeds 10 feet (Fish and Stewart, 1991).

The Biscayne aquifer is composed of interbedded, unconsolidated sands and shell units with varying thickness of consolidated, highly solutioned limestones and sandstones (Shine et al. 1989). In general, the Biscayne aquifer contains less sand and more solutioned limestone than most of the SAS. The Biscayne aquifer is one of the most permeable aquifers in the world and has transmissivities in excess of seven million gallons per day, per foot of drawdown (Parker et al., 1955).

Due to the regional importance of the Biscayne aquifer, it has been designated as a sole source aquifer by the U.S. Environmental Protection Agency (USEPA) under the Safe Drinking Water Act and is, therefore, afforded stringent protection. This designation was made because it is a principal source of drinking water and is highly susceptible to contamination due to its high permeability and proximity to land surface in many locations. Major sources of contamination are saltwater intrusion and infiltration of contaminants from canal water. Sources of contamination include surface water runoff (pesticides and fertilizers); leachate from landfills, septic tanks, and sewage plant treatment ponds; and injection wells used to dispose of storm water runoff or industrial waste. Trichloroethylene and vinyl chloride are examples of ground water contaminants of concern. Numerous hazardous waste sites (e.g., Superfund and Resource Conservation and Recovery Act sites) have been identified in the area underlain by the Biscayne aquifer. Action to remove existing contamination is under way at many of these sites. Waste management practices are generally monitored to prevent further contamination.

Floridan Aquifer System

The FAS is a thick sequence of carbonate units. Less permeable carbonate units, referred to as the middle confining unit, separate the system into two major aquifers called the Upper and Lower Floridan aquifers. The FAS is one of the most productive aquifers in the world and is a multiple-use aquifer system. Where it contains fresh water, it is the principal source of water supply, especially north of Lake Okeechobee. The Upper Floridan aquifer is used for drinking water supply in parts of Martin and St. Lucie counties.

From Jupiter to southern Miami, water from the FAS is mineralized (total dissolved solids are greater than 1,000 mg/L). More than 600 feet of low permeability sediments confine this aquifer and create artesian conditions. Although the head gradient is upward, the low permeability units prevent significant upward migration of saline waters into the shallower aquifers. Depth to the Floridan aquifer is approximately 900 feet in coastal Miami-Dade County. In the LEC Planning Area, the Upper Floridan aquifer is being considered for storage of potable water within an ASR system. In the Lower Floridan aquifer, there are cavernous zones with extremely high transmissivities. However, because these zones produce saline water, they are not used for drinking water supply. Because of their depth and salinity, these deeper zones of the Lower Floridan aquifer are used primarily for injection of treated wastewater.

Saltwater Intrusion

The inland movement of salt water is a major resource concern in the coastal areas of the LEC Planning Area and can significantly affect water availability in areas adjacent to saline water bodies. When water is withdrawn from the surficial aquifer at a rate, that exceeds its recharge capacity, the amount of freshwater head available to impede the migration of saltwater is reduced, and saltwater intrusion becomes likely. The saline interface moved significantly inland during the 1940s in southeast Broward County and northern Miami-Dade County due to construction of the coastal canals which drained the freshwater mound behind the coastal ridge. Historical changes in saltwater intrusion boundaries in Miami-Dade County are shown in **Figure 16**. More recently, several wells in the cities of Hollywood, Hallandale, and Dania were taken out of service due to saltwater contamination. The recharge capacity of the aquifer was exceeded.

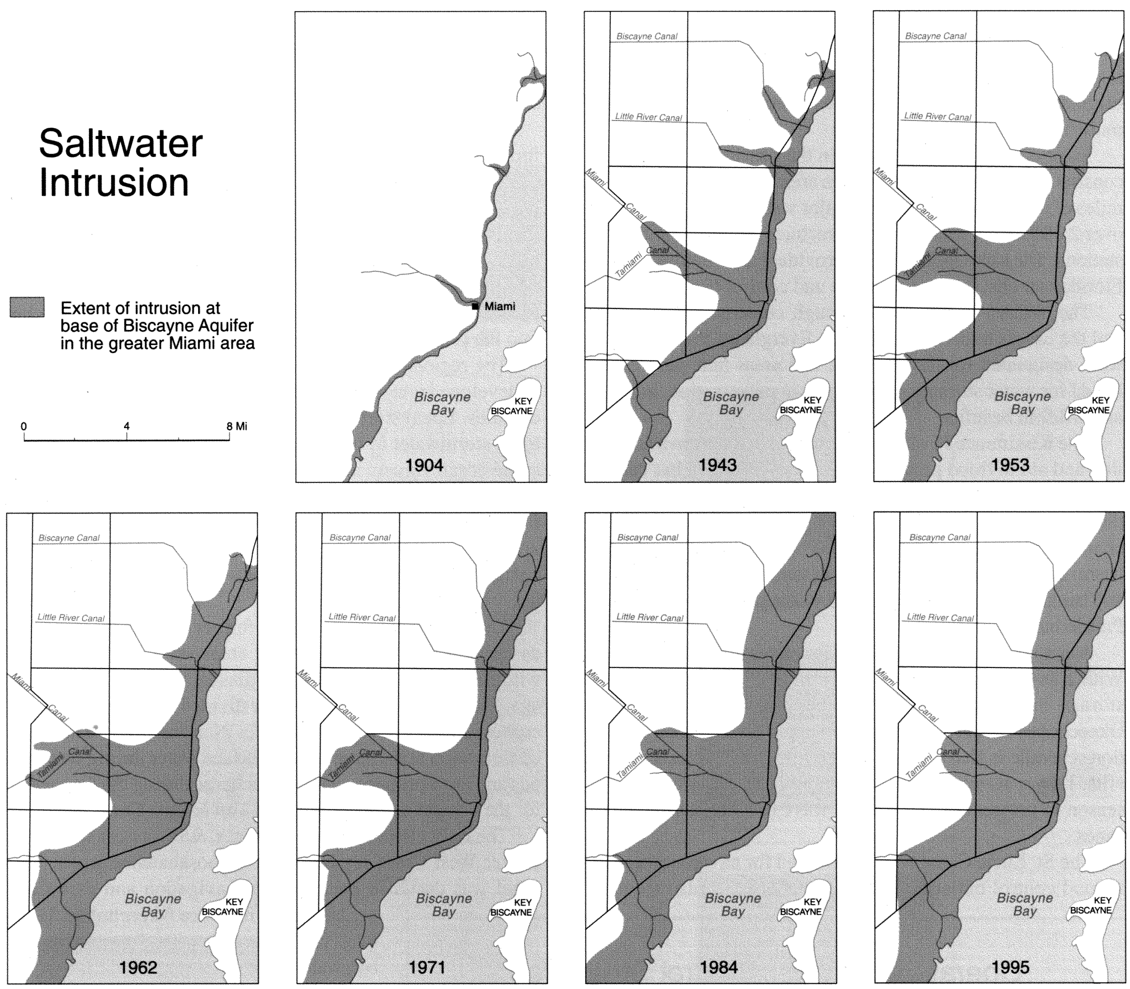

Figure 16. Historical Extent of Saltwater Intrusion in Coastal Miami-Dade County.

The District's Consumptive Use Permitting (CUP) criteria includes denial of permits that would cause significant saline water intrusion. Section 3.4, Saline Water Intrusion, of the District's Basis of Review for Water Use Permit Applications (SFWMD, 1997d) defines significant saline water intrusion as follows:

- Movement of the saline water interface to a greater distance inland or vertically upward towards a freshwater source than has historically occurred as a consequence of seasonal fluctuations.
- A sustained increase from background values of saline monitor wells with regard to dissolved chloride concentration.

Impacts include the potential to permanently move the saline interface inland, reducing the quality and quantity of water available at existing wellfields and impeding future withdrawals at favorable locations (near population centers and treatment plants).

Historically, the District's CUP Program has required water users to maintain a minimum of one foot of freshwater head between their wellfields and saline water as a guideline for the prevention of saltwater intrusion. This guideline, in combination with a saltwater intrusion monitoring program, has been largely successful in preventing saltwater from occurring based on consideration of individual permits and utility operations. The LEC Plan is taking a more comprehensive view of the potential for saltwater intrusion by identifying areas that are most vulnerable and developing proactive measures to reduce occurrence of, and better manage, saltwater intrusion.

WATER MANAGEMENT

The LEC Planning Area portion of C&SF Project is divided into three hydrologically related geographical areas consisting of 1) Lake Okeechobee and the EAA; 2) the WCAs, and 3) the east coast canals.

Lake Okeechobee and Everglades Agricultural Area

The location of major features of the Lake Okeechobee Service Area (LOSA) and the EAA are shown in **Figure 17**. With a surface area of more than 730 square miles, Lake Okeechobee represents the third largest lake in the United States. Lake Okeechobee was formed approximately 6,000 thousand years ago. Construction of the levee system around the lake during the twentieth century, and the lowering of lake levels to a maximum of 17 ft NGVD, effectively isolated thousands of acres of marsh, creating a new littoral zone/ marsh community in areas where one had not previously existed. This wetland area now occupies more than 20 percent (98,000 acres) of the total surface area of the lake and provides habitat for a wide variety of plant and animal communities, including a number of rare, threatened, or endangered species such as the snail kite, wood stork, West Indian manatee, and the Okeechobee gourd. The littoral zone provides an important nursery ground and habitat for fish and other aquatic organisms. Migratory birds and waterfowl also use the littoral zone and open water areas of the lake as a resting area along the Atlantic flyway. The lake also supports a nationally renowned sport fishery for largemouth

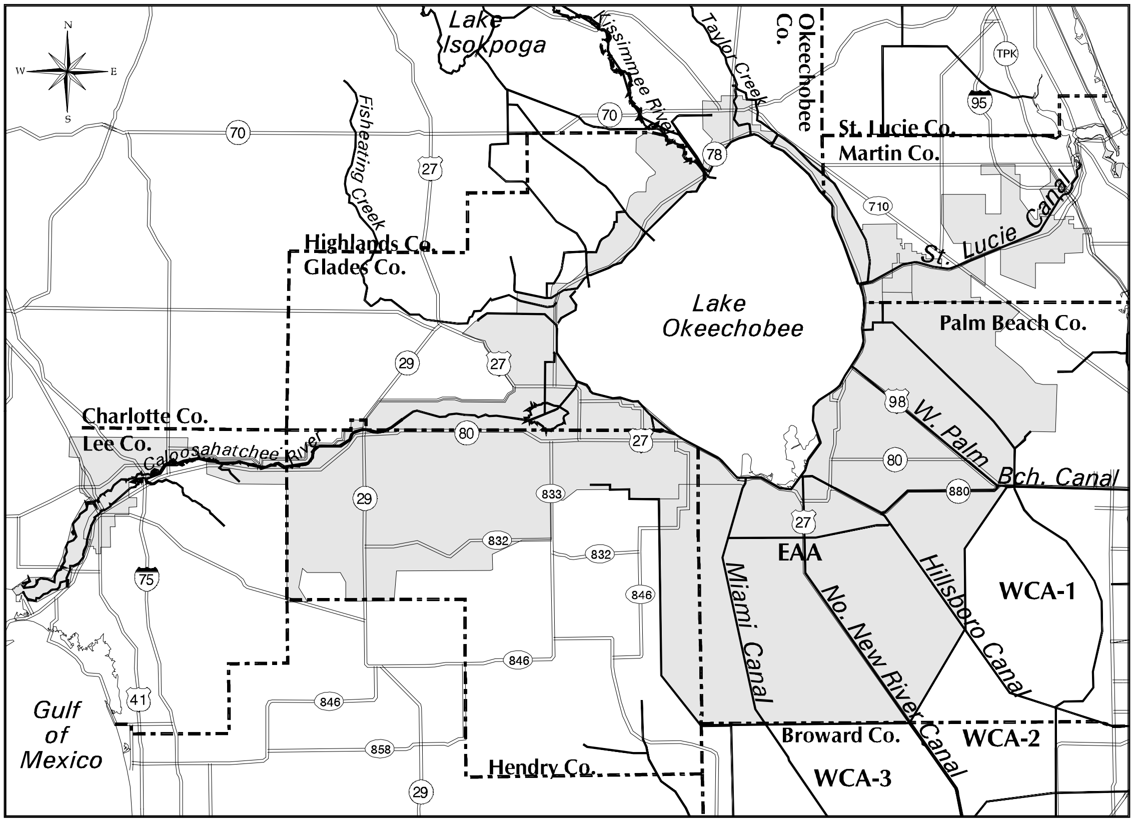

Figure 17. The Lake Okeechobee Service Area, including the Everglades Agricultural Area.

bass, black crappie, bluegill, redear sunfish, and catfish. Recreational and commercial fisheries combined have an estimated value of more than 28 million dollars per year. The lake's littoral zone also supports significant wading bird populations and is an important waterfowl hunting area.

The historical Everglades area contains the largest known contiguous body of organic soils in the world. The EAA, located south of Lake Okeechobee within eastern Hendry and western Palm Beach counties, encompasses an area of totaling approximately 718,400 acres (1,122 square miles) of highly productive agricultural land comprised of rich organic peat or muck soils. Approximately 77 percent of the EAA (553,00 acres) is in agricultural production. Nitrogen-rich organic (peat) soils and a warm subtropical climate permit the year-round farming of sugarcane, winter vegetables, and rice with a 1988 total economic impact estimated near $1.3 billion dollars (Mulkey and Clouser, 1988).

Water levels in Lake Okeechobee are regulated by a complex system of pumps and locks. A regulation schedule has been established for Lake Okeechobee to achieve multiple uses and provide seasonal lake level fluctuations that vary from high stages in the late fall, winter, and early spring to low stages at the beginning of the wet season. The regulation schedules contain instructions and guidance on how project pumps, locks, and spillways are to be operated to maintain appropriate water levels. The schedule maintains a low lake stage to provide both storage capacity and flood protection for surrounding areas during the wet season. During the winter, lake levels may be increased to store water for the upcoming dry season. The general plan of operation is based on 1) providing flood protection from lake waters and hurricane-driven wind tides for lands adjacent to the lake; 2) maintaining an eight-foot navigation depth, as part of the Okeechobee Waterway; and 3) storing water to meet requirements of agricultural and urban areas south and east of the lake.

Flood control works on Lake Okeechobee consist of a system of about 1,000 miles of encircling levees, designed to withstand severe flood stage and wind conditions, plus regulatory and water supply outlets of the St. Lucie Canal and the Caloosahatchee River. The design discharge of Moore Haven Spillway is 9,300 cubic foot per second (cfs) and that of St. Lucie Spillway is about 16,000 cfs. Following removal of local runoff from the agricultural areas south of the lake, an additional regulatory capability of several thousand cfs is available through the Miami, North New River, Hillsboro, and West Palm Beach canals by pumping into the WCAs.

Agriculture within the EAA requires extensive drainage of 553,00 acres of rich organic soil. The primary drainage and irrigation system within the EAA consists of an extensive network of canals, levees, pumps and water control structures constructed by the USACE as part of the C&SF Project and is currently operated and maintained by the District. Drainage of the EAA is achieved through six primary canals (Hillsboro, North New River, Miami, West Palm Beach, Cross and Bolles canals). Seven major pump stations and have a total design capacity to remove excess water from each subbasin at a maximum rate of 3/4 of an inch of runoff per day. Nine smaller, Chapter 298 drainage districts also maintain secondary drainage systems and operate pump facilities within the EAA to provide local control of water movement within and between subbasins. In addition, individual farms operate numerous private pumps, some of which are portable, that move water to and from the main canals.

Everglades Protection Area

The Everglades Protection Area lies south of the EAA, west of the Atlantic Coastal Ridge, and east of the Big Cypress Preserve. It is comprised of a number of different management areas that have different operational needs and priorities, including the WCAs; the Holey Land and Rotenberger Wildlife Management Areas (WMAs); and Everglades National Park, which also includes Florida Bay (**Figure 18**).

The Everglades is an internationally recognized ecosystem that covers approximately two million acres in South Florida and represents the largest subtropical wetland in the United States. Prior to drainage and development, this area consisted largely of vast sawgrass plains, dotted with tree islands and interspersed with wet prairies and aquatic sloughs covering most of southeastern Florida (Davis, 1943). Everglades National Park and the WCAs are the surviving remnants of the historical Everglades, which extended over an area approximately 40 miles wide by 100 miles long, from the south shore of Lake Okeechobee to the mangrove estuaries of Florida Bay. This remaining area provides significant ecological, water storage, flood control, and recreational benefits to the region, as well as important habitat for wildlife of national significance. The

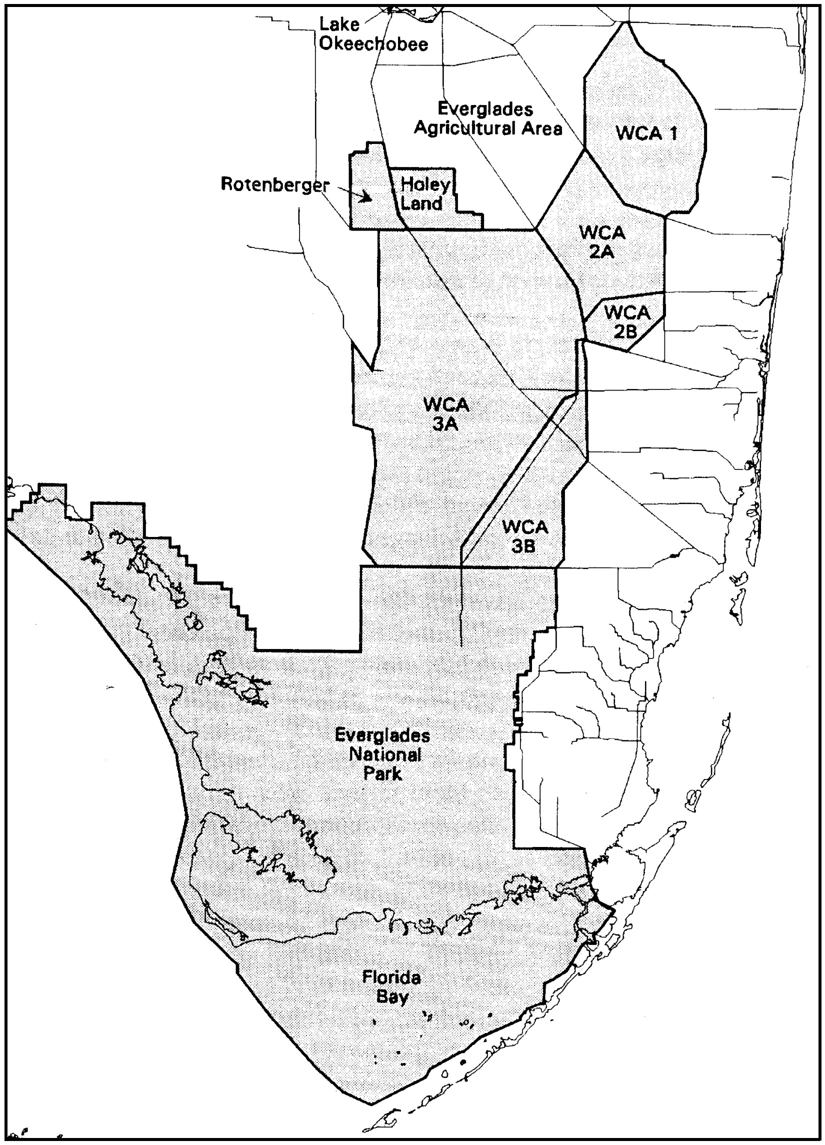

Figure 18. Everglades Protection Area.

predrainage Everglades had three essential characteristics: 1) it was largely a rain-driven ecosystem, 2) it contained large spatial scale and extent, and 3) its hydrologic regime featured dynamic storage and sheetflow.

Construction of canals, levees, and water control structures as part of the C&SF Project has compartmentalized the WCAs into five separate reservoirs. These five WCAs contain the last remnants of the tall sawgrass, wet prairie, deep water slough, and tree island landscapes that remain intact outside of Everglades National Park. The WCAs are completely contained by levees, except for about seven miles on the west side of WCA-3A, which has a tieback levee. Additional levees on the east side of the Everglades protect adjacent agricultural, urban, and industrial areas. This whole region is managed with a system of canals, pump stations, and control structures.

The WCAs provide a detention reservoir for excess water from the EAA and parts of the LEC Planning Area, and for flood discharges from Lake Okeechobee. The WCA levees prevent Everglades floodwaters from inundating east coast urban areas and hold back water that can later be supplied to east coast areas and Everglades National Park. In addition, these levees help maintain higher water levels that provide recharge to surficial aquifers, ameliorate saltwater intrusion in coastal basins, reduce seepage, and benefit fish and wildlife in the Everglades.

The WCA regulation schedules essentially represent seasonal and monthly limits of storage. This seasonal range permits the storage of runoff during the wet season for use during the dry season. In addition, it maintains and preserves native plant communities, which are essential to fish and wildlife and the prevention of wind tides. The regulation schedules include a minimum water level, below which water releases are not permitted unless water is supplied from another source. When water levels fall below the minimum levels, transfers from Lake Okeechobee or the WCAs are thus made to meet water demands.

East Coast Canals and Service Areas

Coastal Canals

Flood control and outlet works extend from St. Lucie County southward through Martin, Palm Beach, and Broward counties to Miami-Dade County, a distance along the coast of about 170 miles. The South Miami-Dade Conveyance System was added to the existing flood control system to provide a way to deliver water to areas of south Miami-Dade County. The main design functions of these project canals and structures are to protect adjacent lands against floods; store water in the WCAs; control water elevations; and provide water for conservation and human uses. These works protect against major flood damages. However, due to urbanization, the existing surface water management system now has to handle greater peak flows than in the past. Project works consist of 40 operating canals, one levee, and 50 operating structures. The operating structures consist of 35 spillways, 14 culverts, and one pump station. Many of these canals are used to remove water from interior areas to tidewater. Damages to agriculture, citrus, and pasturelands have been reduced due to the effective drainage capabilities of the canals. The project works maintain optimum stages for flood control, water supply, ground water recharge, and prevention of saltwater intrusion.

Areas become flooded during heavy rainfall events due to antecedent conditions that cause saturation and high runoff from both developed and undeveloped areas. To reduce the threat of flooding, automatic controls have been installed on some control structures. Saltwater intrusion has declined considerably at coastal structures since the installation of salinity dams downstream and salinity sensors near the structures.

The coastal canals and control structures are designed to permit rapid removal of floodwaters from their immediately adjacent drainage area. The degree of flood protection provided by outlet capacity depends on whether the protected area is urban or agricultural.

Maximum rates of removal vary from 40 to 100 percent of the Standard Project Flood, a mathematically derived severe storm event.

The network of canals and control structures also provide capacity for water supply and salinity control in the area. Wellfields, which are the primary source of municipal water supplies, are significantly recharged by releasing water from the WCAs and conveying this water through coastal canals to the vicinity of the wellfields. Water stored in the WCAs can also be used to maintain ground water levels and a freshwater head for salinity control in the coastal area and to irrigate agricultural areas.

North Palm Beach Service Area

The North Palm Beach Service Area (NPBSA) includes all of the coastal and inland portions of northern Palm Beach County west of the EAA and north of the West Palm Beach Canal Basin (**Figure 19**). In presenting the results of the plan, the southern L-8 Basin and the M-Canal/Water Catchment Area Basins are included with the NPBSA. This service area contains extensive urban, agricultural, and natural areas. The major natural areas within the NPBSA include the DuPuis Reserve, the J.W. Corbett WMA, the West Palm Beach Water Catchment Area, the Loxahatchee Slough, the Loxahatchee River, and the Pal Mar Wetlands. The urban areas have experienced rapid growth for several decades and a continuation of this growth is expected through 2010. Agricultural land uses occur mostly in the L-8 and C-18 basins. The major utilities in the NPBSA include West Palm Beach, Riviera Beach, Seacoast, Jupiter, and Tequesta.

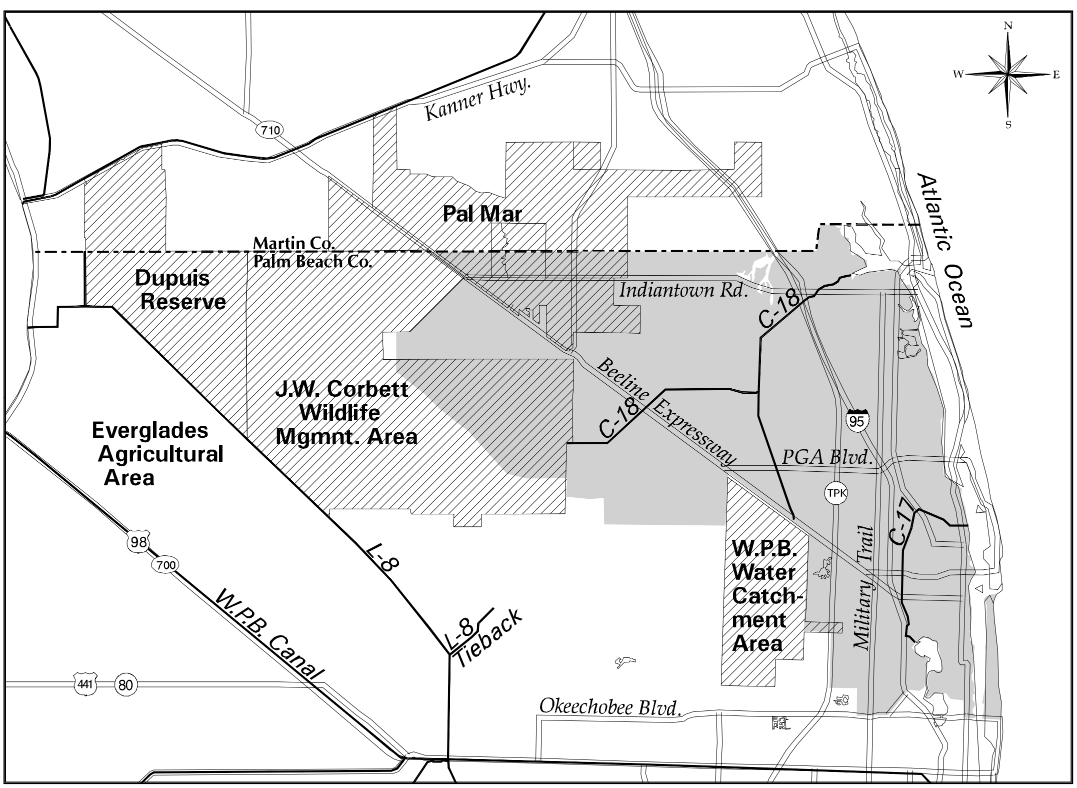

Figure 19. The North Palm Beach Service Area, including the Everglades Agricultural Area.

Lower East Coast Service Area 1

The Lower East Coast Service Area 1 (LECSA 1) includes the portion of Palm Beach County east of WCA-1 and a small portion of Broward County (**Figure 20**). The service area includes the West Palm Beach Canal (C-51) and Hillsboro basins. This service area is heavily urbanized and has experienced rapid growth for several decades. A large amount of agriculture, principally winter vegetables, citrus, and nurseries are located in the western portions of the service area. Utilities within Palm Beach County, which are in LECSA 1, include Lake Worth, Lantana, Delray Beach, Highland Beach, Boca Raton, Royal Palm Beach, Acme, Palm Beach County, Palm Springs, Atlantis, Jamaica Bay, Boynton Beach, Manalapan, and the Village of Golf. The utilities in Broward County, which are in LECSA 1, include a section of Broward County 2A, Deerfield Beach, the North Springs Improvement District, and Parkland.

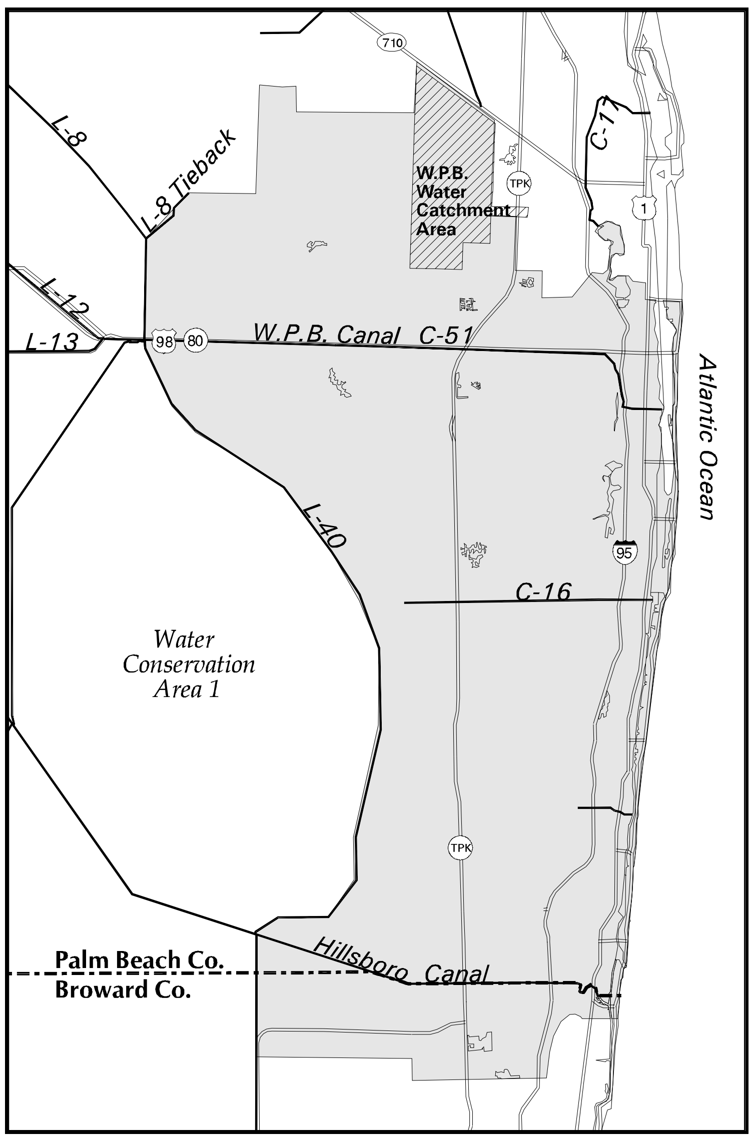

Figure 20. The Lower East Coast Service Area 1.

Lower East Coast Service Area 2

Lower East Coast Service Area 2 (LECSA 2) includes the portion of Broward County east of the WCAs and south of the Hillsboro Canal Basin and the C-9 Canal Basin in northern Miami-Dade County (**Figure 21**). This LECSA 2 is heavily urbanized and has experienced rapid growth for several decades. While the rate of growth is slowing, the increasing population results in significant increases in demand for potable water.

Utilities within Broward County which are within LECSA 2 include Broadview; Broadview Park; Broward County 1A, 1B, 3A, and 3B; Cooper City; city of Coral Springs; Coral Springs Improvement District; Dania; Davie; Ferncrest; Fort Lauderdale; Hallandale; Hillsboro Beach; Hollywood; Lauderhill; Margate; Miramar; North Lauderdale; Pembroke Pines; Plantation; Pompano Beach; Royal; Seminole Industries; South Broward; Sunrise; and Tamarac. One utility within Miami-Dade County, North Miami Beach, also lies within this area.

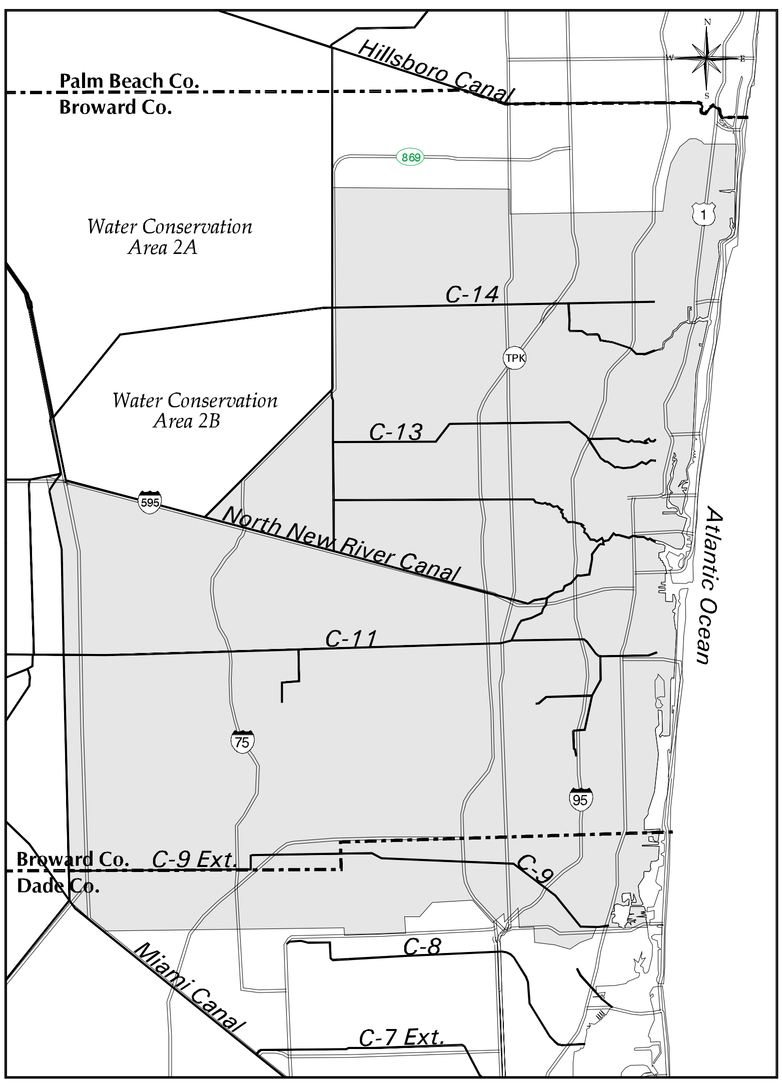

Figure 21. The Lower East Coast Service Area 2.

Lower East Coast Service Area 3

Lower East Coast Service Area 3 (LECSA 3) includes that portion of Miami-Dade County east of WCA-3B, and Everglades National Park, as well as the Florida Keys (**Figure 22**). The Florida Keys are included in LECSA 3 because their primary source of drinking water is the Florida Keys Aqueduct Authority wellfield located near Florida City.

Other major water suppliers in this service area include Miami-Dade Water and Sewer Department, the city of North Miami, the city of Homestead, Florida City, and Homestead Air Force Base.

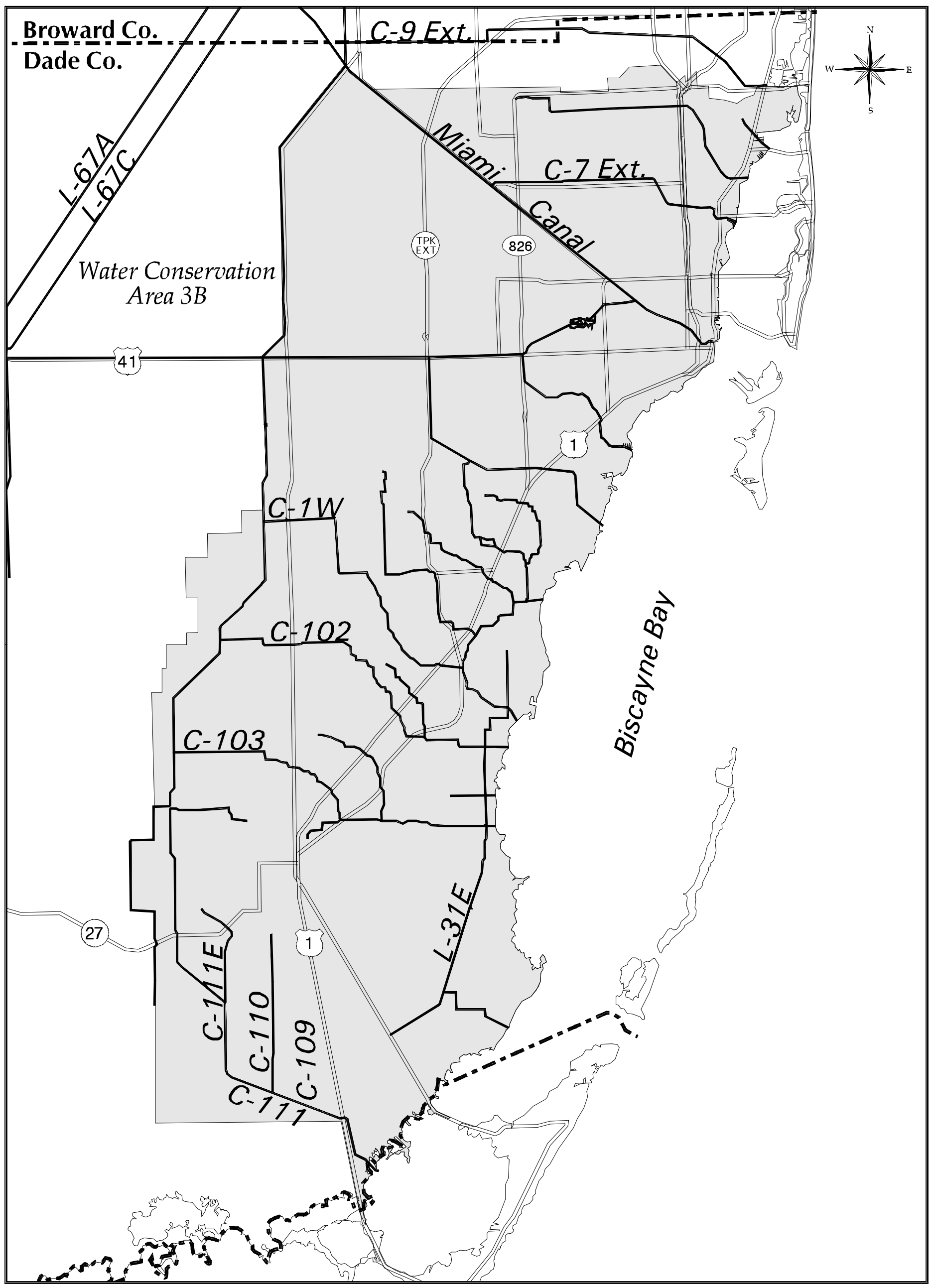

Figure 22. The Lower East Coast Service Area 3.

Water demand in LECSA 3 is generated primarily by a mixture of urban and agricultural land uses. Population is expected to grow and displace some of the agriculture currently in southern Miami-Dade County. The citrus, winter vegetables, and tropical fruit farming in southern Miami-Dade County currently represents the second largest agricultural area in South Florida. Early efforts to drain the area caused significant saltwater intrusion and the abandonment of coastal wellfields in favor of large, regional wellfields located west of the Atlantic Coastal Ridge. The saltwater intrusion situation along the coast now appears to have stabilized.

During dry periods, rainfall and seepage are insufficient to maintain the Biscayne Aquifer at levels which meet demands and prevent saltwater intrusion. In these times the area is highly dependent on additional deliveries from regional storage via the C-4 and C-6 canals for the recharge of major public water supply wellfields.

Besides local rainfall, LECSA 3 receives large quantities of regional water due to ground water seeping from WCA-3B and Everglades National Park. Due to this seepage, efforts to restore water levels in areas west of the levee system to historic levels impact the drainage needs of land uses east of the levee system, while helping to recharge major public water supply wellfields.

SOCIOECONOMICS

The economy of South Florida is based on services, agriculture, and tourism. Florida's warm weather and extensive coastline attract vacationers and other visitors and helps to make the state a significant retirement destination for people from all over the country. The 16 South Florida counties that fall within the District had a 1990 population of 6.3 million, accounting for nearly half (about 49 percent) of Florida's total population. This share has changed very little over the past 20 years and recent U.S Department of Commerce projections predict it will remain stable over the next 50 years. Over 60 percent of this South Florida population lives in Palm Beach, Broward, and Miami-Dade counties. By 2020, the LEC Planning Area population may exceed 6.9 million.

About one-third of Florida’s employment and earnings occurs in the LEC Planning Area. Palm Beach, Broward, and Miami-Dade counties account for about 80 percent of the District’s regional aggregate socioeconomic activity. Employment and income within the District have continued to grow in recent decades faster than the national average. Growth has been significantly greater in the southwest counties of the planning area and the Florida Keys than elsewhere in the U.S. Department of Commerce’s study area.

LAND USE

Existing use of land within the study boundaries varies from undeveloped to high-density multifamily and industrial urban uses. Much of South Florida remains undeveloped, although much of this is disturbed land. The dominant natural features are Everglades National Park, Lake Okeechobee, and the WCAs. Generally, urban development is concentrated along the lower east coast from Palm Beach to Miami-Dade counties, with a number of small communities surrounding Lake Okeechobee. Agriculture plays an important role in the region. More than two million acres are being farmed, half of which is pastureland. Predominant crops are sugarcane and vegetables. Vegetable crops, especially tropical varieties, also dominate in southern Miami-Dade County. Citrus is grown in every county within the LEC Planning Area, but is concentrated in Collier County. The EAA has over 700,000 acres of irrigated farmland, producing sugarcane, rice, row crops, and sod. Extensive pasturelands are located west and north of Lake Okeechobee. Directly south of the EAA, the WCAs cover 1,372 square miles and consist mainly of sawgrass marshes and tree islands.

The urban area extends approximately 100 miles through the coastal portions of Palm Beach, Broward, and Miami-Dade counties and is the most densely populated subregion in the state with more than 4.5 million people. The subregion also contains substantial agricultural acreage, particularly in southwestern Miami-Dade County (90,000 acres) and eastern Palm Beach County (29,000 acres). Rapid population growth and land development practices have resulted in notable western urban sprawl, with the predominant land use being single-family residential.

The Florida Keys are made up of over 1,700 islands that encompass approximately 100 square miles and contain the largest reef system in the United States. While most of Monroe County is designated as conservation land within Everglades National Park, Big Cypress National Preserve, or the National Key Deer Refuge, use of most of the remaining land is either residential or geared towards supporting tourism, the county’s main industry.

RECREATION RESOURCES

Recreation opportunities abound in the LEC Planning Area. South Florida is rich in water resources, with easy access to fresh, estuarine, and marine resources for fishing, boating, swimming, diving, camping, and sightseeing. Lake Okeechobee is a nationally recognized bass and pan fishing resource and offers other recreational amenities as well. Airboat and swamp buggy rides, hunting, bike riding, hiking, picnicking, camping, and nature interpretation are popular land-based recreation activities.

The urbanized east coast includes good quality marine-based recreation activities such as underwater diving, fishing, boating, surfing, and, of course, the beach. County and state parks, scenic rivers, state reserves and forests, and federal refuges provide wildlife viewing, nature interpretation, hiking, and canoeing opportunities. Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), Scenic River, DuPuis Reserve State Forest, and the Loxahatchee River–Lake Worth Creek Aquatic Preserve provide high quality opportunities for boating, fishing, and nature interpretation activities. The Intracoastal Waterway, Lake Worth Lagoon, and northern Biscayne Bay provide excellent fishing and boating, as well as access to marine waters through natural and man-made inlets. Southern Biscayne Bay offers probably the highest quality recreation within the study area. Biscayne National Park provides access and facilities for bird watching, recreational hiking, boating, fishing, snorkeling, diving, and picnicking.

The LEC Planning Area also has inland water and upland resources that include WCA-1 and the Rotenberger and Holey Land WMAs. These areas provide high quality boating, fishing, and nature interpretation activities. The Miccosukee State Indian Reservation offers opportunities for hunting, boating, and fishing. Fishing, hunting, boating, and air boating are popular activities in the WCAs and WMAs.

Everglades National Park and Florida Bay support unique and diverse recreational pursuits. Day use and camping facilities are available. Recreation opportunities include hiking trails, boating, fishing, and nature interpretation. Several roads open up access to diverse ecosystems within the park. Shark River Slough furnishes a lookout tower, tramway, biking, interpretive center, and camping. Florida Bay, Whitewater Bay, and the Ten Thousand Islands are characterized primarily by water-based resources and include excellent boating, fishing, and nature interpretation. Camping and other day use activities are also popular in the region.

The Florida Keys are very popular tourist destinations and offer high quality water-based recreation with some upland and shoreline activities. Five wildlife refuges and one of the busiest state parks are located here. John Pennekamp Coral Reef State Park and the Florida Keys National Marine Sanctuary were created to protect the delicate reefs that are also popular diving destinations. Diving, boating, fishing, and nature watching are the most popular recreational activities.

WATER SUPPLY AND FLOOD CONTROL

Management Considerations

One primary function of the C&SF Project is to provide a highly efficient flood control system, which is designed to keep urban and agricultural areas dry in the wet season. Flood protection is provided by discharging excess water to tide or into the WCAs and Everglades National Park. Rapid wet season flood releases to tide, coupled with the reduced capacity to retain water in Lake Okeechobee, the northern historical sawgrass plains, and the eastern peripheral wetlands and sloughs, have severely reduced the overall ability to store water in the regional system.

The sawgrass plains, for example, once stored and slowly released much of the water that overflowed from Lake Okeechobee. Today, large areas of these sawgrass plains have been converted to agriculture within the EAA. Water from the lake and excess runoff water are now quickly passed to the WCAs and the coast during the wet season to prevent crop damage. Water levels in coastal canals are maintained at relatively low levels during the wet season to provide additional capacity for storage and conveyance of flood waters, resulting in low ground water levels.

Another impact of the loss of water storage is that, during the dry season, high levels of demands may exceed the capacity to obtain water from nearby wetlands. When this occurs, water is released from Lake Okeechobee to meet crop and urban demands. Lack of storage, not lack of water, is the problem. During dry periods, minimum levels for lower east coast canals are principally maintained to protect the Biscayne aquifer from saltwater intrusion. The head created in the canals raises ground water levels, recharging the aquifer and the urban wellfields, but also increases the likelihood that localized flooding will occur during an extreme storm event. During the wet season, wellfields are recharged by local rainfall and by seepage from the Everglades and the canals. During the dry season, recharge is more dependent on the regional system. Unfortunately, during both the wet and dry seasons, excess storm water is passed through the canals and out to tide when it should be stored. Without sufficient storage, it is difficult to have water available during dry periods and avoid flooding during wet periods.

While sufficient water is present to meet local needs during wet seasons and normal rainfall years, during extremely dry years, urban wellfields depend heavily on seepage and releases from the WCAs and Lake Okeechobee. During drought years, urban and agricultural areas have additional needs and more water is used for landscape maintenance, primarily to water lawns.

The amount of water needed to recharge urban wellfields is less than the volume needed to prevent saltwater intrusion. However, the cost of replacing damaged wells is very high. The amount of water needed to prevent saltwater intrusion, in turn, is much less than the wet season coastal discharges. If coastal flows were captured and stored, more than enough water would be available to maintain dry season salinity barriers without removing water from the natural system.

Within the LEC Planning Area, ecological benefits may accrue from maintaining higher ground water levels. For example, low ground water levels have had significant effects on Biscayne Bay, including increased salinity, increased turbidity, and lower water quality. In south Miami-Dade County, lowered ground water levels have caused wetland desiccation and shifts in vegetation from freshwater marshes that existed next to the bay in the early 1900s to saltmarsh and mangrove communities that predominate today.

Present Operation of the Regional System

Sources of Water Supply

Local water supply utilities and individual users obtain water from two primary sources: 1) by withdrawal from a surface water body such as a canal, lake, river, or wetland; or 2) by withdrawal from a ground water well. Virtually all of the LEC public water supply is from ground water except for the city of West Palm Beach. Throughout much of the LEC Planning Area, a regional system of canals provides a means to move water from one location to another. Water is transported generally from north to south, from Lake Okeechobee through water control structures to the EAA canals and into the WCAs. Water flows from the WCAs via structures and canals to Everglades National Park and the coastal basins. Water in coastal canals provides recharge to surficial aquifers, thus enhancing ground water supplies and helping replenish water in lakes, rivers, and wetlands.

Management During Wet Periods

During wet years, seepage from the Everglades is generally more than adequate to maintain water levels in the coastal aquifers and no releases for this purpose are required. However, releases through coastal canals may be required to maintain regulation schedules in natural storage areas, such as Lake Okeechobee and the WCAs, and to provide flood protection.

In order to promote development of coastal basins for urban and agricultural use during the past century, water levels along the coastal ridge have been lowered by construction of drainage facilities. Over time, drainage has continued further westward to allow replacement of most of the wetlands in the Transverse Glades areas in Miami-Dade and Broward counties with homes, farms, and nurseries. Large areas have been mined for the underlying rock that is used for roads and fill.

Due to the high transmissivity of the surficial Biscayne aquifer, lowering of water levels to protect one area results in reduction of water levels over large areas. Attempts to provide drainage and flood protection to coastal areas have thus lowered water tables and shortened hydroperiods of wetlands further west into the Everglades. Large amounts of fresh water that would have remained in these wetlands or moved slowly southward to Everglades National Park have been lost as surface water flow through coastal canals to Biscayne Bay.

Analyses conducted for the Restudy and for the development of the LEC Plan have attempted to compensate for the effects of drainage by establishing long-term restoration goals and management targets that reflect how the natural systems functioned before the area was drained. The Natural System Model (NSM) is used to represent predrainage conditions by simulating hydrologic conditions that existed before canals were constructed and before water levels and topography were altered by drainage. The water levels predicted by the NSM, in conjunction with historical data and expert opinion, were used during the Restudy as a basis to establish Everglades restoration goals for both low water and high water conditions. Consumptive use permits, in turn, consider these restoration water levels as the no harm standard that should be maintained under all conditions less severe than a 1-in-10 year drought.

Due to the conceptual nature of the Restudy and the modeling tools used for the alternative analyses, detailed flood damage assessment was not performed for the Restudy. However, maintaining levels of flood protection remains an important purpose of the C&SF Project and an objective of the CERP. The U.S. Army Corps of Engineers (USACE) will carefully evaluate any potential flood control impacts before any Restudy/ CERP components are built. Project Implementation Reports (PIRs) for individual components, or groups of components, will include a detailed review of flood protection for the area affected by the components. Opportunities for enhancing flood protection in conjunction with other design objectives will be investigated. In addition, the Restudy report includes the provision that, "Flood level protection monitoring will ensure that the existing level of protection is not compromised as a result of implementation of the recommended plan." (USACE and SFWMD, 1999).

Management During Droughts

During dry years, additional water may be released from the regional system through the coastal canals to help recharge surficial aquifers in the coastal basins. These water supply releases are made on an as needed basis, triggered either by a decline in water levels in the canals below their maintenance levels or a movement of the saltwater front in the coastal aquifers as detected in monitoring or production wells. **Figures 23** and **24** show how regional water conveyance facilities are managed during wet and dry periods.

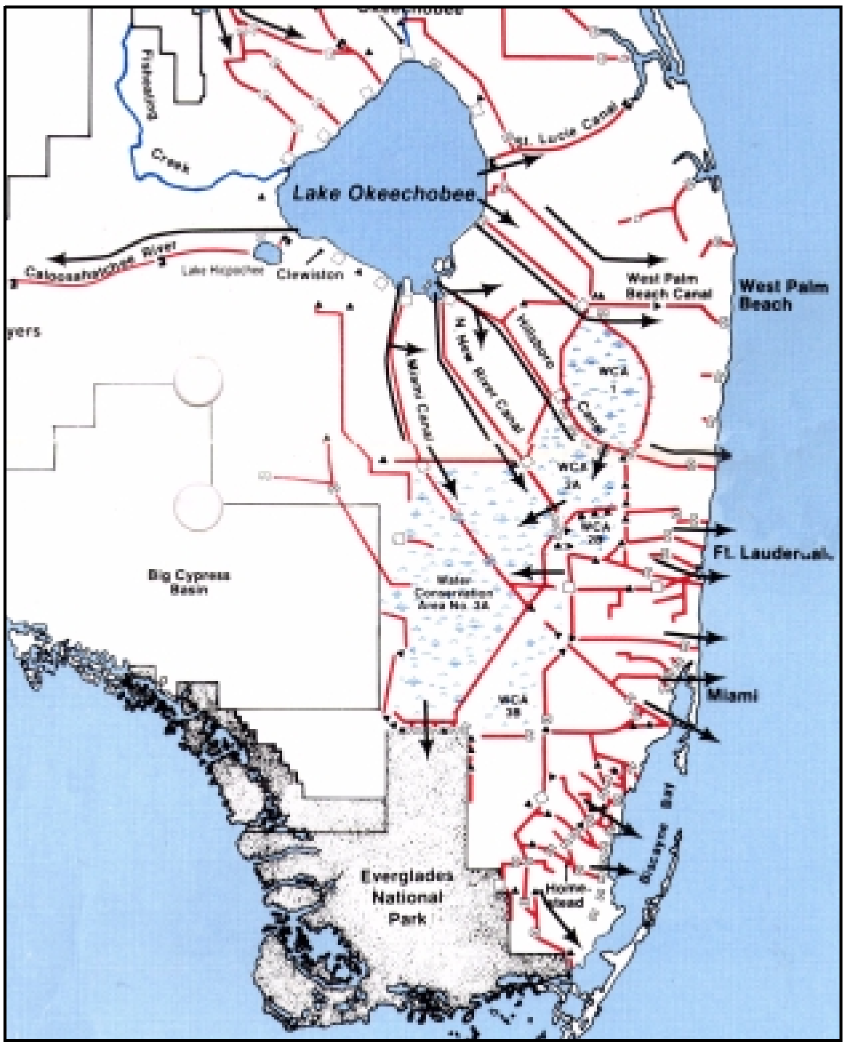

Figure 23. Water Conveyance in the Regional Systems During Wet Periods. Arrows Indicate Direction of Pumpage or Flow.

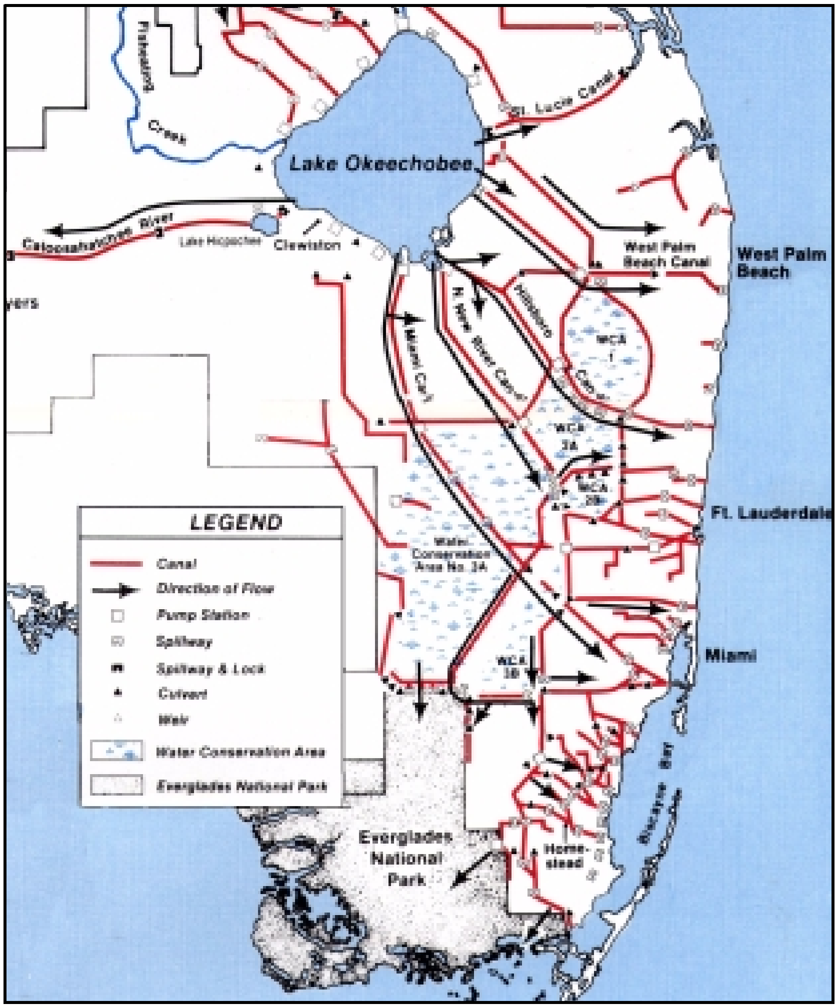

Figure 24. Water Conveyance in the Regional Systems During Dry Periods. Arrows Indicate Direction of Pumpage or Flow.

Supply-Side Management

Water supply allocations from Lake Okeechobee during a drought are determined based on a supply-side management plan. According to this plan, the amount of water available for use during any period of time is a function of the anticipated rainfall, lake evaporation, and water demands for the balance of the dry season in relation to the amount of water currently in storage. Water availability in Lake Okeechobee is calculated on a weekly basis, along with a provision that allows users to borrow from their future supply to supplement existing shortfalls. The borrowing provision places the decision of risk with the user and can significantly affect the distribution of benefits among users because the amount of water borrowed is mathematically subtracted from future allocations. Supply-side management is implemented if it is projected that the lake could fall below 11 ft NGVD at the end of the dry season (May 31).

For Lake Okeechobee, the current procedure is based on a calculation of irrigation water demands in four agricultural basins: the North Shore, the Caloosahatchee, the St. Lucie, and the EAA. Lower east coast urban demands were omitted because they are not generally required during a normal rainfall year; however, they can be significant during dry periods. Another major omission from this calculation is the environmental demand. As part of the LEC Plan, steps will be recommended to improve supply-side management and water shortage management to better address urban and environmental water needs.

Water Shortage Frequencies

The frequency of water shortages is defined based on statistical analysis of data from a particular monitoring station, basin, or region. The numbers represent the estimated time period between occurrences of events that have similar magnitude. Drought events can be defined for different time periods (monthly, dry season, wet season, annual, and biannual) based on a number of different criteria, including lack of sufficient rainfall, lack of adequate water levels in the aquifer, or lack of water available in the regional system.

For example, assume that the average rainfall is 54 inches per year in a particular basin and rainfall of 47 inches occurs this year. Based on statistical analysis of historical data from rainfall monitoring stations within this basin, this degree of deficiency was determined to occur once every ten years. Annual rainfall of 47 inches thus corresponds to a 1-in-10 year drought condition for that basin based on rainfall. Different water management actions may be required, depending on the location, nature, and magnitude of the drought.

Chapter 4
ANALYSIS AND EVALUATION OF MODEL RESULTS

ANALYTICAL PROCESS OVERVIEW

Both regional and subregional computer hydrologic simulations were used extensively by the South Florida Water Management District (District, SFWMD) to help develop the *Lower East Coast Regional Water Supply Plan* (LEC Plan). The South Florida Water Management Model version 3.7 (SFWMM) was used as the principal tool to evaluate overall regional performance, while subregional ground water models were used to simulate impacts at smaller scales, such as effects within service areas and impacts of individual wellfields. Data from SFWMM and subregional ground water model simulations were analyzed and interpreted to determine how to modify and improve the District's water management practices, the major features of the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project), and local water management facilities to meet the future water needs of South Florida. First, present and future base case simulations of the regional SFWMM and the subregional ground water models were made to determine water requirements. From these model simulations it was possible to depict the historic and future water distribution to service areas, the frequency and severity of water shortages, and the ability to achieve environmental goals. This information was then used to evaluate the regional capacity and future water needs of the Lower East Coast (LEC) Planning Area. Second, the effects of the components recommended in the *Central and Southern Florida Project Comprehensive Review Study Final Feasibility Report and Programmatic Environmental Impact Statement* (Restudy) (USACE and SFWMD, 1999) that will be completed by 2020 were determined. Major features of the Restudy will dramatically affect water use and supply throughout the region. Analysis of the Restudy components included a similar examination of water distribution, water shortages, and the ability to achieve environmental restoration goals by 2020.

The LEC planning process then considered other options, either local water supply development or regional water resource development projects that could be implemented to meet future agricultural, urban, and environmental water supply needs by 2020. The planning goal of these efforts is that the local and regional projects combined should provide sufficient water to meet the 1-in-10 year level of certainty criteria for urban and agricultural water users, achieve the proposed minimum water level criteria, and substantially achieve long-term environmental restoration goals of the region. The ability to meet these demands, as identified in various statutes and mandates (meeting Minimum Flows and Levels, providing for public and agricultural water supply needs and achieving Everglades restoration), was evaluated for each model simulation using a comprehensive set of performance measures.

Data from local land use comprehensive plans, utilities, University of Florida Institute of Food and Agricultural Sciences (IFAS), and District permits were used to support these analyses and their assumptions. Conservative best professional judgement was used in circumstances where specific information was not available.

South Florida Water Management Model

The regional South Florida Water Management Model (SFWMM) was used to simulate the major components of the hydrologic cycle in South Florida including rainfall; evapotranspiration; infiltration; overland, ground water, and canal flow; canal-ground water and levee seepage; and ground water pumping. This large-scale (two-mile by two-mile grid size) regional model was developed specifically for the South Florida system, and is currently the best available tool that can simulate both the current and future operational complexities of the regional water control system and provide adequate technical information to make water management decisions (see **Chapter 2** and **Appendix E** for more information on the SFWMM). The base case simulations incorporated current or proposed water management control structures, operational rules, and water shortage policies. Daily hydrologic conditions were simulated using climate data for the 1965-1995 period of record, which includes droughts and wet periods.

Subregional Ground Water Models

Although the SFWMM is the principal tool used in the evaluation of the LEC Plan, five higher-resolution, subregional ground water flow models were developed as part of the planning process to evaluate potential benefits and impacts of specific options on local resources. Ground water models developed during this planning process include (1) the North Palm Beach Ground Water Model; (2) the South Palm Beach Ground Water Model; (3) the Broward Ground Water Model; (4) the North Miami-Dade Ground Water Model; and (5) the South Miami-Dade Ground Water Model. These models use the United States Geological Survey (USGS) modular three-dimensional finite difference ground water flow model, commonly known as MODFLOW. More information concerning these models is provided in **Chapter 2** and each model is described in greater detail in **Appendix F**.

The ground water models were also used to estimate the 1-in-10 year level of certainty for public and agricultural water uses. The simulation period of each model was January 1987 to December 1990. Results are reported only for the last two years to allow the models to warm up for one year. The simulation period from January 1989 to December 1990 contains rainfall deficient conditions that are approximately equivalent to a 1-in-10 year drought.

Other Models

Modeling was also used to analyze water availability and water demands in the Caloosahatchee Basin. These modeling efforts are described in the *Caloosahatchee Water Management Plan* (CWMP) (SFWMD, 2000d). Analytical tools used in this analysis included the Agricultural Field Scale Irrigation Requirements Simulation (AFSIRS) Model, the Water Management Optimization Model, and the MIKE SHE model. The AFSIRS is a surface water budget model which was used to approximate surface water availability in each of the major surface water subbasins in order to quantify the demands that could not be satisfied by surface water. The Water Management Optimization Model was used to determine how to best store and release water as needed to meet urban, agricultural, and environmental needs. The MIKE SHE model is an integrated surface water/ground water model that was used to identify potential impacts of water use on the environment and water resources.

RELATIONSHIP BETWEEN GOALS AND PLANNING CRITERIA

The model simulations were evaluated based on analysis of the planning criteria required by state statute (Section 373.036, F.S.):

- Provide for a 1-in-10 year level of certainty for users, without causing harm
- Protect water resources from significant harm
- Restore hydropatterns to water resources

The performance measures indicate the degree to which the water resource development projects and water supply options are likely to help meet these planning criteria and the goals and objectives of the LEC Plan. Performance measures are specific, selected, hydrologic targets that are outputs of the Natural System Model (NSM), SFWMM, and subregional ground water models. Results based on key performance measures that best summarize the performance of the simulations are presented later in this chapter.

PLANNING CRITERIA AND PERFORMANCE MEASURES

1-in-10 Year Level of Certainty

Each model requires a different approach to determine if a 1-in-10 year level of certainty can be met for urban and agricultural water users. In the Restudy, the 1-in-10 year level of certainty for water supply was determined based on a performance measure that considered the probability that water shortages would be declared during the 31-year period simulated by the SFWMM. An additional performance measure for 1-in-10 year level of certainty was developed for the LEC Plan analysis using the subregional models. Since the subregional ground water models were used to simulate a time period that included a 1-in-10 year, rainfall-deficit, drought condition, performance measures based on simulated ground water stages were used to determine how well local water demands were met during this drought period without causing harm to the environment.

Meeting 1-in-10 Year Level of Certainty for Water Supply During the 31-Year Period of Record

One measure of the ability to meet water supply demands for the Lake Okeechobee Service Area (LOSA) and Lower East Coast Service Areas (LECSAs) is if water supply restrictions can be avoided during the 31-year period of record except during the most severe droughts. State law enables the District to impose water restrictions during droughts to conserve regional water resources. The SFWMM mimics this policy by imposing restrictions on consumptive users when regional water supplies are diminished. Water demands are cut back when low ground water stages occur in selected trigger cells (based on historical monitoring well locations) located along the lower east coast of Florida, low stages in Lake Okeechobee or Water Conservation Area (WCA) canals, or due to continuation of the restriction in the dry season. The SFWMM restricts water supplies in each LEC service area if the LOSA is in Supply-Side Management for seven days consecutively during the dry season (October-May). The LOSA is placed on Supply-Side Management restrictions (or cutbacks) when Lake Okeechobee levels are expected to be lower than 11 ft NGVD at the end of the dry season (May 31). The Supply-Side Management criteria conserve water in the lake to meet crucial events in the future and, thereby, reduce the risk of serious or significant harm.

Results from the SFWMM are displayed for the LOSA and each LEC service area in a table format. The table displays the type, severity, and duration of cutbacks by water year (October-September). Types of cutbacks include those caused by Lake Okeechobee levels, low ground water levels along the coast, and dry season criteria. Water years are used, because counting water demand cutbacks by calendar year would, in some areas, double count events that extend throughout the dry season. The graphic summarizing these SFWMM results is entitled Frequency of Water Restrictions for the 1965-1995 Simulation Period (see **Figure D-1** in **Appendix D**).

The target for the LOSA and the LECSAs is to meet a 1-in-10 year level of certainty for water supply, as determined by counting the number of water years when significant water supply cutbacks occur due to exceeding Supply-Side Management criteria on the lake. A significant water supply cutback event occurs when the total volume of water not supplied to the LOSA exceeds approximately 100,000 acre-feet (ac-ft). To meet the 1-in-10 year level of certainly criterion in the LOSA and the LECSAs, significant water supply cutbacks should occur due to Lake Okeechobee stages in no more than three water years during the 31-year period of record.

For the LECSAs, additional information from the subregional ground water models is needed to assess local ground water conditions. The SFWMM's large cell size and emphasis on surface water hydrology limits its ability to simulate ground water levels and withdrawals along the coast near the model boundary. The ability of the SFWMM to distinguish between water stages at the trigger well and nearby withdrawal wells is limited because the trigger well and withdrawal wells can occur within the same model grid cell. More precise results can be achieved with the subregional ground water models.

Meeting the Level of Certainty for Water Supply During a 1-in-10 Year Drought Event

The second measure of the ability to meet water supply demands is to avoid water supply restrictions during a 1-in-10 year drought event due to low ground water stages along the coast. The subregional models approximate District water shortage policy by simulating restrictions on consumptive users. The ground water models simulate local conditions more accurately than the SFWMM, due to the smaller grid cell size. In addition, they can simulate ground water conditions including stratification of the aquifer.

In the subregional ground water models, the LECSAs are divided into Water Restriction Areas to more accurately reflect how the District's water shortage policy may be implemented. Results from ground water models are displayed spatially for each service area and as a table showing locations of trigger cells and the severity and duration of cutbacks by cause: Lake Okeechobee levels, low ground water levels along the coast, or dry season criteria. Information on cutbacks due to Lake Okeechobee stage is imported from the SFWMM to the subregional ground water models.

Due to the size and complexity of the subregional ground water models, they simulate a shorter period of record that includes a 1-in-10 year drought event. It begins June 1989 and ends May 1990 for North Palm Beach Service Area, LEC Service Area 1 (LECSA 1), and LEC Service Area 2 (LECSA 2). The rainfall drought for LEC Service Area 3 (LECSA 3) begins and ends one month earlier. Regional conditions are from the same historical period and are considered to be within the range of average regional flows from ground and surface water sources (see **Appendix I** for more information). To meet a 1-in-10 year level of certainty in LECSA, no water restrictions should occur during the 1-in-10 year drought event due to low ground water stages in selected trigger cells as simulated by the ground water models. The graphic summarizing these results is entitled Frequency and Severity of Water Restrictions by Water Restriction Area (see **Figure D-2** in **Appendix D**).

Saltwater Intrusion Analysis

Areas within the LEC Planning Area that have the highest potential for saltwater intrusion were determined using the following criteria:

- Water restriction frequency and duration
- Ground water stages as indicated by water shortage trigger wells
- Net westward ground water flow along the saline water interface

The application of water restrictions was discussed above. The two remaining factors are discussed below.

Water Levels as Indicated by Water Shortage Trigger Wells

Information about ground water stages at trigger wells is obtained as an output from the subregional ground water models. Ground water stages along the coast are indicative of changes elsewhere in the LEC Planning Area. Water shortage triggers, or water levels at which phased restrictions will be declared under the District's water shortage program, are used to curtail withdrawals by water use types. Such curtailment is imposed to avoid water levels declining to and below levels where serious or significant harm (i.e., saltwater intrusion) could potentially impact water resources (such as the Biscayne aquifer).

Saline Water Intrusion Criterion

The saline water intrusion criterion for the LEC Plan is defined as follows: water use withdrawals should not cause water flows towards the east in the Surficial Aquifer System to be less than the flows west near the saline water interface during a 12-month drought condition that occurs as frequently as once every 10 years. If ground water flow east towards the coast is less than the flow west, the saline interface has the potential to move. Ground water flows east were subtracted from the westward flows to calculate the net westward flow. Only positive flows (to the west) are shown in the performance measure graphic. The net flow is calculated for all layers of the models based on results of the subregional ground water models for the LECSAs.

This protection criterion is established to protect the quality and sustainability of the Surficial Aquifer System and to avoid impacts to existing users. The subregional ground water models used for the LEC Plan were not configured as chemical transport models and, therefore, cannot be used directly to simulated saline water intrusion. Instead, staff assumed that a net westward flow of water across the freshwater-saltwater interface is an indicator of potential intrusion. In general, proximity of a water use to the saline water interface necessitates a detailed evaluation prior to implementing an alternative or issuing a consumptive use permit. Given the regional nature of the plan, the ground water flow, water level, and water restriction analyses method were used to screen for the potential of coastal wellfields to induce westerly flow of saline water over large areas. Additional criteria or refinement of these methods will be applied during the Consumptive Use Permitting (CUP) process. See **Figure D-11** in **Appendix D** for an example of the output for this performance measure**.**

Isolated Wetland Protection Criteria

Criteria have also been defined for isolated wetlands which lie outside of the Everglades Protection Area in the LOSA and the LECSAs and are protected from harm due to water use permits up to 1-in-10 year droughts. The following criteria was applied to results from the subregional ground water models: ground water stage drawdowns induced by cumulative pumping withdrawals beneath wetlands should not exceed one foot at the edge of the wetland for more than one month during a 12-month drought condition that occurs as frequently as once every 10 years. For planning purposes, this criterion was applied to surficial aquifer drawdowns in areas that have been classified as wetlands according to the National Wetlands Inventory (NWI). The NWI cover was partially updated to reflect land use changes, primarily urban development, near wellfields. See **Figure D-10** in **Appendix D** for an example of the output from this performance measure.

Because of variations in methods used to identify and characterize wetlands, as well as temporal changes that occur in wetland characterization resulting from environmental resource mitigation activities, maintaining a detailed regional geographic inventory of local wetland conditions is difficult and beyond the scope of this plan. Instead, the best available geographic data was compiled and processed to provide a reasonable representation of wetland locations. In practice, implementation of the LEC Plan will require an inventory of potentially affected wetlands for protection or mitigation. Further, the criteria used for the LEC regional water supply planning analysis are not the same as the criteria used in the CUP Program. The CUP criteria will undergo rulemaking as part of the implementation of the District's regional water supply plans. The LEC Plan's criteria are used as a screening tool to alert future permittees of the need to evaluate wetlands in the vicinity of proposed withdrawals. More information regarding future rulemaking is included in **Chapter 5** and **Chapter 6**.

Minimum Flows and Levels

Minimum Flows and Levels (MFL) are the point at which further withdrawals would cause significant harm to water resources. The LEC Plan is statutorily required to achieve MFLs that have been established for priority surface water bodies and aquifers or to develop a recovery and prevention strategy for those water bodies that are expected to exceed the proposed criteria. In the LEC Planning Area, MFLs have been proposed for three priority water bodies: Lake Okeechobee, the Everglades, and the Biscayne aquifer. The criteria defined in the *Minimum Flows and Levels for Lake Okeechobee, the Everglades, and the Biscayne Aquifer Final Draft Report* dated February 29, 2000, (SFWMD, 2000e) are described below and were incorporated into the modeling targets for the LEC Plan. In addition, MFLs are scheduled to be established for the Caloosahatchee River. These criteria were addressed in the CWMP and incorporated into the LEC Plan.

The ability to meet the proposed MFL criteria was determined by examining flow rates, water depth, duration of low water conditions, and return frequencies in Lake Okeechobee, coastal canals, and at various locations in Everglades' peat soil and marl soil environments. The ability to achieve MFLs was assessed using the SFWMM for the 31-year simulation period. The subregional models were not used for such analyses because of the relatively short time period (two years) evaluated in these models and because they do not simulate Lake Okeechobee water levels; coastal canal stages, that are part of the Biscayne aquifer criteria; or many of the Everglades MFL gage locations.

Meeting MFL Criteria for Lake Okeechobee

Significant harm criteria developed for Lake Okeechobee were based on the relationship between water levels in the lake and the ability to a) protect the coastal aquifer against saltwater intrusion, b) supply water to Everglades National Park, c) provide littoral zone habitat for fish and wildlife, and d) ensure navigational and recreational access. Consideration was also given to the lake's function as a storage area for supplying water to adjacent areas such as the Everglades Agricultural Area (EAA), the Seminole Indian Tribe Reservervations, the Caloosahatchee and St. Lucie basins, and the LOSA.

Water Supply Planning MFL Criteria

Water levels should not fall below 11 ft NGVD for more than 80 days duration, more often than once every six years, on average (SFWMD, 2000e).

Meeting MFL Criteria for the Everglades

Technical relationships considered for developing MFL criteria for the Everglades included the effects of water levels on hydric soils and plant and wildlife communities, and frequency and severity of fires. Impacts associated with significant harm include increased peat oxidation, frequency of severe fires, soil subsidence, loss of aquatic refugia, loss of tree islands, and long-term changes in vegetation or wildlife habitat. The proposed minimum water level criteria for the Everglades were based on protecting the two dominant soil types found within the ecosystem as follows:

MFL Criteria for Peat-Forming Wetlands

Water levels within wetlands overlying organic peat soils within the WCAs, Rotenberger and Holey Land wildlife management areas, and Shark River Slough (Everglades National Park) shall not fall below ground surface for more than 30 days and shall not fall below 1.0 foot below ground for one day or more of that 30-day period, at specific return frequencies for different areas, as identified in **Table 44** later in this chapter.

MFL Criteria for Marl-Forming Wetlands

Water levels within marl-forming wetlands that are located east and west of Shark River Slough, the Rocky Glades, and Taylor Slough within Everglades National Park, shall not fall below ground surface for more than 90 days and shall not fall below 1.5 feet below ground for one day or more of that 90-day period at specific return frequencies for different areas, as identified in **Table 44** later in this chapter.

Meeting MFL Criteria for the Biscayne Aquifer

Criterion for the Biscayne aquifer were developed based on analysis of technical relationships among ground water levels and canal water levels, and the potential for saltwater intrusion. Harm occurs when the saltwater interface moves further inland than has occurred historically due to seasonal water level fluctuations, up to and including a 1-in-10 year drought. Significant harm occurs when saline ground water moves inland to an extent that it limits the ability of users to obtain fresh ground water in the amounts specified in their permits and will require several years for the freshwater source to recover.

The proposed criteria do not address the ground water base flows to Biscayne Bay or Florida Bay. Data are presently being collected to define MFLs for these water bodies.

Biscayne Aquifer Minimum Level

The term minimum level for the Biscayne aquifer refers to water levels associated with movement of the saltwater interface landward to the extent that ground water quality at the withdrawal point is insufficient to serve as a water supply source for a period of several years before recovering. For evaluation of model simulations, operational criteria are applied to the coastal canals that receive regional water. **Table 6** provides the minimum canal operational levels for eleven primary water management structures. To meet the operational criteria, the canal stage cannot fall below the levels for more than 180 days, and the average annual stage must be sufficient to allow levels and chloride concentrations in the aquifer to recover to levels that existed before a drought or discharge event occurred. See **Figure D-4** in **Appendix D** for an example of the model output for this performance measure.

Table 6. Minimum Canal Operation Levels of Coastal Canals.

Canal/Structure	Minimum Canal Operation Levels to Protect Against MFL Violations (ft NGVD)
C-51/S-155	7.80
C-16/S-41	7.80
C-15/S-40	7.80
Hillsboro/G-56	6.75
C-14/S-37B	6.50
C-13/S-36	4.00
North New River/G-54	3.50
C-9/S-29	2.00
C-6/S-26	2.50
C-4/S-25B	2.50
C-2/S-22	2.50

Meeting MFL Criteria for the Caloosahatchee Estuary

The proposed Caloosahatchee Estuary MFL criteria is based on maintaining freshwater base flows to the upper reaches of the Caloosahatchee Estuary, which will prevent excessive salinity levels in the estuary from causing significant harm to submerged aquatic vegetation and fish and invertebrate communities. Research data were used to relate freshwater flow rates to salinity distributions along the Caloosahatchee River and to correlate biologic community responses to varying salinity conditions. These relationships were established for submerged aquatic vegetation, fish, and invertebrates with major emphasis on the salinity requirements of the freshwater grass *Vallisneria* (commonly known as tape grass or eel grass). It was determined that the distribution and abundance of *Vallisneria* at a location 30 kilometers upstream of Shell Point is the best biological indicator for addressing freshwater flow needs for the restoration of the Caloosahatchee Estuary. The magnitude of die-off, combined with the frequencies of die-off events, and the resulting impact to fisheries resulting from the loss of *Vallisneria* habitat formed the basis of the proposed MFL criteria.

Proposed Estuary Minimum Flow Criteria

Low freshwater flows, when sustained, cause an increase in salinity, that result in die off of *Vallisneria* to less than 20 shoots per square meter as measured at a monitoring station located 30 kilometers upstream of Shell Point during the months of February through April. Significant harm to the Caloosahatchee Estuary is considered to occur when these freshwater grasses die back due to high salinity from low freshwater inflows for three years in succession. Harm to the Caloosahatchee Estuary is considered to occur when freshwater grasses die back due to high salinity from low freshwater inflows, for two consecutive years. The freshwater inflow needed to prevent harm or significant harm is an average of 300 cubic feet per second (cfs) per day at the S-79 structure during the months of February through April.

Environmental Resource Management Performance Indicators

Restoration Criteria from the Restudy

A number of resource protection criteria and performance measures that relate to hydropattern restoration of wetland systems and mimic the performance targets and evaluation criteria were used in the Restudy. The recommendations made within the Restudy will be refined and implemented in the Comprehensive Everglades Restoration Plan (CERP) currently being developed. District staff reviewed the Restudy natural area performance measures and indicators and incorporated them or revised versions of them into the LEC Plan as appropriate. Review of performance criteria showed that the model simulation for the 2020 with Restudy features completed by 2020 did not match the performance of model simulation for 2050 with CERP (Alternative D13R), because not all restoration components will be in place by 2020 (e.g., the Lake Belt projects are only about 50 percent complete by 2020). It was also recognized that the Alternative D13R simulation did not meet every target in 2050, hence the 2020 LEC Plan does not meet all of the performance measure targets identified in the CERP. Performance measures used in the LEC Plan were developed to evaluate the potential for the LEC Plan to achieve the following:

- Meet MFL criteria
- Promote protection and accretion of peat and marl soils
- Protect tree island communities
- Reestablish inundation patterns that will maintain Everglades sawgrass or ridge and slough marsh communities

In many areas, historic water conditions as predicted from results of the Natural System Model (NSM), were considered to be appropriate targets. For WCA-1 and WCA-3A, other targets were developed by the Restudy evaluation process that are more appropriate than NSM-like targets. Model results for each alternative were evaluated at the level of individual indicator regions (**Figure 25**). An indicator region is a group of model grid cells with similar vegetation and soil type.

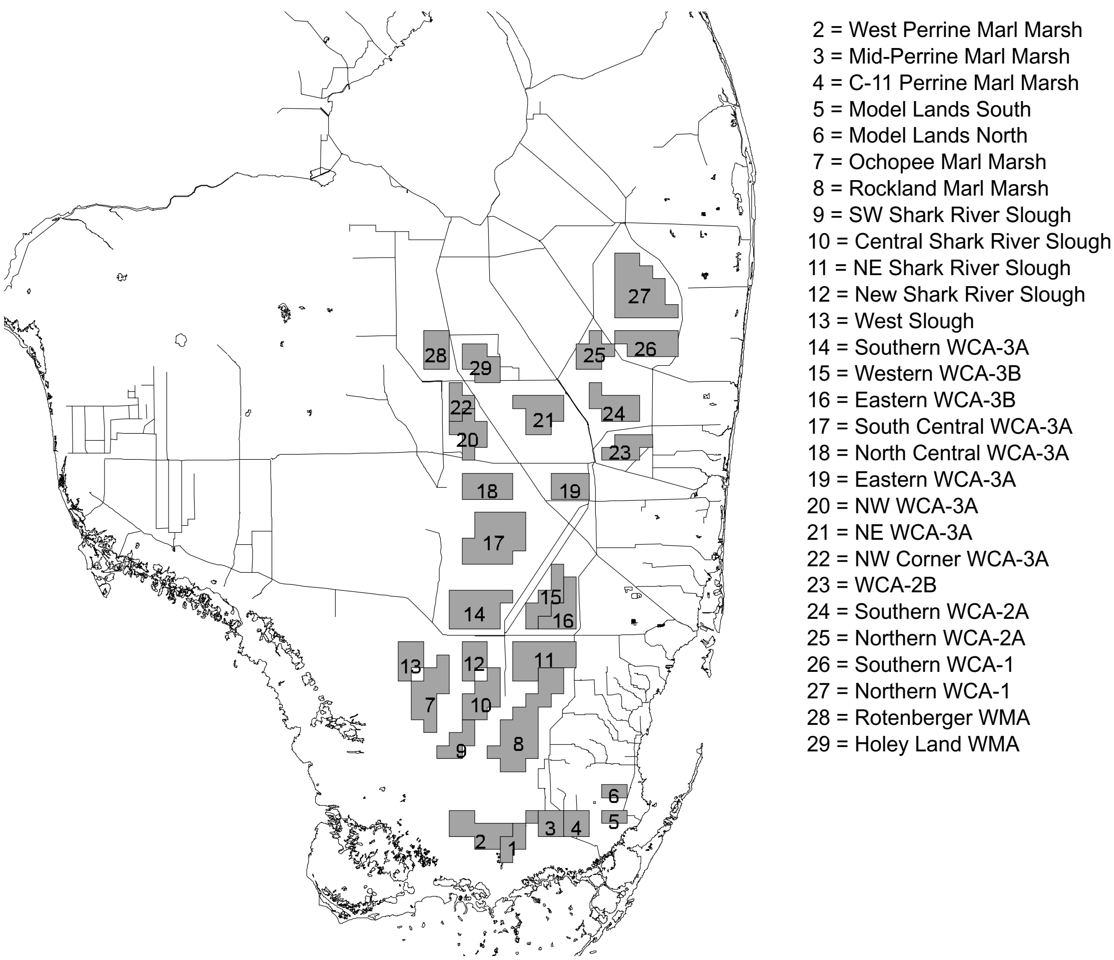

Figure 25. Locations of Indicator Regions Within the Everglades That Were Evaluated for the LEC Plan.

Performance of the model simulation was evaluated by considering the following performance measures, which are further described in **Appendix D**:

- The ability to meet MFL criteria for selected indicator regions
- The ability to meet NSM-defined patterns of surface water flooding inundation/duration where appropriate
- The number and duration of extreme high and low water events
- Interannual depth variation
- Temporal variation in mean weekly stage

Extreme High and Low Water Criteria

The following performance measures were initially developed by the Southern Everglades Restoration Alliance Natural Systems Team. These performance measures were used to evaluate SFWMM output and identify those areas of the Everglades that may suffer from either extreme high water or extreme low water events that impact the structure and function of existing wetland communities. These same performance measures were also used to screen proposed alternatives as outlined in the Restudy. In implementing the plan, it will be necessary to recognize that these performance measures, which are intended for comparison among model simulations, are not likely to translate directly into management criteria. Instead, further work will be needed to develop the information base from which to establish actual high and low water level targets for management purposes. It needs to be clearly recognized that the high and low water criteria contained in **Appendix D** were used primarily to identify extreme high or low water events that may impact Everglades tree islands, soils, plants, and/or wildlife communities. These criteria should not be interpreted as desired Everglades management objectives, but rather as screening tools to identify undesirable high or low water levels that should occur infrequently or be avoided.

Low Water Criterion. For extreme low water events, a criterion of 1.0 foot below ground surface was used for all indicator regions in the northern Everglades where peat-forming wetlands occur. A criterion of 1.5 feet below ground surface was applied to marl-forming soils located within the southern Everglades. These criteria are similar to the MFL water depth criteria proposed for the Everglades (SFWMD, 2000e).

High Water Criterion. For extreme high water events, a criterion of 2.5 feet above the ground surface was used in the northern Everglades (WCA-1, WCA-2, and WCA-3, except for northeastern WCA-3A [Indicator Region 21]). These regions are part of the historic Everglades predrainage ridge and slough landscape (McVoy, et al., in review), and include a variety of tree island types ranging from low stature peat islands that rise less than 1.0 foot above marsh ground elevation to tropical hardwood hammocks that exceed marsh ground elevation by more than 4.0 feet at their summits. The 2.5 feet criterion was based on several sources of information: 1) best professional judgement derived from federal and state agency scientists who have conducted research in the WCAs; 2) analysis of data collected from recent (1994 - 1995) high water events in

WCA-3A (Guerra, 1996); and 3) recent tree island and slough water level information collected from WCA-3A and WCA-3B by the Florida Wildlife Commission (FWC), formerly known as the Florida Fish and Wildlife Conservation Commission (FFWCC) (Heisler and Towles, 1999). For Indicator Region 21 in northeastern WCA-3A, a high water criterion of 2.0 feet was used, based on the rationale that this area of the Everglades was originally part of the remnant sawgrass plains and overall depth targets should be lower than for the ridge and slough landscape.

Based on the recommendations of FWC staff, a high water criterion of 1.5 feet was used for the Rotenberger WMA (Indicator Region 28), based on observations that tree islands in this area have reduced elevations as a result of peat loss from wildfires. For the Holey Land WMA (Indicator Region 29), a criterion of 1.5 feet was initially set, based on FWC observations that tree island wildlife refuges in the Holey Land WMA are eliminated once water depths exceed 1.5 feet. This criterion was later revised to 1.75 feet following further discussion with the FWC staff. As a result, a value of 1.5 feet appears in SFWMM output tables for the Holey Land WMA, although District staff actually used 1.75 feet as a minimum target for interpreting model output.

Interim Management Targets for Other Areas

For the St. Lucie River, the low flow, high flow, and estuary protection flow rates as defined by ongoing research and management studies, were used as performance measures. For Lake Worth Lagoon, only a high flow criterion has been defined. The performance measures for Biscayne Bay are composed of mean annual wet and dry season surface flows from various tributary canals. For the purposes of this study, the performance target for Biscayne Bay is that future flows delivered to the estuary should be similar to the flows provided in the 1995 Base Case. For western Florida Bay and Whitewater Bay, performance is based on surface flow at key gages and total flows delivered to the estuaries across selected transects located in central Shark River Slough. Flow targets are based on the ability to sustain the aquatic resources in the bays. These provisional criteria are subject to change as additional studies are completed and the District completes the actions needed to develop technical criteria, define MFLs, and implement associated rules that affect these estuaries (See **Recommendations 35** through **37** in **Chapter 6** and **Appendix J**).

Additional Performance Indicators

Water Supply Performance Indicators

A number of additional performance measures are routinely evaluated to determine the ability of the regional water supply system to provide water to individual utilities. These measures are used to identify specific areas where problems may occur, possible causes, and potential solutions. Measures used include the following (see **Appendix D** for more information):

- Daily hydrographs for each trigger cell in water restriction areas

- Monthly volumes of simulated water supply cutbacks for restriction areas
- Percentage of annual demand not met, by use type, for restriction areas
- Frequency and severity of water supply restrictions

Hydrologic Performance Indicators

A number of additional measures were used in the evaluation that did not have specific targets, but provided an overall indication of the relative behavior of each water supply alternative. Measures used include the following (see **Appendix D** for more information):

- Weekly stage hydrographs and stage-duration curves for selected indicator regions
- Normalized stage duration curves and hydrographs for selected indicator regions
- Hydroperiod distributions and hydroperiod matches
- Ground water flows, ground water heads, and overland flows

MODEL SIMULATIONS

Overview of Model Simulations

In the SFWMM and subregional ground water models, base case model simulations were conducted to determine current and future conditions of the LEC Planning Area. The 1995 estimated public water supply demand (1995 Base Case) and the 2020 projected public water supply demand (2020 Base Case) were used for these simulations. The 2020 base case assumed that a) water withdrawals for Public Water Supply reflect LEC utilities' preferred sources, b) future water users would withdraw water in the quantities indicated by public water suppliers, and c) existing agricultural and irrigation water users would use the same sources for both their current and future demands, unless information was made available indicating a change. The existing and projected uses of reclaimed water and Aquifer Storage and Recovery (ASR) systems (where information was available) were incorporated into the simulations.

In addition, the future base case assumes that other currently ongoing or proposed construction and planning efforts have been completed, including the Everglades Construction Project, Modified Water Deliveries to Everglades National Park, and the C-111 Basin project. Base case simulations represent the no action approach to water resource and supply development and are not a likely scenario.

Next, SFWMM and subregional ground water model simulations that include Restudy components were completed. It is anticipated that components of the Restudy will be substantially completed by 2020, with one notable exception: the Central and North Lake Belt storage areas. These projects are expected to be only 50 percent complete by 2020. These model simulations are referred to as 2020 with Restudy.

Additional simulations were also made to determine the cumulative effects of water supply withdrawals by utilities. In these simulations, referred to as LEC-1A, public water supplies and supplemental irrigation uses for golf courses, nurseries, agricultural crops, and landscaping were eliminated from the subregional ground water models. In the SFWMM simulations, only public water supply withdrawals were eliminated. ASR facilities associated with the Restudy remained active.

SFWMM simulations were also made to determine incremental benefits of proposed operational and structural changes over time, to simulate conditions that may exist in 2005, 2010, and 2015, as features of the Restudy, the LEC Plan, and other activities are completed. Additional improvements to water resource and water supply development projects that were identified in LEC-1 simulation were incorporated into the LEC-1 Revised simulation. An additional incremental modeling scenario, the 2005 SSM Scenario was also completed. The 2005 SSM Scenario was exactly the same as the 2005 incremental simulation, except that in the 2005 SSM Scenario Lake Okeechobee stages at which supply-side management restrictions are triggered (indicated by the supply-side management line) were lowered by 0.5 feet from the beginning of October through the end of May. The Lake Okeechobee target for May 31 was also reduced from 11.0 to 10.5 ft NGVD in the 2005 SSM Scenario.

Even though both types of models, the SFWMM and the subregional ground water models, simulate the LEC service areas, and its associated public water supply withdrawals, comparison of results between these two types of models is not appropriate due to differences in how features are simulated. Each model should be used to evaluate the areas and features for which it is best suited. The SFWMM, with its ability to simulate overland flow in wetlands, Lake Okeechobee, and the coastal canals, and its long simulated period of record, is best suited to analyze long-term regional trends in performance of those features. The ground water models with their small cells, stratification of the aquifer, and short time periods are adept at simulating small-scale features such as changes in wellfield locations, effects of ASR withdrawals, and ground water stages along the coast. The SFWMM with its large cells tends to lump these features and limit its sensitivity to small changes in assumptions and performance.

Both types of models, the regional SFWMM and subregional ground water models, initially performed five simulations: the 1995 Base Case, the 2020 Base Case, the 2020 with Restudy features, the LEC-1, and LEC-1A (no public water supply). Acronyms for these simulations are provided in **Table 7**. These same acronyms are used on the performance measure graphics compiled in **Appendix H**.

Table 7. Acronyms for SFWMM and Subregional Ground Water Model Base Case and Alternatives Simulations.

Simulation	SFWMM Acronym	Ground Water Model Simulation Acronym
1995 Base Case	95BSR	95Base
2020 Base Case	20BSR	20Base
2020 with Restudy	2020WR	20wres
LEC-1	LEC-1	LEC-1
LEC-1A	LEC-1A	LEC-1A

Assumptions for Base Cases and Alternatives

The regional and subregional models simulate the hydrology of South Florida on a daily basis including major components of the hydrologic cycle: rainfall, evapotranspiration, infiltration, ground water flow, canal flow, canal-ground water seepage, levee seepage, and ground water withdrawals. The SFWMM uses the climatic conditions from the 1965-1995 period, which includes both droughts and wet periods, while the subregional ground water models simulate the dry period from January 1988 to December 1990. The 1995 Base Case provides an understanding of the how the 1995 water management system with 1995 land use and demands responds to historic (1965-1995) climatic conditions. The 2020 Base Case provides information of how the system would respond to anticipated future operations and demands under the same historic climatic conditions with currently authorized restoration projects implemented, but without Restudy features. Comparison of the 1995 and 2020 base cases shows system performance with increased demands and inclusion of new projects and operating criteria.

The 2020 with Restudy simulations provide information on how the system performs with the implementation of the Restudy projects that would be completed by 2020 along with 2020 demands and operating criteria. The LEC-1 simulation provides information on how additional changes to water resource and water supply development projects may alter hydrologic performance.

The LEC-1A simulation was undertaken to understand the impact that permitted consumptive uses might have on the regional system. Using the subregional ground water models, effects on wetlands can be evaluated by comparing ground water stages in the LEC-1 simulation to the LEC-1A simulation. The manner in which the SFWMM and subregional ground water models simulate this varies. The SFWMM does not include public water withdrawals in Palm Beach, Broward, Miami-Dade, and Monroe counties, but includes agricultural and landscape irrigation demands. The subregional ground water models more closely mimic the permit review process by eliminating all consumptive uses (public water demands, agriculture, and landscape irrigation) within the models' boundaries from this simulation. In both simulations, ASR systems recommended in the Restudy operate as designed.

Primary Differences Between Base Cases and Alternatives

The major differences between the different types of model simulations are 1) changes in public water supply demands and locations of withdrawals, 2) inclusion of future projects and components, 3) modifications to Lake Okeechobee and WCA operation schedules, and 4) changes in land use between 1995 and 2020 and the resulting effect on agriculture and landscape irrigation demands. **Table 8** provides a summary of the the assumptions used in the 1995 and 2020 base cases, the 2020 with Restudy, and the LEC-1 simulations.

Table 8. Comparison of Assumptions in the 1995 and 2020 Base Cases, 2020 with Restudy, and LEC-1 Simulations.

Feature	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1	LEC-1A
Land Use for Urban and Agricultural Areas	Best available information for 1995	Projections based on county comprehensive plans; adjusted to reflect construction of Stormwater Treatment Areas (STAs)	Projections based on county comprehensive plans; adjusted to reflect construction of STAs and reservoirs as per Restudy	Projections based on county comprehensive plans; adjusted to reflect construction of STAs and reservoirs as per Restudy	Projections based on county comprehensive plans; adjusted to reflect construction of STAs and reservoirs as per Restudy
Vegetation Cover for Natural Areas	Best available information; generally reflect conditions between 1990-1995	Best available information; generally reflect conditions between 1990-1995	Best available information; generally reflect conditions between 1990-1995	Best available information; generally reflect conditions between 1990-1995	Best available information; generally reflect conditions between 1990-1995
LOSA Mean Annual Supplemental Irrigation Demands	170,000 ac-ft	191,000 ac-ft	239,000 ac-ft	227,000 ac-ft	227,000 ac-ft
EAA Mean Annual Supplemental Irrigation Demands	372,000 ac-ft	335,000 ac-ft	327,000 ac-ft	328,000 ac-ft	328,000 ac-ft
Lake Okeechobee Regulation Schedule	Run 25 Schedule	Water Supply and Environmental (WSE) Schedule	Modified Run 25 Schedule	Modified WSE Schedule	Modified WSE Schedule
Lake Okeechobee Supply-Side Management for LOSA	Yes	Yes	Yes	Yes	Yes
Caloosahatchee River Basin Demands (including municipal demands)	Demands based on historical records	25 percent increase over 1995 average annual demands	25 percent increase over 1995 average annual demands	25 percent increase over 1995 average annual demands	25 percent increase over 1995 average annual demands
Caloosahatchee Backpumping	N/A	N/A	As per Restudy	Reduced to zero as per CWMP	Reduced to zero as per CWMP
St. Lucie River Basin Demands	Demands based on historical records	Same as 1995	Same as 1995	Same as 1995	Same as 1995
C-44 Basin Storage Reservoir	N/A	N/A	As per Restudy	Modified as per Indian River Lagoon Feasibility[a] Study	Modified as per Indian River Lagoon Feasibility[a] Study
Brighton Seminole Indian Reservation Demands	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	52,000 ac-ft per year	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr

Table 8. Comparison of Assumptions in the 1995 and 2020 Base Cases, 2020 with Restudy, and LEC-1 Simulations. (Continued)

Feature	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1	LEC-1A
STAs Associated with the EAA	No	Yes	Yes	Yes	Yes
EAA Runoff Reduction and Make-Up Water BMPs	No runoff reduction or make-up water delivered	No runoff reduction or make-up water delivered	20 percent EAA runoff reduction and make-up water delivered	No runoff reduction or make-up water delivered	No runoff reduction or make-up water delivered
Make-Up Water Associated with BMPs from Lake Okeechobee	No	No	No	No	No
WCA-1 Schedule	C&SF Interim Regulation Schedule	C&SF Interim Regulation Schedule	C&SF Interim Regulation Schedule	C&SF Interim Regulation Schedule	C&SF Interim Regulation Schedule
WCA-2 and WCA-3 Schedules	Current regulation schedule	Rain-driven operations and Modified Water Deliveries Project	Rain-driven operations	Rain-driven operations	Rain-driven operations
Everglades National Park Operations	Experimental Rainfall Delivery Plan via S-12s and S-333	As per Modified Water Deliveries Project	As per Restudy	As per Restudy	As per Restudy
LECSAs Population for Utilities	4,755,776 persons	6,951,998 persons as per LEC utility survey	6,951,998 persons as per LEC utility survey	6,951,998 persons, as per LEC utility survey	6,951,998 persons, as per LEC utility survey
LECSAs Public Water Supply Demands on Surficial Aquifer System and Surface Water	Actual 1995 demands: 286,429 MGY (784.1 MGD)	Projected demands based on LEC utility survey: 443,411 MGY (1,214.8 MGD)	Projected demands based on LEC utility survey: 443,411 MGY (1,214.8 MGD)	Projected demands based on LEC utility survey: 443,411 MGY (1,214.8 MGD)	No public water supply demand
LECSAs Public Water Supply Wellfield Distribution	Actual 1995 locations	Utility preferred wellfield locations, as per LEC utility survey	As per Restudy	Modifications to eleven utilities preferred wellfield locations as per LEC utility survey	Not applicable
LECSAs Water Shortage Policy	Yes	Yes	Yes	Yes	Yes
LEC Irrigation Demands on Surficial Aquifer System	Based on 1995 land use and climatic variation	Based on projected 2020 land use and climatic variation	Based on projected 2020 land use and climatic variation	Based on projected 2020 land use and climatic variation	Based on projected 2020 land use and climatic variation
Operational Adjustments to Meet MFLs for Biscayne Aquifer	No	Canal operation criteria (**Table 23**)	Canal operation criteria (**Table 23**)	Canal operation criteria (**Table 23**)	Canal operation criteria (**Table 23**)
L-8 Project[b]	No	Yes, as per the LEC Interim Plan	Yes, as per Restudy	Yes, as per Restudy	Yes, as per Restudy
Northern Broward County Secondary Canal Network[b]	No	Yes, as per the LEC Interim Plan	Yes, as per Restudy	Yes, as per Restudy	Yes, as per Restudy
Miami-Dade Utility ASR[b]	No	150 MGD	150 MGD	75 MGD	75 MGD
Miami-Dade County Reuse[b]	No	No	100 MGD at west facility	50 MGD at west facility	50 MGD at west facility

a. USACE, 1996
b. Ongoing project from the *Interim Plan for Lower East Coast Regional Water Supply* (SFWMD, 1998b)

Public Water Supply Demands

The simulations used two demand sets (allocation sets) for public water supply in the LEC Planning Area: 1995 and 2020. The 1995 demands represent estimated average annual demands for that year (286,429 MGY). The 2020 demands (443,411 MGY) are a projection of future demands provided by public water suppliers to District staff in January 1999. **Appendix B** contains a detailed discussion of estimated and projected public water supply demands. These projected 2020 average annual demands are used in the 2020 simulations (2020 Base Case, 2020 with Restudy, and LEC-1).

The District also developed 2020 public water supply projections in the *Districtwide Water Supply Assessment* (DWSA) (SFWMD, 1998c). The DWSA projected total demands in the LEC Planning Area as 389,440 MGY. The utility projections anticipated a 14 percent higher demand in 2020 than the estimates in the DWSA. The average public water supply per capita rate for the LECSAs fairly constant for the utility (176 gallons per capita daily [gpcd]) and District projections (179 gpcd). Most utilities continued their current per capita water consumption rate, while some anticipate a lower per capita rate coupled with higher population projections or vice versa. These two projections were considered to represent low and high values that bracket a range of future projections. Conservation of water may increase in the future as a greater percentage of houses use low flow fixtures, have smaller yards, or depend on reuse for irrigation. Thus, the lower projection may prove accurate. On the other hand, the population may grow at or above the rates the utilities anticipate and the higher demand projections may be reached. Using the higher demand in the LEC Plan is the more conservative approach. In this case, water resource development projects are needed immediately to meet environmental demands. The population and demand projections will be reassessed for each utility during the CUP process and future updates of LEC Plan.

The physical locations of public water withdrawals also vary between the 1995 and 2020 simulations (see **Appendix B** for maps). In the 1995 Base Case, withdrawals are similar to historic conditions in 1995, i.e., only wells existing in 1995 and the corresponding wellfield distribution were included. In the future 2020 model simulations, locations of withdrawals include new wells built since 1995 and proposed locations provided by public water supply utilities to the District in January 1999. Data provided by the utilities consist of their initial or preferred locations and the resulting distribution of withdrawals among the wellfields. To view how the SFWMM simulates these demands at the utilities preferred locations, refer to the Spatial Distribution of Public Water Supply Demands section in **Appendix B**. Some utilities proposed many new wells to meet future demands while others foresee constructing no new wells by 2020.

The physical locations of public water withdrawals also vary between the 2020 with Restudy and the LEC-1 model simulations. In the 2020 with Restudy, withdrawal locations are similar to those used in the Restudy's Alternate D13R simulation (USACE and SFWMD, 1999). The Restudy relied upon the SFWMM and its four square mile grid to simulate LEC urbanized areas. The primary method to alleviate low ground water levels along the coast and anticipate future well locations was to move public water supply demands inland. The large grid cells do not enable the degree of refinement of well distributions or locations that is possible with the subregional ground water models. In the LEC-1 simulations, most withdrawal locations are the same as in the 2020 Base Case. The LEC-1 incorporates the utility preferred locations for future wells. In addition, eleven utilities had at least a portion, if not all, of their withdrawals relocated to existing wellfield locations further inland to reduce the threat of saltwater intrusion and/or reduce the frequency water supply restrictions. These locations are assumed only for modeling and planning purposes and are not meant to imply that permits are obtainable.

Agricultural Water Supply Demands

In the SFWMM, the 1995 demand level represents estimated agricultural water demands for acreage that was permitted by the District through the end of 1995. For irrigation uses, demands for permitted acreage were calculated based on crop type and simulated rainfall events. The 2020 demand level is based on projected 2020 agricultural acreage, as indicated in on local county comprehensive plans. All irrigation demands were calculated using the modified Blaney-Criddle method for each rainfall condition. A detailed discussion of this method can be found in the District's *Management of Water Use Permitting Information Manual, Volume III* (SFWMD, 1997d). Blaney-Criddle is currently used to estimate supplemental crop requirements in the District's CUP program. Details of demand assumptions are described in **Appendix B.**

In the base cases and alternatives, agricultural demands in the Caloosahatchee Basin were projected using the same method applied in the Restudy. The projected demands in 2020 are 25 percent greater than in 1995. While in the Restudy the 2050 projection was 40 percent greater than 1995. Refer to the CWMP for more information regarding the assumptions that were used in the integrated surface and ground water model.

Inclusion of Restudy Components

The second primary difference between the base case and alternative simulations is inclusion of future projects and components. The 2020 with Restudy simulation only includes those Restudy components that are expected to be completed by 2020. According to the Restudy Implementation Plan (USACE and SFWMD, 1999), all components are to be completed by 2020 except that only half of the total volume of the North and Central Lake Belt projects will be available. **Table 9** identifies the Restudy components included in the 2020 with Restudy simulation performed by the SFWMM and subregional ground water models.

Table 9. Components Included in the 2020 with Restudy Model Simulations.

Component Name	Regional SFWMM v3.7	Subregional Ground Water Models
Indian River Lagoon		
C-44 Basin Storage Reservoir[a]	X	
C-23/C-24/Northfork and Southfork Reservoirs[a]	X	
Lake Okeechobee Headwaters Storage		
Taylor Creek/Nubbin Slough Storage Reservoir and STA[a]	X	
North of Lake Okeechobee Storage Reservoir[a]	X	
Lake Okeechobee		
Lake Okeechobee ASR[a]	X	
Caloosahatchee River Basin		
C-43 Basin Storage Reservoir with ASR[a]	X	
Caloosahatchee Backpumping with STA[ab]	X	
Everglades Agriculture Area		
EAA Storage Reservoirs[a]	X	
Lower East Coast		
LEC Utility Water Conservation		
Broward County Secondary Canal System	X	X
C-4 Control Structure	X	X
C-111N Spreader Canal	X	X
Water Preserve Area Components		
C-9 STA/Impoundment	X	X
Western C-11 Diversion Impoundment and Canal	X	X
Dade-Broward Levee/Pennsuco Wetlands	X	X
Hillsboro (Site 1) Impoundment and ASR	X	X
Acme Basin B Discharge	X	X
Protect and Enhance Existing Wetland Systems along Loxahatchee National Wildlife Refuge including the Strazulla Tract	X	X
Pal-Mar and J.W. Corbett WMA Hydropattern Restoration	X	X
C-17 Backpumping and Treatment	X	X
C-51 Backpumping and Treatment	X	X
Bird Drive Recharge Area	X	X
Levee Seepage Management		
L-31N Levee Improvements for Seepage Management	X	X
WCA-3A and WCA-3B Seepage Management	X	X
Construction of S-356 Structures and Relocation of a Portion of the L-31N Borrow Canal	X	X
C-111 Operational Modifications[c]	X	X
Storage with ASR Components		
L-8 Project	X	X
C-51 and Southern L-8 Reservoir	X	X
C-51 Regional Ground Water ASR	X	X
Palm Beach County Agricultural Reserve Reservoir and ASR	X	X

Table 9. Components Included in the 2020 with Restudy Model Simulations. (Continued)

Component Name	Regional SFWMM v3.7	Subregional Ground Water Models
Lake Belt Storage and Conveyance		
Central Lake Belt Storage Area, Phase 1[d]	X	X
Divert flows from Central Lake Belt Storage Area to WCA-3B	X	X
Divert Flows from WCA-3 to Central Lake Belt Storage Area	X	X
Divert Flows from WCA-2 to Central Lake Belt Storage Area	X	X
North Lake Belt Storage Area, Phase 1[d]	X	X
Water Conservation Areas and Everglades National Park		
Revised Holey Land WMA Operation Plan[a]	X	
Revised Rotenberger WMA Operation Plan[a]	X	
Loxahatchee National Wildlife Refuge Internal Structures	X	X
Reroute Miami-Dade Water Supply Deliveries	X	X
Additional S-345 Structures	X	X
Decompartmentalize WCA-3	X	X
G-404 Pump Station Modification	X	X
Biscayne Bay		
Biscayne Bay Coastal Wetlands	X	X
West Miami-Dade County Reuse	X	X
South Miami-Dade County Reuse	X	X
Western Basin		
Miccosukee Tribe Water Management Plan[a]	X	
Flow to Northwest and Central WCA-3A[a]	X	
Big Cypress/L-28 Interceptor Modifications[a]	X	
Seminole Tribe Big Cypress Basin Water Conservation Plan[a]		
Stand Alone Other Project Elements (OPEs)		
Lake Okeechobee Watershed Water Quality Treatment Facilities[e]		
Lake Okeechobee Tributary Sediment Dredging[e]		
Lake Worth Lagoon Restoration[e]		
Pineland and Hardwood Hammocks Restoration[e]		
Melaleuca Eradication Project and Other Exotics[e]		
Florida Keys Tidal Restoration[e]		
Winsburg Farms Wetlands[e]		

a. Outside of the subregional ground water models' boundaries
b. Modeled in the CWMP
c. The C-111 Operational Modifications are part of the Modification to South Dade Conveyance System in Southern Portion of L-31N and C-111 Canals component.
d. 50 percent completed by 2021
e. Cannot be simulated with these types of hydrologic models

Lake Okeechobee and Water Conservation Area Schedules

Changes in the Lake Okeechobee and WCAs schedules can have significant impacts on how outflows from the lake are managed to meet multiple purposes. The LEC 1995 Base Case relies upon the current U.S. Army Corps of Engineers (USACE) approved schedules to manage water in the lake and WCAs, while the all future simulations (2020 Base Case, LEC-1, and LEC-1A) anticipates implementation of the Water Supply and Environmental (WSE) schedule on the lake and rain-driven schedules for the WCAs and Everglades National Park. The 2020 with Restudy simulation follows this precedent, relies upon rain-driven schedules for the WCAs, but uses a modified Run 25 schedule for the lake. When comparing results, the changes in operations and schedules have significant effects on the ability to meet performance targets.

Current and Future Land Use

One of the primary model assumptions is how land is used, whether it is covered with houses and roads or is a natural wetland. The type of land use applied in the model most directly affects how the models handle evapotranspiration and overland flow or recharge. Three land use databases were developed for the LEC Plan analysis: 1) 1995 land use, which is based on interpretation of aerial surveys; 2) 2020 land use, which is an interpretation of the county comprehensive land use plans; and 3) 2020 with Restudy land use, which is the same as the 2020 land use except that it has been modified to reflect construction of the Restudy features.

Incremental Simulations

The purpose of this analysis was to understand how the system performs in the interim period between now and 2020. Incremental years, 2005, 2010, and 2015, were selected to provide snapshots of how the system performs with partial completion of the Restudy projects and how the ability to meet the 1-in-10 year level of certainty criteria improves over time. Also, improvements to the performance of LEC-1 were incorporated into the LEC-1 Revised, which is the now the new 2020 end point for comparing simulations.

This analysis consisted of identifying the components that were scheduled to be complete and fully operational by the end of each year selected (**Table 10**). These components were then modeled to evaluate whether the partial or sequential completion of projects would cause ecological or water supply conditions that are worse than the 1995 Base Case or would result in progressive improvement in performance during the interim period. The modeling analysis and evaluation of the components utilized the same performance measures as the base cases and LEC-1 analyses. This analysis was used to identify problem areas and confirm that the original implementation schedule developed for Restudy was sequenced in a logical order that furthered the goals and objectives of the LEC Plan.

Table 10. Implementation Schedule for Restudy Components in Five-Year Increments.

Component Name	2005	2010	2015	LEC-1 Revised
Indian River Lagoon				
C-44 Basin Storage Reservoir		X	X	X
C-23/C-24/Northfork and Southfork Reservoirs		X	X	X
Lake Okeechobee Headwaters Storage				
Taylor Creek/Nubbin Slough Storage Reservoir and STA		X	X	X
North of Lake Okeechobee Storage Reservoir			X	X
Lake Okeechobee				
Lake Okeechobee ASR			X (50%)	X
Caloosahatchee River Basin				
C-43 Basin Storage Reservoir		X	X	X
C-43 Basin ASR			X	X
Caloosahatchee Backpumping with STA				
Everglades Agriculture Area				
EAA Storage Reservoirs, Phase 1		X	X	X
EAA Storage Reservoirs, Phase 2			X	X
Lower East Coast				
LEC Utility Water Conservation				
Broward County Secondary Canal System		X	X	X
C-4 Control Structure	X	X	X	X
C-111N Spreader Canal		X	X	X
Water Preserve Area Components				
C-9 STA/Impoundment		X	X	X
Western C-11 Diversion Impoundment and Canal		X	X	X
Dade-Broward Levee/Pennsuco Wetlands		X	X	X
Hillsboro (Site 1) Impoundment		X	X	X
Hillsboro (Site 1) Impoundment ASR			X	X
Acme Basin B Discharge		X	X	X
Protect and Enhance Existing Wetland Systems along Loxahatchee National Wildlife Refuge including the Strazulla Tract		X	X	X
Pal-Mar and J.W. Corbett WMA Hydropattern Restoration		X	X	X
C-17 Backpumping and Treatment		X	X	X
C-51 Backpumping and Treatment		X	X	X
Bird Drive Recharge Area			X	X
Levee Seepage Management				
L-31N Levee Improvements for Seepage Management		X	X	X
WCA-3A and WCA-3B Seepage Management		X	X	X
Construction of S-356 Structures and Relocation of a Portion of the L-31N Borrow Canal		X	X	X
C-111 Operational Modifications[a]	X	X	X	X
Storage with ASR Components				
L-8 Project			X	X
C-51 and Southern L-8 Reservoir			X	X

Table 10. Implementation Schedule for Restudy Components in Five-Year Increments.

Component Name	2005	2010	2015	LEC-1 Revised
C-51 Regional Ground Water ASR			X	X
Palm Beach County Agricultural Reserve Reservoir and ASR			X	X
Lake Belt Storage and Conveyance				
Central Lake Belt Storage Area, Phase 1				X
Divert flows from Central Lake Belt Storage Area to WCA-3B			X	X
Divert Flows from WCA-3 to Central Lake Belt Storage Area				X
Divert Flows from WCA-2 to Central Lake Belt Storage Area				X
North Lake Belt Storage Area, Phase 1				X
Water Conservation Areas and Everglades National Park				
Revised Holey Land WMA Operation Plan		X	X	X
Revised Rotenberger WMA Operation Plan	X	X	X	X
Loxahatchee National Wildlife Refuge Internal Structures	X	X	X	X
Reroute Miami-Dade Water Supply Deliveries		X	X	X
Additional S-345 Structures		X	X	X
Decompartmentalize WCA-3		X	X	X
G-404 Pump Station Modification		X	X	X
Biscayne Bay				
Biscayne Bay Coastal Wetlands				X
West Miami-Dade County Reuse				X (50%)
South Miami-Dade County Reuse				X
Western Basin				
Miccosukee Tribe Water Management Plan		X	X	X
Flow to Northwest and Central WCA-3A		X	X	X
Big Cypress/L-28 Interceptor Modifications				X
Seminole Tribe Big Cypress Basin Water Conservation Plan		X	X	X
Stand Alone OPEs				
Lake Okeechobee Watershed Water Quality Treatment Facilities				
Lake Okeechobee Tributary Sediment Dredging				
Lake Worth Lagoon Restoration				
Pineland and Hardwood Hammocks Restoration				
Melaleuca Eradication Project and Other Exotics				
Florida Keys Tidal Restoration				
Winsburg Farms Wetlands				

a. The C-111 Operational Modifications are part of the Modification to South Dade Conveyance System in Southern Portion of L-31N and C-111 Canals component.

Assumptions for Incremental Simulations

Incremental simulations were performed with the SFWMM to understand how the system behaves as features of the plan are constructed or implemented. The 1995 Base Case and LEC-1 provide beginning and end points to evaluate progress over time as components are implemented. The beginning and end points were revised to make comparisons to the incremental simulations valid, i.e. incorporate similar model assumptions so the only variables were the Restudy projects themselves. These simulations are referred to as the 1995 Revised Base Case and the LEC-1 Revised, respectively. **Table 11** references the acronyms used in the model results graphics found in **Appendix H**. Agricultural, urban, and environmental demands increased over time as demands and water supplies increased. A summary of the modeling assumptions for the incremental simulations can be found in **Table 12**.

Table 11. Acronyms for SFWMM Incremental Simulations.

Simulation	Acronym
1995 Revised Base Case	95BSRR
2005	2005R
2005 SSM Scenario	2005 SSM
2010	2010R
2015	2015R
LEC-1 Revised	LEC-1R or 2020R

Assumptions for 2005 SSM Scenario

A 2005 Supply-Side Scenario (SSM) was also simulated with the SFWMM as part of the incremental simulation analysis. The purpose of this scenario was to determine how sensitive the modifications to the regional system were to Lake Okeechobee's operations and its ability to meet water supply demands. In the 2005 SSM Scenario, the Lake Okeechobee supply-side management criteria were modified. Other alternatives to achieve this goal will also be considered in solution development.

The Supply-Side Management restrictions were designed to be conservative and retain water in the regional system to meet unforeseen demands later in the drought or dry season. The conservative approach may be too restrictive for future conditions, especially considering additional demands placed on the lake since the supply-side management criteria was developed. By 2005, several new demands are placed on Lake Okeechobee, but no regional storage features are available to meet some of these new demands. The increased demands in 2005 include the Everglades Construction Project, the rain-driven schedules for the WCAs, and Caloosahatchee Basin and lower Lake Istokpoga supplemental irrigation demands. To meet the existing and future demands on Lake Okeechobee, the stage that triggers supply-side management was lowered by approximately one-half of a foot. The end of dry season (May 31) stage target was also reduced from 11.0 to 10.5 ft NGVD.

Table 12. Comparison of Assumptions for Incremental Model Simulations by the SFWMM.

Feature	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Land Use for Urban and Agricultural Areas	Best available information for 1995	Best available information for 1995; adjusted to reflect construction of STAs	2020 projections based on county comprehensive plans; adjusted to reflect construction of STAs and appropriate components in Restudy	2020 projections based on county comprehensive plans; adjusted to reflect construction of STAs and appropriate components in Restudy	2020 projections based on county comprehensive plans; adjusted to reflect construction of STAs and appropriate components in Restudy
Vegetation Cover for Natural Areas	Same as 1995; best available information; generally reflects conditions between 1990-1995	Same as 1995; best available information; generally reflects conditions between 1990-1995	Same as 1995; best available information; generally reflects conditions between 1990-1995	Same as 1995; best available information; generally reflects conditions between 1990-1995	Same as 1995; best available information; generally reflects conditions between 1990-1995
LOSA Mean Annual Supplemental Irrigation Demands	217,000 ac-ft	234,000[a] ac-ft	260,000 ac-ft	225,000 ac-ft	229,000 ac-ft
EAA Mean Annual Supplemental Irrigation Demands	371,000 ac-ft	351,000 ac-ft	332,000 ac-ft	327,000 ac-ft	333,000 ac-ft
Lake Okeechobee Regulation Schedule	WSE schedule	WSE schedule	Modified WSE schedule[b]	Modified WSE schedule[b]	Modified WSE schedule[b]
Lake Okeechobee Supply-Side Management for LOSA	Current schedule	Current schedule	Modified schedule[c]	Modified schedule[c]	Modified schedule[c]
Caloosahatchee River Basin Demands (including municipal demands and supplies)	Demands for 1995 estimated using AFSIRS method per CWMP	Demands for 2005 estimated using AFSIRS method per CWMP	Demands for 2010 estimated using AFSIRS method per CWMP	Supplies limited to Restudy deliveries of approx. 29,000 ac-ft/ yr at S-77	Supplies limited to Restudy deliveries of approx. 29,000 ac-ft/ yr at S-77
Caloosahatchee Backpumping	Not applicable	Not applicable	Set to zero as per CWMP	Set to zero as per CWMP	Set to zero as per CWMP
C-44 Basin Storage Reservoir	Not constructed	Not constructed	Constructed and operated as per Indian River Lagoon Feasibility Study[d]	Constructed and operated as per Indian River Lagoon Feasibility Study[d]	Constructed and operated as per Indian River Lagoon Feasibility Study[d]
Brighton Seminole Indian Reservation Demands	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr	28,500 ac-ft annual average; maximum 44,000 ac-ft/yr
STAs Associated with the EAA	Yes	Yes	Yes	Yes	Yes
EAA Runoff Reduction and BMP Make-Up Water	No runoff reduction or make-up water delivered	No runoff reduction or make-up water delivered	No runoff reduction or make-up water delivered	No runoff reduction or make-up water delivered	No runoff reduction or make-up water delivered
Make-Up Water Associated with Best Management Practices (BMPs) from Lake Okeechobee	No	No	No	No	No
EAA Storage Reservoirs	Not constructed	Not constructed	Redirect Miami, North New River, and Hillsboro basins' runoff to EAA Storage Reservoirs; 30,000 acres for EAA water supply and 30,000 acres for environmental water supply; used to meet demand in all major EAA basins (including West Palm Beach)	Redirect Miami, North New River, and Hillsboro basins' runoff to EAA Storage Reservoirs; 30,000 acres for EAA water supply and 30,000 acres for environmental water supply; used to meet demand in all major EAA basins (including West Palm Beach)	Redirect Miami, North New River, and Hillsboro basins' runoff to EAA Storage Reservoirs; 30,000 acres for EAA water supply and 30,000 acres for environmental water supply; used to meet demand in all major EAA basins (including West Palm Beach)

Table 12. Comparison of Assumptions for Incremental Model Simulations by the SFWMM. (Continued)

Feature	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
WCA-1 Schedule	Interim regulation schedule	Interim regulation schedule	Interim regulation schedule	Interim regulation schedule	Interim regulation schedule
WCA-2A Schedule	Current regulation schedule	Current regulation schedule	Rain-driven schedule	Rain-driven schedule	Rain-driven schedule
WCA-2B, WCA-3A, and WCA-3B Schedules	Current regulation schedule	Rain-driven schedule	Rain-driven schedule	Rain-driven schedule	Rain-driven schedule
Everglades National Park Operations	Experimental Rainfall Delivery Plan via S-12s and S-333 structures	As per Modified Water Deliveries Project GDM w/o tailgated constraints on L-29	As per MWD Project GDM w/o tailwater constraints on L-29	As per Restudy	As per Restudy
LECSA Population	4,755,776 persons	5,304,831 persons	5,853,886 persons	6,402,941 persons	6,951,998 persons, as per LEC utility survey
LECSAs Public Water Supply Demands on Surficial Aquifer System and Surface Water	Actual 1995 demands: 286,429 MGY (784.10 MGD)	325,464 MGY (892.5 MGD)	364,927 MGY (999 MGD)	403,948 MGY (1,106.5 MGD)	Projected demands based on LEC utility survey: 443,411 MGY (1,214.8 MGD)
LECSAs Public Water Supply Wellfield Distribution	Actual 1995 locations	Modifications to eleven utilities' preferred wellfield locations (based on LEC utility survey)	Modifications to eleven utilities' preferred wellfield locations (based on LEC utility survey)	Modifications to eleven utilities' preferred wellfield locations (based on LEC utility survey)	Modifications to eleven utilities' preferred wellfield locations (based on LEC utility survey)
LECSAs Water Shortage Policy	Yes	Yes	Yes	Yes	Yes
LEC Irrigation Demands on Surficial Aquifer System	Based on land use and climatic variation	Based on projected 1995 land use and climatic variation	Same as LEC-1 Revised	Same as LEC-1 Revised	Based on projected 2020 land use and climatic variation
Operational Adjustments to Meet MFLs for Biscayne Aquifer	No	Canal operation criteria (**Table 6**)	Canal operation criteria (**Table 6**)	Canal operation criteria (**Table 6**)	Canal operation criteria (**Table 6**)
L-8 Project	Not constructed	Not constructed	Not constructed	As per Restudy	As per Restudy
Broward County Secondary Canal System	Not constructed	Partial, the northern portion only	As per Restudy	As per Restudy	As per Restudy
Miami-Dade Utility ASR	Not constructed	25 MGD	50 MGD	75 MGD	75 MGD
Miami-Dade County Reuse	Not constructed	0 MGD	0 MGD	0 MGD	50 MGD west facility; 131 MGD south facility
Optimization of Regional ASR	Not applicable	Not applicable	Not applicable	Excess water from C-51 ASR and West Palm Beach Catchment Area ASR sent to meet EAA demands	Excess water from C-51 ASR and West Palm Beach Catchment Area ASR sent to meet EAA demands
Lake Istopokga Demand and Runoff	12,000 ac-ft average annual demands; 6,000 ac-ft average annual runoff	12,000 ac-ft average annual demands; 6,000 ac-ft average annual runoff	12,000 ac-ft average annual demands; 6,000 ac-ft average annual runoff	12,000 ac-ft average annual demands; 6,000 ac-ft average annual runoff	12,000 ac-ft average annual demands; 6,000 ac-ft average annual runoff

a. Accounts for reduction due to construction of STAs and reservoirs
b. WSE schedule was modified to incorporate operations associated with the Lake Okeechobee ASR, the EAA Storage Reservoirs, and the North of Lake Okeechobee Storage Reservoir
c. Modified supply-side schedule management accounts for storage available in reservoirs around Lake Okeechobee
d. USACE, 1996

Additional Assumptions of Base Cases, Alternatives, and Incremental Simulations

Modifications to assumptions in the SFWMM were made to improve performance and meet hydrologic targets. Additional assumptions were also made to update information included in the SFWMM to reflect best available information. These changes are discussed below. To identify which simulations incorporated these assumptions, refer to **Tables 8** and **12**.

Best Management Practice Make-Up Water

In previous analyses, it had been assumed that the implementation of Best Management Practices (BMPs) in the EAA would reduce the volume of runoff from the EAA to the Everglades by 20 percent. According to the Everglades Forever Act, and subsequent SFWMD rules, this reduction of flow must be offset by additional releases from Lake Okeechobee. Now that the BMPs have been in place for five full years, actual runoff data have been analyzed to quantify the change in runoff attributable to the BMP Program. An extensive review of the available data conducted under the auspices of the EAA Environmental Protection District indicates that no measurable reduction in runoff has occurred due to implementation of BMPs. Therefore, for the purposes of computer modeling to support the LEC Plan, no reduction in runoff and, consequently, no make-up water deliveries were simulated. Ongoing rulemaking by the District on the make-up water requirements will assess the quantity of runoff from the EAA, which will then be incorporated into future regional analyses.

Brighton Seminole Indian Reservation Demands

The Seminole Tribe has an existing compact[1] with the SFWMD for water deliveries from Lake Okeechobee to meet supplemental irrigation demands of the Brighton Reservation. In the LEC Plan, the demand varies seasonally and annually with a maximum annual demand of 44,000 ac-ft and an average annual demand of 28,500 ac-ft. These demands differ from what was assumed during the Restudy.

Miccosukee Tribe of Indians Demands

The demands of the Miccosukee Tribe of Indians assumed in the regional water supply planning process are based on representations of the Miccosukee Tribe as to their water needs for the next 20 years. No attempt was made in this planning process to determine whether the Miccosukee Tribe of Indians has any federal legal right to the requested water quantities. As a result, the findings and the conclusions of the LEC Plan are not intended to create or alter any rights to water the Miccosukee Tribe may currently have or intend to perfect in the future under federal or state law. The Governing Board encourages the Miccosukee Tribe to engage in negotiations with the District and the State

1. Water Rights Compact in 1987 which was enacted by Pub. L. No. 100-228, 101 Stat. 1556, and Chapter 87-292, Laws of Florida, and codified in Section 285.165, Florida Administrative Code (F.A.C.)

of Florida to achieve a mechanism for recognition of tribal water rights. The District will participate in any processes conducted to achieve this goal.

Caloosahatchee Basin Demands

The Caloosahatchee Basin demand projections used in the 1995 and 2020 base cases, 2020 with Restudy, and LEC-1 simulations were derived in the same fashion as those assumed in the Restudy modeling. The 1995 Base Case is based on historical demands and the 2020 demand projection is 25 percent greater than in 1995. The Restudy assumed a 40 percent increase in demands in 2050 compared to 1995. The future supplemental irrigation demands are met from Lake Okeechobee in the 2020 Base Case. In the 2020 with Restudy and LEC-1 simulations, the future demands are met partially from the C-43 Reservoir and ASR facilities.

The demand projections that were developed for the CWMP form the basis for the evaluation of demands in the Caloosahatchee Basin in the incremental simulations performed for the LEC Plan. These demands were met from Lake Okeechobee in the 1995 Revised Base Case and the 2005 and 2010 incremental simulations. In the 2015 and LEC-1 Revised regional model simulations, the demands were met from the C-43 Reservoir and ASR system and a portion was met from Lake Okeechobee. In the incremental simulations, the demands in 2010, 2015, and LEC-1 Revised are capped at the same average annual volume that can be provided in the 2020 with Restudy model simulation. In other words, the demands in the incremental simulations use the revised demands as projected by the CWMP, but they are met from within the Caloosahatchee Basin once the C-43 Reservoir is constructed.

Caloosahatchee Basin Backpumping to Lake Okeechobee

One major difference between the 2020 with Restudy and LEC-1 model simulations is that in the LEC-1 simulation, no backpumping occurs from the Caloosahatchee Basin. This source of water to the lake is no longer considered available. This is also true for all incremental model simulations. This assumption will need further evaluation as the demand and runoff estimates developed by AFSIRS are part of the Restoration, Coordination, and Verification (RECOVER) process for the CERP.

Minimum Flows and Levels for the Biscayne Aquifer

The minimum water levels for coastal canals that are needed to protect the northern portion of the Biscayne aquifer were recently developed (SFWMD, 2000e). These minimum levels correlate to operation levels for eleven coastal canals as indicated in **Tables 8** and **12**. These levels vary slightly from what was assumed during the Restudy.

Lake Istopokga Demands

Additional pasture land in the lower Lake Istopokga Basin is expected to be converted to sugarcane in the near future, resulting in new demands and runoff. Seasonally and annually varied demands and runoff from the lower Lake Istopokga Basin were used with an average annual demand of 12,000 ac-ft and an average annual runoff of 6,000 ac-ft. Modeling for the LEC Plan assumed Lake Okeechobee would supply the supplemental irrigation water in the incremental simulations.

Seepage from the North of Lake Okeechobee Storage Reservoir

The design of the North of Lake Okeechobee Storage Reservoir in the Restudy did not include seepage from the reservoir back to Lake Okeechobee. The LEC Plan assumed a 50 percent seepage return to the lake. This assumption will need to be reevaluated as more information about the geology of the area and design of the reservoir becomes available.

C-44 Reservoir Modifications

The Indian River Lagoon Feasibility Study (USACE, 1996) recently completed an investigation to optimize the C-44 Reservoir. St. Lucie Estuary targets (**Table 13**), local basin runoff, reservoir size, and operations were also modified. The C-44 reservoir size was reduced to 30,000 acres while the depth has increased to 10 feet. When appropriate, the revised design and operation were incorporated into all simulations performed for the LEC Plan.

Table 13. Revised Performance Targets for the St Lucie Estuary.

Flow Range	Desired Maximum Number of Months in Range
< 350 cfs - monthly	178
> 2,000 cfs - monthly	23
> 3,000 cfs - monthly	5
> 2,000 cfs – 14 -day average	23

ANALYSIS OVERVIEW

In order to determine the effects of existing and proposed water management facilities on water resources and the environment and the ability to meet projected water demands, base case simulations were performed with both the SFWMM and the subregional ground water models.

The first set of simulations represented current (1995) conditions under historic 1995 demands. The second set represented future (2020) demands under identical rainfall conditions with projects expected to be completed by 2020 in place. This includes the Everglades Construction Project, the Lake Okeechobee WSE Schedule, Modified Water Deliveries for Everglades National Park, the C-111 Basin Project, and portions of the *Interim Plan for Lower East Coast Regional Water Supply* (LEC Interim Plan) (SFWMD, 1998b). The third set of simulations, 2020 with Restudy, included the construction projects and operational features of the Restudy that are expected to be in place by 2020. The fourth set, LEC-1, includes all features of the previous simulation plus additional features and operational changes that are specific to this plan, such as redistribution of wellfields, implementation of selected water supply development options, and refinements concerning implementation of the water resource development projects which are being made in the CERP. Areas that performed well were identified by applying the planning criteria and performance measure targets such as MFLs, 1-in-10 year level of certainty, and resource protection criteria.

Given the large number of criteria applied and the large number of areas evaluated in the LEC Planning Area, a simplified approach was used to display evaluations. The performance of a model simulation is summarized as green, yellow, or red for each evaluation criterion, based on the ability to meet an environmental criterion/target. The color provides an assessment of the ability of the plan to achieve the resource protection, recovery, and/or long-term sustainability objectives defined by the performance measure(s) and best professional judgement. Green means that the combination of features in the model simulation is likely to meet the management objective described by the performance measure. Yellow means that achievement of the objective is marginal or uncertain and that improvement is needed or that the hydrologic target is not defined. Red means that the objective may not be met. The color coding scheme is similar to that used in the Restudy to assess the overall performance of the recommended components when compared to the no action alternative.

The Caloosahatchee Basin performance was analyzed in the CWMP. The recommendations made in the CWMP that are pertinent to the LEC planning process can be found in **Chapter 6** of this plan (**Recommendations 28**, **29**, **30**, and **35**).

URBAN AND AGRICULTURAL WATER SUPPLY RESULTS

This section presents and discusses the results of LEC Plan base cases, alternatives, and incremental evaluations with regard to urban and agricultural water supply. Results are first presented for the Lake Okeechobee Service Area (LOSA) and then for the LEC Service Areas (LECSAs): North Palm Beach Service Area, Lower East Coast Service Area 1 (LECSA 1), Lower East Coast Service Area 2 (LECSA 2), and Lower East Coast Service Area (LECSA 3). For each service area, discussion of the results is followed by a summary. The service areas themselves are delineated and described in **Chapter 3**. The results are evaluated in terms of water supply performance goals, which have been described in **Chapter 2** and previously in this chapter. Descriptions of the key assumptions of the base cases, alternatives, and incremental simulations have been presented in the water and land use assumptions section of this chapter.

Lake Okeechobee Service Area

The Lake Okeechobee Service Area (LOSA) includes those areas for which Lake Okeechobee is the primary direct storage source. The major subbasins within the LOSA include the EAA, the Caloosahatchee Basin (C-43 Basin), the St. Lucie Canal Basin (C-44 Basin), the Brighton Seminole Indian Reservation, the Lower Lake Istokpoga Basin, and the Big Cypress Seminole Reservation (see **Figure 17** in **Chapter 3**).

In the LOSA, water supply evaluations were made using the SFWMM which performs simulations for the 31-year period from 1965 through 1995. For the purpose of water supply evaluations in this largely agricultural area, a water year (from October to September), rather than a calendar year, has been used. Thirty complete water years are covered by the simulation period.

Performance Measures Applied

The key water supply performance goal for the LOSA is that no more than three water years with significant water shortages occur during the simulation period. A water shortage is generally considered significant when greater than 100,000 ac-ft of demands are not met. This performance measure is obtained from a frequency of water restrictions performance graphic (see **Figure D-1** in **Appendix D** for an example and **Appendix H** for actual model results), combined with analysis of the total volume of water restricted from a supply-side management report (see **Appendix H**). During the simulations, a water shortage is recorded when the SFWMM recognizes that regional water storage conditions occur which meet the conditions under which the District will impose supply-side management restrictions on the LOSA. Supply-side management procedures and their application within the LEC Plan evaluations are more completely explained in **Chapter 3**.

If there are significant supply-side management cutbacks during more than three of the water years in the simulation period, the goal of providing a 1-in-10 year level of certainty is not met. One way to look at the significance of these events is to consider the supply-side management cutback volumes for the fourth and fifth worst drought years in a simulation. This information is provided in the last row of the information tables in the results sections below. In considering the supply-side management volumes, it is important to remember that the LOSA contains 600,000 to 700,000 acres of irrigated lands, so that 100,000 ac-ft of supply-side cutbacks implies a delivery deficit of about two inches spread over the irrigated lands in the service area during a 12-month crop year.

Base Cases and Alternatives Results

Information regarding the water supply performance under the base cases and alternatives is presented in **Table 14**. The first row in **Table 14** provides the number of water years with significant water shortage events while the second row provides the total number of water years in which any water shortage event occurs. The remaining information in **Table 14** further clarifies the significance of the water restrictions and the performance pattern that may be achieved through 2020.

1995 Base Case. Water restrictions occur for eight of the 30 water years simulated in the 1995 Base Case and the total number of months of water shortages are 32. The supply-side management cutback volumes were high (over 300,000 ac-ft) for all of the three worst drought years. The supply-side management volumes in the fourth and fifth worst cutback years were 125,000 and 64,000 ac-ft, respectively. The 125,000 ac-ft of restrictions in 1990 indicated an inability to meet the 1-in-10 year level of certainty goal.

Table 14. Information on All Water Restrictions in the SFWMM Simulations for the Base Cases and Alternatives for the Lake Okeechobee Service Area.

	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Number of water years with significant shortages	4	9	3	2
Number of water years with shortages in one or more months	8	16	5	5
Total months of water shortages	32	79	23	18
Total supply-side management cutback volume (ac-ft) for 31-year period	1,419,000	3,894,000	859,000	709,000
Supply-side management cutback volumes for the three worst drought years	1981 - 509,000 1974 - 355,000 1982 - 318,000	1974 - 491,000 1990 - 490,000 1981 - 435,000	1981 - 464,000 1982 - 212,000 1990 - 135,000	1981 - 381,000 1982 - 182,000 1990 - 81,000
Supply-side management cutback volumes for the fourth and fifth worst drought years	1990 - 125,000 1973 - 64,000	1982 - 396,000 1989 - 388,000	1974 - 20,000 1991 - 16,000	1976 - 30,000 1978 - 18,000

2020 Base Case. Water restrictions occurred for 16 of the 30 water years simulated in the 2020 Base Case and the total number of months of water shortages were 79. As with the 1995 Base Case, the supply-side management cutback volumes were high (over 300,000 ac-ft) for all of the three worst drought years. The supply-side management cutback volumes for the fourth and fifth worst years were close to 400,000 acre feet, which could easily lead to significant crop losses. In fact, cutbacks over 100,000 ac-ft occurred in nine of the years.

2020 with Restudy. The 2020 with Restudy simulation had five years with water restrictions and the total number of months of water shortages for the 2020 with Restudy were 23. The second and third worst years were significantly lower (212,000 and 135,000 ac-ft, respectively) for the 2020 with Restudy than for the base cases. The fourth and fifth worst years had restrictions of 20,000 and 16,000 ac-ft, respectively. The volumes of these cutbacks would not lead to significant crop losses. Based on the supply-side management cutbacks, the 2020 with Restudy alternative met the 1-in-10 year level of certainty goal for the LOSA.

LEC-1. The LEC-1 simulation also had five years with water restrictions. The total months of water shortages for this simulation were 18. The supply-side management cutback volumes were lower than those for the 2020 with Restudy and would not lead to significant crop losses. Based on the supply-side management cutbacks, the LEC-1 met the 1-in-10 year level of certainty goal for the LOSA. Supply-side management cutbacks were greater than 100,000 ac-ft and would be considered significant in only two of the years simulated.

Incremental Results

Information regarding the water supply performance in the incremental simulations is presented in **Table 15.** The first row in **Table 15** shows the number of water years with significant water shortage events while the second row provides the number of water years in which any water shortage event occurs. The remaining information in **Table 15** further clarifies the significance of the water restrictions and the performance pattern that may be achieved through 2020.

Table 15. Information on Water Restrictions in the SFWMM Incremental Simulations for the LOSA.

	1995 Revised Base Case	2005	2005 SSM Scenario	2010	2015	LEC-1 Revised
Number of water years with significant shortages	5	7	5	6[a]	3	1
Number of water years with shortages in one or more months	9	11	7	9	6	4
Total months of shortages	37	47	35	36	21	12
Total supply-side management cutback volume (ac-ft) for 31-year period	1,878,000	2,571,000	1,693,000	1,496,000	860,000	432,000
Supply-side management cutback volumes for three worst drought years	1982 - 461,000 1974 - 417,000 1981 - 339,000	1981 - 472,000 1974 - 463,000 1982 - 462,000	1982 - 445,000 1974 - 403,000 1981 - 312,000	1974 - 390,000 1981 - 379,000 1982 - 201,000	1981 - 305,000 1974 - 233,000 1976 - 145,000	1981 - 294,000 1982 - 95,000 1990 - 31,000
Supply-side management cutback volumes for fourth and fifth worst drought years	1973 - 228,000 1990 - 197,000	1973 - 351,000 1990 - 320,000	1973 - 213,000 1990 - 171,000	1976 - 148,000 1973 - 129,000	1982 - 102,000 1990 - 56,000	1978 - 5,000

a. Performance could be improved by continuing supply-side flexibility or other option applied to 2005 SSM Scenario through 2010.

1995 Revised Base Case. The number of water years with water restrictions for the 1995 Revised Base Case simulations were nine and the total number of months of water shortages were 37. These were worse than the original 1995 Base Case due primarily to the inclusion of revised Caloosahatchee hydrology and agricultural demands and the inclusion of the Seminole Big Cypress Reservation demands in the revised simulation. The supply-side cutback volumes were high (over 300,000 ac-ft) for the three worst drought years in the 1995 Revised Base Case simulation. The supply-side management cutback volumes for the fourth and fifth worst years were 228,000 and 197,000 ac-ft, respectively, which represented significant delivery deficits.

2005. The total number of years with water shortages (11) and total number of months of water shortages (47) increased during the 2005 incremental simulation. The supply-side cutback volumes were over 400,000 ac-ft for all of the three worst drought years and the fourth and fifth worst drought years still had significant shortages with supply-side management cutback volumes over 300,000 ac-ft. The increase in shortages between the 1995 Base Case and 2005 simulations can be attributed to a number of factors: 1) the implementation of the Everglades Construction Project in combination with the Lake Okeechobee WSE regulation schedule allowed more lake water to be transferred to the WCAs, which resulted in a lower lake level going into some drought years; 2) the incorporation of rain-driven schedules for the WCAs and Everglades National Park resulted in more urban area demand being satisfied by Lake Okeechobee and less reliance on the WCAs for urban water supply; 3) an increase in agricultural demand in the Lake Istokpoga Service Area was satisfied by Lake Okeechobee in order to achieve environmental objectives in Lake Istokpoga; and 4) land taken out of production for the Everglades Construction Project resulted in an increase in agricultural demand in the Caloosahatchee Basin. These additional demands were expected to occur prior to completion of any significant storage features recommended by the Restudy.

2005 SSM Scenario. With the operational flexibility of the supply-side management criteria, the total number of years with shortages was reduced to seven in the 2005 SSM Scenario. The total number of months of water shortages (35) was also reduced in this simulation. Two of the worst shortages in the 2005 SSM Scenario were over 400,000 ac-ft and the third was just over 300,000 ac-ft. This performance was better than both the original 2005 incremental simulation and the 1995 Revised Base Case. The volumes of cutbacks were 213,000 and 171,000 ac-ft for the fourth and fifth worst droughts, respectively, which represent improvements over the volumes of cutbacks in the 1995 Revised Base Case. Modification of the supply-side management criteria, or an equivalent operational schedule change, would improve upon the ability to achieve a 1-in-10 year level of certainty in the LOSA.

2010. The total number of years with shortages in the 2010 incremental simulation was nine and the total number of months of water shortages was 36. In this simulation, the volume of cutbacks was significantly less than that of the 1995 Revised Base Case, even though the years and months of shortages were about the same. For the 2010 incremental simulation, the worst two years had close to 400,000 ac-ft of supply-side shortages while the third worst year had significantly less cutbacks at 201,000 ac-ft. The cutbacks for the fourth and fifth worst drought years were 148,000 and 129,000 ac-ft, respectively, which were substantially less than previous simulations. This was the first sign that Restudy infrastructure is making water supply conditions better than the 1995 Revised Base Case. The 2010 performance could be improved further by implementing an interim operational change such as modification of the supply-side management criteria.

2015. The total number of years with shortages (six) and the total number of months of water shortages (21) for the 2015 incremental simulation were reduced when compared to previous simulations. The improvement in supply-side cutback volumes which began in the 2010 simulation continued in the 2015 simulation. The third worst supply-side management event shows only 145,000 ac-ft of supply-side management cutbacks. The fourth and fifth worst years had supply-side management cutbacks of 102,000 and 56,000 ac-ft, respectively, and it is unlikely that they would cause significant reductions in crop yields. The 1-in-10 year level of certainty was met during the 2015 simulation.

LEC-1 Revised. The LEC-1 Revised simulation's performance improved when compared to the original LEC-1 simulation. The chief reasons for this appear to be the changed configuration and operations of the EAA Storage Reservoirs, capture and storage of runoff from the Hillsboro Basin, and use of water from the C-51 and West Palm Beach ASR systems to meet demands in the EAA. The total number of months of water shortages and the volumes of cutbacks were reduced when compared to previous incremental simulations. The third worst supply-side management event had only 31,000 ac-ft of cutbacks and the fourth worst year of cutbacks was only 5,000 ac-ft, which is clearly insignificant. The results indicate that the LEC-1 Revised alternative met the 1-in-10 year level of certainty.

Summary of Results for the Lake Okeechobee Service Area

- The poor water supply performance of the 1995 and 2020 base cases indicated that significant water resource development efforts will be needed to achieve a 1-in-10 year level of certainty for water users in the LOSA.
- The 2020 with Restudy, LEC-1, and LEC-1 Revised model simulations, which contain the projects recommended in the Restudy as their primary water resource development components, were capable of meeting 1-in-10 year level of certainty performance within the LOSA.
- The incremental simulations indicate improvements to the ability to meet the LOSA's demands will occur as Restudy projects are implemented and performance improves between 1995 and 2020.
- The incremental simulations indicate that the 1-in-10 year level of certainty water supply performance can be met by 2015 in the LOSA.
- The incremental simulations indicate that optimization in the design and operation of the Restudy projects can significantly improve the performance that was originally estimated in the Restudy. These refinements to the Restudy projects will be included in the recommendations to the CERP.
- Actions such as CERP acceleration, changes to supply-side management criteria, or other operational improvements are

needed to reduce the risk of water shortage losses in the interim period. The 2005 SSM Scenario demonstrated that flexibility in the application of supply-side management is one tool that could be used to meet water demands during droughts in the interim period until water resource development projects were completed. Other operational options should also be investigated.

Specific Analyses Related to the Seminole Tribe of Florida

In 1996, the *Agreement Between the South Florida Water Management District and the Seminole Tribe of Florida Providing for Water Quality, Water Supply, and Flood Control Plans for the Big Cypress Seminole Indian Reservation and the Brighton Seminole Indian Reservation, Implementing Section V.C. and VI.D. of the Water Rights Compact* (Seminole Agreement) was executed. The Seminole Agreement obligated the District to conduct several studies related to the quantity of surface water supply for the Big Cypress Seminole Indian Reservation. Additional studies related to water supply for the Brighton Seminole Indian Reservation were also agreed upon. As required, the studies are included as integral parts of the District's LEC regional water supply planning effort. While analyses of these issues are included in this plan, the Seminole Agreement obligates the District to give ongoing consideration of impacts to the Seminole Tribe's rights as plans and/or changes are reviewed in the future. The Seminole Agreement states the Big Cypress Seminole Indian Reservation studies will determine the following:

- The amount and timing of deliveries needed for hydroperiod restoration in the northwest corner of WCA-3A, as a part of Everglades Forever Act implementation
- The potential effect of the Everglades Program on the tribe's ability to use the alternative water supply delivery system (contemplated in Subsection 6) on the Big Cypress Seminole Indian Reservation resulting from diversion of the C-139 Basin and, if diverted, the C-139 Annex
- The potential effect of revising Lake Okeechobee's regulation schedule on available water supply for the Big Cypress Seminole Indian Reservation, if water from Lake Okeechobee is part of the water supply for the reservation
- The potential effect of District water supply plans and Everglades hydropattern changes, which may be developed and adopted in the future, on available surface water supplies from Lake Okeechobee for the Brighton Seminole Indian Reservation
- The potential effect of changes to Lake Okeechobee's regulation schedule, which may be developed and adopted in the future, on available surface water supplies from Lake Okeechobee for the Brighton Seminole Indian Reservation

- The potential effect, if any, of implementation of the Everglades Program on the available surface water supplies from Lake Okeechobee for the Brighton Seminole Indian Reservation

A summary of the District's efforts in regard to these studies is summarized below.

Northwestern Corner of WCA-3A Hydroperiod Restoration. As part of the LEC regional water supply planning process, District staff utilized measures of hydroperiod (inundation duration), and the number of times high water criteria were exceeded, and the number of times water fell below the low water criteria to evaluate simulated performance in northwestern corner of WCA-3A under various modeled alternatives. These performance measures and the results of the evaluations are described in detail in the **Environmental Resources Results** section of this chapter. In summary, under current conditions (simulated by the 1995 Base Case) hydroperiod performance in the northwestern corner of WCA-3A failed to achieve desired targets, while in the 2020 with Restudy simulation, hydroperiods in the same area either met or exceeded the performance targets established in the planning process for hydroperiod restoration.

Effect of the Everglades Program. The Everglades Program's projects are included in the assumptions for alternatives modeled for the LEC Plan. The effect on the Seminole Tribe of Florida of these assumptions is evident by comparison of the 1995 Base Case (without Everglades Program projects) with results of alternative model simulations, that include the Everglades Program projects. Historically, the Big Cypress Seminole Indian Reservation did not rely upon surface water deliveries from the L-4 Canal. Because the Everglades Program and the Seminole Agreement contemplate surface water deliveries to Big Cypress Seminole Indian Reservation via pump station G-409, the Seminole Tribe's water demands are included as input files in the model simulations performed for the LEC water supply planning process. The amount and timing of these water deliveries were determined using demand estimates based on land use projections in the 2010 incremental simulation and calculated over the 31-year simulation period using the Blaney-Criddle method. These deliveries exceed the Seminole Tribe's surface water entitlement as established in the Final Order 98-115 DAO, except in wet months when demands were less than the entitlement (**Figure 25**). In summary, the Seminole Tribe's surface water demands are satisfied most of the time from a variety of sources. As projects associated with the CERP and the LEC regional water supply planning effort become operational, modeling indicates the Seminole Tribe's unmet demands decrease from 15 percent in the 1995 Base Case to less than two percent of the time by 2020. Due to Big Cypress Seminole Indian Reservation reliance on Lake Okeechobee supplies, the effects of regulation schedule changes on the Big Cypress Seminole Indian Reservation are integrated in these results, as described below.

Effects of Lake Okeechobee Regulation Schedule Changes. Lake Okeechobee's regulation schedule is an integral component of each alternative model simulation. Since various Lake Okeechobee regulation schedules were considered, several model simulations were completed to assess the effects of Lake Okeechobee's regulation schedule, as well as other C&SF Project modifications. As noted above, the Seminole Tribe's surface water demands for both the Big Cypress Seminole Indian Reservation and the Brighton Seminole Indian Reservation were included in input files, where applicable, for these model simulations. **Tables 16** and **17** specify the Lake Okeechobee regulation schedule used for each simulation.

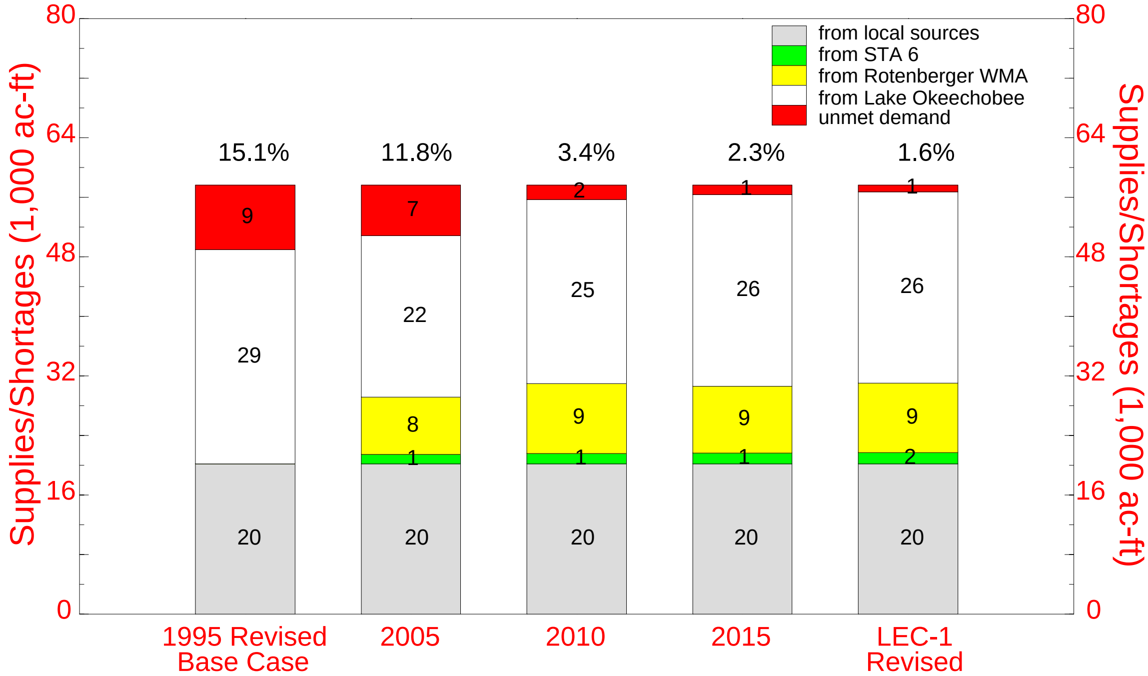

Figure 26. Average Annual (1965-1995) Irrigation Supplies and Shortages for the Seminole Tribe Big Cypress Reservation. The data on top of each bar represents the percentage of unmet demands.

Table 16. Comparison of Assumptions for the Base Case and Alternative Simulations.

Simulation	Lake Okeechobee Schedule
1995 Base Case	Run 25
2020 Base Case	WSE
2020 with Restudy	Run 25 modified for Restudy components
LEC-1	WSE modified for Restudy components

Table 17. Assumptions for the Incremental Model Simulations by SFWMM.

Simulation	Lake Okeechobee Schedule
1995 Revised Base Case	Run 25
2005	WSE
2005 SSM Scenario	WSE modified for supply-side management
2010	WSE modified for Restudy components
2015	WSE modified for Restudy components
LEC-1 Revised	WSE modified for Restudy components

Given the operational components and agreements between the District and the Seminole Tribe, additional matters related to the Brighton Seminole Indian Reservation must be considered. The Seminole Agreement reserves a volume of water from Lake Okeechobee for the Seminole Tribe, integrates supply from Lake Okeechobee to meet the Seminole Tribe's entitlement, and establishes operational criteria for water shortages. Generally, the operational criteria are based upon canal water elevations. Pump stations G-207 and G-208 have intake elevations at 10 feet, which are also integral to the ability of the pumps to provide Lake Okeechobee water to the Brighton Seminole Indian Reservation. Analysis of Lake Okeechobee stage duration curves indicates that Lake Okeechobee levels drop below 11 feet (where pump efficiency is reduced) four to five percent of the time in the LEC-1 simulation compared to three percent of the time that observed lake stages dropped below 11 feet during the 1952 to 1977 period (Marban and Trimble, 1988).

Lower East Coast Service Areas

For planning purposes, the coastal areas east of the Everglades has been divided into four service areas: North Palm Beach Service Area, LEC Service Area 1 (LECSA 1), LEC Service Area 2 (LECSA 2), and LEC Service Area 3 (LECSA 3). The service areas generally reflect the historical sources of water delivered from the regional system. LECSA 1 includes coastal basins, which receive water from WCA-1. Likewise LECSA 2 and LECSA 3 include coastal basins which receive water from WCA-2 and WCA-3, respectively. The North Palm Beach Service Area has historically received water from Lake Okeechobee via the L-8 and the M canals. More complete descriptions of these areas and figures showing their extent (**Figures 19**, **20**, **21**, and **22**) are provided in **Chapter 3**.

Two situations will cause declarations of water shortages to be simulated in the these service areas. The first situation occurs when supply-side management is imposed in the LOSA for longer than seven days. This indicates that water from regional storage might not be available and cutbacks in usage and deliveries at this time may be needed to save water for more crucial times later in the dry season. The other situation occurs when ground water levels at coastal saltwater intrusion monitoring locations indicate that water restrictions are necessary to minimize saltwater intrusion. Note that the SFWMM can only provide generalized indications regarding water levels at coastal saltwater intrusion monitoring locations because of the large (two-mile by two-mile) grid cell size used in this model. Because of this limitation, performance at the coastal ground water monitoring locations is also analyzed in the subregional ground water models. The incremental simulations do not include results from the subregional ground water models for the LEC service areas and, therefore, the incremental analyses should be considered preliminary and are not indicative of future performance.

SFWMM Base Cases and Alternatives Results

During the 30 water years simulated, the numbers of years water restrictions occurred within the LEC service areas due to Lake Okeechobee supply-side management were five for the 1995 Base Case, 11 for the 2020 Base Case, three for the 2020 with

Restudy, and two for the LEC-1. These data are presented together for the entire service area, since any shortage declarations apply equally to all of the coastal basins. The number of such shortages for both the 1995 and 2020 base cases were excessive and indicate the inadequacy of regional storage in the absence of major water resource development projects. The number of years of water shortages for the 2020 with Restudy and LEC-1 simulations indicated that the components recommended by the Restudy can provide a 1-in-10 year level of certainty for the LEC service areas. It should be noted, that in all cases, these declarations were for Phase I and Phase II shortages and restrictions that pose an inconvenience to users, but were not likely to result in economic losses. A more detailed discussion of water shortage phases is provided on **pages 25** through **28** in **Chapter 2**.)

The information in **Table 18** summarizes the modeled frequency of water shortage declarations that occurred due to coastal saltwater intrusion water level criteria. These data are presented for each service area since water shortages are usually declared based on local resource conditions.

Table 19 presents tabulations of the number of times water shortages were triggered by local ground water conditions based on trigger well locations. Amounts and locations of withdrawals significantly affected coastal saltwater intrusion problems. Both SFWMM and subregional ground water model results were analyzed to determine if a 1-in-10 year level of certainty was met. The subregional ground water results are discussed later in this section, following the SFWMM discussion.

Table 18. Number of Years with Water Restrictions Caused by Local Triggers in the Base Case and Alternative SFWMM Simulations for the Lower East Coast Service Areas During the 30 Water Years Simulated.

Service Area	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
North Palm Beach Service Area	5	0	0	0
LECSA 1	7	8	0	0
LECSA 2	21	23	2	12
LECSA 3	3	3	2	2

1995 Base Case. Water shortages occurred in significant numbers in the 1995 Base Case in all service areas except LECSA 3, where regional wellfields have been established inland from areas subject to saltwater intrusion. Ground water level monitoring locations in the Tequesta, Jupiter, Lake Worth, Fort Lauderdale Airport, Hollywood, and Homestead areas accounted for most of the shortages. A 1-in-10 year level of certainty performance was not met in this simulation.

2020 Base Case. In the 2020 Base Case, which uses the utility preferred locations for future withdrawals, significant numbers of water shortages caused by local triggers occurred only in LECSA 1 and LECSA 2. Ground water level monitoring trigger events in the North Palm Beach Service Area had been eliminated, most likely due to

Table 19. Number of Times Water Restriction Triggers in the SFWMM Base Case and Alternatives for the Lower East Coast Service Area Were Triggered.[a]

Trigger Well	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1	LEC-1A
Tequesta	5				
Jupiter	4				
Gardens					
Lake Worth	11	13			
Pompano	1				
North Lauderdale	3	3	3	3	
Lauderdale	4	19 + (4)			
Fort Lauderdale Airport	27 + (1)	31 + (2)	1	2	
Hollywood	54 + (2)	61 + (6)	4	17	
North Miami Beach	1	1			
Miami		1			
Cutler Ridge	1	6			
Homestead	5	5			
Florida City	2	3			
Taylor	3	4	5	5	5

a. Phase 2 in parentheses, all others are Phase 1

assuming that a recharge canal exists and the use of Floridan aquifer water was increased. Lake Worth, Fort Lauderdale Airport, and Hollywood areas continued to indicate low ground water levels. Trigger events increased in Lauderdale and Cutler Ridge compared to the 1995 Base Case. A 1-in-10 year level of certainty performance was not met in this simulation.

2020 with Restudy. In the 2020 with Restudy model simulation, not only was the Restudy infrastructure through 2020 modeled as having been completed, but significant public water supply demands were redistributed within the service area as well. Eastern wellfields at Miramar, Hollywood, Broward County 3A/3B/3C, Dania, and Hallandale were assumed to be placed on standby, with their entire demands met from western facilities. The following utilities had a portion of their demands shifted inland: Riviera, Lake Worth, Manalapan, Lantana, Boca Raton, and Florida City. These assumptions were consistent with the Restudy's recommendations. Based on coastal ground water levels, all four service areas met the 1-in-10 year level of certainty. No ground water level triggering occurred in the North Palm Beach Service Area or LECSA 1 during the 2020 with Restudy simulation (**Table 18**). In LECSA 3, the two years of locally triggered water shortages can be discounted because they were caused exclusively by the Taylor monitoring location, which triggered even when public water supply withdrawals were eliminated (see results for the LEC-1A simulation). The two cutback events that occurred in LECSA 2 were caused by coastal ground water level monitoring locations in the Hollywood, North Lauderdale, and Fort Lauderdale Airport areas. These events occurred during 1971 and 1975 and not during the 1-in-10 drought year identified and used for the ground water model simulations discussed below. The 2020 with Restudy simulation solved the low ground water level in this area, as seen in the 2020 Base Case, by placing the coastal wellfields in southeast Broward County on standby.

LEC-1. In the LEC-1 model simulation, not only was the Restudy infrastructure through 2020 modeled as complete, but different wellfield withdrawals and distributions were modeled compared to the 2020 with Restudy. In the LEC-1 model simulation, North Palm Beach Service Area, LECSA 1, and LECSA 3 met the 1-in-10 year level of certainty based on coastal ground water conditions. No ground water level triggering occurred in the North Palm Beach Service Area or LECSA 1 during the LEC-1 simulation. In LECSA 3, only the same nonwithdrawal related triggers occurred at Taylor. However, twelve years of coastal saltwater intrusion triggers occurred in LECSA 2 (**Table 18**). They primarily occurred at the coastal ground water level monitoring location in the Hollywood area. A few triggers also occurred in the North Lauderdale and Fort Lauderdale Airport areas (**Table 19**). In this case, restrictions did occur during the 1-in-10 drought year that was identified and used for the subregional ground water model simulations discussed below. Because the utility preferred locations for withdrawals were the basis for the LEC-1 simulations, a greater volume of public water supply withdrawals remained at the current locations along the coast near the saline interface than in the 2020 with Restudy simulation, especially in southeast Broward County. The potential for saltwater intrusion due to public water supply withdrawals was high and this area was very sensitive to public water supply withdrawal amounts and locations simulated in LEC-1. The utility preferred locations as modified in LEC-1 indicated that a smaller volume of withdrawals may need to be moved away from the coast than was moved during the 2020 with Restudy simulation. The higher number of water restrictions in LEC-1 in the Hollywood area could be reduced to meet a 1-in-10 year level of certainty as seen in the 2020 with Restudy simulation. Model iterations with different wellfield distributions would demonstrate this.

The SFWMM simulations indicated that with the planned water resource development projects and appropriate water supply development (in the form of locations of demands that meet existing permit criteria), water shortages will occur only about one year in ten. It is important, however, to look at the ability to meet demands during a 1-in-10 year drought event with the high resolution ground water models. This is the focus of evaluation of subregional ground water model results.

Subregional Ground Water Models Base Case and Alternatives

The numbers of years when water restrictions within the LEC service areas were caused by Lake Okeechobee supply-side management during the 30 water years simulated were five for the 1995 Base Case, 11 for the 2020 Base Case, three for the 2020 with Restudy, and two for the LEC-1. These data are presented together for all of the service areas since any shortage declarations apply equally to all of the coastal basins. The number of such shortages for the 1995 and 2020 base cases were excessive and indicated the inadequacy of regional storage in the absence of major water resource development projects. The number of years of water shortages for the 2020 with Restudy and LEC-1 simulations indicated that the components recommended by the Restudy can provide a 1-in-10 year level of certainty for the LEC service areas.

Five subregional ground water models were used to evaluate the ability to meet a 1-in-10 year level of certainty in the LEC service areas. They provided a more detailed look at water conditions compared to the SFWMM, because of their fine grid cell size, generally 500-feet by 500-feet, compared to the two-mile by two-mile cell for the SFWMM. Because of the detail involved in simulations of these models, they were the primary tool used to evaluate performance during a historic period that closely matches a 1-in-10 year drought event. This detail allowed performance to be evaluated in terms of three water resource conditions during that 1-in-10 year drought event:

- The triggering of water shortages was evaluated based on water levels at selected monitoring locations. This measure paralleled the water shortage triggering evaluated in the SFWMM, but provided much more location specificity, because of the fine grid cell size.
- Potential movement of the saltwater interface was evaluated by considering the net westward flow across the present location of the saltwater interface for the year that represented the 1-in-10 year drought condition.
- Potential impacts on wetlands were evaluated by considering ground water level drawdown events of one foot or more under identified wetland areas. An event occurred when the 30-day average head differed, between the simulation and the no consumptive use withdrawals simulation, by one foot or more.

Despite the detail of the ground water models, the model results are not predictive. They are not necessarily representative of actual local conditions, either now or in the future. Thus, failure to identify problems in the model simulations in this plan does not ensure issuance, reissuance, or modification of water use permits, nor does it ensure that a problem does not exist.

Results of the evaluations of the ground water model results for the 2020 with Restudy and LEC-1 alternatives, with respect to the three performance areas, are presented in **Table 20.**

Table 20. Water Supply Results for Ground Water Model Simulations of the 2020 with Restudy and the LEC-1 Alternatives.[a]

Water Restriction Area	Coastal Water Shortage Triggers During LEC 1-in-10 Year Drought Conditions	Net Westward Ground Water Flow at the Saltwater Interface During LEC 1-in-10 Year Drought Conditions	Impacts on Isolated Wetlands During LEC 1-in-10 Year Drought Conditions
North Palm Beach			
Jupiter	No indicated problems	Tequesta: Locally, west flows intersected the interface. Probably related in part to individual well withdrawal distribution and model cell size.	Seacoast, Jupiter, and Riviera Beach: Numerous wetlands affected by drawdown events. Need to verify location and condition of wetlands inside one-foot drawdown.
Clear Lake	Riviera Beach: Results for PB-632 trigger well appeared to be very sensitive to how much pumpage was east of C-17. LEC-1 has limited pumpage to the east and shows no triggering. 2020 with Restudy has all withdrawals east of C-17 and triggers Phase 2 shortages. Results for PB-809 show some triggering in LEC-1 associated with operations of ASR wells during dry periods. This problem does not appear in the 2020 with Restudy simulation.	Riviera Beach: Westward ground water flows intersected the interface in both LEC-1 and 2020 with Restudy.	No indicated problems
Palm Beach Gardens	No indicated problems	No indicated problems	No indicated problems
LEC Service Area 1			
Lake Worth	No indicated problems	No indicated problems	Lake Osborne ASR wells showed wetlands affected by drawdown events. Some wetlands are connected to and controlled by the lake, others are not.
Royal Palm Beach/ Wellington	No indicated problems	No indicated problems	No indicated problems
Delray Beach	No indicated problems	No indicated problems	Palm Beach County Utilities and Delray Beach: Few scattered wetlands affected by drawdown events from wellfields along and east of the Turnpike. The location and condition of wetlands need to be verified.
Boca Raton	No indicated problems	Boca East Wellfield: Westward flow at the interface	No indicated problems
Boca Raton West	No indicated problems	No indicated problems	Boca's west wellfield: Wetland to the east affected by drawdown events. Configuration suggests this may be excavated and not natural wetland.
LEC Service Area 2			
Pompano Beach	No indicated problems	Pompano: Westward flow across the interface in LEC-1 and 2020 with Restudy.	Pompano's east wellfield: A wetland east of the wellfield was affected by drawdown events. Need to verify location and condition of wetland.

Table 20. Water Supply Results for Ground Water Model Simulations of the 2020 with Restudy and the LEC-1 Alternatives.[a] (Continued)

Water Restriction Area	Coastal Water Shortage Triggers During LEC 1-in-10 Year Drought Conditions	Net Westward Ground Water Flow at the Saltwater Interface During LEC 1-in-10 Year Drought Conditions	Impacts on Isolated Wetlands During LEC 1-in-10 Year Drought Conditions
Fort Lauderdale Airport	Potential saltwater intrusion problems triggers were sensitive to location of withdrawals. Geographic distribution of wellfield withdrawals in 2020 with Restudy did not trigger shortages, while the distribution in LEC-1 did.	Dixie: Slight west flow across the interface in LEC-1.	Fort Lauderdale Airport: A wetland southeast of wellfield was affected by drawdown events and should be verified.
Hollywood	No indicated problem, but the trigger well is east of C-10 and may not reflect problems caused by withdrawals at Hollywood's wellfields in LEC-1.	Hollywood: Westward flow across the interface in LEC-1	No indicated problems
Western Broward County	No indicated problems	No indicated problems	Sunrise: Wetlands near Broward County South Regional Wellfield and Miramar were affected by drawdown events. Size and shape of wetlands suggest excavations, not natural. City of Coral Springs and North Springs Improvement District: Scattered wetland was affected by drawdown events. Coral Springs Improvement District: Wetlands at the edge of the one-foot contour.
North Miami Beach	No indicated problems	North Miami: Westward flow across interface in LEC-1 and 2020 with Restudy, based on 4.45 MGD with balance of demands from WASD Northwest wellfield in LEC-1. North Miami Beach: OK at 15 MGD with balance of demands from WASD Northwest wellfield in LEC-1.	No indicated problems
LEC Service Area 3			
Miami	No indicated problems	Hialeah-Preston: Westward flow across the interface which may have been due to surface drainage features	Northwest wellfield: Extensive wetlands affected by drawdown events in the area are likely to have been mitigated under existing permit.
Kendall	No indicated problems	No indicated problems	No indicated problems
Kendall Lakes	No indicated problems	No indicated problems	No indicated problems
Homestead	No indicated problems	Rex-Homestead area: Significant westward flow across interface in 2020 with Restudy	West wellfield: Wetlands affected by drawdown events in Bird Drive mitigation areas

a. This table generally summarizes conditions observed in ground water models of the LEC Planning Area. Model results are not predictive, are regional and generalized in nature, and not necessarily representative of actual local conditions, either now or in the future. Please note that a determination of no problems from a model simulation does not ensure issuance, reissuance, or modification of water use permits, nor does determination of a problem preclude it.

The 1-in-10 year level of certainty was met in the 2020 with Restudy and LEC-1 simulations. A summary of water restrictions due to coastal ground water levels in all of the base cases and alternatives from the ground water models is presented in **Table 21**. In most areas, the coastal water shortage triggers did not trigger a water restriction during an 1-in-10 year drought event. In the isolated cases where model results indicated problems, changing withdrawal locations or other operations enabled the water shortage criteria for coastal ground water levels to be met. These isolated events are discussed below:

- Results for the LEC-1 simulation indicated that low ground water levels at PB-632 in the Riviera Beach Area, which were evidenced in the 2020 with Restudy simulation, can be avoided by shifting public water supply withdrawals to Riviera Beach's proposed wellfields located farther west, but within the constraints of the landfill.
- The restrictions associated with the PB-809 trigger in the Clear Lake area in the 2020 with Restudy simulation appeared to result from the assumption that ASR wells in the area would be injecting during dry periods. An appropriate response would be to stop injecting during this period in the model simulation. This assumption was incorporated into LEC-1.
- In the Fort Lauderdale Airport area (LECSA 2), the trigger well is sensitive to wellfield withdrawal distributions. The 2020 with Restudy simulation did not trigger shortages in this area, but the LEC-1 simulation did. A slight change in distribution within the Dixie Wellfield would prevent these low ground water levels and resulting restrictions in LEC-1. It is important to note that, while there were no restrictions in the Hollywood area in LEC-1, the location of the trigger well, east of the C-10 Canal, may have precluded it from accurately assessing saltwater intrusion effects of the Hollywood withdrawal. The aquifer recharge provided by the Broward County Secondary Canal System from the C-9 created a mound that effectively protects the trigger cell (F-219) from effects of withdrawals in the Hollywood’s south wellfield. The effectiveness of the recharge facility, timing of construction, and public water supply demands need to be assessed during the CUP process.
- Most wellfields in LECSA 3 avoided water restrictions due to low ground water levels along the coast, because they are centralized inland in Miami-Dade County.

Generally, the distribution of public water supply withdrawals in the 2020 with Restudy simulation did not perform well due to the wellfield distribution assumed. The water supply demands simulated in the LEC-1, which was based primarily on the utility-preferred withdrawal locations and sources, were met.

Indications of net westward ground water flows at the saltwater interface were noted in about half of the water restriction areas under the 1-in-10 year drought conditions. In several cases, the westward ground water flow across the saltwater interface occurred in

Table 21. The Number of Days Each Water Restriction Area Was Cutback in the LEC Service Areas Due to Local Ground Water Conditions.

LEC Service Area	Water Restriction Area	Subregional Ground Water Model Simulation			
		1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
North Palm Beach Service Area	Jupiter	127	0	112	0
North Palm Beach Service Area	Palm Beach Gardens	0	0	112	0
North Palm Beach Service Area	Clear Lake	0	0	75	19
LECSA 1	Royal Palm Beach	0	0	112	0
LECSA 1	Wellington	0	0	0	0
LECSA 1	Lake Worth	0	114	0	0
LECSA 1	Delray Beach	0	0	0	0
LECSA 1	Boca Raton	0	0	0	0
LECSA 1	Boca West	0	0	14	0
LECSA 2	Western Broward	0	0	0	0
LECSA 2	Pompano	0	0	0	0
LECSA 2	Fort Lauderdale Airport	157	188	0	42
LECSA 2	Hollywood	194	192	0	0
LECSA 2	North Miami Beach	0	0	0	0
LECSA 3	Kendall Lakes	0	0	0	0
LECSA 3	Miami	0	0	0	0
LECSA 3	Kendall	0	0	0	0
LECSA 3	Homestead	0	0	0	0

one alternative and not the other. This is indicative that redistribution of wellfield withdrawals should be avoided (refer to **Appendix H** for the performance measures graphics). Also, indications of drawdowns greater than one foot for more than 30 days beneath wetlands occurred in about half of the water restriction areas under the 1-in-10 year drought conditions. In many instances, the existence and nature of the mapped wetland areas needed to be verified. Also, sometimes the impacts shown were known and had been dealt with in previous permitting processes through avoidance and mitigation. For the most part, these results imply that more detailed evaluation will be necessary during any permit application process that involves public water supply amounts and distributions similar to those evaluated in these simulations.

SFWMM Incremental Simulations Results

The number of years with water restrictions caused by Lake Okeechobee supply-side management was five for both the 1995 Revised Base Case and 2005 simulations. The number decreases to three for the 2010 simulation and then to two for both the 2015 and LEC-1 Revised simulations. Results for the 1995 Revised Base Case and 2005 simulations indicated that they could not meet a 1-in-10 year level of certainty due to Lake Okeechobee stages. Regional storage in the absence of major water resource development projects, which will not be completed until after 2005, were inadequate. The results for the 2015 and LEC-1 Revised simulations indicated that the projects recommended by the Restudy will provide a 1-in-10 year level of certainty for the four LEC service areas and

LOSA. In the 2005 SSM Scenario, the performance remained the same as the original 2005 simulation. Changes to the supply-side management criteria did not affect the ability to provide regional water to the LEC service areas during a 1-in-10 year drought event.

The information in **Table 22** summarizes the frequency of water shortage declarations due to coastal saltwater intrusion water level criteria. These data are presented for each service area, since water shortage declarations are usually based on local resource conditions.

Table 22. Number of Years with Water Restrictions Caused by Local Triggers in the SFWMM Incremental Simulations for the Lower East Coast Service Areas during the 30 Water Years Simulated.

Service Area	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
North Palm Beach Service Area	5	1	0	0	0
LECSA 1	7	0	0	0	0
LECSA 2	21	13	8	11	12
LECSA 3	4	5	3	3	2

Table 23 presents tabulations of the number of times water shortages were triggered by local ground water conditions by trigger well locations during each of the simulations. It should be noted, that in all cases, these declarations were for Phase I and Phase II shortages and restrictions that pose an inconvenience to users, but were not likely to result in economic losses. A more detailed discussion of water shortage phases is provided on **pages 25** through **28** in **Chapter 2**.) In all of the simulations, amounts and locations of pumpage significantly affected coastal saltwater intrusion problems. Such problems were solved as soon as the appropriate wellfield distributions or water supply development options were implemented.

1995 Revised Base Case. Water shortage problems were significant in the 1995 Revised Base Case in all service areas except LECSA 3, where regional wellfields have been established inland from areas subject to saltwater intrusion (**Table 23**). Ground water stage monitoring locations in the Tequesta, Jupiter, Lake Worth, Fort Lauderdale Airport, Hollywood, and Homestead areas accounted for most of the shortages. This simulation did not meet the 1-in-10 year level of certainty.

2005. In the 2005 simulation and subsequent incremental simulations, the utility-preferred wellfield distribution, as modified in LEC-1, is applied. In the 2005 simulation, water shortages caused by local triggers were eliminated in LECSA 1 and were greatly reduced in the North Palm Beach Service Area. The number of cutbacks in LECSA 2 was primarily a result of the sensitivity to the assumed location of public water supply withdrawals from the Surficial Aquifer System (SAS). The number of restrictions in LECSA 3 increased slightly when compared to the 1995 Revised Base Case. This may have been due to demand growth, changes in pumpage distribution from the 1995 Revised Base Case, or other factors that affect water levels in areas near the Miami and Cutler Ridge monitoring locations.

Table 23. Number of Times Water Restriction Triggers in the SFWMM Incremental Simulations for the Lower East Coast Service Areas Were Triggered.[a]

Trigger Well	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Tequesta	5				
Jupiter	4	1			
Gardens		1			
Lake Worth	11				
Pompano	1				
North Lauderdale	3	5	2	2	3
Lauderdale	4	1			
Fort Lauderdale Airport	27 + (1)	25 + (1)	1	1	1
Hollywood	53 + (3)	21	12	15	17
North Miami Beach	1				
Miami		2			
Cutler Ridge	1	4			
Homestead	5	7	3	3	
Florida City	3	2			
Taylor	3	5	5	5	5

a. Phase 2 in parentheses, all others are Phase 1

2010. The 2010 simulation indicated that the 1-in-10 year level of certainty can be met, based on coastal ground water conditions. No cutbacks due to low ground water levels occurred in the North Palm Beach Service Area or LECSA 1. In LECSA 2, the numbers of restrictions that occurred in the Fort Lauderdale Airport and Hollywood area declined from 2005, probably due to inclusion of the southern portion of the Broward Secondary Canal Recharge System, as recommended in the Restudy. Also, triggering for North Miami Beach, whose wellfield is in LECSA 2, were eliminated. In LECSA 3, triggers in the Miami, Cutler Ridge, and Florida City areas were eliminated while those in the Homestead area were further reduced. These improvements were likely due to the implementation of features recommended in the Restudy and the addition of Miami-Dade County Utility ASR facilities.

2015. As in the 2010, ground water level triggering did not occur in the North Palm Beach Service Area or LECSA 1 in the 2015 simulation. In LECSA 2, some additional triggering occurred in the Hollywood area, probably as a result of demand growth in the area without any infrastructure or wellfield location improvements beyond 2010. Water demands in Hollywood increased slightly from 19.31 MGD in 1995 to 22 MGD in the LEC-1 Revised, while Hallandale, Dania Beach, and Broward 3A were on standby starting in 2005 and withdrawal was relocated to the Broward County South Regional Wellfield. In LECSA 3, triggers in the Homestead area remained the same as in 2010.

LEC-1 Revised. In the LEC-1 Revised simulation, no water shortages occurred due to low ground water levels in the North Palm Beach Service Area or LECSA 1. In LECSA 2, some additional trigger events occurred in the Hollywood area and one additional trigger event occurred in the Lauderdale area compared to 2015. These were also the likely result of demand growth without any additional infrastructure or wellfield location improvements beyond 2010 refinement of the wellfield distribution. In LECSA 3, trigger events in the Homestead area were eliminated and only those in the Taylor area, which are insensitive to public water supply withdrawals remained.

The incremental simulation results indicated that the ability to meet a 1-in-10 year level of certainty improved over time as the Restudy and other water resource development projects were implemented. The volume and location of public water supply withdrawals significantly affected coastal saltwater intrusion. Saltwater intrusion was largely be avoided, and the associated restrictions diminished, when appropriate water supply options such as wellfield relocation, distribution, and operational changes were implemented. In 2005, use of the utility-preferred wellfield distribution (same as LEC-1) solved coastal trigger problems in the North Palm Beach Service Area, LECSA 1, and LECSA 3. The low coastal ground water stages in LECSA 2 were avoided by altering the distribution or allocation of public water supplies year-round or conditionally, depending on the severity and location of low ground water stages. The LEC-1 Revised simulation demonstrated the ability to avoid saltwater intrusion and water restrictions with minor adjustments to public water supply distribution.

Hollywood Seminole Indian Reservation

The Seminole Tribe of Florida is currently reviewing its options to self-supply its Hollywood Seminole Indian Reservation by shifting supply of its public water supply demands to its own utility system. The average and maximum daily demands associated with this facility during the planning horizon are expected to be approximately 1.5 MGD and 2.0 MGD, respectively. The modeling analyses performed to support the LEC regional water supply planning process did not include these demands in the model assumptions, but did evaluate withdrawals on the Hollywood Seminole Indian Reservation at a rate of 0.88 MGD on average. It is staff's opinion that average withdrawals of 1.5 MGD and a maximum daily withdrawal of 2.0 MGD on the Hollywood Reservation are attainable. In addition, the Seminole Tribe has agreed to participate in the Southeast Broward County Interconnected Water Supply System discussions (**Recommendation 8** in **Chapter 6**). These discussions will deal with developing water supply solutions for the water supply utilities of southeast Broward County, while protecting the water rights of the Seminole Tribe.

Summary of Results for the Lower East Coast Service Areas

- The 1995 and 2020 base cases did not meet a 1-in-10 year level of certainty performance.
- The 2020 with Restudy, LEC-1, and LEC-1 Revised model simulations were capable of meeting 2020 water supply projections in the LEC service areas.
- The SFWMM results demonstrated that the frequency of supply-side management restrictions in the 2020 with Restudy, the

LEC-1, and the LEC-1 Revised simulations met the 1-in-10 year level of certainty planning criteria for the LEC service areas.

- The redistribution of wellfield withdrawals in the 2020 with Restudy and the LEC-1 simulations demonstrated the significant effect that wellfield withdrawals had on local ground water conditions and on the ability to meet the 1-in-10 year level of certainty. This is evidenced in southeast and central Broward County, where redistribution of wellfield withdrawals in the model simulations was the determining factor for meeting the 1-in-10 year level of certainty based on local conditions.
- A 1-in-10 year level of certainty for public water supply was not met in the LEC service areas. The subregional ground water model simulations indicated that water shortage restriction criteria were met and harm to wetlands and the Biscayne aquifer were avoided. Implementation of Restudy projects, refinement of utility preferred wellfield distributions and operations, and implementation of water supply development options were necessary to meet the 1-in-10 year level of certainty.
- Assuming the utility-preferred withdrawal locations are implemented as proposed, several public water suppliers may need to implement water supply development options and/or further refine their preferred wellfield locations in order to meet the 1-in-10 year level of certainty. These utilities include Lake Worth, Manalapan, Lantana, Fort Lauderdale, Hallandale, Hollywood, Dania Beach, and Broward County 3A, 3B, and 3C.
- A few utilities may meet a 1-in-10 year level of certainty, but may not meet CUP criteria for wetland drawdowns, and/or avoid saltwater intrusion, unless their wellfield distribution and seasonal operations are refined. These utilities include Seacoast, Jupiter, Riviera Beach, Pompano Beach, Boca Raton's eastern wellfield, Coral Springs, North Springs Improvement District, the proposed Miami-Dade WASD’s proposed south regional wellfield and existing west wellfield, North Miami, North Miami Beach, and Homestead.

ENVIRONMENTAL RESOURCES RESULTS

As with the evaluations of urban areas, two different sets of simulations were performed using the SFWMM. The first set of simulations compares current (1995) and future (2020) base case conditions. A second set of model simulations was created to visualize the incremental changes that occur to the overall system at five-year intervals (2005, 2010, and 2015) as Restudy and other water resource development components come on-line. Detailed descriptions of the parameters, conditions, and rationales used in each model simulation can be found in the **Model Simulations** section of this chapter. An overview of results for each set of simulations is presented first, then performance measures and results for both sets of simulations are discussed by natural area.

District staff have recently developed proposed MFL criteria for three priority water bodies included within the LEC Planning Area (SFWMD, 2000e). These water bodies include Lake Okeechobee, the Biscayne aquifer, and the Everglades. The Everglades includes the WCAs, the Holey Land and Rotenberger WMAs, and the freshwater regions of Everglades National Park. The final draft document proposes minimum water level depths, durations, and frequencies of occurrence that will guide the operation of the C&SF Project and future management of Lake Okeechobee, the Everglades, and the Biscayne aquifer. The ability to achieve these proposed MFL criteria is assessed for each natural area and each set of model simulations.

Overview of Results

Overview of Base Cases and Alternatives Results

Results for the current (1995) and future (2020) base cases were obtained from model simulations for the same conditions that were obtained for the urban areas: 1995 Base Case, 2020 Base Case, 2020 with Restudy, and LEC-1. These conditions were analyzed and the results are displayed in formats similar to the methods that were used for the Restudy, with the addition of the MFL criteria, which were subsequently developed for Lake Okeechobee, the Everglades, and the Biscayne aquifer (SFWMD, 2000e).

Table 24 provides a color-coded evaluation of the overall results of each base case and alternative simulation. The color codes (green, yellow, or red) represent a scoring system to evaluate model output, based on review of key environmental performance measures discussed later in this chapter and in **Appendix D** and use of best professional judgement by District scientists. Similar color-coding schemes and definitions were used in the Restudy to provide a qualitative assessment of the ability of particular water supply actions or features to meet environmental management objectives of this plan.

1995 Base Case. A majority of the natural areas (14 out of 21 areas evaluated) in the 1995 Base Case were scored as red, indicating they did not currently meet LEC environmental planning criteria (**Table 24**). These areas were Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries, Lake Worth Lagoon, Rotenberger WMA, WCA-2B, all of WCA-3 except Indicator Region 17, Shark River Slough, the Rockland marl marsh, western Florida Bay, and Whitewater Bay. Ecosystems will not recover in these areas unless major hydrologic improvements occur. Five areas were scored yellow (**Table 24**), indicating marginal or uncertain ability to meet environmental targets and achieve recovery. These areas were the Holey Land WMA, northern WCA-2A (Indicator Region 25), central WCA-3A (Indicator Region 17), WCA-3B, and central and southern Biscayne Bay. Only three areas were scored green (**Table 24**), indicating that they currently met environmental performance measure targets and will likely result in long-term sustainability of the ecosystem, providing water quality standards are met. These

Table 24. South Florida Water Management Model Results for Base Cases and Alternatives for Natural Areas within the Lower East Coast Planning Area.[a]

Area	Indicator Region(s)[b]	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Lake Okeechobee	NA	R	R	G	G
Caloosahatchee Estuary	NA	R	R	G	G
St. Lucie Estuary	NA	R	R	G	G
Lake Worth Lagoon	NA	R	Y	Y	Y
Loxahatchee National Wildlife Refuge (WCA 1)	27 and 26	G	Y	G	G
WCA-2A	24 and 25	Y/G	Y/G	Y/G	Y/G
WCA-2B	23	R	R	R	R
Holey Land WMA	29	Y	Y	G	G
Rotenberger WMA	28	R	G	G	G
Northwestern WCA-3A	20 and 22	R	G	G	G
Northeastern WCA-3A	21	R	Y	G	G
Eastern WCA-3A	19	R	Y	Y	Y
Central WCA-3A	17 and 18	Y/R	Y/R	G/Y	G/Y
Southern WCA-3A	14	R	R	G	G
WCA-3B	15 and 16	Y	Y	Y	Y
Shark River Slough	9, 10, and 11	R	R	G/Y	G/Y
Rockland Marl Marsh	8	R	R	Y	Y
Northern Biscayne Bay	NA	G	Y	Y	Y
Central Biscayne Bay	NA	Y	Y	Y	Y
Southern Biscayne Bay	NA	Y	Y	Y	G
Western Florida and Whitewater Bays	NA	R	R	G	G

a. G (green) = planning targets met
Y (yellow) = ability to meet targets was marginal or uncertain, or goal was not defined
R (red) = planning targets not met

b. An indicator region is a grouping of model grid cells within the SFWMM that consists of similar vegetation cover and soil type. Indicator regions were used only in simulations for the Everglades.

areas were the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), southern WCA-2A (Indicator Region 24), and northern Biscayne Bay.

2020 Base Case. Fewer areas scored red in the 2020 Base Case compared to the 1995 Base Case, but most of the region still did not meet the environmental planning targets (**Table 24**). The 2020 Base Case showed improvement in some areas over the 1995 Base Case. These areas were Lake Worth Lagoon, the Rotenberger WMA, and northeastern, northwestern, and eastern WCA-3A. Lake Worth Lagoon improved due to the capability to store water in STA-1 East, which reduced the amount of water discharged to the lagoon. The Rotenberger WMA and northern WCA-3A improved due to completion of the Everglades Construction Project in 2003. Two areas became worse under the 2020 Base Case, the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) and northern Biscayne Bay, changing from green to yellow.

2020 with Restudy and LEC-1. Results show that the 2020 with Restudy and LEC-1 simulations performed very similar to each other (**Table 24**) and provided significant hydrological improvements to the regional ecosystem. Significant and substantial progress was made in these alternatives toward meeting environmental restoration targets for the Everglades and the estuaries. Overall, 14 out of 21 sites scored green under the LEC-1 and 2020 with Restudy alternatives, indicating they met LEC water supply planning targets and will likely result in recovery and long-term sustainability of the ecosystem, providing water quality standards are met. These areas were Lake Okeechobee, the St. Lucie and Caloosahatchee estuaries, the Holey Land and Rotenberger WMAs, Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), northern WCA-2A (Indicator Region 25), northeastern and northwestern WCA-3A, a portion of central WCA-3A (Indicator Region 17), southern WCA-3A, western Florida Bay, and Whitewater Bay. These alternatives show great improvement relative to the 1995 and 2020 base cases. Shark River Slough scored green/yellow, which was an improvement relative to the base cases, but did not perform quite as well as Alternative D13R in 2050, when all of the Restudy projects were completed (USACE and SFWMD, 1999).

Areas that indicated marginal or uncertain ability to meet the environmental objectives of the LEC Plan (scored yellow) and need further improvement, or where the target was not yet defined, include Lake Worth Lagoon, southern WCA-2A (Indicator Region 24), eastern WCA-3A (Indicator Region 19), a portion of central WCA-3A (Indicator Region 18), WCA-3B, the Rockland marl marsh located within Everglades National Park, and northern and central Biscayne Bay (**Table 24**). These results were very similar to those achieved under Alternative D13R, with the Restudy projects completed by 2050 (USACE and SFWMD, 1999).

Only one area, WCA-2B, was scored red for the 2020 with Restudy and LEC-1 alternatives (**Table 24**). These results indicated that environmental planning targets will not be met, ecosystem recovery will not likely occur, and WCA-2B will need improvements. Again, these results were similar to results from the Restudy model simulations for this area. However, LEC-1 showed improved performance as compared to Alternative D13R (USACE and SFWMD, 1999).

Overview of Incremental Modeling Results for Natural Areas

Table 25 provides a color-coded evaluation of the overall results of each incremental simulation based on a review of key performance measures discussed later in this chapter and in **Appendix D**. Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries showed improvements by 2010, and met their respective planning targets by 2015. These improvements were due in part to the construction of regional reservoirs within the C-43 and C-44 basins. Similar improvements occurred over time in the Arthur R. Marshall Loxahatchee National Wildlife Refuge, northern WCA-3A, and the Holey Land and Rotenberger WMAs. These areas met proposed planning targets during the 2010 simulation as a result of completion of the Everglades Construction Project and the EAA Storage Reservoirs, and implementation of rain-driven water deliveries for the WCAs. In contrast, performance measure targets were not met in central and southern WCA-3A and WCA-3B until the LEC-1 Revised simulation (2020).

Table 25. South Florida Water Management Model Results for Incremental Simulations for Natural Areas within the Lower East Coast Planning Area.

Area	Indicator Region(s)[a]	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised	D13[b]
Lake Okeechobee	NA	R/Y	Y	Y	G	G	G
Caloosahatchee Estuary	NA	R	R	Y	G	G	G
St. Lucie Estuary	NA	R	R	Y	G	G	G
Lake Worth Lagoon	NA	R	R	Y	Y	Y	Y
Loxahatchee National Wildlife Refuge (WCA 1)	27 and 26	G	G/Y	G	G	G	G
WCA-2A	24 and 25	G/Y	G/Y	G/Y	G/Y	G/Y	G/Y
WCA-2B	23	R	R	R	R	R	R
Holey Land WMA	NA	R	R	G	G	G	G
Rotenberger WMA	NA	R	Y	G	G	G	G
Northwestern WCA-3A	20 and 22	R	Y	G	G	G	G
Northeastern WCA-3A	21	R	G	G	G	G	Y
Eastern WCA-3A	19	R	Y	Y	Y	Y	Y
Central WCA-3A	17 and 18	Y/R	G/Y	G/Y	G/Y	G/Y	G/Y
Southern WCA-3A	14	R	Y	Y	Y	G	G
WCA-3B	15 and 16	Y	Y	Y	Y	Y/G	Y
Shark River Slough	9, 10, and 11	R	R	R/Y	Y	G/Y	G
Rockland Marl Marsh	8	R	Y	Y	Y	Y	Y
Northern Biscayne Bay	NA	G	Y	G	G	Y	G
Central Biscayne Bay	NA	Y	Y	Y	Y	Y	G
Southern Biscayne Bay	NA	Y	Y	Y	Y	G	G
Western Florida and Whitewater Bays	NA	R	Y	Y	Y	G	G

a. An indicator region is a grouping of model grid cells within the SFWMM that consists of similar vegetation cover and soil type. Indicator regions were used only in simulations for the Everglades.
b. D13 is short for Alternative D13, a simulation performed for the Restudy (USACE and SFWMD, 1999).

Incremental modeling results for Everglades National Park showed a gradual improvement in the ability to attain flow targets. Beginning with the 2005 simulation, the distribution and volume of water provided to northeastern and northwestern Shark River Slough significantly improved. During the 2010 simulation substantial improvements in meeting NSM hydroperiod targets were recorded in northeastern and central Shark River Slough, with nearly full achievement of the target during the LEC-1 Revised simulation (100 percent of the slough matches the NSM hydroperiod target during the LEC-1 Revised simulation). In the Rockland marl marsh, significant hydroperiod improvements were first noted during the 2005 simulation within this overdrained area of the park and continued through the LEC-1 Revised simulation. These improvements appear to be linked to the construction of the Lake Belt Project (which is expected to be only 50 percent complete by 2020) and full implementation of Lake Okeechobee ASR, which will free up water that can be delivered downstream from the lake to Everglades National Park. These results showed the importance of the Lake Belt Project, which will have large water storage reservoirs to capture and store water during wet periods and deliver it to Everglades National Park with the proper timing and volumes to hydrologically restore this area.

A number of areas did not fully meet the planning targets and were scored as yellow or red (**Table 25**). One area, WCA-2B, was scored red in the LEC-1 Revised Simulation, indicating that it did not meet planning targets and was in need of major improvement. Areas that scored yellow (exhibited marginal or uncertain performance) in LEC-1 Revised Simulation included the Lake Worth Lagoon, southern WCA-2A (Indicator Region 24), northeastern (Indicator Region 21) and eastern (Indicator Region 19) WCA-3A, a portion of central WCA-3A (Indicator Region 18), a portion of Shark River Slough (Indicator Region), the Rockland marl marsh located within Everglades National Park, and northern and central Biscayne Bay. These results were similar to the findings presented by the Restudy, which identified problems in meeting proposed environmental targets for these areas by 2050 (USACE and SFWMD, 1999).

Lake Okeechobee

Extreme fluctuations of both high and low water levels within Lake Okeechobee over the past two decades have had major adverse impacts on water quality, the distribution of littoral zone vegetation communities that support fish and wildlife habitat, and downstream estuaries which receive regulatory releases from the lake. The following set of performance measures were developed to judge how well each water supply alternative reduces the frequency of these extreme high and low water events and improves the overall ability of the regional ecosystem to meet the environmental objectives of the LEC Plan.

Performance Measures Applied

Performance measures and hydrologic targets developed for Lake Okeechobee are listed below. These performance measures are similar to those used in the Restudy and that were developed by Havens and Rosen (1995). These two references provide the background information and rationale for development of the following five priority performance measures for Lake Okeechobee, which were used to evaluate the lake:

- Number of times lake stages exceeded 17 ft NGVD for more than 50 days
- Number of times lake stages exceeded 15 ft NGVD for more than one year
- Number of times lake stages fell below 12 ft NGVD for more than one year
- Number of times lake stages fell below 11 ft NGVD
- Number of spring water level recessions, i.e., the number of times between the months of January and March that lake stages declined from near 15 to 12 ft NGVD (these conditions are judged as favorable for wading bird foraging and nesting and other water-dependent wildlife present within the littoral zone)

Base Cases and Alternatives Results

Table 26 provides an evaluation of the lake under the 1995 and 2020 base cases as compared to the 2020 with Restudy and LEC-1 simulations.

Table 26. Summary of Base Case and Alternative Modeling Results for Lake Okeechobee Priority Performance Measures.

Priority Performance Measures	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Number of times stages exceeded 17 ft NGVD for more than 50 days	4	2	2	2
Number of times stages exceeded 15 ft NGVD for more than one year	4	1	1	1
Number of times stages fell below 12 ft NGVD for more than one year	1	2	1	1
Number of times stages fell below 11 ft NGVD	4	19	4	4
Number of spring water level recessions[a]	5	4	9	8

a. Number of years during the months of January-May that lake levels declined from near 15 to 12 ft NGVD (without a water level reversal greater than 0.5 feet). These conditions are judged as favorable for wading bird foraging and nesting and also benefit other wildlife species present within the marsh. These water level recessions are also beneficial for reestablishment of willow stands and also allow fire to burn away cattail thatch (Havens et al., 1998).

1995 Base Case. The 1995 Base Case had the largest number of extreme high water events (number of times stages exceeded 17 ft NGVD for more than a 50-day duration) that impacted the littoral zone, increased the frequency that large volumes of water were discharged to downstream estuaries, and increased the risk of flooding of lakeside communities. In addition, the number of times that the littoral zone was flooded for long periods of time (number of times lake stages exceeded 15.0 ft NGVD for more than one year) was greater than the numbers that occurred during the future water supply simulations. In contrast, fewer extreme low water events (number of times lake stages fell below 11 and 12 ft NGVD) that dried out the marsh and impacted the ability of the lake to provide water supply for the LEC Planning Area occurred under the 1995 Base Case than under the future simulations (**Table 26**). The lake also had relatively fewer occurrences of favorable spring water level recessions that benefit wading bird and snail kite foraging and nesting as compared to the 2020 with Restudy and the LEC-1 (**Table 26**).

2020 Base Case. Increased water demands under the 2020 Base Case led to a significant increase in the number of times lake levels fell below 11 ft NGVD as compared to the 1995 Base Case (19 times versus four times). This increase in low water periods had the potential to dry out the marsh more often and impact water supplies. The 2020 Base Case showed an improvement in reducing the number of times that extreme high water conditions occurred during the 31-year simulation period when compared to the 1995 Base Case (**Table 26**). Although lake dry downs occurred more often under the 2020 Base Case than under the 1995 Base Case, they did not appear to coincide with the spring water level recessions preferred by wading birds and other water-dependent species.

2020 with Restudy and LEC-1. The 2020 with Restudy and LEC-1 alternatives both performed significantly better than the base cases to meet the five priority performance measures for Lake Okeechobee (**Table 26**). The most dramatic improvement occurred in terms of the reduced number of extreme low lake stage events (i.e., lake stages which receded below 11 ft NGVD and completely dried out the littoral zone). Review of stage duration curves also showed improved hydrologic conditions within the littoral zone for the 2020 with Restudy and LEC-1 alternatives.

Littoral Zone Impacts. Under the 1995 Base Case simulation, the littoral zone was flooded 37 percent of the time during the 31-year simulation period. These results were similar to current conditions on the lake, which have resulted in prolonged flooding of the littoral zone and loss of beneficial littoral zone plant communities in favor of introduced exotics (e.g., torpedo grass), as well as impacts to wading birds and other water-dependent wildlife. High lake stages have also been associated with increased in-lake nutrient loading, turbidity, and increased frequency of blue-green algal blooms (SFWMD, 1997).

Long-term flooding of the littoral zone was reduced significantly under the 2020 Base Case, 2020 with Restudy, and LEC-1 alternatives, which exhibited littoral zone flooding for 21, 18, and 16 percent of the time, respectively, during the 31-year simulation period. This was a major improvement over the 1995 Base Case condition. Although each of these simulations resulted in a lower number of damaging high water events compared to the 1995 Base Case, only the 2020 with Restudy and LEC-1 alternatives showed improved hydrologic benefits at both ends of the hydrograph (**Appendix H**).

Minimum Flows and Levels. Minimum water level criteria were met for Lake Okeechobee under the 1995 Base Case, 2020 Base Case, 2020 with Restudy, and LEC-1 simulations (**Table 27**). Best results occurred under the 1995 Base Case, 2020 with Restudy, and LEC-1 simulations, which met the criteria by a wide margin. Water levels fell below 11 ft NGVD for greater than 80 days only twice (once every 15 years) during the 31-year simulation period. In contrast, increased water use demands in the 2020 Base Case caused water levels to dropped below 11 ft NGVD for more than an 80-day duration a total of five times (once every six years) during the 31-year simulation period. These results were just within the limits of meeting the proposed MFL criteria for Lake Okeechobee.

Table 27. The Ability of Base Case and Alternative Simulations to Meet Proposed Minimum Water Level Criteria[a] for Lake Okeechobee for the 31-Year Simulation Period.

Performance Measure	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Number of times water levels fell below 11 ft NGVD for more than 80 days duration	2 (1-in-15 years)	5 (1-in-6 years)	2 (1-in-15 years)	2 (1-in-15 years)

a. MFL Planning Target = water levels should not fall below 11 ft NGVD for more than 80 days, no more often than once every six years

Incremental Simulations Results

Hydrologic Performance. Table 28 provides a summary of the ability of the incremental simulations to meet the five priority performance measures developed for Lake Okeechobee. The incremental modeling simulations shown in **Table 28** included the WSE schedule for Lake Okeechobee. Implementation of the WSE under the 1995 Revised Base Case showed an improvement in reducing the number of times lake stages exceeded 17 ft NGVD when compared to the 1995 Base Case (**Table 26**). This reduction in the number of extreme high water events should help protect the ecosystem from the effects of damaging high water levels that impact the littoral zone and increase the risk of flooding.

In the incremental simulations, the number of times water levels fell below 11 ft NGVD were reduced (**Table 28**), which helped protect the littoral zone and increased the District's ability to protect the Biscayne aquifer against saltwater intrusion during dry periods. This was the result of new regional reservoirs coming on-line in 2010, 2015, and 2020, and implementation of the Lake Okeechobee ASR, which helped decrease demands on the lake during dry periods.

Table 28. Summary of Incremental Modeling Results for Lake Okeechobee Priority Performance Measures.

Priority Performance Measure	1995 Revised Base Case	2005	2005 SSM Scenario	2010	2015	LEC-1 Revised
Number of times stages exceeded 17 ft NGVD for more than 50 days	2	2	2	1	2	2
Number of times stages exceeded 15 ft NGVD for more than one year	3	3	3	2	2	1
Number of times stages fell below 12 ft NGVD for more than one year	1	1	1	1	1	1
Number of times stages fell below 11 ft NGVD	8	12	11	9	5	3
Number of spring water level recessions[a]	5	5	5	5	6	10

a. Number of years during the months of January-May that lake levels declined from near 15 to 12 ft NGVD (without a water level reversal greater than 0.5 feet). These conditions are judged as favorable for wading bird foraging and nesting and also benefit other wildlife species present within the marsh. These water level recessions are also beneficial for reestablishment of willow stands and also allow fire to burn away cattail thatch (Havens et al., 1998).

The number of spring water level recessions increased during the LEC-1 Revised simulation. The timing of these water level recessions was favorable for wading bird foraging and nesting and also provided benefits to other water-dependent wildlife present within the littoral zone.

Comparison of the 2005 incremental simulation versus the 2005 SSM Scenario showed only minor differences in performance for Lake Okeechobee. The primary difference was that under the 2005 SSM Scenario, slightly less water was available in the lake during dry periods. However, this difference was not enough to exceed proposed MFL criterion for the lake (**Table 29**). Review of the five priority performance measures developed for Lake Okeechobee showed very similar performance for both simulations. Results from the 2005 incremental simulation and the 2005 SSM Scenario are presented in **Table 28**.

Minimum Flows and Levels. The water supply planning MFL criterion for the lake is as follows: water levels should not fall below 11 ft NGVD greater than 80 days, no more often than once every six years on average. **Table 29** presents incremental modeling results that describe how well the proposed MFL criterion were met over the 20-year planning period. These values were well within the range of the proposed MFL target for Lake Okeechobee. The MFL planning target was not met only five times during the 31-year simulation period.

Table 29. Lake Okeechobee Minimum Flows and Levels Incremental Results for the 31-Year Simulation Period.

MFL Criterion	Target	1995 Revised Base Case	2005	2005 SSM Scenario	2010	2015	LEC-1 Revised
Number of times lake stages fell below 11 ft NGVD for more than 80 days	5 (1-in-6 years)	2 (1-in-15 years)	2 (1-in-15 years)	4 (1-in-8 years)	3 (1-in-10 years)	2 (1-in-15 years)	1 (1-in-30 years)

St. Lucie and Caloosahatchee Estuaries

Large releases of fresh water discharged from Lake Okeechobee and the associated local canal watersheds have contributed to poor water quality conditions and caused wide fluctuations of salinity to occur within both the St. Lucie and Caloosahatchee River estuaries. These high volume discharge events have increased turbidity, caused color problems, reduced light penetration, and created salinity conditions that are too low to support important estuarine species (e.g., oysters). During high rainfall years, maximum mean monthly flows occasionally exceed 5,000 cfs for the St. Lucie Estuary and 7,000 cfs for the Caloosahatchee Estuary, causing each system to become entirely fresh water. These low salinity conditions result in death of benthic invertebrates, displacement of other estuarine species, and adverse impacts on aquatic productivity within these systems and adjacent waters of the Indian River Lagoon, San Carlos Bay, the Gulf of Mexico, and the Atlantic Ocean. Continuation of the present flow regime will not allow reestablishment of important benthic communities and submerged aquatic vegetation within the inner estuaries. In addition to the damaging effects of these high volume discharge events, estuarine productivity has also been impacted by long-term freshwater discharges that cause sustained, low salinity conditions throughout the estuary.

Another important consideration is the maintenance of base flows to these estuaries during dry periods. Chamberlain et al. (1995) reported salinities greater than 50 percent seawater (17 ppt) within the upper Caloosahatchee Estuary during prolonged low flow conditions. Similarly, relatively high salinity conditions, up to 80 percent of seawater (28 ppt), periodically occur in the St. Lucie Estuary. These relatively high salinity conditions (for an estuary) result in stress to estuarine organisms and reduction of their populations due to increased predation and parasites. The dry season, low flow criteria used in this analyses for the St. Lucie and Caloosahatchee estuaries represent preliminary attempts to establish MFL criteria and performance measures for these systems. District staff are continuing efforts to develop science-based minimum flow criteria for the Caloosahatchee and St. Lucie estuaries that are expected to be completed in 2000 and 2001, respectively.

St. Lucie Estuary

Performance Measures Applied

Three performances measures were developed to help evaluate SFWMM model results for the St. Lucie Estuary:

- Number of times mean monthly flow exceeds 3,000 cfs (high discharge criteria) as compared to target flow criteria
- Number of times mean monthly flow exceeds 2,000 cfs (recommended estuary protection criteria) as compared to target flow
- Number of months that low flow criteria were not met (flows less than 350 cfs from Lake Okeechobee and the C-44 Basin)

Base Cases and Alternatives Results

1995 Base Case. High lake stages and runoff from local basins result in an increased number of times that large volumes of fresh water are discharged to the St. Lucie Estuary. Under the 1995 Base Case, the estuary experienced a high discharge event (mean monthly flows greater than 3,000 cfs) approximately once every year on average during the 31-year simulation (**Table 30**). Fresh water releases of this magnitude resulted in the entire inner estuary becoming fresh water for one month or longer. These types of high volume releases have a major impact on maintaining the estuary's salinity regime, produce poor water quality, and significantly impact estuarine biota.

2020 Base Case. Increased water demands on Lake Okeechobee in 2020 resulted in reduced numbers of high volume releases to the estuary, but did not significantly improve the number of times estuarine protection criteria (mean monthly flow greater than 2,000 cfs) were exceeded (**Table 30**). This was an improvement over the 1995 Base Case, but was still far from the preferred management target.

2020 with Restudy and LEC-1. The number of high volume discharge events (mean monthly flows greater than 3,000 cfs) which impact the estuary was reduced by more than two-thirds compared to the 1995 Base Case and represents a major

Table 30. Number of Times Discharge Criteria Were Exceeded for the St. Lucie Estuary During the 31-Year Simulation Period.

Performance Measure	Target	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Number of times mean monthly flow exceeded 3,000 cfs (high discharge criteria)	5	30	19	8	8
Number of times mean monthly flows exceeded 2,000 cfs (recommended salinity envelop criteria)	23	60	56	27	28
Number of months that low flow criteria were not met (flows less than 350 cfs)	178	150	158	51	127

improvement in hydrologic performance. Both the 2020 with Restudy and LEC-1 model simulations almost met proposed performance targets for the St. Lucie Estuary (**Table 30**). Under these two simulations, mean monthly flows greater than 3,000 cfs (maximum discharge volumes) were exceeded only eight times during the 31-year simulation period, compared to 30 times for the 1995 Base Case and 19 times for the 2020 Base Case.

The 2020 with Restudy and LEC-1 alternatives had fewer times when the recommended salinity envelope was exceeded (i.e., mean monthly flow volumes greater than 2,000 cfs). The 2020 with Restudy and LEC-1 model simulations showed only 27 and 28 instances of the criteria being exceeded, respectively, during the 31-year simulation as compared to 60 events for the 1995 Base Case and 56 events for the 2020 Base Case. The recommended low flow criteria were met for the estuary during all simulations (**Table 30**).

Incremental Results

The number of high discharge events and the number of times proposed estuary protection criteria were exceeded for the St. Lucie Estuary were gradually reduced over time (**Table 31**). Significant reductions in these performance measures first appeared in the 2010 simulation, as a result of construction of regional storage reservoirs within the C-44 (St. Lucie) Basin, and showed continued improvement in the 2015 and LEC-1 Revised simulations. Likewise, the number of times proposed estuary protection criteria were exceeded for the estuary also showed improvement by 2010 for the same reasons. Incremental results also showed that estuary low flow targets were met for all years as shown in **Table 31**. Overall, these values were close enough to meeting the environmental performance measure targets developed for the estuary to be scored as green in **Table 25**.

Caloosahatchee Estuary

Performance Measures Applied

Three performances measures were developed to help evaluate SFWMM model results for the Caloosahatchee Estuary:

Table 31. Number of Times Discharge Criteria Were Exceeded for the 31-Year Simulation Period in the Incremental Simulations for the St. Lucie Estuary.

Performance measure	Target	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Number of times mean monthly flows exceeded 3,000 cfs (high discharge criteria)	5	22	21	12	8	8
Number of times mean monthly flows exceeded 2,000 cfs (estuary protection criteria)	23	61	56	38	28	29
Number of times low flow criteria were not met (flows less than 350 cfs)	178	146	156	127	128	127

- Number of times mean monthly flow exceeded 4,500 cfs (high discharge criteria) as compared to target flow criteria
- Number of times mean monthly flow exceeded 2,800 cfs (recommended estuary protection criteria) as compared to target flow
- Number of months that low flow criteria were not met (flows less than 300 cfs from Lake Okeechobee and the C-43 Basin)

Base Cases and Alternatives Results

1995 Base Case. Results for the 1995 Base Case were similar to those observed for the St. Lucie Estuary. High lake stages and runoff from local basins resulted in an increased number of times that large volumes of fresh water were discharged to the Caloosahatchee Estuary. For the 1995 Base Case, the estuary experienced 36 high discharge events (mean monthly flows greater than 4,500 cfs) as compared to the target of only six events during the 31-year simulation period (**Table 32**). Freshwater releases of this magnitude resulted in the entire inner estuary becoming fresh water for one month or longer. These high volume releases had a major impact on maintaining the estuary's salinity regime, resulted in poor water quality, and impacted estuarine biota.

2020 Base Case. Increased water demands on Lake Okeechobee in 2020 reduced the number of high volume releases to the Caloosahatchee Estuary (28 events) and slightly reduced the number of times estuarine protection criteria (mean monthly flow greater than 2,800 cfs) were exceeded as compared to the 1995 Base Case (**Table 32**). This was an improvement over the 1995 Base Case, but was still far from the recommended target.

2020 with Restudy and LEC-1. Under these two water supply alternatives, mean monthly flows greater than 4,500 cfs (maximum discharge volumes) were exceeded only four times for the 2020 with Restudy and eight times for the LEC-1, as compared to 36 times for the 1995 Base Case and 28 times for the 2020 Base Case. This represented a major improvement in hydrologic performance for the Caloosahatchee Estuary. The 2020

Table 32. Number of Times Discharge Criteria Were Exceeded for the Caloosahatchee Estuary During the 31-Year Simulation Period.

Performance Measure	Target	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Number of times mean monthly flow exceeded 4,500 cfs (high discharge criteria)	6	36	28	4	8
Number of times mean monthly flows exceeded 2,800 cfs (recommended salinity envelop criteria)	23	76	67	12	28
Number of months that low flow criteria were not met (flows less than 300 cfs)	60	105	109	36	36

with Restudy performed better than the recommended target for the estuary, while LEC-1 came close to meeting the target (**Table 32**). The 2020 with Restudy and LEC-1 alternatives also produced fewer numbers of times when the recommended salinity envelope was exceeded (mean monthly flow volumes greater than 2,800 cfs). These two water supply alternatives resulted in only 12 and 28 failures to met the criteria, respectively, during the 31-year simulation as compared to 76 events for the 1995 Base Case and 67 events for the 2020 Base Case. Both the 2020 with Restudy and LEC-1 alternatives meet or performed better than the proposed low flow target.

Incremental Results

Incremental modeling results for the Caloosahatchee Estuary were similar to those recorded for the St. Lucie Estuary. The number of high discharge events and the number of times proposed estuary protection criteria were exceeded for the Caloosahatchee Estuary were gradually reduced over time (**Table 33**). Significant reductions in the number of high discharge events first appeared in the 2010 simulation, as a result of construction of regional storage reservoirs within the C-43 (Caloosahatchee) Basin, and showed continued improvement in the 2015 and LEC-1 Revised simulations. Likewise, the number of times proposed estuary protection criteria were exceeded also showed improvement in the 2010 simulation for the same reasons. Estuary low flow targets were met for the incremental simulations (**Table 33**). Overall, these values met the environmental performance measure targets developed for the Caloosahatchee Estuary and were, therefore, scored green (**Table 25**).

Table 33. Number of Times Discharge Criteria Were Exceeded for the 31-Year Simulation Period in the Incremental Simulations for the Caloosahatchee Estuary.

Performance measure	Target	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Number of times mean monthly flows exceeded 4,500 cfs (high discharge criteria)	6	33	29	13	9	8
Number of times mean monthly flows exceeded 2,800 cfs (estuary protection criteria)	22	77	64	32	31	29
Number of times low flow criteria were not met (flows < 300 cfs from Lake Okeechobee and the C-43 Basin)	60	146	153	76	36	36

Lake Worth Lagoon

The Lake Worth Lagoon is located along one of the most heavily urbanized areas of the LEC Planning Area. Historically, the lagoon has been subject to inlet and channel dredging, shoreline bulkhead construction, draining and filling of adjacent wetlands, causeway and bridge construction, dock and marina development, industrial and sewage waste disposal, power plant operations, and storm water runoff from three major South Florida drainage canals (C-51/S-155, C-15/S-40, and C-16/S-41). In general terms, problems associated with Lake Worth Lagoon are similar to those experienced in other estuaries within the planning area. During high rainfall periods, large volumes of poor quality water are discharged into the lagoon from drainage basins located more than 20 miles west of the lagoon (e.g. C-51 Basin). These high discharge periods deposit large amounts of suspended solids and produce major impacts to both water quality and the salinity regime of the inner lagoon. While the cumulative impacts of these activities have significantly altered the character of the lagoon and diminished its value as a healthy estuarine ecosystem, it still supports a number of important natural resources and recreational values that should be protected.

Performance Measures Applied

Two performances measures were developed to help evaluate SFWMM model results for the Lake Worth Lagoon:

- The number of times a 14-day moving average discharges from C-15, C-16, and C-51 canals exceeds 500 cfs during the 31-year simulation period was calculated. Preliminary modeling results obtained from Palm Beach County Department of Resource Management (DERM) indicates that flow discharges from the C-51 Canals within the range of 500 cfs was roughly equivalent to a salinity of about 23 ppt within the lagoon under steady state conditions.
- The average annual wet and dry season flows delivered to the Lake Worth Lagoon via C-51/S-155, C-15/S-40 and C-16/S-41 during the 31-year simulation period was calculated.

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Under current (1995 Base Case) conditions the lagoon experienced a high number of high volume discharge events with 308 months during the 31-year simulation period exceeding 500 cfs (**Table 34**). Large volumes of poor quality water were discharged to the lagoon from upstream basins that drain urban and residential developments. These high volume discharge events impacted both water quality and the salinity regime of the inner lagoon. Under the 2020 Base Case, the numbers of high discharge events were reduced by approximately 26 percent due, in part, to increased regional water supply demands and completion of STA-1 East as part of the Everglades Construction Project. The STA-1 East Project includes facilities to divide the C-51 Basin and pump water to the west from developed areas within western Palm Beach

County (known as the Acreage), Royal Palm Beach, and Wellington into the STA-1 East Impoundment for treatment and eventual discharge into WCA-1.

2020 with Restudy and LEC-1. High volume discharge events were reduced even further under the 2020 with Restudy and LEC-1 alternatives to only 114 and 109 high discharge events, respectively, during the 31-year simulation period. These represented 63 and 65 percent reductions, respectively, over the 1995 Base Case (**Table 34**). Reductions in discharges occurred primarily due to a number of water capturing features of the Restudy which routed water away from the lagoon and directed it west and south to the Everglades and other urban areas where water was needed. Because the Lake Worth Lagoon does not currently have an established, science-based flow/ salinity target, it is uncertain whether reductions in flows of this magnitude will have the desired results. For this reason District staff scored this area as yellow (**Table 25**), since it is uncertain whether planning targets can or cannot be met under these two simulations.

Table 34. Number of Times Discharge Criteria Were Exceeded for the Lake Worth Lagoon During the 31-Year Simulation Period.

Performance Measure	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Number of months 14-day moving average flows exceeded 500 cfs	308	228	114	109
Mean annual wet and dry season flows discharged to the lagoon from S-155, S-40, and S-41	561	425	258	252

Incremental Results

Implementation of the STA-1 East Project reduced high volume discharges to the lagoon as early as 2005. These improvements gradually increased over time and by 2020 the total number of times flows exceeded the 500-cfs target was reduced by 65 percent and the total volume of water discharged to the lagoon as storm water runoff was reduced by 51 percent (**Table 35**).

Table 35. Number of Times Discharge Criteria Were Exceeded During the 31-Year Simulation Period in the Incremental Simulations for the Lake Worth Lagoon.

Performance Measure	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Number of months that 14-day moving average flows exceeded 500 cfs	304	225	200	98	105
Mean annual wet and dry season flows discharged to the Lake Worth Lagoon from S-155, S-40, and S-41	556	427	395	227	241

Because a clearly defined environmental target has not yet been developed for the Lake Worth Lagoon, this area was scored yellow, indicating that it is uncertain whether flow reductions of these magnitudes will benefit the ecosystem. As part of the LEC Interim Plan, a contract has been funded to work with Palm Beach County DERM to determine both minimum and maximum flow targets for the major canals that discharge into the lagoon. This work is currently under way and should be completed within the next two years.

Results for the Lake Worth Lagoon may need to be reevaluated in future planning efforts. The physical location of the S-155A structure varies from its location in the SFWMM. It was modeled further east than its actual location, and therefore, the model may underestimate flows to the lagoon. In addition, flows from C-17/S-44 need to be considered in the evaluation.

The Everglades

Performance Measures Applied

Performance measures for the Everglades were created with the intent of restoring the essential hydrological features of the natural system that existed prior to drainage and development of the region. Most of the performance measures used in this evaluation are similar to those used by the Restudy, with addition of MFL criteria for Lake Okeechobee, the Everglades, and the Biscayne aquifer. These performance measures were used to evaluate each model simulation's potential to (1) protect and support accretion of peat and marl soils, (2) protect tree island communities, and (3) maintain Everglades sawgrass or ridge and slough communities. The majority of performance measure targets for the Everglades were based on restoring the hydrological pattern predicted by the Natural System Model version 4.5 Final (NSM), with a few exceptions. The performance measures applied are as follows:

- Ability to meet the Everglades minimum water level criteria presented in **Table 44** (SFWMD, 2000e)
- Ability to meet NSM-defined surface water inundation/duration patterns, where appropriate
- Number and duration of extreme high and low water events
- Interannual depth variation (average and standard deviation of water depths for the months of May and October for the 31-year simulation period)
- Temporal variation in mean weekly stage
- Review of stage hydrographs and stage duration curves

More detailed descriptions of these performance measures and their associated targets can be found in **Appendix D** of this document.

Overview of Everglades Results

Model results for each alternative were evaluated at the level of individual indicator regions. An indicator region is a grouping of model grid cells within the SFWMM that consists of similar vegetation cover and soil type. These larger groupings of cells were developed to reduce the uncertainty of evaluating results from a single two-by-two square mile grid cell that represents a single water management gage or area. **Figure 27** shows the location of each indicator region evaluated in this study.

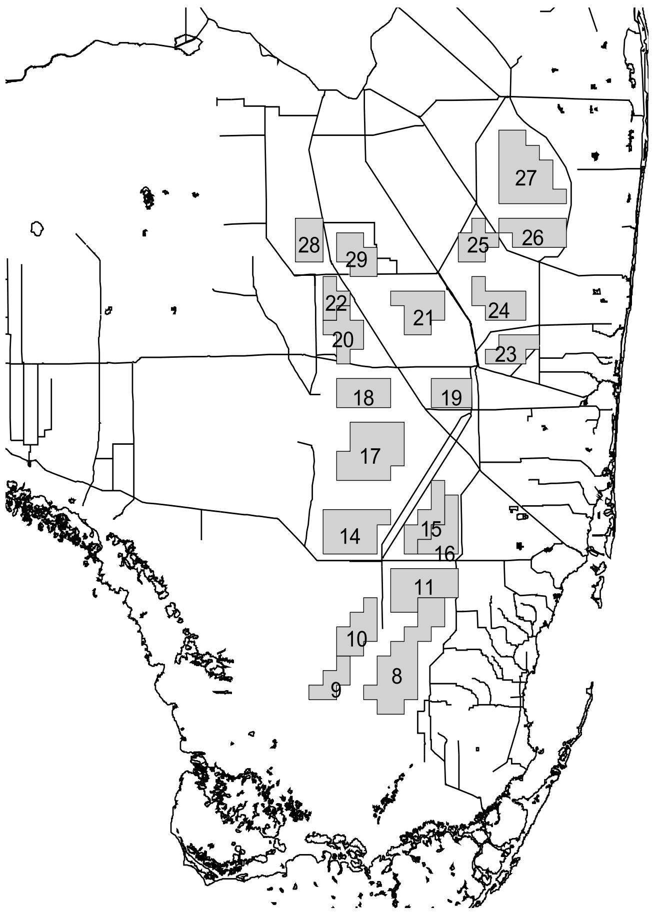

Figure 27. Everglades Indicator Regions used in the Analysis of Model Run Alternatives.

For final analyses, indicator regions that fell within areas of similar hydrological conditions or within the same impoundment system were grouped together. The final evaluation classified the indicator regions into 11 hydrological subregions of the Everglades:

- Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1): Indicator Regions 26 and 27
- Holey Land and Rotenberger WMAs: Indicator Regions 29 and 28

- WCA-2A: Indicator Regions 24 and 25
- WCA-2B: Indicator Region 23
- Northern WCA-3A: Indicator Regions 20, 21, and 22
- Eastern WCA-3A: Indicator Region 19
- Central WCA-3A: Indicator Regions 17 and 18
- Southern WCA-3A: Indicator Region 14
- WCA-3B: Indicator Regions 15 and 16
- Shark River Slough: Indicator Regions 9, 10, and 11
- Rockland marl marsh: Indicator Region 8

The results of the base case and alternative simulations are presented by indicator region in **Tables 36**, **37**, and **38**. Results of the incremental simulations (2005, 2010, 2015, and LEC-1 Revised) are presented in **Tables 39**, **40**, and **41**. These tables present several types of data: duration of average annual flooding (**Tables 36** and **39**); the number of weeks that water levels were below the low water depth criteria (**Tables 37** and **40**); and the number of weeks the high water depth criteria were exceeded (**Tables 38** and **41**). Results will be discussed in detail by hydrological subregion. Graphical depictions of the results can be found in **Appendix H**.

Table 36. Duration of Average Annual Flooding in the Base Case and Alternative Simulations for the Everglades.[a]

Area Name	Indicator Region	Percent of Year				
		NSM	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Northern WCA-1	27	92	97	92	96	96
Southern WCA-1	26	89	99	96	99	100
Northern WCA-2A	25	86	86	93	92	93
Southern WCA-2A	24	91	90	90	88	89
WCA-2B	23	92	84	86	81	80
Holey Land WMA	29	88	96	96	88	88
Rotenberger WMA	28	76	59	79	79	79
Northwest corner WCA-3A	22	91	76	92	94	95
Northwestern WCA-3A	20	91	81	87	88	88
Northeastern WCA-3A	21	85	74	92	83	85
Eastern WCA-3A	19	86	99	93	92	93
North Central WCA-3A	18	89	91	90	97	97
South Central WCA-3A	17	87	94	88	95	95
Southern WCA-3A	14	92	98	93	95	95
Western WCA-3B	15	92	96	92	97	98
Eastern WCA-3B	16	95	89	83	96	96
NE Shark River Slough	11	100	87	88	97	97
Central Shark River Slough	10	100	92	93	98	98
SW Shark River Slough	9	98	88	91	96	96
Rockland marl marsh	8	65	29	46	58	55

a. Data from the Inundation Duration Summary.

Table 37. Number of Weeks Water Levels Were Below The Low Water Depth Criterion in the Base Case and Alternative Simulations for the Everglades.[a]

Area Name	Indicator Region	Depth[b] (ft.)	NSM	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Northern WCA-1	27	< -1.0	27	6	11	3	1
Southern WCA-1	26	< -1.0	37	0	4	0	0
Northern WCA-2A	25	< -1.0	60	89	32	36	38
Southern WCA-2A	24	< -1.0	46	62	62	86	70
WCA-2B	23	< -1.0	22	104	71	99	103
Holey Land WMA	29	< -1.0	84	6	10	43	42
Rotenberger WMA	28	< -1.0	136	297	86	56	56
Northwest corner WCA-3A	22	< -1.0	36	181	36	22	19
Northwestern WCA-3A	20	< -1.0	36	119	66	48	44
Northeastern WCA-3A	21	< -1.0	106	194	45	79	65
Eastern WCA-3A	19	< -1.0	60	0	29	31	17
North Central WCA-3A	18	< -1.0	47	56	49	7	6
South Central WCA-3A	17	< -1.0	55	21	53	12	11
Southern WCA-3A	14	< -1.0	29	0	20	15	12
Western WCA-3B	15	< -1.0	5	1	9	6	4
Eastern WCA-3B	16	< -1.0	1	46	76	10	8
NE Shark River Slough	11	< -1.0	1	59	50	6	4
Central Shark River Slough	10	< -1.0	1	45	38	3	1
SW Shark River Slough	9	< -1.0	5	72	39	17	14
Rockland marl marsh	8	< -1.5	200	465	329	244	254

a. The desired condition is to go below the low depth as few times as possible.
b. The low water depth criterion is -1.0 feet below ground for peat-forming wetlands and -1.5 feet below ground for marl-forming marshes.

Table 38. Number of Weeks the High Water Depth Criterion was Exceeded in the Base Case and Alternative Simulations for the Everglades.[a]

Area Name	Indicator Region	Depth[b] (ft.)	NSM	1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
Northern WCA-1	27	>2.5	0	4	1	1	1
Southern WCA-1	26	>2.5	0	486	371	405	436
Northern WCA-2A	25	>2.5	0	0	0	12	17
Southern WCA-2A	24	>2.5	0	2	10	55	73
WCA-2B	23	>2.5	20	246	790	162	131
Holey Land WMA	29	>1.5	182	602	628	115	114
Rotenberger WMA	28	>1.5	76	0	0	0	0
Northwest corner WCA-3A	22	>2.5	0	0	0	0	0
Northwestern WCA-3A	20	>2.5	0	1	1	0	0
Northeastern WCA-3A	21	>2.0	3	15	13	32	38
Eastern WCA-3A	19	>2.5	0	877	235	322	373
North Central WCA-3A	18	>2.5	0	32	16	14	17
South Central WCA-3A	17	>2.5	0	65	40	15	18
Southern WCA-3A	14	>2.5	0	599	114	12	14
Western WCA-3B	15	>2.5	38	13	89	55	52
Eastern WCA-3B	16	>2.5	65	26	164	95	85
NE Shark River Slough	11	>2.5	144	0	0	53	46
Central Shark River Slough	10	>2.5	56	1	0	19	18
SW Shark River Slough	9	>2.5	0	0	0	0	0
Rockland marl marsh	8	>2.0	0	0	0	0	0

a. The desired condition is to exceed the high water depth as few times as possible.
b. Depth is the high water depth criterion.

Table 39. Duration of Average Annual Flooding in the Incremental Simulations for the Everglades.[a]

Area Name	Indicator Region	Percent of the Year					
		NSM[b]	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Northern WCA-1	27	92	96	92	94	95	96
Southern WCA-1	26	89	99	96	97	98	99
Northern WCA-2A	25	86	86	92	89	92	93
Southern WCA-2A	24	91	90	86	89	91	91
WCA-2B	23	92	84	74	78	82	83
Holey Land WMA	29	88	96	96	87	88	88
Rotenberger WMA	28	76	59	74	79	79	79
Northwest corner WCA-3A	22	91	76	85	91	94	94
Northwestern WCA-3A	20	91	80	81	87	91	88
Northeastern WCA-3A	21	85	74	87	85	84	83
Eastern WCA-3A	19	86	98	99	91	91	93
North Central WCA-3A	18	89	91	89	94	98	97
South Central WCA-3A	17	87	94	93	90	93	95
Southern WCA-3A	14	92	98	98	92	91	95
Western WCA-3B	15	92	96	96	93	93	98
Eastern WCA-3B	16	95	89	88	90	90	96
NE Shark River Slough	11	100	87	87	86	91	97
Central Shark River Slough	10	100	92	90	92	94	98
SW Shark River Slough	9	98	88	89	91	92	96
Rockland marl marsh	8	65	29	58	51	53	55

a. Data from Inundation Duration Summary for the incremental simulation
b. NSM = Natural System Model version 4.5 Final

Table 40. Number of Weeks Water Levels Were Below the Low Water Depth Criterion in the Incremental Simulations for the Everglades.[a]

Area Name	Indicator Region	Depth[b] (ft)	NSM[c]	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Northern WCA-1	27	< -1.0	27	6	13	6	4	1
Southern WCA-1	26	< -1.0	37	0	2	2	1	0
Northern WCA-2A	25	< -1.0	60	87	43	65	34	33
Southern WCA-2A	24	< -1.0	46	64	81	70	56	60
WCA-2B	23	< -1.0	22	110	184	142	105	89
Holey Land WMA	29	< -1.0	84	6	9	44	43	41
Rotenberger WMA	28	< -1.0	136	297	163	57	57	56
Northwest corner WCA-3A	22	< -1.0	36	185	92	35	22	14
Northwestern WCA-3A	20	< -1.0	36	123	121	63	28	43
Northeastern WCA-3A	21	< -1.0	106	195	97	104	85	91
Eastern WCA-3A	19	< -1.0	60	1	0	47	35	25
North Central WCA-3A	18	< -1.0	47	56	55	31	5	6
South Central WCA-3A	17	< -1.0	55	21	28	40	24	13
Southern WCA-3A	14	< -1.0	29	0	1	36	32	13
Western WCA-3B	15	< -1.0	5	1	2	27	29	5
Eastern WCA-3B	16	< -1.0	1	47	46	60	55	9
NE Shark River Slough	11	< -1.0	1	60	67	61	30	6
Central Shark River Slough	10	< -1.0	1	45	60	46	31	5
SW Shark River Slough	9	< -1.0	5	71	64	51	44	12
Rockland marl marsh	8	< -1.5	200	470	321	336	309	263

a. The desired condition is to go below the low water depth as few times as possible.
b. The low water depth criterion is -1.0 feet below ground for peat-forming wetlands and -1.5 feet below ground for marl-forming marshes.
c. NSM = Natural System Model version 4.5 Final

Table 41. Number of Weeks the High Water Depth Criterion was Exceeded in the Incremental Simulations for the Everglades.[a]

Area Name	Indicator Region	Depth[b] (ft)	NSM[c]	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Northern WCA-1	27	>2.5	0	4	8	8	11	11
Southern WCA-1	26	>2.5	0	475	429	488	506	510
Northern WCA-2A	25	>2.5	0	0	0	10	12	11
Southern WCA-2A	24	>2.5	0	2	0	52	53	58
WCA-2B	23	>2.5	20	235	181	141	151	158
Holey Land WMA	29	>1.5	182	599	706	114	105	108
Rotenberger WMA	28	>1.5	76	0	0	0	0	0
Northwest corner WCA-3A	22	>2.5	0	0	0	0	0	0
Northwestern WCA-3A	20	>2.5	0	1	0	6	2	0
Northeastern WCA-3A	21	>2.0	3	15	6	26	25	30
Eastern WCA-3A	19	>2.5	0	860	315	137	144	351
North Central WCA-3A	18	>2.5	0	30	11	22	21	13
South Central WCA-3A	17	>2.5	0	64	23	27	28	14
Southern WCA-3A	14	>2.5	0	593	108	58	65	12
Western WCA-3B	15	>2.5	38	13	52	3	3	51
Eastern WCA-3B	16	>2.5	65	22	67	19	20	89
NE Shark River Slough	11	>2.5	144	0	49	20	20	52
Central Shark River Slough	10	>2.5	56	1	13	15	15	20
SW Shark River Slough	9	>2.5	0	0	0	0	0	0
Rockland marl marsh	8	>2.0	0	0	0	0	0	0

a. The desired condition is to exceed the high water depth as few times as possible.
b. Depth is the high water depth criterion.
c. NSM = Natural System Model version 4.5 Final

Loxahatchee National Wildlife Refuge (WCA-1)

Base Cases and Alternatives Results

1995 and 2020 Base Cases. The current U.S. Fish and Wildlife Service's (USFWS's) regulation schedule for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) was in effect under the 1995 Base Case and was adopted as the performance target for the refuge at the request of refuge staff. Under these conditions this area met the proposed target and, therefore, was scored green for the 1995 Base Case (**Table 24**). Increased regional water supply demands under the 2020 Base Case showed a tendency toward slightly lower water levels and shorter hydroperiods as compared to the 1995 Base Case target. Overall, during the 2020 Base Case, the refuge had approximately a five percent shorter annual period of flooding (**Table 36**) and more weeks that water levels were below the low water criterion (**Table 37**). Because of these factors, this area was scored yellow for the 2020 Base Case (**Table 24**).

2020 with Restudy and LEC-1. Conditions in the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) met the proposed environmental performance targets in both the northern (Indicator Region 27) and southern (Indicator Region 26) sections and were scored green under the 2020 with Restudy and LEC-1 model simulations (**Table 24**).

Incremental Results

The current USFWS's regulation schedule for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) was in effect under the 1995 Revised Base Case and was adopted as the performance target for the area. Under these conditions this area met the proposed target and, therefore, was scored green for the 1995 Revised Base Case (**Table 25**). Increased regional water supply demands under the 2005 simulation showed a tendency toward slightly lower water levels as compared to the 1995 Revised Base Case. Overall, the 2005 simulation had a shorter annual period of flooding (**Table 39**) and a small increase in the number of weeks that water levels were below the low water criterion (**Table 40**). Because of these factors, this area was scored green/yellow for the 2005 simulation (**Table 25**). However, conditions in the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) closely match the 1995 Revised Base Case for the 2010, 2015, and the LEC-1 Revised simulations (**Tables 39**, **40**, and **41**) and was scored green (**Table 25**).

Water Conservation Area 2A

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Water levels were consistently higher and fluctuated over a wider range of water depths as compared to the NSM target in the 1995 and 2020 base cases for WCA-2A. In particular, northern WCA-2A (Indicator Region 25) exhibited wet and dry season water depth ranges in excess of NSM targets (**Tables 37** and **38**). These deeper water levels are presumed to be undesirable for the recovery and maintenance of the remaining tree islands. Under the base cases, the water levels in WCA-2A were below the low water depth criterion (number of times that water levels fell more than one foot below ground) more often than the NSM target (**Table 37**). These events are undesirable for the protection and accretion of peat soils. Although southern WCA-2A (Indicator Region 24) performed better, wet season surface water ponding generally elevated water levels above the NSM target range. WCA-2A was scored green/yellow for both simulations to account for differences in performance between northern and southern WCA-2A (**Table 24**).

2020 with Restudy and LEC-1. WCA-2A did not perform better in the 2020 with Restudy or LEC-1 alternatives, and was scored green/yellow (**Table 24**). Performance during the base case and alternative simulations was very similar. The main difference was that the high water criterion (number of weeks water depths exceeded 2.5 feet) was exceeded during more weeks under the 2020 with Restudy and LEC-1 simulations than during the 1995 and 2020 base cases (**Table 38**). It appears that water management in this area creates trade-offs between flooding and drying that are difficult to balance. Operational parameters or physical features can be further refined to bring the performance of this area closer to the NSM target.

Incremental Results

Overall, the northern and southern portions of WCA-2A contrasted in performance for the incremental simulations. Water levels and hydroperiods within northern WCA-2A (Indicator Region 25) came close to meeting NSM-defined targets (**Tables 39** and **41**). For this reason, northern WCA-2A was scored green for generally meeting the target. In contrast, under the 2010, 2015, and LEC-1 Revised simulations, southern WCA-2A (Indicator Region 24) exhibited water depths in excess of NSM-defined targets during wet years (**Tables 39** and **41**). These deep water conditions may be undesirable for the recovery and maintenance of remaining tree islands. For this reason, southern WCA-2A was scored yellow for these incremental simulations. Because of the large difference in performance between southern and northern WCA-2A, this area was given an overall scored of green/yellow for all of the incremental simulations (**Table 25**).

Water Conservation Area 2B

Base Cases and Alternatives Results

1995 and 2020 Base Cases. WCA-2B (Indicator Region 23) performed poorly in both the 1995 and 2020 base cases. Water levels were much higher and much more variable as compared to the NSM target (**Table 38**). Inundation patterns were of much longer duration (**Table 36**), with more frequent and more extreme high and low water periods (**Tables 37** and **38**). The high water criterion (number of weeks that surface water depth was greater than 2.5 feet) was exceeded 50 percent of the time in the 2020 Base Case. These sustained inundation depths would be detrimental to tree island and sawgrass communities within this WCA. Annual ranges of depth between wet and dry seasons were larger than the target. Many of the problems in this area are due to its relatively small size; its location above the Biscayne aquifer, which results in large seepage losses; its unusual shape that promotes ponding in its southern end; and its position in the landscape. Because of the magnitude of difference between the NSM target and the 1995 Base Case, this area was scored red (**Table 24**).

2020 with Restudy and LEC-1. Although a number of different management strategies (e.g., rain-driven system, regulation schedule) have been tried within the Restudy and LEC regional water supply planning efforts, few have been successful in meeting NSM targets for this area. The 2020 with Restudy and LEC-1 alternatives also had problems meeting both high water and low water criteria (**Tables 37** and **38**). However, the LEC-1 simulation performed better than the 2020 with Restudy. Although these events were not as severe as those in the base cases, sufficient deviations from the NSM target occurred to warrant a red score for this area (**Table 24**).

Incremental Results

WCA-2B (Indicator Region 23) performed poorly in both the 1995 Revised Base Case and throughout the incremental simulations. In the 1995 Revised Base Case, water levels were much higher and much more variable as compared to the NSM targets (**Tables 40** and **41**). Inundation patterns were of much longer duration (**Table 39**), with more frequent and more extreme high water and low water periods (**Tables 40** and **41**). The high water criterion was often exceeded. Sustained inundation depths near or greater than 2.5 feet would be detrimental to tree island and sawgrass communities within this WCA. Annual ranges of water depths between wet and dry seasons were larger than the target. Although problems with high water improved somewhat through time, this came with a trade-off of significant increases in the occurrence of drying events. For all incremental simulations, WCA-2B was scored red (**Table 25**). Alternate D13R of the Restudy recognized this problem and arrived at the same conclusions (USACE and SFWMD, 1999). Many of the problems in this area are due to its relatively small size; its location above the Biscayne aquifer, which results in large seepage losses; its unusual shape that promotes ponding in its southern end; and its position in the landscape.

Holey Land and Rotenberger Wildlife Management Areas

Base Cases and Alternatives Results

1995 and 2020 Base Cases. For the 1995 and 2020 base cases, the Holey Land WMA (Indicator Region 29) had higher water levels than the NSM target (**Table 38**). The high water depth criterion was exceeded during more than 600 weeks, which was more than three times the target (**Table 38**). This was due to the fact that the FWC's regulation schedule was in effect. Water levels exceeded the high water criterion for approximately 35 percent of the year and low water periods were infrequent. For this reason, the Holey Land WMA was scored yellow for the 1995 and 2020 base cases. In contrast, in the 1995 Base Case, the Rotenberger WMA (Indicator Region 28) had a much shorter average annual inundation period than the target (**Table 36**). In the 1995 Base Case, this area had more than double the number of weeks that water levels were below the low water depth criterion (one foot below the soil surface) (**Table 37**), and for this reason, the Rotenberger WMA was scored red for the 1995 Base Case (**Table 24**). In the 2020 Base Case, conditions improved greatly in this WMA due to the operation of upstream STAs and the Rotenberger WMA was scored green for this simulation (**Table 24**).

2020 with Restudy and LEC-1. Conditions in the Holey Land and Rotenberger WMAs were much improved in both the 2020 with Restudy and LEC-1 alternatives. Water levels were maintained near that of the NSM targets (**Table 37** and **38**) and, for this reason, both WMAs were scored green for these alternatives (**Table 24**).

Incremental Results

Generally, the Holey Land and Rotenberger WMAs showed incremental improvements over the base case conditions and NSM-defined targets were met during the 2010 simulation (**Tables 39**, **40**, and **41**). For the 1995 Revised Base Case and 2005 simulations, the Holey Land WMA (Indicator Region 29) had higher water levels than the NSM target (**Table 41**). This was due to the fact that the FWC's regulation schedule was in effect. The number of weeks that the high water depth criterion was exceeded was more than three times the target for these two simulations (**Table 41**). Water levels exceeded the high water criterion for more than 30 percent of the year and low water periods were infrequent (**Table 40**). For this reason, the Holey Land WMA was scored red for the 1995 Revised Base Case and the 2005 simulations. In contrast, the Rotenberger WMA (Indicator Region 28) had a much shorter average annual inundation period in the 1995 Revised Base Case than the target (**Table 39**). This area had more than double the number of weeks that water levels were below the low water depth criterion (one foot below the soil surface) compared to the NSM target (**Table 40**). As a result, the Rotenberger WMA was scored red for the 1995 Revised Base Case. During the 2005 simulation, conditions improved greatly in this WMA due to the operation of upstream STAs and the area was scored yellow. Performance was near that of the NSM targets in both the Holey Land and Rotenberger WMAs during the 2010, 2015, and LEC-1 Revised simulations and the WMAs were scored green for these simulations (**Table 25**).

Northern Water Conservation Area 3A

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Northeastern WCA-3A (Indicator Region 21) performed poorly in the 1995 Base Case. In general, this area had a problem with both high and low water extremes (**Tables 37** and **38**). This area had 11 percent less average annual duration of flooding (**Table 36**), indicating that more severe drying events occurred. Performance improved somewhat in the 2020 Base Case, prompting a change from a red score in the 1995 Base Case to yellow in the 2020 Base Case (**Table 24**).

In the 1995 Base Case, northwestern WCA-3A (Indicator Regions 20 and 22) suffered from chronic low water conditions and overdrained conditions in most years (**Table 37**). As compared to the NSM target, the average period of annual flooding was more than 10 percent shorter (**Table 36**), resulting in extended periods of more severe drying increasing the frequency of muck fires, which impact tree islands and wildlife. Because of these problems, northwestern WCA-3A was scored red in the 1995 Base Case (**Table 24**). Under the 2020 Base Case, conditions improved significantly with the operation of the STAs to the north of WCA-3A (**Tables 36**, **37**, and **38**). This increased hydroperiod gave this area more NSM-like hydrology. Therefore, northwestern WCA-3A was scored green for the 2020 Base Case (**Table 24**).

2020 with Restudy and LEC-1. In both the 2020 with Restudy and LEC-1 alternatives, northern WCA-3A performed well and showed much improvement over the 1995 and 2020 base cases (**Tables 36**, **37**, and **38**). The hydropatterns were NSM-like, aided by the operation of the EAA Storage Reservoirs, the completed STAs to the north, and other Restudy components. This area was scored green in both alternatives (**Table 24**).

Incremental Results

Generally, northern WCA-3A showed incremental improvements over the base case conditions and NSM-defined targets were met by 2010. Northern WCA-3A (Indicator Regions 20, 21, and 22) performed poorly in the 1995 Revised Base Case. In general, this area had a problem with drying and water levels often fell below the low water criterion (depth more than one foot below the soil surface) (**Table 40**). Performance improved somewhat in 2005, prompting a change from a red score in the 1995 Revised Base Case to yellow/green (**Table 25**). By 2010, NSM targets were close to being met in all northern WCA-3 indicator regions, and this trend continued through 2020. Much of this improvement can be attributed to the construction and operation of STAs and completion of the EAA Storage Reservoirs along the northern boundary of WCA-3A.

Eastern Water Conservation Area 3A

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Eastern WCA-3A (Indicator Region 19) performed poorly in the 1995 Base Case. Water levels were much higher and much more variable than in the NSM target (**Table 38**). Inundation patterns were of much longer duration (**Table 36**), with more frequent and extreme high water periods (**Table 38**). The high water depth criterion was exceeded approximately 55 percent of the time and this area was scored red (**Table 24**). Performance improved some in the 2020 Base Case. Prolonged high water events were reduced (**Table 38**), although annual flooding was still much longer than the NSM targets (**Table 36**). In the 2020 Base Case, eastern WCA-3A was scored yellow (**Table 24**), indicating marginal ability to meet LEC planning targets.

2020 with Restudy and LEC-1. Eastern WCA-3A was also scored yellow in the 2020 with Restudy and LEC-1 alternatives (**Table 24**). Problems similar to those seen the 2020 Base Case, such as longer annual flooding (**Table 36**) and more weeks that the high water criterion has been exceeded (**Table 38**) than the NSM target continue to exist.

Incremental Results

Eastern WCA-3A (Indicator Region 19) performed poorly in the 1995 Revised Base Case. Water levels were much higher and much more variable than the NSM targets (**Table 41**). Inundation occurred for much longer periods (**Table 39**), with more frequent and extreme high water conditions (**Table 41**) and, therefore, this area was scored red (**Table 25**). Performance improved in 2005. Prolonged high water events were reduced, although annual flooding still exceeded the NSM target (**Table 39**). No further improvements were seen through 2020 and eastern WCA-3A was scored yellow for the remaining incremental simulations (2005, 2010, 2015, and LEC-1 Revised) (**Table 25**), indicating marginal or uncertain ability to meet LEC planning targets.

Central Water Conservation Area 3A

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Central WCA-3A (Indicator Regions 17 and 18) generally had increased numbers of extreme high water events (**Table 38**) and longer duration of flooding (**Table 36**) than the NSM targets for this area. Indicator region 18 recorded both extreme high and extreme low water levels (**Tables 37** and **38**) and was scored red for the 1995 and 2020 base cases (**Table 24**). Indicator Region 17, exhibited a number of extreme high water events (**Table 38**) that could potentially impact existing tree island vegetation in central WCA-3A. Therefore, this area was scored yellow under the 1995 and 2020 bases cases (**Table 24**).

2020 with Restudy and LEC-1. Central WCA-3A showed a number of improvements in both hydropattern (more NSM-like) and reduction of extreme high water events for the 2020 with Restudy and LEC-1 alternatives relative to the base cases (**Tables 36** and **38**). Indicator Region 17, located in south central WCA-3A, performed well with respect to meeting NSM targets and was scored green. In contrast, Indicator Region 18 exhibited prolonged hydroperiods in excess of the NSM target (**Table 36**), but did show a reduction in the number of both extreme high and low water events (**Tables 37** and **38**) as compared to the bases cases. Prolonged hydroperiods exhibited during the 2020 with Restudy and LEC-1 simulation appear to be the result of the relocation of Pump Station S-140 to the south of Alligator Alley, which moves a good deal more water across Indicator Region 18, and prevents the area from drying out. For these reasons Indicator Region 18 was scored yellow.

Incremental Results

In the 1995 Revised Base Case, central WCA-3A (Indicator Regions 17 and 18) generally experienced more extreme high water events (**Table 41**) and had longer duration of flooding as compared to the NSM target (**Table 39**). Under the 1995 Revised Base Case, the increased numbers of extreme high water events could potentially cause damage to existing tree island communities. For this reason this area was scored red for Indicator Region 18 and yellow for Indicator Region 17 (**Table 25**).

By 2005, Indicator Region 17 showed an improved ability to meet NSM hydropattern targets (**Table 39**), and a reduced number of extreme high water events (**Table 38**). In contrast, Indicator Region 18 remained problematic with prolonged hydroperiods in excess of the NSM target (**Table 39**). Again these problems appeared to be associated with the relocation of Pump Station S-140. For these reasons, Indicator Region 17 was scored green and Indicator Region 18 was scored yellow for the 2005, 2010, 2015, and LEC-1 Revised simulations.

Southern Water Conservation Area 3A

Base Cases and Alternatives Results

1995 and 2020 Base Cases. In the base cases, water in southern WCA-3A (Indicator Region 14) tended to pond and caused excessive flooding (**Tables 36** and **38**). Here, the high water depth criterion was exceeded more than 35 percent of the time during the 31-year simulation period. This condition is unfavorable for the protection of tree island or sawgrass communities. Because of the extreme nature of these problems, this area was scored red in both base cases (**Table 24**).

2020 with Restudy and LEC-1. In both the 2020 with Restudy and LEC-1 alternatives, southern WCA-3A performs well. The hydropatterns were NSM-like and were greatly improved over the 1995 and 2020 base cases (**Tables 36**, **37**, and **38**). This area was scored green for both alternatives (**Table 24**).

Incremental Results

Southern WCA-3A showed gradual improvement from the 1995 Revised Base Case simulation through the LEC-1 Revised simulation. In the 1995 Revised Base Case, water in southern WCA-3A (Indicator Region 14) tended to pond (**Table 39**) and caused excessive flooding (**Table 41**). This condition is unfavorable for the protection of tree island or sawgrass communities. Because of these extreme high water problems, this area was scored red for the 1995 Revised Base Case (**Table 25**). Improvement of performance was seen in the 2005, 2010, and 2015 simulations, where the severity of high water problems was moderated (**Table 41**). However, the NSM-defined targets were not met during these time frames, so a score of yellow was assigned (**Table 25**). Southern WCA-3A performed well in the LEC-1 Revised simulation. Hydropatterns were similar to the NSM target (**Tables 39**, **40**, and **41**) and this area was scored green for the LEC-1 Revised simulation (**Table 25**).

Water Conservation Area 3B

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Eastern WCA-3B (Indicator Region 16) was overall drier on average as compared to the NSM targets for both base cases (**Table 36**). Under the 2020 Base Case, eastern WCA-3B experienced a larger number of weeks that water levels fell below the low water criterion and a larger number of weeks that the high water criterion were exceeded compared to NSM targets (**Tables 37** and **38**). In contrast, western WCA-3B (Indicator Region 15) experienced average annual flooding events (hydroperiod) similar to NSM targets for both base cases (**Table 36**), however, this area also experienced a larger number of weeks that water levels fell below the low water criterion and a larger number of weeks that the high water criterion were exceeded compared to NSM targets (**Tables 37** and **38**). For these reasons WCA-3B was scored yellow (**Table 24**) indicating that this area of the Everglades has marginal or uncertain ability to achieve recovery or long-term sustainability. Hydrologic improvements are needed to meet LEC planning targets.

2020 with Restudy and LEC-1. Although the duration of average annual flooding (hydroperiod) for both the LEC 2020 with Restudy and LEC-1 alternatives were close to NSM values, too many high water events that impact the area occurred (**Table 38**). For this reason WCA-3B continued to be scored yellow for both of the alternatives (**Table 24**).

Incremental Results

For the 1955 Revised Base Case, western WCA-3B (Indicator Region 15) tended to be flooded longer and had a fewer number of extreme low water events as compared to the NSM target (**Tables 39** and **40**). Conversely, eastern WCA-3B (Indicator Region 16) was overall drier than the target leading to a larger number of weeks that water levels fell below the low water depth criterion (**Table 40**). These conditions did not improve significantly until the LEC-1 Revised simulation, when additional operational and structural features were in place to resolve some of these problems. As a result, both eastern and western WCA-3B were scored intermediate between yellow and green (yellow/green) for the LEC-1 Revised simulation indicating that hydrologic restoration of the area appears close to the NSM target. However, there is still room for improvement in these areas (**Table 25**).

Shark River Slough

Base Cases and Alternatives Results

1995 and 2020 Base Cases. Under both base cases, water levels in northeastern Shark River Slough (Indicator Region 11) were below the low water depth criterion more often (**Table 37**) and the duration of annual flooding (hydroperiod) in the area was significantly less (**Table 36**) when compared to the NSM targets. Similar problems with low water levels and increased number of dry downs occurred in central and southwestern Shark River Slough (Indicator Regions 9 and 10) under the base cases (**Tables 36** and **37**). This excessive drying is unfavorable for development or preservation of peat soils and protection of wetland plant and animal communities. For this reason, this area was scored red for both the 1995 and 2020 base cases (**Table 24**).

2020 with Restudy and LEC-1. The performance of the 2020 with Restudy and LEC-1 alternatives for Shark River Slough was much improved compared to the base cases (**Tables 36**, **37**, and **38**). Significantly more water was delivered to the system, which increased the duration of annual flooding and reduced the number of times this area dried out as compared to the base cases. Improvements both in the quantity and timing of water delivered to Shark River Slough occurred primarily because a number of Restudy projects came on-line by 2020. These components included the completion of 50 percent of the Lake Belt Storage Area components, decompartmentalization of WCA-3, and enhanced flows under Tamiami Trail. Because performance was significantly improved over the base cases, but still did not quite meet the NSM target, this area was scored as intermediate between green and yellow (green/yellow) (**Table 24**).

Incremental Results

In the 1995 Revised Base Case and 2005 simulations, water levels throughout Shark River Slough (Indicator Regions 9, 10, and 11) were below the low water depth criterion more often (**Table 40**) and the duration of annual flooding in the area was significantly less (**Table 39**) compared to the NSM targets. This excessive drying is unfavorable for development or preservation of peat soils and protection of wetland plant and animal communities. Furthermore, Shark River Slough had a tendency toward early dry season recession of the surface water during these simulations. This can be problematic for wildlife species that rely on timing of the dry season dry downs for foraging or reproduction cycles. For this reason, Shark River Slough was scored red for both the 1995 Revised Base Case and 2005 simulations (**Table 25**).

Modeling results showed a gradual improvement over time to provide increased flows to Everglades National Park. Beginning with the 2005 simulation, a significant improvement in both the distribution and volume of water delivered to northeastern and northwestern Shark River Slough occurred (**Table 42**).In the 2010 simulation, significant improvements in meeting NSM hydroperiod targets were recorded within northeastern and central Shark River Slough (**Tables 39**, **40**, and **41**). One hundred percent of the slough matched the NSM hydroperiod target in the LEC-1 Revised simulation (**Table 43**). However, because performance was still short of the target, this area was scored intermediate between green and yellow (green/yellow) for the LEC-1 Revised simulation (**Table 25**).

Table 42. Total Average Annual Flows Discharged into Northern Everglades National Park, East and West of L-67A (1000 ac-ft).

Area	Average Annual Flow (ac-ft x 1,000)				
	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
NW Shark River Slough	461	568	397	434	579
NE Shark River Slough	88	402	524	596	685
Total	549	970	921	1,030	1,264

Table 43. Mean NSM Hydroperiod Matches with Respect to NSM.[a]

Area	1995 Revised Base Case	2005	2010	2015	LEC-1 Revised
Everglades[b]	58%	64%	74%	77%	78%
WCAs[c]	64%	69%	80%	79%	75%
Everglades National Park	54%	60%	66%	75%	87%
Shark River Slough[d]	53%	44%	71%	95%	100%
Rockland Marl Marsh[d]	49%	70%	65%	67%	75%

a. Match corresponds to a match with the NSM target +/- 30 hydroperiod days
b. Includes WCAs, Holey Land and Rotenberger WMAs, and Everglades National Park
c. Includes WCA-1, 2A, 2B, 3A, and 3B
d. Within Everglades National Park

Rockland Marl Marsh

Base Cases and Alternatives Results

1995 and 2020 Base Cases. The Rockland marl marsh area of Everglades National Park (Indicator Region 8) performed poorly in both the 1995 and 2020 base cases. This area had problems with extremely low water levels. Water levels were often below the low water depth criterion (**Table 37**). This excessive drying is unfavorable for development or preservation of marl soils. This area was scored red for both base cases (**Table 24**).

2020 with Restudy and LEC-1. Performance of the Rockland Marl Marsh improved significantly in the 2020 with Restudy and LEC-1 alternatives. More water was delivered to the system and the hydroperiod was much closer to the NSM target than for the base cases (**Tables 36** and **37**). Because performance was still short of the target, this area was scored yellow (**Table 24**).

Incremental Results

The Rockland marl marsh area of Everglades National Park (Indicator Region 8) performed poorly in the 1995 Revised Base Case. Water levels in this area were below the low water depth criterion more often than the NSM target (**Table 40**). Excessive drying is unfavorable for development or preservation of marl soils, and, therefore, a score of red was assigned to the 1995 Revised Base Case (**Table 25**).

The incremental simulations showed improved performance through time. By 2005, more water was delivered to the system and the hydroperiod was much closer to the NSM target than for the base cases (**Tables 39** and **40**). Performance continued to improve from 2005 through 2020, as shown by sequential decreases in the number of weeks that water levels were below the low water depth criterion (**Table 40**) and closer hydroperiod matches to the NSM-defined target (**Table 43**). Although significant hydroperiod improvements were noted, this area was scored yellow to indicate for the LEC-1 Revised that performance was still short of the NSM target in 2020 (**Table 25**). Alternative D13R from the Restudy indicated similar problems with lowered water levels for the Rockland marl marsh (USACE and SFWMD, 1999).

Minimum Flows and Levels

Model results for MFLs were evaluated at the level of key gage stations. The locations of the key gages are shown in **Figure 28**. **Table 44** provides a summary of the proposed MFL criteria for the Everglades. These MFL criteria were proposed in the *Minimum Flows and Levels for Lake Okeechobee, the Everglades, and the Biscayne Aquifer* (SFWMD, 2000e).

Base Cases and Alternatives Results

1995 Base Case. Under the 1995 Base Case, proposed minimum water level criteria were not met for 12 out of 19 indicator regions located within the northern Everglades and Everglades National Park (**Table 45**). This was due largely to impoundment of these marshes and the construction of major canals throughout the northern Everglades as part of the C&SF Project. During dry periods, these canals lower ground water levels and over drain these wetlands, causing extensive peat fires, soil subsidence, changes in Everglades vegetation communities, and impacts to wildlife species. MFLs were not met in the Rotenberger WMA, northern WCA-3A, and WCA-3B. In Everglades National Park, MFLs were not met within Shark River Slough, the Rockland marl marsh, and marl wetlands located east and west of Shark River Slough. Areas that did meet the proposed criteria included the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1); WCA-2A; WCA-2B; Holey Land WMA; central and southern WCA-3A; and Taylor Slough (**Table 45**).

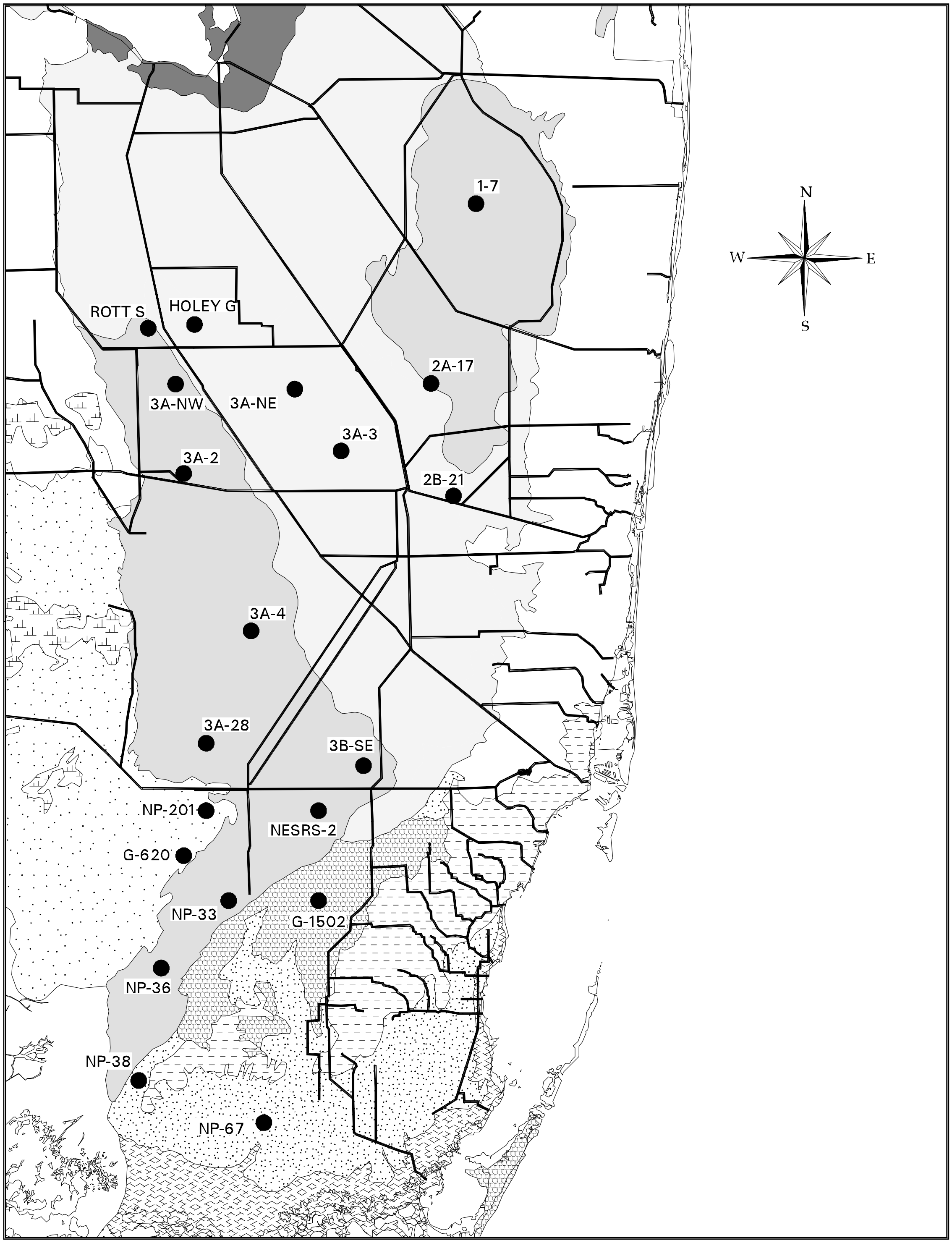

Figure 28. Location of Key Gages Used for Minimum Flows and Levels Simulations.

Table 44. Minimum Water Level, Duration, and Return Frequency Performance Measures for Selected Water Management Gages Located within the Everglades (SFWMD, 2000e).

Area	Key Gage	Indicator Region[a]	Soil Type	Minimum Depth (ft) and Duration (days)	Return Frequency (years)[b]
Loxahatchee National Wildlife Refuge (WCA-1)	1-7	27	Peat	-1.0 ft > 30 days	1-in-4
WCA-2A	2A-17	24	Peat	-1.0 ft > 30 days	1-in-4
WCA-2B	2B-21	23	Peat	-1.0 ft > 30 days	1-in-3[c]
Holey Land WMA	HoleyG	29	Peat	-1.0 ft > 30 days	1-in-3
Rotenberger WMA	Rotts	28	Peat	-1.0 ft > 30 days	1-in-2
Northwest corner of WCA-3A	3A-NW	22	Peat	-1.0 ft > 30 days	1-in-4
Northwestern WCA-3A	3A-2	20	Peat	-1.0 ft > 30 days	1-in-4
Northeastern corner of WCA-3A	3A-3	68	Peat	-1.0 ft > 30 days	1-in-3
Northeastern WCA-3A	3A-NE	21	Peat	-1.0 ft > 30 days	1-in-2
Central WCA-3A	3A-4	17	Peat	-1.0 ft > 30 days	1-in-4
Southern WCA-3A	3A-28	14	Peat	-1.0 ft > 30 days	1-in-4
WCA-3B	3B-SE	16	Peat	-1.0 ft > 30 days	1-in-7
Northeastern Shark River Slough	NESRS-2	11	Peat	-1.0 ft > 30 days	1-in-10
Central Shark River Slough	NP-33	10	Peat	-1.0 ft > 30 days	1-in-10
Southwestern Shark River Slough	NP 36	9	Peat	-1.0 ft > 30 days	1-in-7
Marl wetlands east of Shark River Slough	NP-38	70	Marl	-1.5 ft > 90 days	1-in-3[d]
Marl wetlands west of Shark River Slough	NP-201 G-620	12	Marl	-1.5 ft > 90 days	1-in-5
Rockland Marl Marsh	G-1502	8	Marl	-1.5 ft > 90 days	1-in-2[d]
Taylor Slough	NP-67	1	Marl	-1.5 ft > 90 days	1-in-2[d]

a. See **Figure 27** for the location of each indicator region

b. Return frequencies for peat based wetlands located within the WCAs were based largely on output of the Natural System Model, version 4.5 Final.

c. Expert opinion of District staff and results from the NSM concur that a 1-in-6 return frequency is needed to protect peat soils of this region from significant harm. District staff recognizes that this value had to be modified to account for consideration of changes and structural alterations that have occurred to the hydrology of WCA-2B. Model results of the Restudy and LEC water supply planning process suggest full restoration of WCA-2B may not be possible. A policy decision was made to present a MFL return frequency of 1-in-3 in this table to reflect conditions that can be practically achieved.

d. These return frequencies reflect the expert opinion of District staff based on agreed upon management targets developed for the Restudy and LEC Plan and output of the NSM. It is the expert opinion of Everglades National Park staff that NSM does not properly simulate hydrologic conditions within the Rockland marl marsh and Taylor Slough, and the proposed return frequencies listed above may not necessarily protect these marl-forming wetlands from significant harm. They propose that a frequency of 1-in-5 may be necessary to prevent significant harm from occurring to these unique areas of Everglades National Park.

2020 Base Case. The ability of the regional system to meet MFLs did not improve under the 2020 Base Case. As in the 1995 Base Case, 12 out of 19 indicator regions exceeded the proposed criteria (**Table 45**). However, northeastern WCA-3A showed hydroperiod improvements associated with completion of STA-3 and STA-4 and the reestablishment of sheetflow to northeastern WCA-3A.

2020 with Restudy and LEC-1. Implementation of the 2020 with Restudy and LEC-1 alternatives significantly improved the system's ability to meet proposed MFL criteria. Under the 2020 with Restudy simulation, 17 of 19 sites met the proposed criteria (**Table 45**). MFL performance was slightly improved under LEC-1, with 18 out of 19 indicator regions meeting the proposed criteria. Areas that showed the most improvement were WCA-3A, WCA-3B, and Shark River Slough. Areas that still need improvement included WCA-2A, the marl wetlands east of Shark River Slough, and the Rockland marl marsh. (**Table 45**).

Table 45. Minimum Flows and Levels Results of the Base Case and Alternative Simulations for the Everglades.[a]

Geographic Location				Return Frequency (Years)				
Area	Key Gage	IR[b]	Soil[c]	Target	1995 Base Case	2020 Base Case	2020 With Restudy	LEC-1
Loxahatchee National Wildlife Refuge (WCA-1)	1-7	27	peat	1-in-4	1-in-15	1-in-4	1-in-10	1-in-15
WCA-2A	2A-17	24	peat	1-in-4	1-in-4	1-in-4	1-in-3	1-in-3
WCA-2B	2B-21	23	peat	1-in-3	1-in-3	1-in-4	1-in-3	1-in-3
Holey Land WMA	HoleyG	29	peat	1-in-3	1-in-5	1-in-6	1-in-3	1-in-3
Rotenberger WMA	Rotts	28	peat	1-in-2	1-in-1	1-in-1	1-in-2	1-in-2
Northwest corner of WCA-3A	3A-NW	22	peat	1-in-4	1-in-1.5	1-in-3	1-in-4	1-in-6
Northwestern WCA-3A	3A-2	20	peat	1-in-4	1-in-2	1-in-3	1-in-4	1-in-4
Northeastern corner of WCA-3A	3A-3	68	peat	1-in-3	1-in-5	1-in-3	1-in-3	1-in-3
Northeastern WCA-3A	3A-NE	21	peat	1-in-2	1-in-1.6	1-in-4	1-in-2	1-in-2
Central WCA-3A	3A-4	17	peat	1-in-4	1-in-5	1-in-3	1-in-8	1-in-8
Southern WCA-3A	3A-28	14	peat	1-in-4	PF	1-in-4	1-in-6	1-in-8
WCA-3B	3B-SE	16	peat	1-in-7	1-in-3	1-in-2	1-in-10	1-in-10
Northeastern Shark River Slough	NESRS-2	11	peat	1-in-10	1-in-3	1-in-3	1-in-15	1-in-15
Central Shark River Slough	NP-33	10	peat	1-in-10	1-in-3	1-in-4	1-in-15	1-in-15
Southwestern Shark River Slough	NP-36	9	peat	1-in-7	1-in-3	1-in-4	1-in-8	1-in-8
Marl wetlands east of Shark River Slough	NP-38	70	marl	1-in-3	1-in-1.2	1-in-2	1-in-2	1-in-3
Marl wetlands west of Shark River Slough	NP-201/ G-620	12	marl	1-in-5	1-in-3	1-in-3	1-in-6	1-in-6
Rockland Marl Marsh	G-1502	8	marl	1-in-2	1-in- 1	1-in-1.3	1-in-1.3	1-in-1.5
Taylor Slough	NP-67	1	marl	1-in-2	1-in-2	1-in-2	1-in-2	1-in-2
Total Violations (number of sites which did not meet criteria)					12/19	12/19	3/19	2/19

a. [white box] = exceeded proposed MFL criteria; [shaded box] = met proposed MFL criteria
b. IR = Indicator Region
c. MFL Criteria for peat-forming wetlands are -1.0 feet below ground for more than 30 days; MFL criteria for marl-forming wetlands are -1.5 feet below ground for more than 90 days

Incremental Results

1995 Revised Base Case. Model simulations showed that under the 1995 Revised Base Case, proposed minimum water level criteria were not met for 11 out of 19 indicator regions (**Table 46**). MFLs were not met in the Rotenberger WMA, most of northern WCA-3A, WCA-3B, Shark River Slough, marl wetlands located east and west of Shark River Slough, and the Rockland marl marsh. Areas that met the proposed criteria were the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), WCA-2A, WCA-2B, the Holey Land WMA, the northeastern corner of WCA-3A (Indicator Region 68), central and southern WCA-3A, and Taylor Slough.

2010, 2015, and LEC-1 Revised. Conditions did not begin to improve in the northern Everglades until the 2010 simulation, and improvements continued incrementally through 2020 (LEC-1 Revised) when almost all areas met MFL criteria. In Everglades National Park, performance did not improve until the LEC-1 Revised simulation. This was primarily due to Lake Belt Project components not being implemented until 2020. Proposed Everglades MFL criteria were met at 17 out of the 19 indicator regions during the LEC-1 Revised simulation (**Table 46**). The two areas where MFLs were not met were WCA-2B and the Rockland marl marsh located in Everglades National Park.

2005 and 2005 SSM Scenario. Review of MFL performance for the Everglades showed no major differences between the 2005 incremental simulation and the 2005 SSM Scenario results (**Table 46**). After review of stage hydrographs, stage duration curves, inundation summary tables, and high and low water criteria (**Appendix H**) it was concluded that differences, if any, between the 2005 incremental simulation and the 2005 SSM Scenario were insignificant. All performance measures, including meeting MFLs, for the Everglades showed virtually identical behavior under both simulations.

Biscayne Bay

Performance Measures Applied

For purposes of this study, the performance measure for Biscayne Bay was that future flows delivered to the estuary should not be less than those currently discharged to the bay under the 1995 Base Case. Mean annual wet and dry season flows were based on SFWMM output for the primary water management structures which discharge into the northern, central, and southern portions of Biscayne Bay. These structures included the following:

- Northern Biscayne Bay: Snake Creek (S-29), G-58, S-28, and S-27
- Central Biscayne Bay: Miami River (S-25, S-25B, and S-26), G-97, S-22, and S-123
- Southern Biscayne Bay: S-21, S-21A, S-20F, and S-206

Table 46. Minimum Flows and Levels Results of the Incremental Simulations.[a]

Geographic Location				Return Frequency (Years)						
Area	Key Gage	IR[b]	Soil[c]	Target	1995 Revised Base Case	2005	2005 SSM Scenario	2010	2015	LEC-1 Revised
Loxahatchee National Wildlife Refuge (WCA-1)	1-7	27	peat	1-in-4	1-in-15	1-in-4	1-in-6	1-in-10	1-in-15	1-in-15
WCA-2A	2A-17	24	peat	1-in-4	1-in-4	1-in-4	1-in-2	1-in-3	1-in-3	1-in-4
WCA-2B	2B-21	23	peat	1-in-3	1-in-3	1-in-4	1-in-2	1-in-3	1-in-3	1-in-2
Holey Land WMA	HoleyG	29	peat	1-in-3	1-in-5	1-in-6	1-in-8	1-in-3	1-in-3	1-in-3
Rotenberger WMA	Rotts	28	peat	1-in-2	1-in-1	1-in-1	1-in-1	1-in-2	1-in-2	1-in-2
Northwest corner of WCA-3A	3A-NW	22	peat	1-in-4	1-in-1.5	1-in-3	1-in-2	1-in-4	1-in-6	1-in-8
Northwestern WCA-3A	3A-2	20	peat	1-in-4	1-in-2	1-in-3	1-in-2	1-in-4	1-in-4	1-in-3
Northeastern corner of WCA-3A	3A-3	68	peat	1-in-3	1-in-5	1-in-3	1-in-4	1-in-3	1-in-3	1-in-4
Northeastern WCA-3A	3A-NE	21	peat	1-in-2	1-in-1.6	1-in-4	1-in-3	1-in-2	1-in-2	1-in-2
Central WCA-3A	3A-4	17	peat	1-in-4	1-in-5	1-in-3	1-in-4	1-in-8	1-in-8	1-in-8
Southern WCA-3A	3A-28	14	peat	1-in-4	PF[d]	1-in-4	1-in-31	1-in-6	1-in-8	1-in-8
WCA-3B	3B-SE	16	peat	1-in-7	1-in-3	1-in-2	1-in-3	1-in-10	1-in-10	1-in-30
Northeastern Shark River Slough	NESRS-2	11	peat	1-in-10	1-in-3	1-in-3	1-in-3	1-in-15	1-in-15	1-in-30
Central Shark River Slough	NP-33	10	peat	1-in-10	1-in-3	1-in-4	1-in-3	1-in-15	1-in-15	PF
Southwestern Shark River Slough	NP-36	9	peat	1-in-7	1-in-3	1-in-4	1-in-3	1-in-8	1-in-8	1-in-8
Marl wetlands east of Shark River Slough	NP-38	70	marl	1-in-3	1-in-1	1-in-2	1-in-2	1-in-2	1-in-3	1-in-3
Marl wetlands west of Shark River Slough	NP-201	12	marl	1-in-5	1-in-3	1-in-3	1-in-3	1-in-6	1-in-6	1-in-6
Rockland Marl Marsh	G-1502	8	marl	1-in-2	1-in-1	1-in-1	1-in-1.5	1-in-1	1-in-1.5	1-in-1.7
Taylor Slough	NP-67	1	marl	1-in-2	1-in-2	1-in-2	1-in-2	1-in-2	1-in-2	1-in-2
Total Violations (number of sites which did not meet criteria)					11/19	11/19	12/19	3/19	2/19	2/19

a. [white box] = exceeded proposed MFL criteria; [shaded box] = met proposed MFL criteria
b. IR = Indicator Region
c. MFL Criteria for peat-forming wetlands are -1.0 feet below ground for more than 30 days; MFL criteria for marl-forming wetlands are -1.5 feet below ground for more than 90 days
d. PF = Permanently Flooded

Base Cases and Alternatives Results

1995 and 2020 Base Cases. The 1995 Base Case is the recommended flow target for Biscayne Bay. Increased regional water demands in the 2020 Base Case reduced the total amount of water discharged to Biscayne Bay by approximately 12 percent as compared to the 1995 Base Case (**Table 47**).

Table 47. Total Mean Annual Flows Discharged into Northern, Central, and Southern Biscayne Bay for the Base Case and Alternative Simulations during the 31-Year Simulation Period.

Area	Average Annual Flow (ac-ft x 1,000)						
	1995 Base Case[a]	2020 Base Case		2020 with Restudy		LEC-1	
		Flows	Change from Target	Flows	Change from Target	Flows	Change from Target
Northern Bay	312	298	-4%	241	-23%	259	-17%
Central Bay	434	335	-23%	252	-42%	269	-38%
Southern Bay	223	215	-4%	247	11%	267	20%
Totals	969	848	-12%	740	-24%	795	-18%

a. The 1995 Base Case is the recommended flow target for Biscayne Bay

2020 with Restudy and LEC-1. Performance of the 2020 with Restudy and LEC-1 alternatives showed total mean annual surface flows delivered to the bay was reduced by 24 and 18 percent, respectively, as compared to the 1995 Base Case (**Table 47**). These reductions in flow were caused primarily by construction of the C-4 structures which reduced the amount of water discharged through S-25B and the Miami Canal into central Biscayne Bay. As a result, the largest reductions in flow occurred in this area of the bay under the 2020 with Restudy and LEC-1 alternatives (**Table 47**).

In contrast, flows delivered to southern Biscayne Bay increased by 11 and 20 percent for the 2020 with Restudy and LEC-1 alternatives, respectively, as compared to the 1995 Base Case. This increase in water flow to southern Biscayne Bay was the result of incorporation of the water reuse components contained within both the 2020 with Restudy and LEC-1 alternatives (**Table 47**).

Incremental Results

Significantly lower mean annual flows were delivered to Biscayne Bay as a whole during the 2005 and LEC-1 Revised simulations compared to the target (1995 Base Case). The reductions were 21 and 18 percent for 2005 and LEC-1 Revised simulations, respectively (**Table 48**). These results, however, varied region by region within the bay. In northern Biscayne Bay, mean average annual flows remained near 1995 Base Case values during the 2005 simulation, increased in the 2010 and 2015 simulations, and then decreased in the LEC-1 Revised simulation due to Lake Belt Project components coming on-line. The most striking results occurred in central Biscayne Bay during the 2005 simulation where total flows delivered to the bay dropped by more than 39 percent compared to the 1995 Base Case (**Table 48**). This was due to construction of the C-4 structures, which significantly reduced flows from S-25B into the Miami Canal and central Biscayne Bay. These values increased during the 2010 and 2015 simulations, but decreased again during the LEC-1 Revised simulation, in part due to Lake Belt Project components coming on-line. In contrast, in southern Biscayne Bay, water reuse projects increased flows to the south by 20 percent during the LEC-1 Revised and improved estuarine conditions in this portion of the bay.

Table 48. Total Mean Annual Flows Discharged into Northern, Central, and Southern Biscayne Bay for the Incremental Simulations during the 31-Year Simulation Period.

Area	Average Annual Flow (ac-ft x 1,000)										
		1995 Revised Base Case		2005		2010		2015		LEC-1 Revised	
	1995 Base Case[a]	Flows	Change from Target	Flows	Change from Target	Flows	Change from Target	Flows	Change from Target	Flows	Change from Target
Northern Bay	312	312	0%	300	-4%	347	11%	340	9%	259	-17%
Central Bay	434	430	-1%	263	-39%	341	-21%	321	-26%	263	-39%
Southern Bay	223	222	0%	203	-9%	219	-2%	217	-3%	268	20%
Totals	969	964	0%	766	-21%	907	-6%	878	-9%	790	-18%

a. The 1995 Base Case is the recommended flow target for Biscayne Bay

Biscayne Aquifer Minimum Flows and Levels

Base Cases and Alternatives Results

All of the base cases and alternatives showed the ability to meet the proposed minimum canal operational levels for the Biscayne aquifer MFLs for the 31-year simulation period (**Table 49)**. These results indicated that the Biscayne aquifer was not threatened by saltwater intrusion in any of these simulations.

Table 49. Number of Times Minimal Minimum Flows and Levels Operational Criteria Were Not Met for the Biscayne Aquifer.

Canal/Structure	Minimum Canal Operation Levels to Protect Against MFL Violations[a]	Number of Times MFL Criteria Not Met			
		1995 Base Case	2020 Base Case	2020 with Restudy	LEC-1
C-51/S-155	7.80	0	0	0	0
C-16/S-41	7.80	0	0	0	0
C-15/S-40	7.80	0	0	0	0
Hillsboro/G-56	6.75	0	0	0	0
C-14/S-37B	6.50	0	0	0	0
C-13/S-36	4.00	0	0	0	0
North New River/G-54	3.50	0	0	0	0
C-9/S-29	2.00	0	0	0	0
C-6/S-26	2.00	0	0	0	0
C-4/S-25B	2.20	0	0	0	0
C-2/S-22	2.20	0	0	0	0

a. Duration criteria: water levels within the above canals may fall below the proposed minimum operational level for a period of no more than 180 days per year

Summary of Minimum Flows and Levels

Lake Okeechobee

MFLs were met in Lake Okeechobee for the 1995 and 2020 Base Cases, the 2020 with Restudy, and the LEC-1 alternatives, as well as the 2005 through 2020 incremental simulations. As a result, the MFL criteria are not expected to be exceeded even if the LEC Plan were not implemented. Therefore, neither a MFL recovery plan nor a prevention strategy is required for Lake Okeechobee.

The Everglades

In contrast, MFL criteria were not met for 12 of 19 selected monitoring sites located within the Everglades for both the 1995 and 2020 Base Cases. A MFL recovery plan will be needed for these areas. Features of this plan are presented in **Appendix J**.

Analyses of the 2020 with Restudy and LEC-1 simulations showed major improvements in the ability to meet the proposed MFL criteria by 2020. Incremental modeling results showed improvements in meeting MFLs within the northern Everglades by 2010 and 2015 as a result of construction of the Everglades Construction Project and the EAA Storage Reservoirs. MFLs were met for the majority of sites located within Everglades National Park by 2020 as a result of construction and operation of 50 percent of the Lake Belt Storage Area projects. By 2020, only two Everglades monitoring sites out of 19 did not meet the proposed MFL criteria.

Biscayne Aquifer

All of the base case and alternative simulations met the proposed minimum canal operational levels for the Biscayne aquifer for the 31-year simulation period. The Biscayne aquifer was not threatened by saltwater intrusion due to the inability to maintain coastal canals levels in any of these simulations. As a result, the proposed minimum canal operational levels are not expected to be exceeded even if the LEC Plan is not implemented. Therefore, neither a MFL recovery plan nor a prevention strategy is required for the Biscayne aquifer at this time.

Summary of Modeling Results for Natural Areas

Lake Okeechobee. Implementation of the WSE schedule in Lake Okeechobee resulted in a number of hydrologic improvements that should benefit the overall ecology of the ecosystem. These improvements began in 2005 and LEC planning targets were met by 2015.

St. Lucie and Caloosahatchee Estuaries. Construction of regional reservoirs combined with water management improvements in Lake Okeechobee by 2010 resulted in significant reductions in the number of high volume discharge events that impact both the St. Lucie and Caloosahatchee estuaries. These hydrologic improvements should help to maintain salinity regimes that will provide significant ecological benefits to both ecosystems.

Lake Worth Lagoon. Construction of STA-1E and other improvements to the regional system resulted in a significant reduction in the number of high volume discharge events that impact the Lake Worth Lagoon.

Holey Land and Rotenberger Wildlife Management Areas. In the EAA, completion of the Everglades Construction Project and EAA Storage Reservoirs, and implementation of rain-driven water delivery schedules for the Holey Land and Rotenberger WMAs provided significant ecological benefits to these overdrained areas by 2010.

WCA-3A and WCA-3B. Completion of the Everglades Construction Project, construction of the EAA Storage Reservoirs, and implementation of rain-driven water delivery schedules within northern WCA-3A reintroduced sheetflow to the northern Everglades system and met NSM-defined hydrologic targets in northern WCA-3A by 2010. These improvements should provide significant ecological benefits to this historically overdrained area of the Everglades system. In addition, WCA-3B and southern WCA-3A showed gradual improvements over time and came close to meeting NSM-defined targets by 2020.

Everglades National Park. Modeling results showed gradual improvement over time in providing increased flows to Everglades National Park. Beginning in 2005, a significant improvements in both the distribution and volume of water delivered to northeast and northwest Shark River Slough occurred. By 2010, the ability to meet NSM hydroperiod targets was significantly improved within northeast and central Shark River Slough, with near full recovery by 2020 (100 percent of the slough matched the NSM hydroperiod target by 2020). In the Rockland marl marsh, significant hydroperiod improvements were noted beginning in 2005 within this overdrained area. These improvements continued through 2020.

Florida Bay. Results also showed that major improvements occurred over time in the ability to provide increased flows toward western Florida Bay and Whitewater Bay. These increased flows should provide significant ecological benefits to areas that have been subject to reduced flows as a result of construction of the C&SF Project.

SYSTEMWIDE PERFORMANCE

Regional water budgets provide a useful means of comparing results of different model simulations. Primary water budget component maps are shown for the 1995 Revised Base Case (95BSRR); the 2005 (2005R), 2010 (2010R), and 2015 (2015R) incremental; and the LEC-1 Revised (2020R) simulations in **Figures 30** through **34**. **Table 50** provides a description for flow arrows depicted on the water budget component maps. The number next to each description refers to the numbered arrow on the primary water budget components key (**Figure 29**). The key reflects all the flow arrows on the water budget maps, while each individual map reflects only those arrows relative to that particular simulation.

Note that the water budget maps show mean annual flows averaged over the 31-year simulation period. They do not depict the desired timing of flows. In order to simplify these maps, flows at several structures are often lumped and represented by a single arrow. These maps are intended for informational purposes only and are not intended to be measures of performance of particular simulations.

Table 50. Description of Flow Arrows on the Primary Water Budget Components Maps.

No.	Description
	Lake Okeechobee
	Area = 728 square miles = 466,000 acres
1	Rainfall on Lake Okeechobee
2	Evapotranspiration from Lake Okeechobee
3	Net Inflows to Lake Okeechobee including Kissimmee River, Taylor Creek, and Nubbin Slough inflows plus S236 runoff plus net delta storage term, which accounts for historical inflow minus outflow not otherwise accounted for
4	Outflow to North of Lake Okeechobee Storage Reservoir
5	Inflow from North of Lake Okeechobee Storage Reservoir
6	Injection to Lake Okeechobee ASR system
7	Recovery from Lake Okeechobee ASR system
8	Change in Lake Okeechobee storage
	Caloosahatchee Basin and Estuary
9	Water supply from Lake Okeechobee to meet Caloosahatchee Estuary minimum environmental flows
10	Regulatory releases from Lake Okeechobee to Caloosahatchee Basin
11	Portion of Lake Okeechobee regulatory releases that go directly to Caloosahatchee Estuary
12	Portion of Lake Okeechobee regulatory releases that are stored in C-43 Basin Storage Reservoir
13	Water supply from Lake Okeechobee towards meeting Caloosahatchee Basin demands
14	Caloosahatchee Basin runoff
15	Caloosahatchee Basin runoff that returns to Lake Okeechobee
16	Portion of Caloosahatchee Basin runoff that flows to Caloosahatchee Estuary and contributes towards meeting environmental demands of estuary
17	Portion of Caloosahatchee Basin runoff that flows to Caloosahatchee Estuary and does not contribute towards meeting estuary demands (i.e. is undesirable flow because it exceeds estuarine targets)
18	Portion of Caloosahatchee Basin runoff that flows to C-43 Basin Storage Reservoir
19	Outflow from C-43 Basin Storage Reservoir and ASR towards meeting environmental demands of Caloosahatchee Estuary
20	Water supply from Caloosahatchee Basin Storage Reservoir and ASR towards meeting Caloosahatchee Basin demands
21	Sum of flows that contribute towards meeting estuarine target
22	Environmental targets for Caloosahatchee Estuary
	St. Lucie Basin and Estuary
23	Water supply from Lake Okeechobee to meet St. Lucie Estuary minimum environmental flows
24	Regulatory releases from Lake Okeechobee to St. Lucie Basin
25	Water supply from Lake Okeechobee towards meeting St. Lucie Basin demands
26	Backflows to Lake Okeechobee from C-44 Basin Storage Reservoir
27	St. Lucie Basin runoff

Table 50. Description of Flow Arrows on the Primary Water Budget Components Maps.

No.	Description
28	St. Lucie Basin runoff that returns to Lake Okeechobee
29	Portion of St. Lucie Basin runoff that flows to St. Lucie Estuary and contributes towards meeting environmental demands of estuary
30	Portion of St. Lucie Basin runoff that flows to St. Lucie Estuary and does not contribute towards meeting estuary demands (i.e. is undesirable flow because it exceeds estuarine targets)
31	Portion of St. Lucie Basin runoff that flows to C-44 Basin Storage Reservoir
32	Outflow from C-44 Basin Storage Reservoir towards meeting environmental demands of St. Lucie Estuary
33	Water supply from C-44 Basin Reservoir towards meeting St. Lucie Basin demands
34	Non-C-44 Basin runoff that contributes towards meeting estuarine targets
35	Sum of flows that contribute towards meeting estuarine target
36	Environmental targets for St. Lucie Estuary
Everglades Agricultural Area	
	Area = 948 square miles = 606,720 acres (Includes Holey Land and Rotenberger WMAs and STAs)
37	Rainfall on EAA
38	Evapotranspiration from EAA
39	Releases from Lake Okeechobee for Big Cypress Seminole's demands
40	Releases from STA-6 and Rotenberger WMA for Big Cypress Seminole Reservation demands
41	Inflow to EAA from Western Basins
42	Water supply from Lake Okeechobee that contributes towards meeting environmental needs in Rotenberger WMA and the Everglades Protection Area
43	Water supply from Lake Okeechobee that contributes towards meeting environmental needs in Rotenberger WMA
44	Water supply from Lake Okeechobee, through EAA, that contributes towards meeting environmental needs in the Everglades Protection Area
45	Regulatory releases from Lake Okeechobee to EAA Storage Reservoir, Compartment 2
46	Water supply from Lake Okeechobee, through EAA, that contributes towards meeting LEC Service Areas' water needs
47	Regulatory releases from Lake Okeechobee, through EAA, to the WCAs (through the STAs where applicable, but is undesirable flow because it exceeds WCA environmental targets)
48	Agricultural water supply to EAA from Lake Okeechobee
49	Runoff from EAA to Lake Okeechobee
50	Ground water flow from the LEC Service Areas to EAA
51	Water supply from EAA to LEC Service Areas (including STA-1E)
52	Inflows to EAA from C-51 Regional Ground Water ASR and West Palm Beach Catchment ASR
53	Inflows to EAA from C-51 Regional Ground Water ASR and West Palm Beach Catchment ASR to meet agricultural demands
54	Inflows to EAA Storage Reservoirs from C-51 Regional Ground Water ASR and West Palm Beach Catchment ASR
55	Ground water flow from WCAs back to EAA
56	Runoff from EAA to WCAs (through STAs where applicable) - excluding L4 wraparound flows through S-140
57	Water supply from EAA Storage Reservoirs that contributes towards meeting environmental needs
58	Runoff from EAA to WCAs (through STAs where applicable) through L4 wraparound and S-140
59	Ground water flow from EAA to Big Cypress National Preserve
60	Runoff from EAA to EAA Storage Reservoirs, Compartment 1
61	Agricultural water supply from EAA Storage Reservoirs, Compartment 1
62	Change in EAA water storage

Table 50. Description of Flow Arrows on the Primary Water Budget Components Maps.

No.	Description
	Water Conservation Areas
	Area = 1,320 square miles = 844,800 acres
63	Rainfall on WCAs
64	Evapotranspiration from WCAs
65	Runoff into WCAs through G-155
66	Runoff from northern Big Cypress National Preserve and runoff from EAA routed westward, which flow through structures into WCAs
67	Overland flow from Big Cypress National Preserve into WCAs
68	Ground water flow from WCAs to Big Cypress National Preserve
69	Structural outflows to southern Big Cypress National Preserve
70	Regulatory releases to Everglades National Park
71	Overland flow from WCA-3 to Everglades National Park
72	Releases to Everglades National Park that contribute towards meeting environmental targets
73	Ground water flow (includes levee seepage) from WCAs to Everglades National Park
74	Water released from WCA-3 to Lakebelt storage areas to help meet environmental targets in WCA-3
75	Water supply from WCAs to help meet LEC Service Areas' demands
76	Runoff from LECSA 2 to WCA-3
77	Water released from WCA-2B to Lakebelt storage areas to help meet environmental targets in WCA-2B
78	Ground water flow (includes levee seepage) from WCAs to LEC Service Areas
79	Runoff from LECSA 1 to WCA-1 (through STAs where applicable)
80	Change in WCAs water storage
	Big Cypress National Preserve
	Area = 1,196 square miles = 765,440 acres
81	Rainfall on Big Cypress National Preserve
82	Evapotranspiration from Big Cypress National Preserve
83	Runoff inflow from the north
84	Flow from SR-29 Canal out of western boundary of Big Cypress National Preserve
85	Overland flow from Big Cypress National Preserve towards Florida Bay
86	Ground water flow from Big Cypress National Preserve towards Florida Bay
87	Southward overland flow from Big Cypress National Preserve to Everglades National Park
88	Ground water flow from Everglades National Park to Big Cypress National Preserve
89	Change in Big Cypress National Preserve water storage
	Everglades National Park
	Area = 972 square miles = 622,080 acres
90	Rainfall on Everglades National Park
91	Evapotranspiration from Everglades National Park
92	Eastward overland flow towards Whitewater Bay and Florida Bay
93	Ground water flow in southwest direction towards Florida Bay and Whitewater Bay
94	Southward overland flow from Everglades National Park towards Florida Bay
95	Southward overland flow from the southwestern area of LEC service areas to the Everglades National Park
96	Levee seepage from Everglades National Park that is returned to the park along the eastern boundary
97	Ground water flow to LEC service areas
98	Pumped outflow into LEC service areas from proposed S-357 Structure in 8.5 Square Mile Area

Table 50. Description of Flow Arrows on the Primary Water Budget Components Maps.

No.	Description
99	Inflow of new water to Everglades National Park from the Lakebelt storage areas, seepage collection, and WCA-3 and WCA-2B excess through structures and overland flow buffer zones along the eastern boundary of the park (S-174; S-332 A,B,D; S-356 A,B), excluding levee seepage from the park that is pumped back into the park
100	Change in Everglades National Park water storage
Lower East Coast Service Areas	
	Area = 2,088 square miles = 1,336,320 acres (Includes L-8 Basin)
101	Rainfall on LEC service areas
102	Evapotranspiration from LEC service areas
103	Net pumpage for water supply
104	Water provided from the reuse of reclaimed water
105	Overland flow to Biscayne Bay
106	Ground water flow to Biscayne Bay
107	Structural flow to Biscayne Bay
108	Ground water flow from Broward County to tide
109	Structural flow from Broward County to tide
110	Overland flow from Broward County to tide
111	Overland flow from Palm Beach County to Lake Worth Lagoon
112	Ground water flow from Palm Beach County to Lake Worth Lagoon
113	Structural flow from Palm Beach County to Lake Worth Lagoon
114	Ground water flow from Northern Palm Beach County to tide
115	Structural flow from Northern Palm Beach County to Loxahatchee River
116	Overland flow from Northern Palm Beach County to Loxahatchee River
117	Overland inflow from the north
118	Runoff from LEC service areas to Lake Okeechobee
119	Injection into ASR systems
120	Recovery from ASR systems
121	Change in LEC service areas water storage

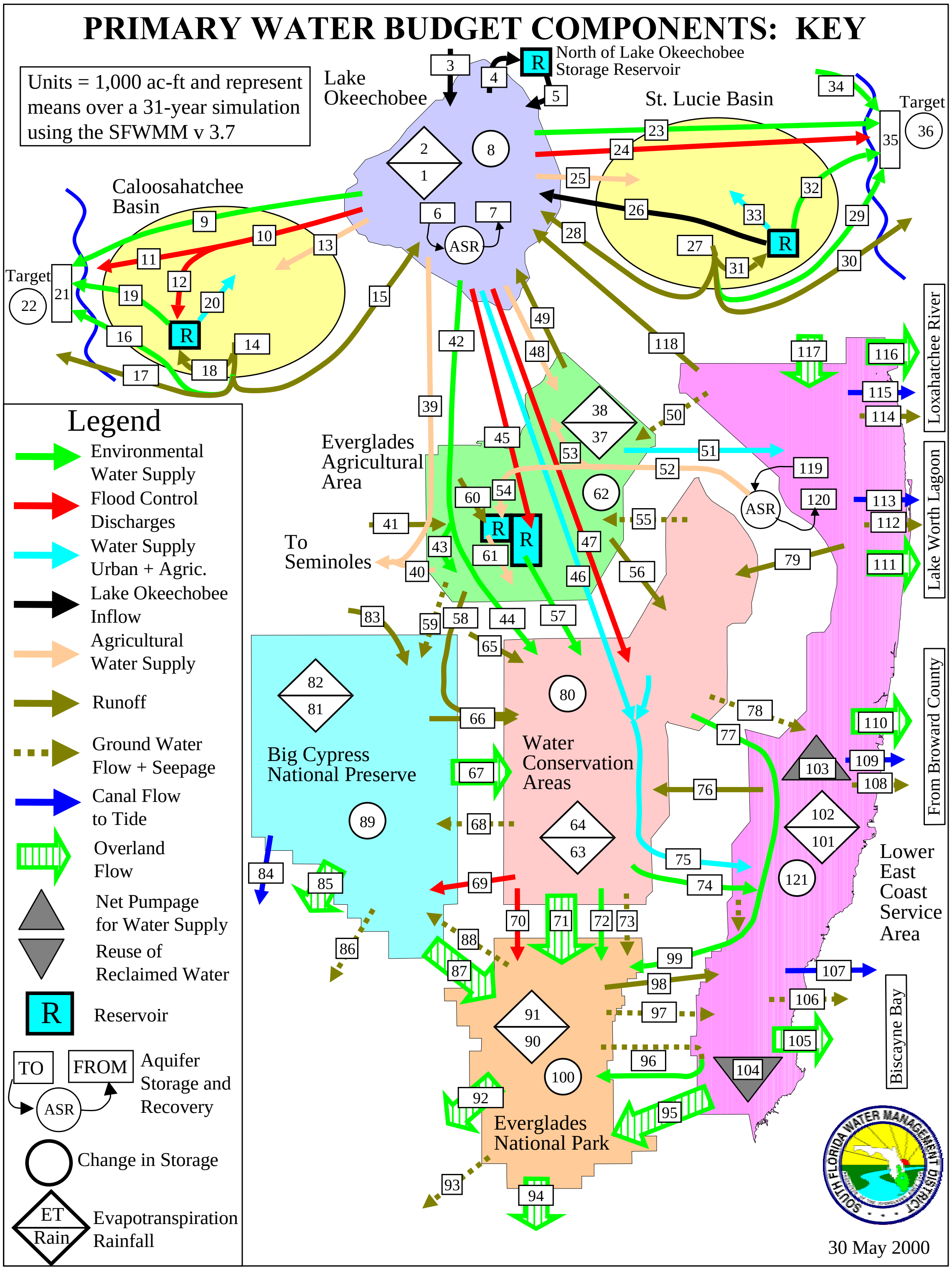

Figure 29. Key for the Water Budget Components Figures.

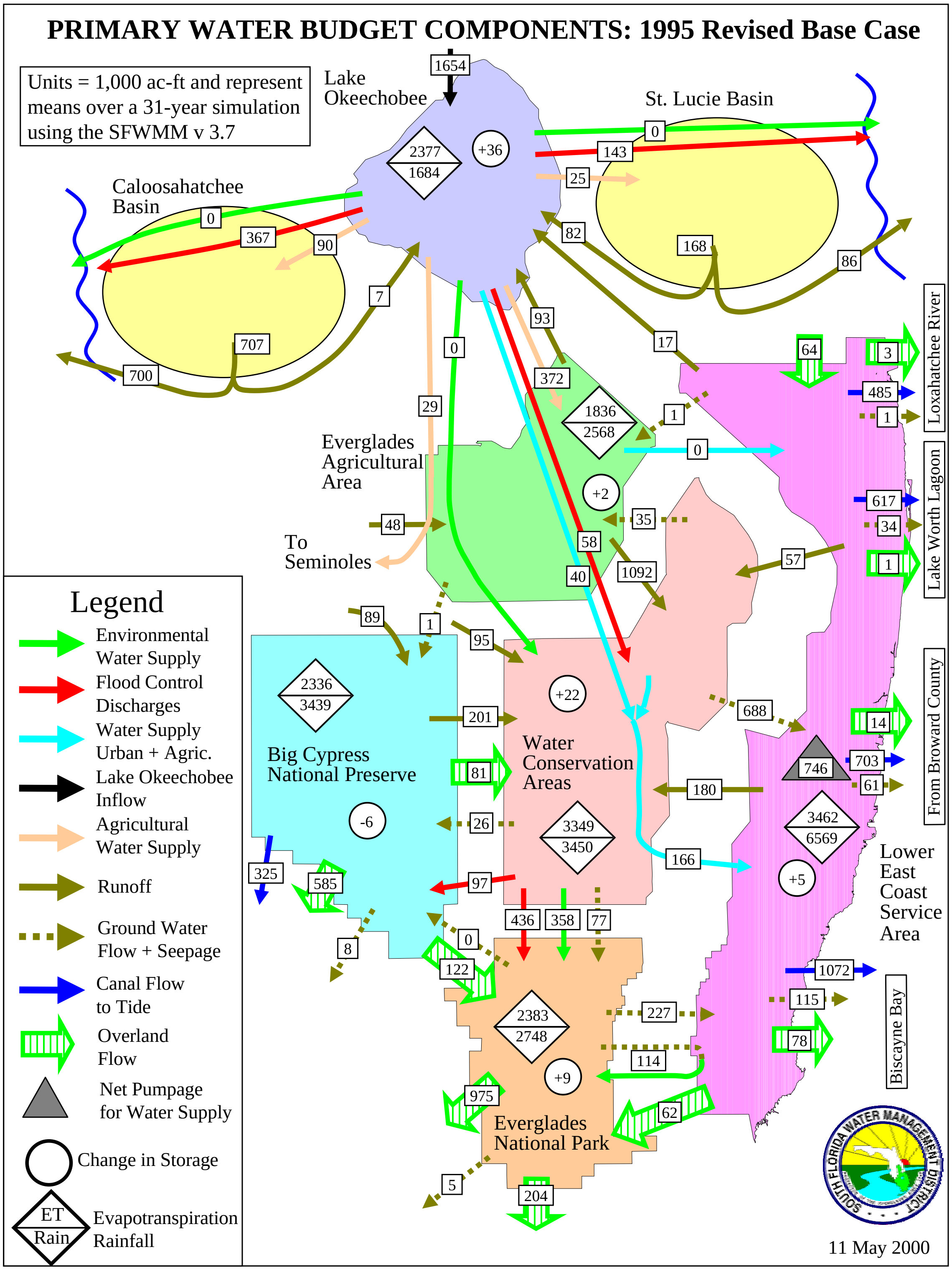

Figure 30. Primary Water Budget Components for the 1995 Revised Base Case.

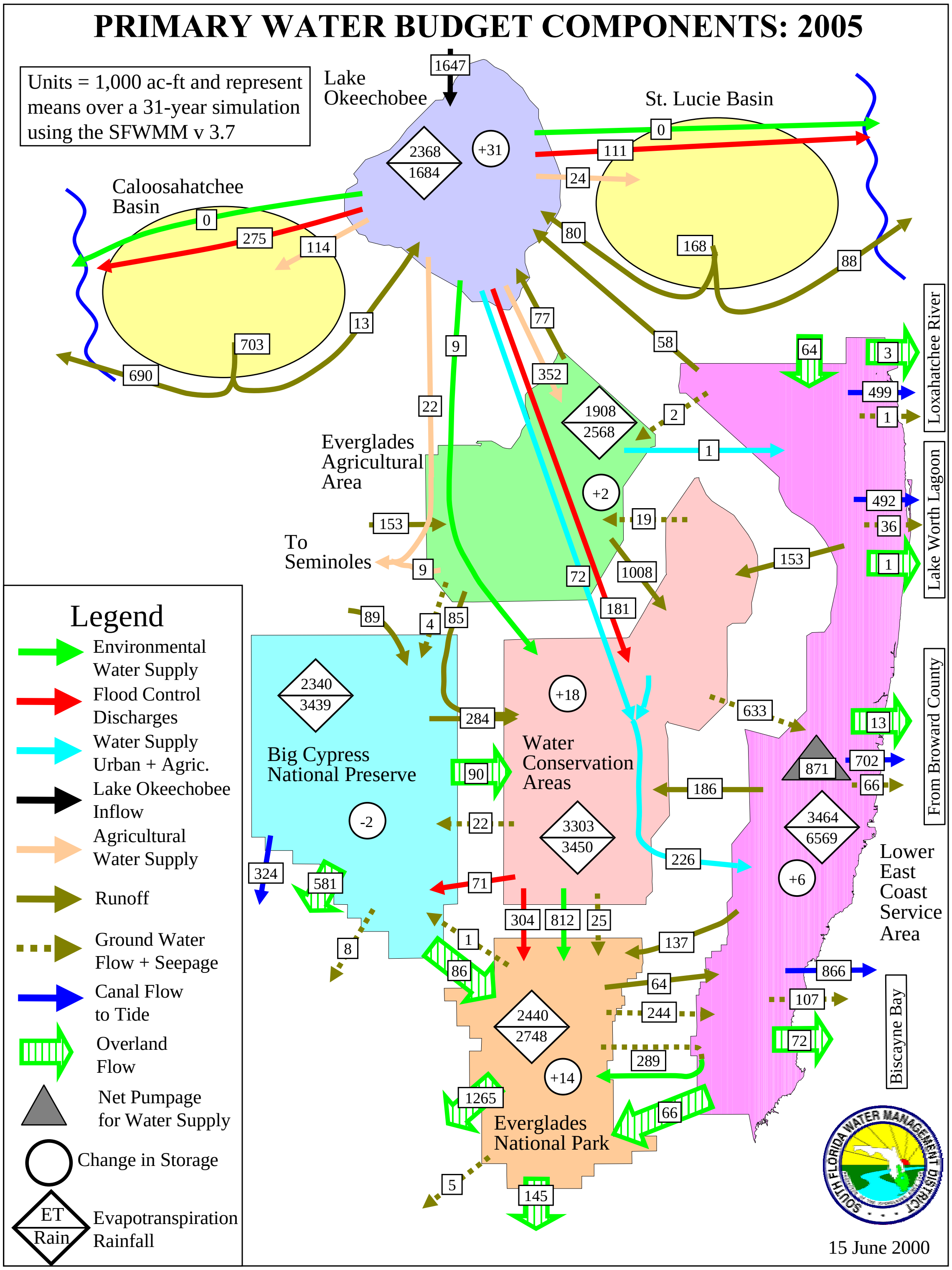

Figure 31. Primary Water Budget Components for the 2005 Incremental Simulation.

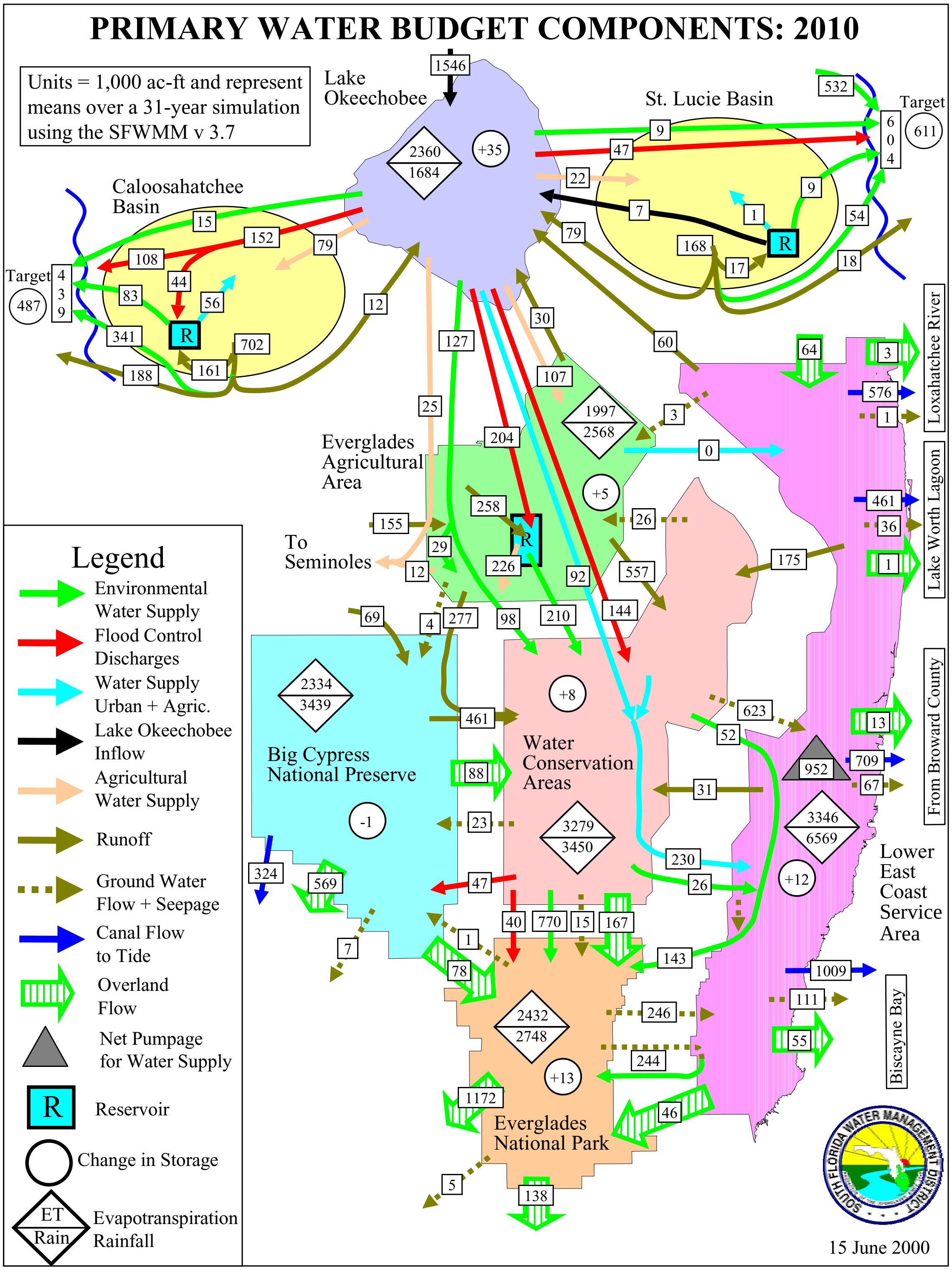

Figure 32. Primary Water Budget Components for the 2010 Incremental Simulation.

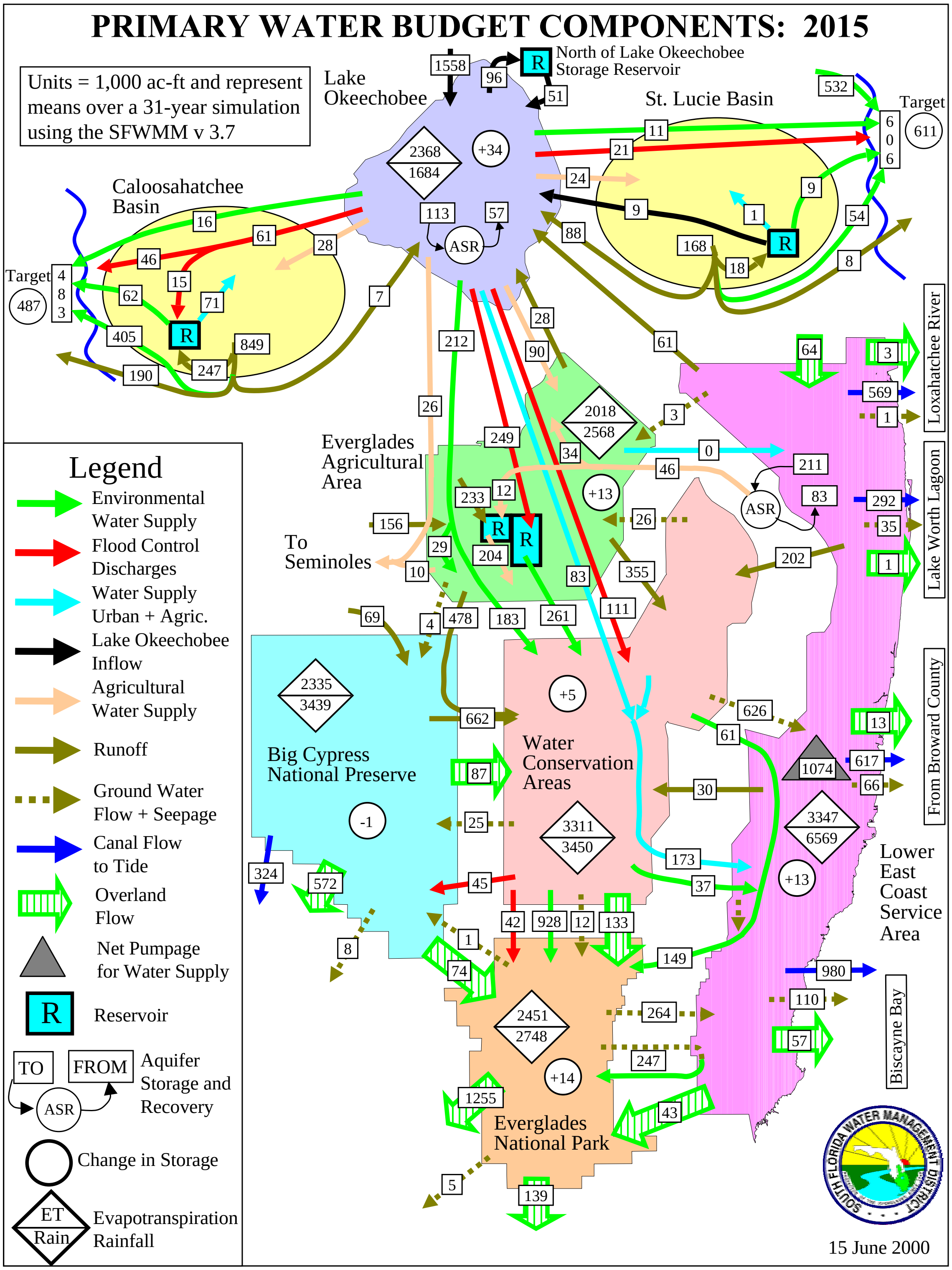

Figure 33. Primary Water Budget Components for the 2015 Incremental Simulation.

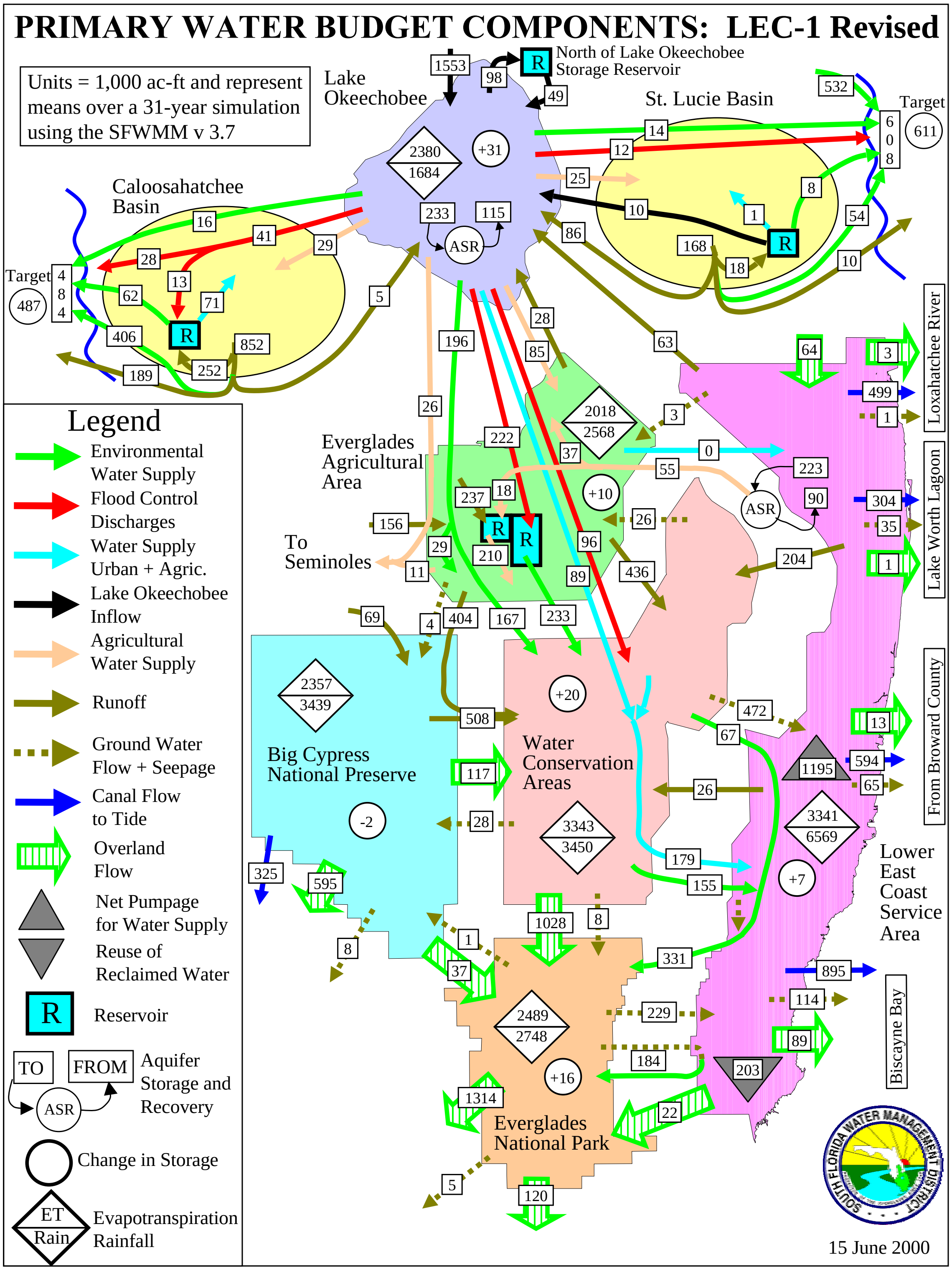

Figure 34. Primary Water Budget Components for the 2020 Incremental Simulation.

Chapter 5
IMPLEMENTATION STRATEGIES AND BASIS FOR RECOMMENDATIONS

INTRODUCTION

This chapter identifies and provides key information about the projects and actions that will be undertaken to implement the *Lower East Coast Regional Water Supply Plan* (LEC Plan). Specific recommendations are presented in **Chapter 6**. The first section of Chapter 5 provides an overview of regional water supply plan implementation strategies. It also provides definitions of water resource development and water supply development projects. The remaining two sections of this chapter present and discuss the water resource development projects and water supply development options proposed under this plan.

REGIONAL WATER SUPPLY PLAN IMPLEMENTATION STRATEGIES

Regional Water Supply Plan Implementation Assurances

Background

During the next 20 years, the South Florida Water Management District (District, SFWMD), the State of Florida, and consumptive users will be partners in implementing regional water supply plans per a directive of Section 373.0361, F.S. The regional water supply plans provide a guide map for meeting consumptive user demands and natural system demands projected for 2020. Economic, technical and political uncertainties are associated with implementing water resource development projects of the complexity and scope recommended in the regional water supply plans. These uncertainties will be particularly evident during the interim period when the various elements will be implemented and become operational. Reasonable certainty is needed for the protection of existing legal users and the water resources during the interim period.

Water resource development projects, operational changes, consumptive use permitting, and rulemaking associated with the regional water supply plans are proposed to occur in phases. The increasing demands of consumptive users and the environment must, to the extent practicable, correspond with the timing of increased water availability. Where shifts from existing sources of water are required for environmental enhancement, it is crucial that replacement sources are available when such shifts occur. Also, resources must be protected from harm, significant harm, and serious harm.

Existing Florida law provides the framework and includes several tools to accomplish these goals. These tools include water reservations, consumptive use permits, Minimum Flows and Levels (MFL) recovery strategies, and water shortage declarations.

A composite schedule for implementation of these water resource tools in concert with water resource development projects must be proposed in the regional water supply plans. This schedule will be further refined in five-year water resource development work plans, five-year water supply plan updates, annual budget reviews, periodic rule updates, and consumptive use permit renewals. Processes for contingency planning will also be developed to address uncertainties in the fulfillment of the water supply plans with the goal of complying with state requirements for the protection of existing legal users and environmental resources.

Water User and Natural System Assurances

The level of assurances to protect existing legal water users and the natural systems (assurances) while implementing the regional water supply plans must be consistent with Chapter 373, F.S. In this implementation process, the District's Governing Board will be faced with many policy decisions regarding the application and interpretation of law. The unique legal, technical, economical, and political implications of the regional water supply plans will all be considered in making these policy decisions. The District will be facing many of these issues for the first time in terms of their scale and significance.

The subject of assurances has been addressed in other forums, particularly in the *Central and Southern Florida Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement* (Restudy) (USACE and SFWMD, 1999). Although these assurances were developed in the context of the Restudy implementation, such assurances are applicable to implementation of regional water supply plan recommendations under state law and have been approved by the District's Governing Board. The Governing Board directs staff to implement the LEC Plan in accordance with the following assurances:

10.2.9. Assurances To Water Users

> The concept of "assurances" is key to the successful implementation of the Comprehensive Plan. Assurances can be defined in part as protecting, during the implementation phases of the Comprehensive Plan, the current level(s) of service for water supply and flood protection that exist within the current applicable Florida permitting statutes. Assurances also involve protection of the natural system.
>
> The current C&SF Project[1] has generally provided most urban and agricultural water users with a level of water supply and flood protection adequate to satisfy their needs. Florida law requires that all reasonable beneficial water uses and natural system demands be met. However, the C&SF Project, or regional system, is just one source of water for south Florida to be used in concert with other traditional and alternative water supplies.

1. C&SF Project refers to the Central and Southern Florida Project for Flood Control and Other Purposes.

The Governor's Commission for a Sustainable South Florida developed a consensus-based set of recommendations concerning assurances to existing users, including the natural system (GCFSSF, 1999). The following text is taken from the Commission's *Restudy Plan Report*, which was adopted on January 20, 1999:

> *"Assurances are needed for existing legal users during the period of plan implementation. It is an important principle that has helped gain consensus for the Restudy that human users will not suffer from the environmental restoration provided by the Restudy. At the same time, assurances are needed that, once restored, South Florida's natural environment will not again be negatively impacted by water management activities. Getting 'from here to there' is a challenge. The implementation plan will be the key to assuring predictability and fairness in the process.*
>
> *<u>Protecting Current Levels of Service (Water Supply and Flood Protection) during the Transition from the Old to the New C&SF Project.</u>*
>
> *The goal of a sustainable South Florida is to have a healthy Everglades ecosystem that can coexist with a vibrant economy and quality communities. The current C&SF Project has generally provided most urban and agricultural water users with a level of water supply and flood protection adequate to satisfy their needs. In fact, if properly managed, enough water exists within the South Florida system to meet restoration and future water supply needs for the region. However, past water management activities in South Florida, geared predominantly toward satisfying urban and agricultural demands, have often ignored the many needs of the natural system (GCSSF, 1995; transmittal letter to Governor Chiles, p. 2). Specifically, water managers of the C&SF Project historically discharged vast amounts of water to tide to satisfy their mandate to provide flood protection for South Florida residents, oftentimes adversely impacting the region's estuarine communities.*
>
> *The Commission recommended that in the Restudy, the SFWMD and the Corps[1] should ensure that the redesign of the system allows for a resilient and healthy natural system (GCSSF, 1995; p. 51) and ensure an adequate water supply and flood protection for urban, natural, and agricultural needs (GCSSF, 1996a; p.14). In response to the need to restore South Florida's ecosystem, and in light of the expected future increase of urban and agricultural water demands, the Restudy aims to capture a large percentage of water wasted to tide or lost through evapotranspiration for use by both the built and natural systems. In order to maximize water storage, the Restudy intends to use a variety of technologies located throughout the South Florida region so that no one single area bears a disproportionate share of the storage burden. This direction reinforces the Commission's recommendation that water storage must be achieved in all areas of the South Florida system using every practical option (GCSSF, 1996a; p. 25).*
>
> *However, concerns have been expressed that a water user would be forced to rely on a new water storage technology before that technology is capable of*

1. U.S. Army Corps of Engineers

fully providing a water supply source or that existing supplies would otherwise be transferred or limited, and that the user would thereby experience a loss of their current legal water supply level of service. Any widespread use of a new technology certainly has potential limitations; however, the Restudy should address technical uncertainties prior to project authorization and resolve them before implementation in the new C&SF Project. With the addition of increased water storage capabilities, water managers will likely shift many current water users to different water sources.

Additionally, stakeholders are concerned that a preservation of the current level of service for legal uses would not encompass all the urban uses, some of which are not incorporated in the term 'legal' and covered by permit. Specifically, an adequate water supply is needed to address urban environmental preservation efforts as well as water level maintenance to reduce the impact of salt water intrusion.

The Commission believes that in connection with the Restudy, the SFWMD should not transfer existing legal water users from their present sources of supply of water to alternative sources until the new sources can reliably supply the existing legal uses. The SFWMD should implement full use of the capabilities of the new sources, as they become available, while continuing to provide legal water users as needed from current sources. It is the Commission's intent that existing legal water users be protected from the potential loss of existing levels of service resulting from the implementation of the Restudy, to the extent permitted by law.

The Commission also recognizes that the SFWMD cannot transfer the Seminole Tribe of Florida from its current sources of water supply without first obtaining the Tribe's consent. This condition exists pursuant to the Seminole Tribe's Water Rights Compact, authorized by Federal (P.L[1]. 100-228) and State Law (Section 285.165, F.S.).

However, the issues surrounding the development of specific assurances to water users are exceedingly complex and will require substantial additional effort to resolve.

RECOMMENDATION

- *The SFWMD and the Corps should work with all stakeholders to develop appropriate water user assurances to be incorporated as part of the Restudy authorizations. These water user assurances should be based on the following principles:*

  A. Physical or operational modifications to the C&SF Project by the federal government or the SFWMD will not interfere with existing legal uses and will not adversely impact existing levels of service for flood management or water use, consistent with State and federal law.

1. P.L. refers to Public Law

B. Environmental and other water supply initiatives contained in the Restudy shall be implemented through appropriate State (Chapter 373 F.S.) processes.

C. In its role as local sponsor for the Restudy, the SFWMD will comply with its responsibilities under State water law (Chapter 373 F.S.).

D. Existing Chapter 373 F.S. authority for the SFWMD to manage and protect the water resources shall be preserved.

Water Supply for Natural Systems

Concerns have been raised about long term protection of the Everglades ecosystem. According to WRDA 1996[1]*, the C&SF Project is to be rebuilt 'for the purpose of restoring, preserving, and protecting the South Florida ecosystem' and 'to provide for all the water-related needs of the region, including flood control, the enhancement of water supplies, and other objectives served by the C&SF Project.'*

Environmental benefits achieved by the Restudy must not be lost to future water demands. When project implementation is complete, there must be ways to protect the natural environment so that the gains of the Restudy are not lost and the natural systems, on which South Florida depends, remain sustainable.

A proactive approach which includes early identification of future environmental water supplies and ways to protect those supplies under Chapter 373 F.S. will minimize future conflict. Reservations for protection of fish and wildlife or public health and safety can be adopted early in the process and conditioned on completion and testing of components to assure that replacement sources for existing users are on line and dependable. The SFWMD should use all available tools, consistent with Florida Statutes, to plan for a fair and predictable transition and long term protection of water resources for the natural and human systems.

Apart from the more general goals of the Restudy, there are specific expectations on the part of the joint sponsors - the State and the federal government. The more discussion that goes into an early agreement on expected outcomes, the less conflict there will be throughout the project construction and operation.

RECOMMENDATIONS

- *The SFWMD should use the tools in Chapter 373 F.S. to protect water supplies necessary for a sustainable Everglades ecosystem. This should include early planning and adoption of reservations. These reservations for the natural system should be conditioned on providing a replacement water source for existing legal users which are consistent with the public interest. Such replacement sources should be determined to be on line and dependable before users are required to transfer.*

1. The Water Resource Development Act of 1996 (WRDA 1996) is legislation passed by the U.S. Congress that authorized the Restudy, the Water Preserve Area Feasibility Study, etc.

- *The SFWMD should expeditiously develop a 'recovery plan' that identifies timely alternative water supply sources for existing legal water users. The recovery plan should consist of water supply sources that can reliably supply existing uses and whose development will not result in a loss of current levels of service, to the extent permitted by law. To assure that long term goals are met, the State and federal governments should agree on specific benefits to water users, including the natural system, that will be maintained during the recovery.*

- *In the short term, the Restudy should minimize adverse effects of implementation on critical and/or imperiled habitats and populations of State and federally listed threatened and/or endangered species. In the long term, the Restudy should contribute to the recovery of threatened species and their habitats.*

Protecting Urban Natural Systems and Water Levels

Water supply for the urban environment is connected to water supply for the Everglades and other natural areas targeted for restoration and preservation under the Restudy.

It is essential that the Restudy projects proposed to restore and preserve the environment of the Everglades do not reduce the availability of water to such an extent in urban areas that the maintenance of water levels and the preservation of natural areas becomes physically or economically infeasible.

The successful restoration of Everglades functions is dependent not only upon the establishment of correct hydropatterns within the remaining Everglades, but also upon the preservation and expansion of wetlands, including those within urban natural areas that once formed the eastern Everglades. Some of the westernmost of these areas have been incorporated in the Restudy as components of the WPAs[1]*. However, the on-going preservation efforts of local governments have acquired hundreds of millions of dollars worth of additional natural areas for protection both inside and outside of the WPA footprint.*

Water supplies for these urban wetlands are not covered by existing permits or reservations and are therefore, not adequately protected. Efforts are underway at both the SFWMD and the local level to preserve these vital areas and assure their continuing function as natural areas and in ecosystem restoration.

Detailed design for the Restudy, in particular the detailed modeling associated with the WPA Feasibility Study[2]*, will make possible plans to protect these urban wetlands from damage and to assure maximum integration with Restudy components.*

1. Water Preserve Areas
2. The Water Preserve Areas Feasibility Study, scheduled for completion in 2001, is investigating methods to capture and store excess surface waters that are normally released to tide via the C&SF Project canal system.

RECOMMENDATIONS

- *The SFWMD and the Corps should acknowledge the important role of urban natural areas as an integral part in the restoration of a functional Everglades system. As a part of the implementation plan, the SFWMD and the Corps should develop an assurance methodology in conjunction with the detailed design and modeling processes, such as the WPA Feasibility Study, to provide the availability of a water supply adequate for urban natural systems and water level maintenance during both implementation and long term operations.*

- *Expand and accelerate implementation of the WPAs. Accelerate the acquisition of all lands within the WPA footprint to restore hydrologic functions in the Everglades ecosystem, and ensure hydrologic connectivity within the WPA footprint. The WPA Feasibility Study process should be given a high priority. The WPA concept should be expanded into other SFWMD planning areas such as the Upper East Coast.*

- *The Restudy should assure that the ecological functions of the Pennsuco wetlands are preserved and enhanced."*

There is a substantial body of law that relates to the operation of Federal flood control projects, both at the state and Federal level. Much of the Governor's Commission language is directed to the South Florida Water Management District and matters of state law. To the extent that the Governor's Commission's guidance applies to the Corps' actions, the Corps will give it the highest consideration as Restudy planning proceeds and as plan components are constructed and brought on-line consistent with state and Federal law. The recommended Comprehensive Plan does not address or recommend the creation or restriction of new legal entitlements to water supplies or flood control benefits.

Regulatory Implementation

Introduction

The purpose of this discussion is to outline the relationship and distinction between the planning process and the regulatory implementation of the LEC Plan. In order to understand how these two water management components work together, it is helpful to know the limits and scope of each. This section describes the planning level vision of the regulatory component. It is essential that the regulatory component described below be viewed as a flexible framework for implementing actions. During development of the rules and other agency actions necessary to implement the regulatory component, public input and District Governing Board direction will be incorporated to further refine this framework.

The water supply plan contains descriptions of structural, regulatory, and operational elements, along with procedures by which the elements will be implemented. Planning evaluations are conducted with a set of assumptions and approximations that may change over time with variations in social and economic factors of the region. While a plan does evaluate cumulative impacts of existing and potential water withdrawals, the plan is not a master permit, nor does it predetermine decisions to be made in the permit review process.

The relatively local variations occurring on a project-by-project basis are not anticipated to have regional, or otherwise significant, implications on the implementation of the regional water supply plan objectives. In order to address the local and regional impacts of water uses on a day-to-day basis, the District utilizes its statutory authorities in regulating the consumptive use of water. When used in conjunction with a regional water supply plan, the Consumptive Use Permitting (CUP) regulatory process is able to prevent over allocation of regional and localized water resources and to assure a level of certainty for permitted users, exempt users, and the environment.

The LEC Plan contains projections for both the water supply and demand estimates over the next twenty years and time frames for expansion of water supplies to meet urban, agricultural, and environmental needs. In addition, protocols for the delivery of water to the natural system and consumptive uses have also been evaluated in the plan. In order to ensure water supplies are used for their intended purposes, or to protect against water supplies being taken away from such intended uses, the District will use its regulatory authority to implement water shortage cutbacks during drought, reserve water from CUP allocation for the natural system and public health and safety, and protect water supplies designated for permit holders.

In order to achieve the regulatory goals of the regional water supply plan, the District will develop rules and implement the rules consistent with state law. However, this raises the following question: If the rule development and implementation process is separate from the plan, how can the public be assured that the resulting rules will be consistent with the plan? This assurance is provided through the administrative procedures outlined in state law under Chapter 120, F.S. Both rulemaking and formal agency actions of the District must comply with requirements affording substantially affected parties the opportunity to participate in the rule development process and to challenge proposed rules, existing rules, and final and proposed agency action.

Should the rulemaking and its intended and unintended effects deviate from performance measures used in the plan, the Governing Board may direct staff to conduct additional evaluations to supplement the planning level evaluations that support the proposed rule, or revise the draft rule consistent with the planned performance measures. In addition, opportunities for public involvement in identifying contingency actions necessary to implement additional water resource development projects by proposed rules are outlined in the **Contingency Planning** section on **page 203** of this chapter.

It has been determined that the existing system used to deliver water throughout the region presents significant constraints on environmental restoration. As a result, significant structural changes, to be completed over time, are necessary to restore hydropatterns in regional natural systems. Therefore, the amounts of water to be delivered and protected, and the timing and sources of supply to be incorporated under reservation rules and other resource protection standards described below will evolve with the implementation of water resource development projects. Florida law is well suited to deal with the changing water supply situation in South Florida that occurs as the water resource development projects outlined in the Comprehensive Everglades Restoration Plan (CERP) and LEC plans are implemented.

The need for flexibility in implementing a phased restoration project raises the following question: What assurances are there that the identified future sources of environmental water supply, including reservations, will not be permitted away? Several factors associated with the implementation of this plan address this concern. First, the plan includes water resource development projects that provide adequate supplies of water through a 1-in-10 year drought condition, to meet the needs of both the environmental restoration and permitted water uses by 2020 to the greatest extent possible. The environment and consumptive uses will not need to compete for water. Secondly, the proposed CUP rules contain provisions to limit new demands on the regional system as the water resource development/CERP projects are being constructed. These include limiting the amounts of regional water that can be allocated to each service area in five-year increments based on the results of the planning analysis. If cumulative regulatory evaluations indicate that the five-year limitations on regional water allocations have been reached, new or increased demands will be met through alternative and local (independent of the regional system) supplies until additional water is available. Also, existing supplies can be more efficiently utilized to meet increasing demands until additional regional supplies are made available. As part of this process, it is envisioned that both CUP water supplies and environmental water reservations will be updated every five years as necessary to reflect changed water supply availability as the projects associated with this plan are completed.

Should the water supply needs of the natural system or consumptive uses exceed the projections in the LEC Plan, the District will utilize the planning process to develop alternative water resources and avoid competition to the greatest degree possible. Assurances set forth in this plan and the contingency planning efforts will be applied to protect both consumptive uses and the natural system while alternative sources as being developed.

As one of the tools for plan implementation, rulemaking to implement the regulatory recommendations of the LEC Plan will constitute a significant effort during the next several years. Rulemaking will include water reservations and numerous CUP criteria, which are interrelated and cumulatively define the availability of water for consumptive uses and water resource protection. As a result, it is recommended in the LEC Plan that certain rulemaking efforts be grouped in phases to allow for the cumulative analysis of the water resource and consumptive use implications of the regulatory program.

Another goal of the rulemaking schedule is to adopt rules as the technical information becomes available. As a result, it is recommended in this plan that initial rulemaking proceed for concepts that were sufficiently identified and evaluated in the planning process. These include establishment of MFLs for the Everglades, Lake Okeechobee, the Biscayne Aquifer, and the Caloosahatchee River.

In addition, uncertainties in the rulemaking process, such as delays for development of supporting technical data or rule challenges, may conflict with the proposed schedule for rule development provided in this plan. The proposed schedule will be adapted to account for such delays, while considering the need to develop associated rules through a coordinated rulemaking process. The contingency process identified in the plan, along with input from the LEC Regional Water Supply Plan Advisory Committee, other members of the public, and the Governing Board may be used to identify necessary changes to the rulemaking schedule.

The following sections give a brief overview of the legal and policy issues associated with the major tools for implementing the regulatory component of the regional water supply plan discussed above. This discussion should be read in context of the LEC Plan as a whole, and is not intended to be inclusive of all of the relevant legal and policy factors considered in development and implementation of the plan.

Water Reservations

Legal Description

Section 373.223(4), F.S., provides the following in relevant part:

> The governing board or the department, by regulation, may reserve from use by permit applicants, water in such locations and quantities, and for such seasons of the year, as in its judgment may be required for the protection of fish and wildlife or the public health and safety.

The statute also provides that reservations are subject to periodic review based on changed conditions. This provides flexibility to account for changes in implementation strategies and contingency plans during the next 20 years. A specific level of protection is also provided to existing legal users when establishing reservations. Existing legal users are protected insofar as they are “not contrary to the public interest” (Section 373.223(4), F.S.).

Reservation Implementation Policies

Reservations will reflect environmental enhancement and protection goals and objectives consistent with the Restudy hydropattern achievable by 2020, based on the degree of CERP implementation expected within that time frame. When appropriate, rain-driven formulas will be used to determine reservation quantities. Reservations will incrementally delineate and protect the volume and timing of necessary environmental water supply deliveries. Likewise, consumptive use demands under conditions up to and including a 1-in-10 year drought event are estimated and will be incrementally protected through consumptive use permits. Water shortage provisions (see below) will govern the actions of the District in providing shared adversity to both the natural system under rain-driven formulas and consumptive users for conditions beyond the 1-in-10 drought year level of certainty.

Water availability and its delivery for environmental purposes will increase as water resource development projects are constructed. Initial and incremental increases in water reservations to provide increased water deliveries to the natural system shall be contingent upon availability of water from water resource development projects provided to augment existing supplies or create new supplies to meet such demands.

The reservation rule will include a description of the ultimate 2020 restoration deliveries to the natural system. The rule will also account for potential changes to reflect refinement of the project designs or restoration targets. The rule will incorporate the list and description of the water resource development projects and amounts of water potentially to be made available for the reservation upon deployment. Finally, the rule will include water supply formulae and protocols to define the amount and timing of water supply deliveries based on the remaining constraints on the regional system. As new water resource development projects are constructed, the rule will be revised to include the resulting improvements in deliveries. A series of water resource development projects that will provide water to meet MFL targets and reservations are listed in **Table 51**. The anticipated completion date of each of these options is also included.

Water reservations rules will be drafted for Everglades National Park, the Water Conservation Areas (WCAs), and the Holey Land and Rotenberger Wildlife Management Areas (WMAs) by 2003. Everglades National Park staff requested that the rain-driven schedules currently being developed by the District be utilized for the initial reservation instead of the existing rain-driven formula that is being used to deliver water to the park. Additional reservation rules for Florida Bay, Biscayne Bay, Loxahatchee Slough and River, the Caloosahatchee and St. Lucie estuaries, and subregional wetlands (in Palm Beach, Broward, and Miami-Dade counties including the Model Lands and south Miami-Dade wetlands) will be undertaken as supporting technical research is concluded and water supplies to meet the natural system demands are made available. In the interim (2000-2004), until reservations can be defined or the CERP implemented, the above water bodies will receive, to the greatest extent practicable, similar water deliveries through time as generally reflected in the incremental performance of the LEC Plan. The systemwide operational protocols, as developed under **Recommendation 31** of this plan, will include, to the greatest extent practicable, the operational assumptions reflected in the South Florida Water Management Model (SFWMM) for the recommended alternative and time horizon.

Consumptive Use Permitting

Legal Description

Under Section 373.219, F.S., the yield of the source, or amount of water which can be permitted for use, is limited, in part, by the resource protection criteria which define when harm will occur to the resource. Resource protection criteria have been adopted by the water management districts pursuant to Section 373.223, F.S. This section requires that all consumptive uses must be reasonable-beneficial. For consumptive uses to be considered reasonable-beneficial they must be efficient, consistent with the public interest, and not interfere with other presently existing legal uses. The aim of the reasonable-

Table 51. Water Resource Development Projects that Provide Water Supplies Associated with MFL Recovery Plans and Water Reservations.

Water Body	Basis of Reservation	Water Supply Development Projects	Year Water Reservation Rule Will Be Developed[a]
Everglades National Park	Rain-driven/ Stage formula	Everglades Construction Project	2005
		Modified Water Deliveries to Everglades National Park	2005
		C-111 Operational Modifications[b]	2005
		L-31 Levee Improvements	2010
		WCA-3A and WCA-3B Seepage Management	2010
		Decompartmentalize WCA-3A, Phase I	2010
		Decompartmentalize WCA-3A, Phase II	2020
		West Miami-Dade County Reuse (50 MGD)	2020
		Central Lake Belt Storage Area (92,160 acre-ft [ac-ft])	2021
WCAs and Everglades National Park	Rain-driven/ Stage formula	EAA Storage Reservoir, Compartment 1 (180,000 ac-ft)	2010
		EAA Storage Reservoir, Compartment A (120,000 ac-ft)	2010
		EAA Storage Reservoir, Compartment B (60,000 ac-ft)	2015
		Taylor Creek/Nubbins Slough Reservoir (50,000 ac-ft)	2010
		Lake Okeechobee ASR, Phase 1 (500 MGD)	2015
		Lake Okeechobee ASR, Phase 2 (1,000 MGD)	2020
		North of Lake Okeechobee Storage Reservoir	2015
St. Lucie Estuary	Salinity envelope criteria	C-44 Basin Storage Reservoir (30,000 ac-ft)	2010
Caloosahatchee Estuary	Salinity envelope criteria	C-43 Basin Storage Reservoir	2010
		C-43 Basin ASR (220 MGD)	2015
Stormwater Treatment Areas (STAs)[c]	Six-inch minimum depth	Lake Okeechobee Storage	2005
Loxahatchee River	Salinity envelope criteria	C-51 and Southern L-8 Reservoir	2015
		West Palm Beach Water Catchment Area ASR[d]	2015
Biscayne Bay Florida Bay	Salinity envelope criteria	Construction of S-356 Structures and Relocation of a Portion of L-31N Borrow Canal	2010
		South Miami-Dade County Reuse (131 MGD)	2020
		Central Lake Belt Storage Area (92,160 ac-ft)	2021
		North Lake Belt Storage Area (45,000 ac-ft)	2021

a. These dates to complete MFLs are taken from a letter from SFWMD to FDEP dated November 15, 1999.
b. C-111 Operational Modifications are part of the Modification to South Dade Conveyance System in Southern Portion of L-31N and C-111 Canals component
c. MFL criteria are not applicable to this water body.
d. The West Palm Beach Water Catchment Area ASR is part of the L-8 Project.

beneficial requirement is to prevent saltwater intrusion and saline water upconing, harm to wetlands and other surface waters, aquifer mining, and pollution.

Harm in the resource protection framework proposed in this plan refers to adverse impacts that require one to two years of average rainfall to recover. Within this document, harm, for purposes of allocating water, occurs when adverse impacts to water resources that occur during dry conditions are sufficiently severe that they cannot be restored within a period of one to two years of average rainfall conditions. These short-term adverse impacts will be addressed under the CUP Program, which calculates allocations to meet demands for use during relatively mild, dry season conditions. The harm criteria will not be exceeded for hydrologic conditions through a 1-in-10 year drought event and permitted allocations will be based on demands up to and including the 1-in-10 year level of certainty.

Consumptive Use Permitting Implementation Policies

The following excerpts from Chapter 373, F.S., provide the basic level of protection given to existing legal users under the law:

> The governing board shall act with a view to full protection of the existing rights to water insofar as is consistent with the purpose of this law [Section 373.171(2), F.S.].
>
> No rule, regulation or order shall require any modification of existing use or disposition of water in the district unless it is shown that the use or disposition proposed to be modified is detrimental to other water users or to the water resources of the state [Section 373.171(3), F.S.].

Projects to supply water to benefit consumptive users shall be prioritized to first meet existing reasonable-beneficial water demands with a 1-in-10 year level of certainty, and then to meet increasing future demands.

Water supplies necessary to meet increasing reasonable-beneficial demands will be contingent upon the demonstrated availability of the water resources to supply required volumes, the performance of water resource development projects identified to augment or create supplies to meet such demands, and the applicant's water supply development strategy for meeting the specified demands. Water availability for future permit allocation will be defined by many factors, including the following:

- Extent to which the resource has been successfully used by the applicant in the past
- Extent to which the particular source is expected to be developed for use and the timing of such demand increases
- Extent to which the water supply source derives water from the regional system versus local storage
- Extent to which the source is being diverted for nonconsumptive uses (e.g., reservations) and the timing of such diversions

- Extent to which a particular use was considered in the regional water supply planning process, the short-term and long-term demand projections for such use, and conservation of water supplies
- Identified water resource development projects and timing of implementation

Once the 1-in-10 year level of certainty criteria is established by rule, permits will be issued based on the applicant's ability to provide reasonable assurances that demands are reasonable, water resources will be protected, and that issuance of the permit will not interfere with existing legal users. For existing projects that have been operational during a 1-in-10 year drought without water resource harm or existing legal user interference, the historical performance of the project will be considered in providing reasonable assurances that the conditions for permit issuance are met upon permit renewal.

Implementation of Minimum Flows and Levels Recovery and Prevention Strategies

Legal Description

MFLs are established pursuant to Section 373.042, F.S., A detailed description of the process and factors for establishing MFLs is included in the document entitled *Minimum Flows and Levels for Lake Okeechobee, the Everglades, and Biscayne Aquifer* (SFWMD, 2000e).

Section 373.0421, F.S., requires that once the MFL technical criteria have been established, the Districts must develop and expeditiously implement a recovery and prevention strategy for those water bodies that are currently exceeding, or are expected to exceed, the MFL criteria. Section 373.0421(2), F.S., provides the following in relevant part:

> The recovery or prevention strategy shall include phasing or a timetable which will allow for the provision of sufficient water supplies for all existing and projected reasonable-beneficial uses, including development of additional water supplies and implementation of conservation and other efficiency measures concurrent with to the extent practical, and to offset, reductions in permitted withdrawals, consistent with the provisions of this chapter.

Minimum Flows and Levels Strategy Implementation Policies

It is possible that the proposed MFL criteria cannot be achieved immediately, because of the lack of adequate regional storage and/or ineffective water distribution infrastructure. These storage and infrastructure shortfalls will be resolved through water resource development and water supply development projects, construction of facilities, and improved operational strategies that will increase the region's storage capacity and improve the existing delivery system. Planning and regulatory efforts will, therefore, include a programmed recovery process that will be implemented over time to improve water supply and distribution to protect water resources and functions. The recovery process includes the following:

- Necessary structural solutions for the recovery and prevention plan will be provided in the form of a list of projects. The list will include the timing and funding requirements for each project. **Table 51** provides a list of the various water resource development projects identified in the LEC Plan that will provide water to meet the proposed MFL targets and water reservations. **Table 51** also includes anticipated completion dates of these projects. In addition, **Tables 53**, **54**, and **55** provide the amounts of water projected to be delivered to each area by components to meet the proposed MFLs.
- If necessary to prevent the MFL criteria from being exceeded, demand management cutbacks for recovery during drought conditions will also be identified (e.g., phased water shortage restrictions to prevent significant or serious harm). The LEC Plan does not propose the use of the Water Shortage Plan as a MFL recovery strategy. However, when a drought occurs, the District will rely upon the Water Shortage Plan, as necessary, to address regional water availability. This strategy is discussed below.
- To the extent practicable, the District shall implement water deliveries to reduce or prevent the MFL criteria from being exceeded. Operational guidelines necessary for implementation of water supply deliveries to achieve MFLs, in concert with meeting other required water demands, will be identified. However, water deliveries to prevent the MFL criteria from being exceeded will be given priority consideration over deliveries for other purposes.
- Before considering reduction in permitted withdrawals in a recovery and prevention strategy, all practical means to prevent reductions in available water supplies for consumptive use shall be explored and implemented. When determining whether reductions in existing legal uses are required, the following factors shall be considered:
    - The extent of MFL shortfall directly caused by existing legal uses
    - The practicality of avoiding the need for reductions in permitted supplies, including structural and operational measures, by maximizing the beneficial uses of the existing water source
    - The risk of significant harm resulting from the existing legal use in the interim period before the recovery strategy is fully implemented

Water Shortage Implementation

Legal Description

Pursuant to Section 373.246, F.S., water shortage declarations are designed to prevent serious harm from occurring to water resources. Serious harm, the ultimate harm to the water resources that was contemplated under Chapter 373, F.S., can be interpreted as long-term, irreversible, or permanent impacts. The District will develop and adopt water shortage triggers to avoid causing harm, significant harm, and serious harm to water resources, in conjunction with the implementation of the District's Water Shortage Plan (Chapter 40E-21, F.A.C.). Water resource triggers will be identified for the imposition of water shortage restrictions, taking into consideration climatic events, continued decline in water levels, and a need to curtail human demand to correspond to decreasing supplies. These restrictions act to apportion among uses, including the environment, a shared adversity resulting from a drought event. Adoption of the resource protection criteria as water shortage trigger indicators also serves the purpose of notifying users of the risks of water shortage restrictions and potential for loss associated with these restrictions.

Water Shortage Implementation Policies

When evaluating options for users and the natural system during droughts, the District will consider the extent to which consumptive use withdrawals influence water levels in the natural system and the extent to which natural system water levels are deviating from rain-driven formula targets for the associated level of drought. Adversity to existing legal users is measured in terms of projected economic losses.

Water supply demands defined by rain-driven formulas, naturally decrease with increased drought levels, while consumptive use demands increase. For this reason, water delivery cutbacks to the natural systems during droughts should not be necessary. An exception to this could occur if the delivery of rainfall-based supplies causes greater environmental harm elsewhere in the natural system. Under this scenario, the Governing Board, after considering all of the specific facts, and in consultation with the public, may order temporary reductions in natural system deliveries in order to protect more vulnerable portions of the natural system from further harm.

Even though water shortage triggers were established and met in the model simulations performed during the LEC regional water supply planning process, actual water restrictions will be determined on a case-by-case analysis for a given drought event. Thus, prior to declaring a water shortage, the District will also analyze the factors listed in the Water Shortage Plan concerning such issues as 1) whether or not sufficient water will be available to meet the estimated and anticipated user demands, and 2) whether serious harm will occur to the water resource. Another exception could occur if severe fires are burning in the Everglades Protection Area, especially in peat wetlands, and delivery of additional water may be needed to help stop the fires.

Contingency Planning

The timing of physical, regulatory, or operational modifications required to implement the regional water supply plan will be coordinated, to the extent practicable, to avoid reductions in water supplies for environmental restoration and consumptive use demands. If, however, practicable measures are not available, the District will provide a contingency plan that is designed to optimize the use of available water supplies, until the long-term source augmentation is implemented.

The regional water supply plans will be updated at least every five years to incorporate contingency methods, as required by law. If significant changes in planning assumptions occur during the five-year intervals and require the plan to be revisited, updates may occur, as appropriate, more often. This determination will be, in part, based on annual status updates to the Florida Department of Environmental Protection (FDEP) and the Florida Legislature and CERP annual status updates.

If the determination is made that contingencies need to be implemented, the process to accommodate these changes will include meetings of the LEC Regional Water Supply Advisory Committee and redirection of staff and resources through the five-year water resource development work plans and the annual budget process.

The District will establish a process for identifying opportunities to provide water supply benefits to natural systems on an annual or seasonal basis when surplus water supplies exist, after considering the permitted demands of consumptive uses. Opportunities to deliver such water supplies through operational flexibility will be examined and implemented, after consideration by the District's Governing Board, as appropriate. The operational flexibility recommendations are discussed further in **Chapter 6** on **pages 307** through **312**.

Public Involvement in the CERP Implementation Process

The Restudy was developed through an inclusive and open process that engaged many stakeholders. All applicable federal, tribal, state, and local agencies were full partners and their views were fully considered. The implementation process for the CERP will continue this effort and facilitate project modifications that are needed to take advantage of what is learned from system responses and as future restoration targets become more refined.

For construction features, work will be conducted in planning, engineering and design, real estate acquisition, and construction. Where appropriate, pilot projects will be conducted to resolve uncertainties before additional planning efforts are undertaken. Operations, maintenance, repair, replacement, and rehabilitation costs will be assessed to determine the continuing costs of each feature once it is constructed. Operational strategies and criteria, such as rain-driven water delivery schedules, will be implemented to achieve maximum benefits from the features in place at any given time. In addition, a comprehensive monitoring and adaptive assessment program (REstoration, COordination and VERification [RECOVER]) will be undertaken to assess systemwide conditions and responses and to provide guidance in the design and operation of components.[1]

The RECOVER team will be particularly important to the LEC Regional Water Supply Plan Advisory Committee, since they will be tracking both systemwide performance and regional water contributions that will be realized from specific projects. The committee will request that the RECOVER team consult with them regarding contingency provisions that may alter assumptions used in the LEC Plan, as well as seek their input regarding other CERP directions and efforts.

Project Implementation Reports (PIRs) will be developed for each CERP component. These will include evaluations to ensure the maintenance or improvement of flood protection and evaluations of the potential for recreational development. Because PIRs will require the approval of the District's Governing Board, the LEC Regional Water Supply Plan Advisory Committee can provide comments regarding the PIRs. Public input to the PIR process will help in the determination of the locations, capabilities, and general design features of the components. In addition, public input to the PIR process will be sought and provided through the required completion of the National Environmental Policy Act documentation.

In addition, the LEC Regional Water Supply Plan Advisory Committee can provide recommendations to the District regarding feasibility studies. Two feasibility studies (the Water Preserve Areas Feasibility Study and the Indian River Lagoon Feasibility Study) are currently being completed. Also, the Comprehensive Integrated Water Quality Plan and three new feasibility studies (the Florida Bay Feasibility Study, the Florida Keys Feasibility Study, the Southwest Florida Study) are being undertaken. Extensive outreach and public involvement, which have been essential parts of the Restudy and the CERP, will continue during the completion of these feasibility studies.

STATUTORY DEFINITION OF WATER RESOURCE DEVELOPMENT AND WATER SUPPLY DEVELOPMENT

The projects and actions proposed for implementation consist of projects from two categories: water resource development projects and water supply development options. This is in concert with amendments to Chapter 373, F.S., that were passed in 1997, which require that water supply plans include a water resource development component and a list or menu of water source options for water supply development that can be chosen by local water users. The statute defines water resource development and water supply development as follows:

> 'Water resource development' means the formulation and implementation of regional water resource management strategies, including the collection and evaluation of surface water and ground water data; structural and nonstructural

1. A more detailed discussion of the CERP implementation process is provided in Chapter 10 of the Restudy (USACE and SFWMD, 1999).

> programs to protect and manage water resources; the development of regional water resource implementation programs; the construction, operation, and maintenance of major public works facilities to provide for flood control, surface and underground water storage, and ground water recharge augmentation; and related technical assistance to local governments and to government-owned and privately owned water utilities.
>
> 'Water supply development' means the planning, design, construction, operation, and maintenance of public or private facilities for water collection, production, treatment, transmission, or distribution for sale, resale, or end use.

Structural and nonstructural water resource development components are identified below. These include actions necessary to implement the LEC Plan, such as MFL recovery and prevention strategies, water reservations, water shortage provisions, operational strategies, and contingency planning.

Chapter 373, F.S., requires that water supply plans include a list or menu of water source options for water supply development that can be chosen by local water users. For each source option listed, the estimated amount of water available for use, cost, potential sources of funding, and a list of projects that meet applicable funding criteria are required. In addition, water supply plans must also include a list of water resource development projects that support water supply development. For each water resource development project, estimates of the amount of water produced, timetables, funding requirements, and participants who will implement the project must also be provided.

The District is primarily responsible for the implementation of the water resource development components. Local users have primary responsibility for water supply development by choosing the water source options that will best meet their needs.

In addition to the legislative definitions described above, the designation of a component as a water resource development project was based on it having the following characteristics:

- Has the opportunity to address more than one resource issue
- Addresses a variety of use classes (e.g., environment, public water supply)
- Protects/enhances resources available for allocation
- Moves water from water surplus areas to water deficit areas
- Has a broad application of technology

The equivalent characteristics that led to designations of projects as water supply development options are as follows:

- Requires localized implementation of technology
- Delivers resources to consumers
- Has regionalized interconnects to consumer

WATER RESOURCE DEVELOPMENT PROJECTS

Water resource development projects to be implemented as part of this plan are discussed in this section. They have been divided into the following categories:

1. Ongoing projects from the *Interim Plan for Lower East Coast Regional Water Supply* (LEC Interim Plan) (SFWMD, 1998b)
2. Other federal, state, and South Florida Water Management District projects
3. CERP projects
4. Recommendations to the CERP resulting from analysis performed during the LEC regional water supply planning process
5. Recommendations to the CERP from the *Caloosahatchee Water Management Plan* (CWMP)
6. Operational recommendations resulting from LEC regional water supply planning process analysis
7. Consumptive use permitting and resource protection projects

Ongoing Projects from the LEC Interim Plan

The first set of water resource development projects are those that were recommended in the LEC Interim Plan (SFWMD, 1998b), have not yet been completed, and are considered appropriate for continued effort. Information regarding each of these projects is briefly discussed in **Table 52**, which also identifies the numbered recommendation in **Chapter 6** to which each project corresponds.

Table 52. Summary Information Regarding Water Resource Development Recommendations from the LEC Interim Plan.

Rec. No.	Water Resource Development Project	Location in the LEC Interim Plan (pages)	Progress	Need for Continued Effort
1	Regional Saltwater Intrusion Management	21 - 22	Additional wells have been installed in Miami-Dade, Broward, and Palm Beach counties.	Gaps remain in the monitoring network and research and modeling need to be undertaken to better define the relationships between water levels and saltwater migration.
2	Floridan Aquifer System Ground Water Model	23 - 24	The initial model was developed.	A need has been identified for more data to augment and refine the model and better assist with planning and regulatory decision making.
3	Northern Palm Beach County Comprehensive Water Management Plan	35 - 36 and 37 - 39	The plan is almost complete and conceptual designs have been largely incorporated into the Restudy and the LEC Plan.	Plan will be completed in the summer of 2000 and implemented through the CERP and the LEC Plan.

Table 52. Summary Information Regarding Water Resource Development Recommendations from the LEC Interim Plan.

Rec. No.	Water Resource Development Project	Location in the LEC Interim Plan (pages)	Progress	Need for Continued Effort
4	Eastern Hillsboro Regional ASR Pilot Project	47 - 49	Biscayne aquifer wells to support the first ASR well are under construction.	The initial Floridan ASR well needs to be completed, its performance evaluated, and a decision made regarding completion of a second ASR well.
5	Hillsboro (Site 1) Impoundment Pilot Project	45-46	The proposed Hillsboro reservoir has been incorporated into the CERP.	The pilot project will proceed in advance of the CERP project. A small-scale reservoir will be constructed and seepage rates and collection systems evaluated.
6	Lake Worth Lagoon Minimum/Maximum Flow Targets	109 - 111	A preliminary hydrodynamic model has been completed.	Additional tidal amplitude and salinity data for dry and wet periods need to be collected. The effort will cover a larger area and be completed for shorter time steps than the original effort. The model needs to be updated and extended using these data. Evaluations need to be conducted to determine the impacts of inflows on biological (sea grass) communities.
7	Northern Broward County Secondary Canals Recharge Network	63 - 64	Three projects (two pump stations and one canal connector) have been funded.	The remainder of the network needs to be designed and constructed.
8	Southeast Broward County Interconnected Water Supply System	65 - 66	Facilitated sessions to achieve agreement on an integrated water supply system for southeastern Broward County are under way.	A final agreement acceptable to all parties needs to be developed and implemented.
9	Broward County Urban Environmental Enhancement	59 - 61	The recommendation to evaluate sources and methods to use surface water to benefit wetlands in coastal Broward County was developed through the Broward County Integrated Water Resource Plan.	This project proposes to implement the recommendation by first identifying wetland systems with needs and then evaluating the advisability of structural and regulatory programs to support the proposed environmental enhancements.
10	Miami-Dade Water and Sewer Department Utility ASR	79 - 80	Some of the ASR wells have been built and are undergoing testing.	Remaining proposed wells need to be constructed.
11	Biscayne Bay Minimum and Maximum Flow Targets	113 - 114	USACE, as part of the Biscayne Bay Feasibility Study, has been developed and is validating a hydrodynamic model. The model is a key tool in determining these targets. The USGS completed a regional ground water model. Ecological response evaluation tools may need to be developed.	To complete this work, additional hydrologic data needs to be collected, performance measures determined, and scenarios simulated and evaluated in terms of ecological responses. Work needs to be completed in close cooperation with CERP RECOVER efforts.

Other Federal, State, and District Projects

Two groups of projects have been included in this category. The first are those critical projects in the LEC Planning Area for which the SFWMD is local sponsor. The critical project program was authorized by congress under the Water Resources Development Act of 1996 to expeditiously implement restoration projects that are deemed critical to the restoration of the South Florida ecosystem. The federal participation in critical projects is for 50 percent of total project costs, with a maximum federal contribution on any project of $25,000,000. The three critical projects (**Recommendation 12**) included are the West Canal Structure (C-4), the Western C-11 Water Treatment Project, and the Lake Okeechobee Water Retention/Phosphorus Removal Project. The second group are three District-initiated projects (**Recommendations 13** through **15**) that effect recommendations developed in the CWMP and **Recommendation 16** regarding Mobile Irrigation Labs (MILs).

Critical Projects (Recommendation 12)

West Canal Structure (C-4)

This project is being implemented as a critical project and is part of the without plan condition (2020 Base Case) used in the modeling performed for the LEC regional water supply planning process. It consists of a new structure in the C-4 Canal, immediately southeast of the Pennsuco Wetlands. It will keep higher surface and ground water levels to the west, which will reduce drainage from the Pennsuco Wetlands and the Everglades and help reestablish natural hydroperiods in these areas.

Western C-11 Water Treatment

This project is also being implemented as a critical project and is also part of the without plan condition (2020 Base Case) used in the modeling performed for the LEC regional water supply planning process. The purpose is to improve the quality and timing of discharges to the Everglades from the Western C-11 Basin. A gated control structure on the C-11 Canal will be used to keep seepage water from mixing with lower quality runoff water from the basin. An additional pump station will be constructed to return seepage water to the Everglades Protection Area.

Lake Okeechobee Water Retention/Phosphorus Removal

This critical project will restore the hydrology of wetlands in four key basins north of Lake Okeechobee using two approaches. First, it will plug drainage ditches that connect wetlands with canals and drain land to create improved pasture. This will help retain water in the wetlands and improve water quality treatment functions of the wetlands. Second, it will divert canal flows into adjacent wetlands, which will also attenuate flows and retain phosphorus.

Well Abandonment Program (Recommendation from the CWMP) (Recommendation 13)

The CWMP has identified a problem with free-flowing, brackish aquifer wells that was not adequately addressed by the Well Abandonment Program that was administered by the District and ended in 1991. In the CWMP, it is recommended that additional efforts should be made to locate and properly abandon the free-flowing wells in the Caloosahatchee Basin. It is further recommended that the District should work with local and state officials to locate uncontrolled abandoned wells and identify strategies and applicable funding sources for proper plugging of these wells.

Saltwater Influence at S-79 (Recommendation from the CWMP) (Recommendation 14)

The need for this project was identified in the CWMP. Historically, the upstream migration of saline water (in excess of 250 milligrams per liter) has been a recurring problem during extended periods of low flow in the Caloosahatchee River. Saline water reaches the potable water intakes in the Caloosahatchee River, which are located approximately one mile upstream of the S-79 structure. While, freshwater releases from Lake Okeechobee for environmental purposes may minimize occurrences of this problem in the future, a number of alternatives warrant further investigation. They include moving the intakes farther upstream, modifications to the structure, limiting lockages during low flow periods, and improved maintenance and operation of the bubble curtain. The proposed project would conduct additional analyses of the saline water problem and potential solutions.

Permitting Issues Associated with ASR Systems and Reuse of Reclaimed Water (Recommendation 15)

Both the CERP and the LEC Plan recognize that the District will need to continue working with the legislature, FDEP, and the U.S. Environmental Protection Agency (USEPA) to develop and update rules and permitting procedures that will facilitate development of Aquifer Storage and Recovery (ASR) systems and application of reclaimed water while providing appropriate protection for potential users. This project provides for staff participation to handle LEC Plan implementation issues that arise as part of this larger process.

Mobile Irrigation Labs (Recommendation 17)

This recommendation continues support for Mobile Irrigation Labs as an effective conservation support program. However, recent decisions by the Governing Board related to CERP funding have indicated that this is not a core program for funding by the District. As a result, District participation in funding will be limited to providing staff to garner support from other agencies such as FDEP, Florida Department of Agriculture and Consumer Services (FDACS), and soil and water conservation districts, as well as customers.

Comprehensive Everglades Restoration Plan Projects (Recommendation 17)

The Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) provides water supply and flood protection for the District. The region's hydrology is now largely governed by a man-made system superimposed on the natural one. Although it has provided for urban and agricultural uses since its inception in 1948, the C&SF Project and the greater-than-expected growth and development that have ensued have unintentionally resulted in extensive damage to the South Florida environment. Over half of the original Everglades have been destroyed and the damage continues. Water is sent to tide through events such as the very wet spring of 1998, involving over 1.4 million acre-feet (ac-ft) of emergency Lake Okeechobee flood control releases to the Caloosahatchee and St. Lucie estuaries. These releases caused major environmental, economic, and human impacts in those estuaries and later resulted in a subsequent need for the lost water as the region headed into drought conditions. Without a change to the current design and operation of the C&SF Project, forecasts project the continued loss of uplands; degradation of wetlands, estuaries, and aquatic life; increased water shortages for agricultural and urban uses; increased flooding; and the loss or forced movement of wellfields.

The keys to Everglades restoration as determined in the C&SF Project Comprehensive Review Study (Restudy) (USACE and SFWMD, 1999), are to increase the amount of water available, ensure adequate water quality, and reconnect the parts of the system. A key aim is to annually regain, for beneficial use, about two million ac-ft of excess water that is currently being discharged to tide for flood control.

The recommendations made within the Restudy (i.e. structural and operational modifications to the C&SF Project) are being further refined and will be implemented in the CERP. The CERP will be implemented by a joint federal/state/District process. The CERP includes components that will change the functioning of the C&SF Project to meet ecosystem restoration and improvement goals and provide regional system features, including water resource development capabilities, needed to meet urban and agricultural water demands through 2050. Many of these water resource development projects had been previously evaluated for the LEC Interim Plan and were further evaluated for the Restudy. Major features of the CERP include the following:

Surface Water Storage Reservoirs. A number of water storage facilities are planned north of Lake Okeechobee, in the Caloosahatchee and St. Lucie basins, in the Everglades Agricultural Area (EAA), and in the Water Preserve Areas of Palm Beach, Broward, and Miami-Dade counties. These areas will encompass approximately 181,300 acres and will have the capacity to store 1.5 million ac-ft of water.

Water Preserve Areas. Multipurpose water management areas are planned in Palm Beach, Broward, and Miami-Dade counties between the urban areas and the eastern Everglades. The Water Preserve Areas will have the ability to treat urban runoff, store water, reduce seepage, and improve existing wetland areas.

Manage Lake Okeechobee as an Ecological Resource. Lake Okeechobee is currently managed for many, often conflicting, uses. The lake's regulation schedule will be modified and plan features constructed to reduce the extreme high and low levels that damage the lake and its shoreline. Management of intermediate water levels will be improved, while allowing the lake to continue to serve as an important source for water supply. Several projects to improve water quality conditions in the lake are included. A study is recommended to evaluate in detail the dredging of nutrient-enriched lake sediments to help achieve water quality restoration targets, important not only for the lake, but also for downstream receiving bodies.

Improve Water Deliveries to Estuaries. Excess storm water that is discharged to the ocean and the gulf through the Caloosahatchee and St. Lucie rivers is very damaging to their respective estuaries. Excess runoff will be stored in surface and underground water storage areas to reduce these discharges. During times of low rainfall, the stored water can be used to augment flow to the estuaries. Damaging high flows will also be reduced to the Lake Worth Lagoon.

Aquifer Storage and Recovery. Wells and associated infrastructure will be built to store water in the upper Floridan aquifer. As much as 1.6 billion gallons a day may be pumped down the wells into underground storage zones. The injected fresh water, which does not mix with the saline aquifer water, is stored in a bubble and can be pumped out during dry periods. This approach, known as Aquifer Storage and Recovery (ASR), has been used for years on a smaller scale to augment municipal water supplies. Since water does not evaporate when stored underground, and less land is required for storage, ASR has some advantages over surface storage. ASR wells will be constructed around Lake Okeechobee, in the Water Preserve Areas, and in the Caloosahatchee Basin.

Stormwater Treatment Areas. Approximately 35,600 acres of man-made wetlands, known as Stormwater Treatment Areas (STAs), will be built to treat urban and agricultural runoff water before it is discharged to the natural areas throughout the system. STAs are included in the Restudy for basins draining to Lake Okeechobee, the Caloosahatchee River Basin, the St. Lucie Estuary Basin, the Everglades, and the Lower East Coast urban areas. These are in addition to the over 44,000 acres of STAs already being constructed pursuant to the Everglades Forever Act to treat water discharged from the EAA.

Improve Water Deliveries to the Everglades. The volume, timing, and quality of water delivered to the South Florida ecosystem will be greatly improved. Compared to current conditions, an average of 26 percent more water will be delivered to Northeast Shark River Slough. This translates into nearly a half million ac-ft of additional water reaching the slough, which is especially critical in the dry season. More natural refinements will be made to the rain-driven operational plan to enhance the timing of water sent to the WCAs, Everglades National Park, and the Holey Land and Rotenberger Wildlife Management Areas (WMAs).

Remove Barriers to Sheetflow. More than 240 miles of project canals and internal levees within the Everglades will be removed to reestablish the natural sheetflow of water through the Everglades. Most of the Miami Canal in WCA-3 will be removed and 20 miles of the Tamiami Trail (U.S. 41) will be rebuilt with bridges and culverts, allowing water to flow more naturally into Everglades National Park, as it once did. In the Big Cypress National Preserve, a north-south levee will be removed to restore more natural overland water flow.

Store Water in Existing Quarries. Two limestone quarries in northern Miami-Dade County will be converted to water storage reservoirs to supply Florida Bay, the Everglades, Biscayne Bay, and Miami-Dade County residents with water. The 11,000-acre area, which is referred to as the Lake Belt, will be ringed with seepage barriers to ensure that stored water does not leak or adjacent ground water does not seep into the area. A similar facility will be constructed in northern Palm Beach County.

Reuse Wastewater. Two advanced wastewater treatment plants are planned for Miami-Dade County. These plants will be capable of making more than 220 million gallons a day (MGD) of the county’s treated wastewater clean enough to discharge into wetlands along Biscayne Bay and for recharging the Biscayne Aquifer. This reuse of water will improve water supplies to south Miami-Dade County and reduce seepage from Northeast Shark River Slough. Given the high cost associated with using reuse to meet the ecological goals and objectives for Biscayne Bay, other potential sources of water to provide freshwater flows to the central and southern bay will be also investigated.

Pilot Projects. A number of technologies proposed in the Restudy have uncertainties associated with them. Uncertainties exist in either the technology itself, its application, or the scale of implementation. While none of the proposed technologies are untested, what is not known is whether actual performance will measure up to that anticipated in the Restudy. The pilot projects, which include reuse of reclaimed water, seepage management, Lake Belt technology, and three ASR projects are recommended to address uncertainties prior to full implementation of these components.

Improve Freshwater Flows to Florida Bay. Improved water deliveries to Shark River Slough, Taylor Slough, and wetlands to the east of Everglades National Park will in turn provide improved deliveries of freshwater flows to Florida Bay. A feasibility study is also recommended to evaluate additional environmental restoration needs in Florida Bay and the Florida Keys.

Southwest Florida Feasibility Study. Additional water resource problems in Southwest Florida require studies beyond the scope of the CERP. In this regard, a feasibility study for Southwest Florida is being recommended to investigate the region’s hydrologic and ecological restoration needs.

Comprehensive Integrated Water Quality Plan. A comprehensive water quality plan needs to be developed to ensure that the implementation of the CERP leads to ecosystem restoration throughout South Florida. The water quality feasibility study needs to be conducted to develop this plan. The feasibility study would include evaluating water quality standards and criteria from an ecosystem restoration perspective and developing recommendations to integrate existing and future water quality restoration targets for

South Florida water bodies into future planning, design, and construction activities to facilitate implementation of the CERP. Further, water quality in the Florida Keys is critical to ecosystem restoration. The Florida Keys Water Quality Protection Plan includes measures for improving wastewater and storm water treatment within the Florida Keys.

A summary of CERP components, areas they benefit, total cost, and timelines for the projects are presented in **Figure 35**. Specific details for each component, including their location, can be found in **Appendix C**.

When looking at alternatives beyond the 2020 Base Case, the LEC Plan included the planned implementation of the CERP. In the simulation of the alternatives, the initial alternative incorporated the CERP components and was called the LEC 2020 with Restudy. The other alternatives, LEC-1 and LEC-1 Revised, also included the CERP components. One of the goals of the alternatives' evaluations was to determine the extent to which the expected CERP projects will provide the water resource development needed to meet the goals of the LEC Plan. The conclusion reached in **Chapter 4** was that the CERP projects scheduled to be completed by 2020, along with the assumed level of wellfield development, provide the needed water resources to achieve the LEC Plan planning goal of providing users with adequate water supplies during a 1-in-10 year drought. Thus, implementation of the CERP is the major water resource development component proposed by the LEC Plan.

The major focus of evaluations of CERP components within the LEC Plan was their aggregate performance in meeting water supply and environmental performance goals. These results were discussed in **Chapter 4**. The amount of water provided by each of the components will be identified. This amount of water can be considered at two levels, the overall water capacity the component and the amount delivered under specific water supply conditions. **Table 53** presents information on those CERP components for which a specific water supply capacity can be attributed. **Table 54** presents results from the SFWMM simulation with the best performance, the LEC-1 Revised simulation, showing the amounts of water provided by key CERP features on an average annual basis during the 31-year simulation and during five drought years. **Table 55** presents similar information from the viewpoint of the demand area, listing the amounts of water delivered to each demand area from each relevant component.

During the modeling and evaluations performed for the LEC regional water supply planning process, further improvements to the CERP performance and cost-effectiveness have been identified. These recommendations are discussed later in this chapter (see the **Recommendations to the CERP from the LEC Plan** section) and in **Chapter 6**.

Task Name	Rec	Benefit	Start	Finish
Lake Okeechobee ASR Pilot	17	Feasibility	Thu 7/1/99	Wed 6/23/04
Caloosahatchee River ASR Pilot	17,28	Feasibility	Wed 11/1/00	Tue 10/25/05
Lakebelt Technology Pilot	17	Feasibility	Thu 7/1/99	Wed 12/14/11
Reuse Technology Pilot	17	Feasibility	Fri 10/1/99	Thu 9/20/07
Seepage Management Pilot	17	Feasibility	Wed 11/1/00	Tue 10/28/03
Hillsboro (Site 1) ASR Pilot	5,17	Feasibility	Thu 7/1/99	Fri 11/1/02
Lake Okeechobee ASR	17	Quantity, Timing	Thu 6/24/04	Wed 6/17/20
Lake Okee Water Quality Treatment	17	Qnty,Qlty,Tmg,Spat Ext	Mon 10/1/01	Fri 9/17/10
North of Lake Okeechobee Storage	17	Quantity, Quality, Timing	Mon 10/3/05	Fri 9/18/15
C-43 Basin Storage Reservoir and ASR	17,29	Quantity, Quality, Timing	Thu 6/1/00	Thu 3/22/12
Caloosahatchee Backpumping/STA	17	Quantity, Quality, Timing	Mon 10/3/05	Fri 9/18/15
L-8 Project	17,21	Quantity, Quality, Timing	Mon 9/27/04	Fri 9/16/11
Lake Okee Tributary Sediment Dred	17	Quality	Tue 10/2/01	Mon 9/26/05
Taylor Ck/Nubbin Slough Storage/STA	17	Quantity, Quality, Timing	Mon 1/31/00	Fri 1/16/09
EAA Storage Reservoirs	17,20	Quantity, Quality, Timing	Thu 7/1/99	Fri 12/25/15
C-17 Backpumping and Treatment	17	Quantity, Quality, Timing	Mon 11/4/02	Fri 10/24/08
Pal Mar/Corbett Hydropattern Rest	17	Distribution, Spatial Extent	Mon 10/1/01	Fri 9/22/06
C-51 and Southern L-8 Reservoir	17	Quantity, Quality, Timing	Mon 9/27/04	Fri 9/12/14
Hillsboro (Site 1) Impoundment/ASR	17	Quantity, Quality, Timing	Fri 9/28/01	Fri 10/17/14
Acme Basin B Discharge	17	Quantity, Quality, Timing	Mon 10/1/01	Fri 9/22/06
C-51 Backpumping and Treatment	17, 18	Quantity, Quality, Timing	Mon 11/4/02	Fri 10/24/08
C-51 Regional Ground Water ASR	17, 22	Quantity, Timing	Mon 9/27/04	Fri 9/13/13
Lake Worth Lagoon Restoration	17	Quality	Tue 10/4/05	Mon 3/28/11
Winsburg Farms Wetlands	17	Quantity, Quality, Timing	Mon 1/3/00	Fri 12/23/05
Prot. Wetlands Near WCA-1 (Strazulla)	17	Spatial Extent	Fri 9/28/01	Fri 10/26/07

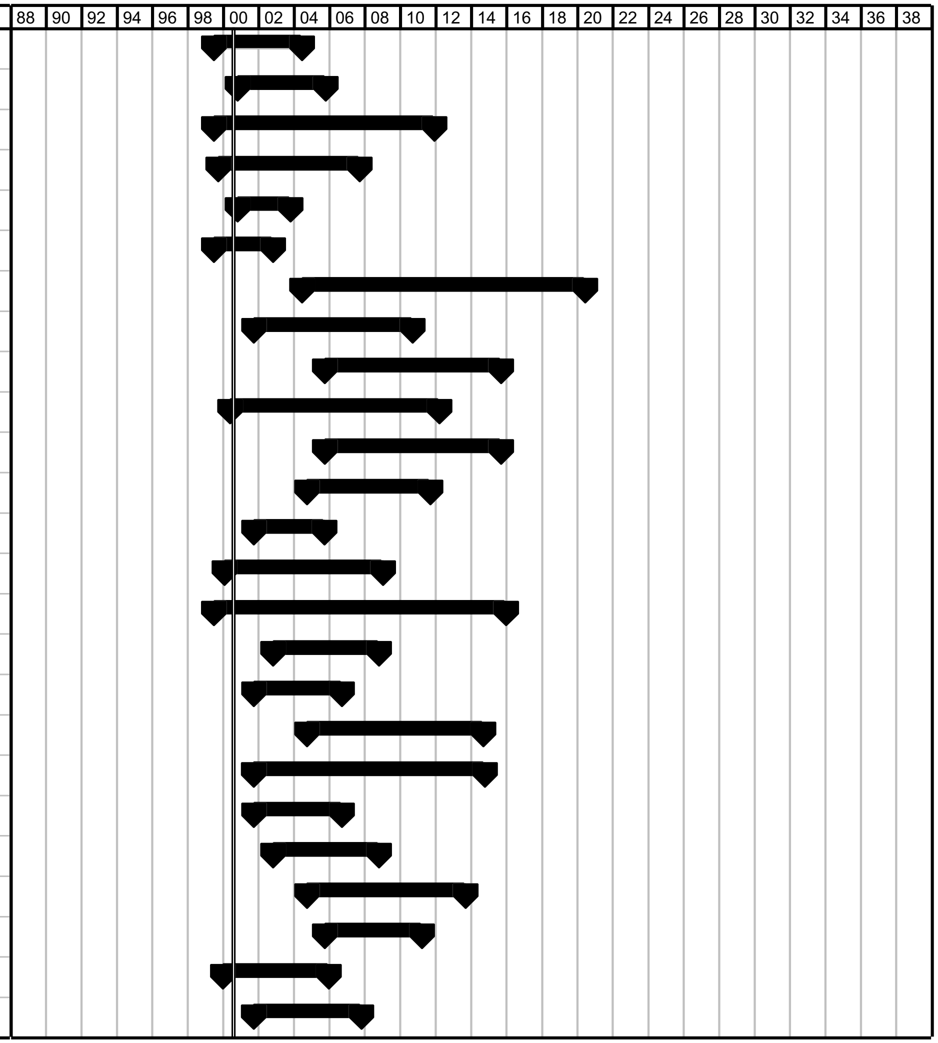

Figure 35. A Summary of CERP Components, Total Costs, Areas They Benefit and Timelines for the Projects.

Task Name	Rec	Benefit	Start	Finish
PBC Ag Reserve Reservoir/STA	17	Quantity, Quality, Timing	Thu 9/1/05	Wed 8/21/13
Western C-11 Diversion	17	Quantity, Quality, Timing	Mon 10/1/01	Fri 9/19/08
C-9 STA/Impoundment	17	Quantity, Quality, Timing	Mon 10/1/01	Fri 9/21/07
Broward Secondary Canals	17	Distribution	Mon 7/2/01	Fri 6/12/09
North Lake Belt Storage Area (NLBSA)	17,25	Quantity, Quality, Timing	Mon 2/27/12	Fri 6/20/36
Central Lakebelt Storage Area (CLBSA)	17,25	Quantity, Quality, Timing	Mon 2/27/12	Fri 12/19/36
C-4 Control Structures	17	Quantity, Distribution	Mon 1/31/00	Fri 7/22/05
Pineland/Hardwood Restoration	17	Spatial Extent	Mon 10/2/00	Fri 3/24/06
Bird Drive Recharge Area	17	Quantity, Quality, Timing	Thu 1/1/04	Wed 12/18/13
L-31N Levee Improvement	17	Quantity, Distribution	Wed 10/30/02	Tue 10/19/10
Dade-Broward Levee/Pennsuco	17	Quantity, Distribution	Mon 10/1/01	Fri 9/19/08
C-111 Operations Mod	17	Timing	Wed 5/1/02	Thu 4/1/04
Reroute Miami Canal Wat Sup Deliv	17	Distribution	Mon 1/28/02	Fri 1/16/09
C-111N Spreader Canal	17	Distribution	Mon 1/31/00	Fri 7/18/08
South Miami-Dade County Reuse	17	Quantity, Quality, Distrib	Mon 7/4/11	Fri 6/19/20
West Miami-Dade County Reuse	17,23	Quantity, Quality, Distrib	Mon 7/4/11	Fri 6/19/20
WCA-1 Internal Structures	17	Distribution	Mon 1/31/00	Fri 7/25/03
Divert WCA-2 Flows to CLBSA	17	Distribution	Mon 4/1/02	Fri 9/17/10
WCA 3A and 3B Seepage Mgmt	17	Quantity, Distribution	Tue 10/2/01	Mon 9/22/08
Additional S-345 Structures	17	Distribution	Mon 1/28/02	Fri 1/16/09
Construction of S-356 Structures	17	Distribution	Mon 11/4/02	Fri 10/26/07
Decompartmentalize WCA-3	17	Distribution	Mon 1/28/02	Fri 1/4/19
Flows to NW/Central WCA-3A	17	Distribution	Thu 11/2/00	Wed 4/22/09
Divert WCA-3 Flows to CLBSA	17	Distribution	Mon 4/1/02	Fri 9/19/08
Divert Flows from CLBSA to WCA-3B	17	Distribution	Mon 2/27/12	Fri 2/17/17

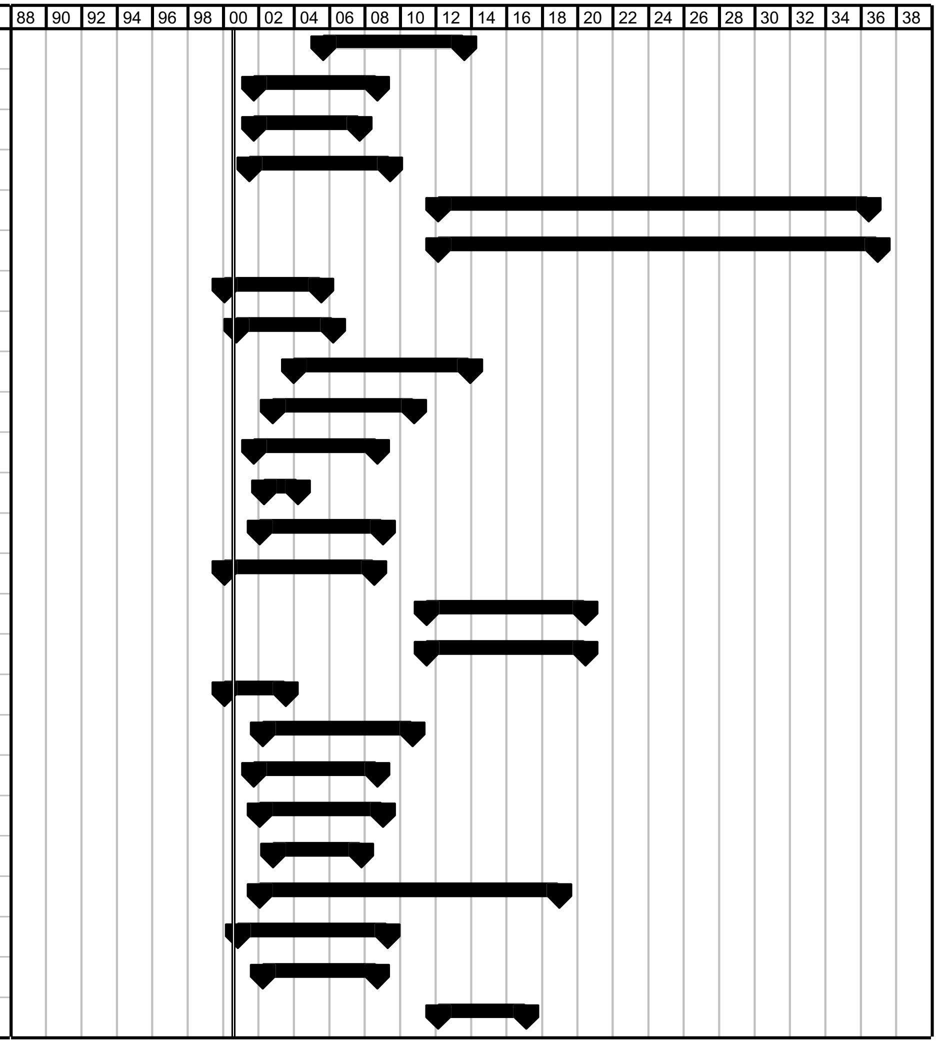

Figure 35. (Continued) Summary of CERP Components, Total Costs, Areas They Benefit and Timelines for the Projects.

Task Name	Rec	Benefit	Start	Finish
G-404 Pump Station Modifications	17	Distribution	Wed 10/1/03	Tue 3/24/09
Biscayne Bay Coastal Wetlands	17	Distribution	Thu 4/20/00	Wed 2/27/19
Florida Keys Tidal Restoration	17	Distribution	Mon 3/6/00	Fri 8/26/05
Big Cypress/L-28 Interceptor	17	Quan, Qual, Timing, Distr	Mon 10/2/06	Fri 9/16/16
Miccosukee Water Mgmt Plan	17	Quantity, Quality, Timing	Mon 7/3/00	Fri 12/19/08
Seminole Water Conservation Plan	17	Quantity, Quality, Timing	Mon 1/1/01	Fri 6/20/08
Melaleuca/Exotic Plant Eradication	17	Exotic Plant Control	Mon 10/2/06	Fri 9/23/11
SW Florida Study	17,30	Feasibility	Thu 4/1/99	Wed 3/24/04
Comprehensive Water Quality Plan	17	Feasibility	Fri 10/1/99	Fri 12/22/06
Florida Bay/Keys Feasibility Study	17	Feasibility	Fri 10/29/99	Fri 10/22/04
RECOVER	17,20	Adaptive Assessment	Thu 7/1/99	Wed 12/22/38

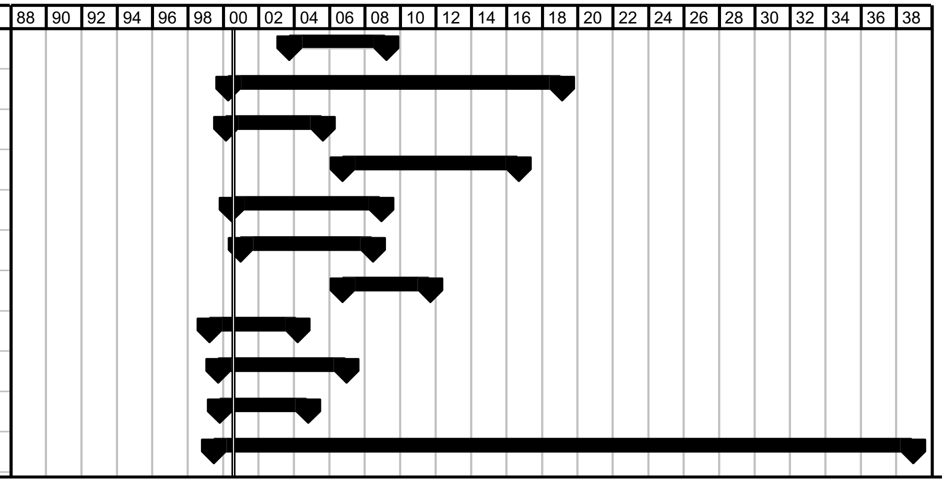

Figure 35. (Continued) Summary of CERP Components, Total Costs, Areas They Benefit and Timelines for the Projects.

Table 53. Minimum and Maximum Water Capacity of Major CERP Components.

Component	Water Capacity	
	Minimum	**Maximum**
Lake Okeechobee ASR	1K MGD ASR	1K MGD ASR
North of Lake Okeechobee Storage Reservoir	100K ac-ft	200K ac-ft
C-44 Basin Storage Reservoir	20K ac-ft	40K ac-ft
C-43 Basin Storage Reservoir with ASR	80K ac-ft	160K ac-ft reservoir 220 MGD ASR
L-8 Project	25 MGD ASR	50 MGD ASR 48K ac-ft reservoir
Taylor Creek/Nubbin Slough Storage Reservoir and STA	50K ac-ft reservoir 20K ac-ft STA	50K ac-ft reservoir 20K ac-ft STA
C-23/C-24/Northfork/Southfork Storage Reservoirs	165K ac-ft	192K ac-ft
EAA Storage Reservoirs	240K ac-ft	360K ac-ft
C-51 and Southern L-8 Reservoir	120K ac-ft	120K ac-ft
Hillsboro (Site 1) Impoundment	10K ac-ft	14.8K ac-ft
Hillsboro (Site 1) ASR	220 MGD ASR	370 MGD ASR
C-51 Regional Ground Water ASR	340 MGD ASR	540 MGD ASR
Palm Beach County Agricultural Reserve Reservoir and ASR	10K ac-ft	19.9K ac-ft reservoir 75 MGD ASR
Western C-11 Diversion Impoundment and Canal	6.4K ac-ft	6.4K ac-ft
C-9 STA and Impoundment	10K ac-ft	10K ac-ft
North Lake Belt Storage Area	70K ac-ft	90K ac-ft
Central Lake Belt Storage Area	80K ac-ft	187.2K ac-ft
Bird Drive Recharge Area	11.5K ac-ft	11.5K ac-ft
L-31N Levee Improvements for Seepage Management	100 percent levee; 100 percent ground water	100 percent levee; 100 percent wet season ground water
South Miami-Dade County Reuse	131 MGD	131 MGD
West Miami-Dade County Reuse	100 MGD	100 MGD

Table 54. Average Annual Amounts of Water Provided by CERP Components.

Component	Beneficiary	Average Annual Water Provided (1,000 ac-ft)	
		LEC-1 Revised During the Simulation Period	During Drought Years[a]
C-44 Basin Storage Reservoir	C-44 Basin water supply	1	1
	St. Lucie Estuary	8	0
	Lake Okeechobee	10	8
North of Lake Okeechobee Storage Reservoir (recovery)	Entire system (via Lake Okeechobee)	49	40
Lake Okeechobee ASR (recovery)	Entire system (via Lake Okeechobee)	115	256
EAA Storage Reservoirs, Compartment 1	EAA agricultural water supply	204	168
	EAA Storage Reservoirs, Compartment 2A	20	26
EAA Storage Reservoirs, Compartment 2A	EAA agricultural water supply	6	2
	WCAs and Everglades National Park	122	42
EAA Storage Reservoirs, Compartment 2B	WCAs and Everglades National Park	110	8
LEC Service Area (LECSA) 1 and North Palm Beach Service Area Reservoirs	LECSA 1 and North Palm Beach Service Area users	10	13
LECSA 1 and North Palm Beach Service Area ASR	LECSA 1 and North Palm Beach Service Area users	51	76
	EAA	37	30
LECSA 2 ASR	LECSA 2 users	32	42
North Lake Belt Storage Area	LECSA 3 water supply	25	27
	Biscayne Bay	109	70
Central Lake Belt Storage Area	WCAs and Everglades National Park	59	75
	Biscayne Bay	27	8
Bird Drive Recharge Area	LECSA 3 water supply	15	19
South Miami-Dade County Reuse	Biscayne Bay	147	147
West Miami-Dade County Reuse	Bird Drive Recharge Area	56	56
Construction of S-356 Structures and Relocation of a Portion of L-31N Borrow Canal	Biscayne Bay	8	6

a. 1971, 1975, 1981, 1986, 1989

Table 55. Average Annual Basin-by-Basin Demands for the 31-Year Simulation Period and for Drought Years and How They Are Met.

Demand Basin/ Water Body	Total Demand/Sources of Supply	Average Annual Water Provided (1,000 ac-ft)	
		LEC-1 Revised During the Simulation Period	During Drought Years[a]
Caloosahatchee Basin (surface water demand)	Lake Okeechobee	29	57
	Local reservoir	Addressed by the CWMP	
	Caloosahatchee Basin ASR		
	Local sources and rainfall		
	Demand not met		
St. Lucie Basin (surface water demand)	Lake Okeechobee	25	48
	St. Lucie Reservoir	1	1
	Demand not met	1	5
EAA	Lake Okeechobee	85	205
	EAA Storage Reservoirs	209	170
	LECSA 1 Regional ASR	37	30
	Local sources and rainfall	905	832
	Demand not met	8	40
LECSA 1 (to maintain coastal canals)	Lake Okeechobee	3	11
	WCAs	32	75
	LECSA 1 Reservoirs	10	13
	LECSA 1 Regional ASR	51	76
LECSA 2 (to maintain canals)	Lake Okeechobee	9	27
	WCAs	8	15
	LECSA 1 Regional ASR	32	42
LECSA 3 (to maintain canals)	Lake Okeechobee	77	212
	WCAs	24	29
	LECSA 3 Reservoirs	40	46
Caloosahatchee Estuary	Caloosahatchee Basin Reservoir	Addressed by the CWMP	
	Local basin runoff		
	Lake Okeechobee (environmental)	16	31
	Lake Okeechobee (regulatory)	28	0
St. Lucie Estuary	C-44 Basin Storage Reservoir	8	0
	Local basin runoff[b]	587	313
	Lake Okeechobee (environmental)	14	1
	Lake Okeechobee (regulatory)	12	0
WCAs and Everglades National Park Rain-Driven Demands	Lake Okeechobee[c]	193	222
	EAA Storage Reservoirs	232	50
	EAA drainage to the south[d]	662	536
	Regulatory from Lake Okeechobee	96	0
Everglades National Park	NW Shark River Slough	451	183
	NE Shark River Slough	685	306
Biscayne Bay	Snake Creek (S29)	114	81
	Northern bay (G58, S28, and S27)	145	111
	Miami River (S26, S25B, and S25)	60	33
	Central bay (G97, S22, and S123)	203	135
	Southern bay (S21, S21A, S20, S20G, and S197)	268	210

a. 1971, 1975, 1981, 1986, and 1989
b. Includes all contributing basins to the St. Lucie Estuary (C-23, C-24, North Fork, South Fork, and C-44)
c. Environmental releases from Lake Okeechobee to meet rain-driven demands
d. Includes flows from Holey Land and Rotenberger WMAs

Recommendations to the CERP from the LEC Plan

As a result of the evaluations conducted in the development of both the LEC Plan and the CWMP, valuable insights have been developed regarding the potential design and operation of CERP projects. These insights should be incorporated into CERP planning and implementation efforts. The consideration of these insights is treated as a formal recommendation of the LEC Plan to the CERP.

The individual recommendations are further described and discussed in **Chapter 6**. They include the following:

- Additional analyses related to the implications of the planned location of S-155A on other CERP components need to be performed (**Recommendation 18**).
- The importance of identifying additional improvements for WCA-2B in CERP planning and RECOVER efforts was reiterated. WCA-2B was the only area of the northern Everglades that received an unacceptable score in LEC regional water supply planning and Restudy efforts to date (**Recommendation 19**).
- Changes are needed in the compartments proposed for the EAA reservoir to increase storage available to meet EAA demands and to increase utilization of the reservoir to meet demands in the West Palm Beach Canal Area of the EAA (**Recommendation 20**).
- The utilization of ASR water in the C-51 Canal, West Palm Beach Catchment Area, and Hillsboro systems needs to be increased above the uses achieved in Restudy evaluations. Use of the C-51 Canal and West Palm Beach Catchment Area water to meet demands in the EAA is suggested. Use of Hillsboro ASR water to meet demands in LECSA 2 is recommended (**Recommendations 21** and **22**).
- Consideration of different capacities and uses of the West Miami-Dade Reuse system is recommended (**Recommendation 23**).
- Modifications of Lake Okeechobee Regulation schedules are recommended to achieve the best performance, given the structural improvements that may be in place at various times during the plan implementation (**Recommendation 24**).
- Implementation of the Lakebelt Storage Areas should begin as soon as possible (**Recommendation 25**).
- Early implementation of rain-driven schedules for the WCAs and Everglades National Park is recommended (**Recommendation 26**).
- Future CERP planning efforts need to consider wellfield configurations and performance evaluated in the LEC Plan, as

well as subsequent consumptive use permitting actions (**Recommendation 27**).

Recommendations to the CERP from the CWMP

The following recommendations from the CWMP are included here because they will provide insight into the implementation of the CERP:

- Confirmation of the advisability of completing the Caloosahatchee ASR Pilot Project (**Recommendation 28**)
- The C-43 Storage Project (**Recommendation 29**)
- The Southwest Florida Study (**Recommendation 30**).

Operational Recommendations

Operational improvements and reevaluations are included in the CERP which call for the development of rain-driven environmental delivery formulas and the revision of operating procedures and protocols to reflect the completion of new facilities. The LEC Plan has identified three additional areas for improvements to operations that are needed for the next five to 10 years until the CERP features begin to come on-line.

Systemwide Operational Protocols (Recommendation 31)

The incremental simulations completed as part of the LEC Plan indicated that the frequency and severity of low lake levels under the 1965 to 1995 climatic conditions would cause water supply problems for users dependent on Lake Okeechobee through 2010. In this period, it is especially important that supply-side management policies be implemented in a flexible way to assure that the water in storage for each dry season is managed in the best way.

Lake Okeechobee supply-side management policy needs to be reevaluated to incorporate operational flexibility to improve water supply performance while taking into account environmental goals and conditions. One example would be the fact that over the last six years, extreme wet periods have kept the lake abnormally high for long periods of time. Under such conditions, a drawdown of the lake would provide ecological benefits.

Periodic Operational Flexibility (Recommendation 32)

Operational priorities and protocols should be reevaluated on an annual basis and a specific strategy presented for Governing Board approval.

Lake Okeechobee Vegetation Management Plan (Recommendation 33)

A Lake Okeechobee Vegetation Management Plan needs to be developed so that detrimental environmental effects from lower lake levels, primarily the spread of torpedo grass and melaleuca, can be effectively managed. The program would then be implemented whenever lower lake levels dry the littoral zone.

Consumptive Use Permitting and Resource Protection Projects

In this section, descriptions of the general implementation legal and policy guidances are provided for implementing reservations, MFL recovery and prevention strategies, consumptive use permitting, water shortage program, and operational strategies.

As one of the tools for plan implementation, rulemaking to implement the regulatory recommendations of the LEC Plan will constitute a significant effort during the next several years. Rulemaking will include water reservations and numerous Consumptive Use Permitting (CUP) criteria, which are interrelated and cumulatively define the availability of water for consumptive uses and water resource protection. As a result, it is recommended in the LEC Plan that certain rulemaking efforts be grouped in phases to allow for the cumulative analysis of the water resource and consumptive use implications of the regulatory program.

Another goal of the rulemaking schedule is to adopt rules as the technical information becomes available. As a result, it is recommended in this plan that initial rulemaking proceed for concepts that were sufficiently identified and evaluated in the planning process. These include establishment of MFLs for the Everglades, Lake Okeechobee, the Biscayne Aquifer, and the Caloosahatchee River.

In addition, uncertainties in the rulemaking process, such as delays for development of supporting technical data or rule challenges, may conflict with the proposed schedule for rule development provided in this plan. The proposed schedule will be adapted to account for such delays, while considering the need to develop associated rules through a coordinated rulemaking process. The contingency process identified in the plan, along with input from the LEC Regional Water Supply Plan Advisory Committee, other members of the public, and the Governing Board may be used to identify necessary changes to the rulemaking schedule.

Water Reservations (Recommendation 34)

Table 51 identifies the water bodies where reservations will be adopted, the basis upon which the reservations of water will be derived, and the targeted operation dates for water resource development projects that can provide the reservation water supplies. The basis upon which the reservations will be derived are rain-driven formulas, stage formulae, salinity envelope criteria, or Stormwater Treatment Area (STA) minimum depth of water.

These factors will be further refined through the reservation rulemaking and implementation process, including detailed design and feasibility analyses of associated water resource development projects. In addition to rule adoption of the reservations to set aside water quantities from allocation, operational protocols will be developed to provide for phased increases in water quantities through 2020. Establishment of reservations are recommended for the following areas:

Caloosahatchee and St. Lucie Estuaries. Reservations for these water bodies will be established for the purpose of providing freshwater inflows to prevent harm. Optimal salinity profiles and corresponding quantities of freshwater inflows, particularly during the dry season, have been identified in technical publications and integrated into the LEC regional model targets. Water reservations will identify water quantities for meeting these targets, and will be applied when associated water resource development projects are constructed. Until the water resource development projects that will make water available for meeting these reservations are operational, the District will utilize an annual process to identify operational actions to optimize water deliveries based on the projected annual conditions to meet these targets. Final rule adoption is projected for the Caloosahatchee Estuary by 2000 and for the St. Lucie Estuary by 2001.

Stormwater Treatment Areas. Reservations for STAs will be adopted for the purpose of protecting fish and wildlife by maintaining water quality functions of the filter marsh and reducing the potential for nutrient releases associated with dry times. The reservation will include water quantities estimated to maintain at least 0.5 feet of water in the STAs to prevent dry out. Conditions on providing this water during droughts will also be identified, including conditions for making water deliveries from Lake Okeechobee with consideration given to other water supply needs of the regional system, consistent with operations in the *Everglades Construction Project Conceptual Design Document*. Final rule adoption is projected for 2001.

Everglades National Park, the WCAs, and the Holey Land and Rotenberger WMAs. Reservations will be adopted for the purposes of protecting fish and wildlife through restoration of hydropatterns as defined by the CERP for 2020. Model results in the LEC Plan indicate the water quantities that should be delivered to these areas based on the incremental increased water availability during the next 20 years through water resource development. The reservation rule will account for these interim incremental increases through time during the next 20 years. Estimates on water quantities to be made available under the reservation, water resource development projects, and operational protocol for providing these water quantities will be identified in the rule. Final rule adoption is projected for 2003.

Subregional Wetland Restorations. Reservations will be adopted, where appropriate, for the purpose of protecting fish and wildlife in urban wetland systems slated for enhancement (Loxahatchee Slough, Pond Apple Slough, Fern Forest, Trade Winds Park, Model Lands, Pennsuco Wetlands, South Dade Wetlands, etc.). The District will work with Palm Beach, Broward, and Miami-Dade counties to quantify the reservations and identify the sources of water, when appropriate. Final rule adoption is projected for 2003.

Biscayne Bay, Florida Bay, and the Loxahatchee River. Reservations will be adopted for the purpose of protecting fish and wildlife through providing freshwater inflows that prevent harm. The Loxahatchee River Reservation Rule will be adopted by December 2001. Research on the freshwater inflows to Florida Bay is scheduled to be completed by December 2002. Final rule adoption is projected for Florida Bay by 2003 and for Biscayne Bay by 2004.

Lake Okeechobee. Lake Okeechobee provides water storage for multiple purposes including consumptive uses of water and a number of water resource protection purposes. It will store and provide water for several reservations including the Everglades, the STAs, the Biscayne aquifer, and the St. Lucie and Caloosahatchee estuaries. However, the lake has its own demand for water supplies to protect fish and wildlife. Therefore, the management of the lake must address its function as a natural system, as well as a water supply source. At the time of completion of this plan, a reservation proposed for the lake had not yet been quantified. It is recommended that the protection of the lake's fish and wildlife be considered and the lake reservation developed in concert with the reservations for the water bodies that rely on the lake.

Following required research to support adoption of reservations for these areas, the District will proceed with identification of operational, regulatory, and water resource development projects necessary to implement the reservations. This will also include integration of the reservations and implementation actions into regional water supply plan updates, five-year water resource development plans, and annual budgets.

Establish MFLs (Recommendation 35)

Eight water bodies located within the LEC planning area have been identified as priority water bodies within the DWMP for the establishment of MFLs. The establishment of MFLs for four of these water bodies (Lake Okeechobee, the Everglades and the WCAs, Biscayne aquifer, and the Caloosahatchee River) is scheduled for completion in 2000. For detailed descriptions of the basis for Lake Okeechobee, the Everglades, and Biscayne Aquifer MFLs refer to *Minimum Flows and Levels for Lake Okeechobee, the Everglades, and the Biscayne Aquifer* (SFWMD, 2000e). The documentation of the Caloosahatchee River MFLs is not yet complete. The recommended MFL criteria for each of these four water bodies used in the evaluation phase of the LEC Plan are listed below. These recommended MFLs will undergo rulemaking later this year.

Lake Okeechobee

Water levels should not fall below 11 ft NGVD for more than 80 days duration, more often than once every six years, on average (SFWMD, 2000e).

Peat-Forming Wetlands in the Everglades and the WCAs

Water levels within wetlands overlying organic peat soils within the WCAs, Rotenberger and Holey Land WMAs, and Shark River Slough (Everglades National Park) shall not fall below ground surface for more than 30 days and shall not fall below 1.0 foot below ground for one day or more of that 30-day period, at specific return frequencies for different areas, as identified in **Table 44** in **Chapter 4**.

Marl-Forming Wetlands in the Everglades and the WCAs

Water levels within marl-forming wetlands that are located east and west of Shark River Slough, the Rocky Glades, and Taylor Slough within Everglades National Park, shall not fall below ground surface for more than 90 days and shall not fall below 1.5 feet below ground for one day or more of that 90-day period at specific return frequencies for different areas, as identified in **Table 44** in **Chapter 4**.

Biscayne Aquifer

The term minimum water level for the Biscayne aquifer refers to water levels associated with movement of the saltwater interface landward to the extent that ground water quality at the withdrawal point is insufficient to serve as a water supply source for a period of several years before recovering. For evaluation of model simulations, operational criteria are applied to the coastal canals that receive regional water. **Table 6** in **Chapter 4** provides the minimum canal operational levels for eleven primary water management structures. To meet the operational criteria, the canal stage cannot fall below the criteria for more than 180 days, and the average annual stage must be sufficient to recover after a drought or discharge event.

Caloosahatchee Estuary

The freshwater inflow associated with preventing harm or significant harm is an average of 300 cfs per day at the S-79 structure during the months of November through March. The determination of this inflow is discussed in **Chapter 4** on **page 92**.

Additional MFLs

MFLs will be established for five additional water bodies: the Loxahatchee River, the St. Lucie Estuary, Florida Bay, Biscayne Bay, and the southern Biscayne aquifer in 2001, 2001, 2003, 2004, and 2003, respectively. Since the research necessary to define the MFLs and restoration targets for each of these water bodies has not been completed, estimates were used as discussed below for evaluating performance measures for this plan. These estimates will be replaced with the actual MFLs during the next five-year LEC Plan update. Options for recovery and prevention strategies will be explored and incorporated into future plan updates.

MFL Criteria for the Rockland Marl Marsh (Recommendation 36)

The majority of plant and animal communities that exist within the remaining Rockland marl marsh, located within and adjacent to Everglades National Park, have been severely impacted by overdrainage and development east of the park. Studies of remaining communities have provided some limited information concerning the appropriate depth and duration of water levels needed to sustain their characteristic vegetation and wildlife communities. Current MFL targets proposed for this area are based on management targets developed as part of the Restudy/CERP and LEC regional water supply planning processes which are based on output of the Natural System Model (NSM).

It is the expert opinion of Everglades National Park staff that the NSM does not properly simulate hydrologic conditions within the Rockland marl marsh and that the interim MFL criteria may not sufficiently protect these wetlands from significant harm. Additional research is required to determine an appropriate return frequency for drought conditions that can be tolerated by both plant and animal populations without causing significant harm to their structure and function. Research on short hydroperiod, marl-forming wetland plant and animal communities is needed to determine the following: the distribution, extent, and structure of these communities within the historic Everglades; their historic and potential future role and significance as sources of food for wading birds and other vertebrates; and the seasonal dynamics of fish and macroinvertebrate populations, especially the amount of time that sustained high water levels are required to maintain ecosystem aquatic productivity.

As part of the LEC water supply planning process, staff from the District, Everglades National Park, and U.S. Geological Survey (USGS) should jointly develop a work plan to conduct the necessary research needed to validate and/or refine the proposed MFL criteria, especially the return frequency component, for the Rockland marl marsh.

MFLs for Florida Bay (Recommendation 37)

Findings of the MFL Scientific Peer Review Panel (Jordan, et al., 1998) recommended that a sufficiency review be conducted to examine existing surface and ground water data, especially data that illustrates the relationship between upstream water levels and flows and their impact on downstream estuary and bay salinity levels. Based on this review, the District and other stakeholders should determine appropriate time frames and mechanisms for the establishment of MFL criteria for Florida Bay.

In response to the above recommendation, and to requests made by Everglades National Park staff, Florida Bay was placed on the District's MFL Priority Water Body List for establishment in 2003. In addition, a formal MFL sufficiency review has been completed for Florida Bay and is currently under review by the Interagency Florida Bay Science Program and Everglades National Park staff. This sufficiency review presents an assessment of currently available technical information needed to develop MFL guidelines for Florida Bay. Florida Bay MFLs are defined as the minimum inputs of freshwater from the southern Everglades required to prevent significant harm to the Florida Bay ecosystem. Significant harm is defined as the loss of specific water resource functions that take multiple years to recover, which result from a change in surface water or ground water hydrology (SFWMD, 2000e).

Establishment of MFLs for Florida Bay is a challenging task because of the size, the spatial complexity of the estuary, and the diffuse nature of freshwater flow to the bay. The task requires an understanding of the physical and ecological characteristics of the bay and their sensitivity to fresh water inputs from the Everglades. By targeting a specific response variable (seagrass) that is critical to many other parts of the ecosystem (nutrient cycling, animals, other plants, water quality, etc.), the District expects to develop initial MFL technical criteria for Florida Bay by 2003. Conceptual models of Florida Bay are currently being developed by the CERP RECOVER team to identify some of the more complex interactions within the ecosystem and may be used as a starting point to develop MFL criteria.

As future research efforts provide additional information on some of these more complex ecological processes, subsequent refinement of the initial MFL criteria may be necessary. A number of research efforts are already under way with a second phase to be completed by 2006. An integrated Interagency Florida Bay Science Program, in which the District participates, has been collecting ecological information on the bay for the past three years. The databases and computer models that are products of this ongoing program will provide a foundation for developing MFL technical criteria.

An ecologically based MFL determination should include the following considerations:

- Salinity is the dominant factor that is affected by changing freshwater flows and levels.
- Salinity is a naturally varying characteristic of estuaries and MFLs must have criteria that incorporate seasonal and interannual variability.
- Water quality components other than salinity are also affected by changes in freshwater flow.
- The effects of salinity are not only direct, such as physiological stress on plants and animals, but also indirect, such as changing nutrient cycles, plant community structure, habitat availability, reproduction, and food webs.
- MFL determination depends on both bay and upstream watershed responses to these changing conditions as these subsystems are interconnected.
- Defining significant harm to the Florida Bay ecosystem requires identification of the main processes that sustain the bay ecosystem and determination of the sensitivity of these processes to the establishment of MFL criteria.

A number of key data collection projects are currently underway, representing collaborations among federal, state, and university scientists. However, most of the interagency projects were not specifically designed for determination of MFL. Modifications of these projects, plus some additional research, will be needed to address specific MFL issues.

MFL Recovery Strategies (Recommendation 38)

Pursuant to the requirements of the MFL statute, analyses of current and future conditions were conducted for each of the priority water bodies where MFLs were defined. When the evaluation showed MFLs are not or will not be met in the future, recovery or prevention strategies, as appropriate, were developed. Following are the MFL recovery/prevention strategies for Lake Okeechobee and the Everglades. The evaluations showed that MFLs for the Biscayne aquifer are expected to be met and, therefore, a recovery/prevention strategy was not required.

Lake Okeechobee

Analysis of the results of the 1995 and 2020 base cases show MFL criteria were met. As a result, the MFL criteria would probably not be exceeded even if the LEC Plan were not implemented. Therefore, a recovery plan is not required for Lake Okeechobee. The prevention strategy consists of implementation of the Water Shortage Plan, including supply-side management, as simulated in the LEC Plan.

Caloosahatchee River and Estuary

Analyses of both the 1995 and 2020 base cases show the proposed MFL criteria for the Caloosahatchee Estuary would be exceeded. Therefore, a recovery plan is necessary. Evaluation of the model results show that while the Caloosahatchee Estuary MFL criteria was exceeded, sufficient quantities of water remained left in Lake Okeechobee to avoid significant harm to the Caloosahatchee Estuary until the proposed long-term regional storage facilities that comprise the recovery plan have been built. These regional storage facilities are recommended in LEC Plan and CWMP, including ASR and regional surface water reservoirs.

Long-term evaluations conducted for both the Restudy and the CWMP indicate that both MFL and minimum restoration flows (300 cfs during the fall and spring) can be met through a combination of the construction of reservoirs and limited deliveries from Lake Okeechobee and ASR systems located within the basin. Over the next five years, activities for construction of regional facilities include 1) implementation of the ASR pilot project, 2) development of the Project Implementation Report (PIR) for the C-43 Regional Surface Water Reservoir, and 3) completion of the Southwest Florida Study. The reservoir and ASR projects are scheduled for completion in 2010 and 2015, respectively (**Table 51**).

In the period of time prior to construction of these facilities, the District will utilize water in Lake Okeechobee, when available, for releases to the Caloosahatchee River to prevent MFL violations, which are projected to occur only during extreme droughts. In implementing this interim recovery and prevention strategy, releases to prevent significant harm will occur as follows: if a die back of *Vallisneria* grass beds occurs in the area identified in the MFL criteria during one year, for at least one of the following two years, an average of 300 cfs of water will be delivered at the S-79 structure during the months of February through April.

The Everglades and Water Conservation Areas

Direct and indirect impacts can occur within the Everglades and WCAs that can be attributed to consumptive use withdrawals. Indirect impacts occur as a result of making regional water deliveries to areas other than the Everglades. Direct impacts result from the pumping of adjacent wellfields that lower the water table along the eastern edge of the

Everglades system, affecting wetlands located directly west of the north-south perimeter levee.

In an effort to define which areas of the Everglades may potentially be affected by existing and projected future water demands, District staff utilized the SFWMM to identify where the proposed MFL criteria were not met for the 1995 and 2020 base cases. Review of the 1995 Base Case showed the proposed Everglades MFL criteria were exceeded at 12 out of 19 locations (indicator regions) within the remaining Everglades system (**Table 45** in **Chapter 4**). Evaluation of the 2020 base case showed similar results (**Table 45** in **Chapter 4**), with no overall increase in the number of sites that exceeded proposed MFL criteria compared to the 1995 Base Case. These results indicate two things. First, a MFL recovery plan will be necessary for the 12 indicator regions identified in this modeling effort. Second, the instances in which the MFL criteria were exceeded were, for the most part, caused by drainage impacts associated with construction and operation of the Central and Southern Florida (C&SF) Project, while some areas may be influenced by a consumptive use withdrawal.

The next step taken was to conduct additional modeling to determine which areas of the Everglades may be affected by consumptive use withdrawals. The following preliminary screening analysis was conducted to identify these areas. The SFWMM simulated two scenarios using the assumptions in the LEC-1 simulation: 1) all LEC public water supply wellfields were turned on in the model, versus 2) all LEC public water supply wellfields were turned off in the model. These are referred to as the Pumps On and Pumps Off scenarios. Modeling results were evaluated using the set of environmental performance measures described in **Chapter 4** and **Appendix D** of this report and are similar to those used in the CERP evaluation process.

Results of the Pumps On and Pumps Off scenarios revealed five indicator regions within the Everglades system that were potentially susceptible to impacts from public water supply withdrawals, as shown in **Table 56**. With the wellfields turned off, improvements were observed in the number of times the MFL criteria were exceeded and the duration of the flooding, and a reduction was observed in the number of extreme low water events. These areas included 1) the Rockland marl marsh (11 percent difference in annual flooding); 2) eastern WCA-3B (six percent difference in annual flooding); 3) WCA-2B (five percent difference in annual flooding); 4) Northeast Shark River Slough (three percent difference in annual flooding), and 5) WCA-1, which showed an improvement in annual flooding (two percent), as well as significant reduction in the number of times the MFL criteria were exceeded. These preliminary results suggest that these five areas of the Everglades system have the potential to be impacted by water supply withdrawals to a limited degree.

Cutting off all public water supply wellfields was not considered practicable, due to the limited benefits to the regional system as projected in the model results balanced against 1) the cost of source replacement, 2) the potential water resource impact of large-scale Floridan aquifer development necessary to replace surficial supplies, and 3) long time frames required to develop such sources. These factors were also considered against the fact that the CERP planning process has already provided consensus based alternatives

Table 56. Summary of the LEC Water Utility Pumps On and Pumps Off Scenarios for Selected Everglades Sites[a] for the 2020 Base Case.

Area	Gage	IR[b]	Number of Times MFL Criteria Were Exceeded[c]	Inundation/Duration Summary[c]			Number of Extreme Low Water Events[c]
				Number of Flooding Events[c]	Duration (weeks)[c]	Percent Increase in Annual Flooding[c]	
Loxahatchee National Wildlife Refuge (WCA-1)	1-7	27	7/1	20/18	74/84	92/94 (2%)	5/1
WCA-2A	2A-17	24	8/7	18/16	80/92	90/92 (2%)	8/9
WCA-2B	central	23	7/6	15/14	93/104	86/91 (5%)	8/6
Holey Land WMA	HoleyG	29	5/5	11/11	140/140	96/96	5/5
Rotenberger WMA	Rotts	28	22/22	38/38	34/34	79/79	20/20
Northwest corner of WCA-3A	3A-NW	22	10/8	22/21	68/72	92/94 (2%)	8/6
Northwestern WCA-3A	3A-2	20	11/11	27/25	52/57	87/88 (1%)	10/8
Northeastern corner of WCA-3A	3A-3	68	10/8	19/17	76/85	90/90	8/8
Northeastern WCA-3A	3A-NE	21	8/7	17/15	88/101	92/94 (2%)	9/8
Central WCA-3A	3A-4	17	10/10	25/24	57/59	88/88	9/9
Southern WCA-3A	3A-28	14	8/7	17/18	88/83	93/93	5/7
WCA-3B	3B-SE	16	15/11	29/20	46/72	83/89 (6%)	19/12
Northeastern Shark River Slough	NESRS-2	11	9/7	20/18	71/82	88/91 (3%)	9/10
Central Shark River Slough	NP-33	10	7/7	15/13	100/117	93/94 (1)	7/8
Southwestern Shark River Slough	NP-36	9	8/6	15/15	98/100	91/93 (2)	11/9
Marl wetlands east of Shark River Slough	NP-38	70	15/13	61/61	15/16	58/59 (1%)	NA[d]
Marl wetlands west of Shark River Slough	NP-201	12	9/8	36/31	36/43	80/82 (2)	20/20
Rockland Marl Marsh	G-1502	8	24/19	40/40	19/23	46/57 (11%)	31/25
Taylor Slough	NP-67	1	16/16	38/36	30/32	71/72	28/28

a. Sites selected based on their potential for impact by a LEC wellfield withdrawal
b. IR = Indicator Region
c. First number in each box represents utility **Pumps On (full water use)**; second number represents **Pumps Off (a 30% cutback in water use by Miami-Dade County)**
d. NA = Not applicable

to meet the recovery goals of South Florida's natural systems. For these reasons, staff proceeded to model a more realistic consumptive use withdrawal scenario that incorporates assumptions based on the District's current water shortage policy.

This modeling effort was basically a sensitivity analysis to identify the relative magnitude of impact that a 30 percent cutback in public water supply might have on the five areas identified above. The sensitivity analysis was conducted with the SFWMM simulating 1) all LEC public water utilities pumps turned on; and 2) all LEC utilities turned on, with Miami-Dade County's wellfields reduced by 30 percent (the level of cutback associated with Phase II water shortage restrictions).

The purpose of this analysis was to see if simply implementing a water shortage cutback could reduce the number of times the MFL criteria was exceeded prior to the construction of the CERP projects. Modeling results were evaluated using the standard set of environmental performance measures developed for the LEC Plan (**Chapter 4** and **Appendix D**). These included review of 1) the number of times the MFL criteria were exceeded during the 31-year simulation period, 2) stage hydrographs and stage duration curves, 3) the number of flooding events and their duration, 4) the percent reduction or increase in annual flooding, and 5) the number of extreme high and low water events.

2005 Incremental Simulation with a 30 Percent Cutback. For the 2005 incremental simulation, three areas were identified that showed hydrologic differences between the two modeling scenarios. These areas were 1) the Rockland marl marsh located with Everglades National Park (Indicator Region 8), 2) Northeast Shark River Slough (Indicator Region 11), also located in Everglades National Park, and 3) southeast WCA-3B (Indicator Region 16). All three of these sites are located within the extreme western portion of urbanized Miami-Dade County (**Table 57**). The impacts of the 30 percent cutback to the other two areas were not measurable.

Table 57. Results of the Model Simulation for Selected Everglades Sites[a]: 2005 versus 2005 with a 30 Percent Cutback in Public Water Supply Withdrawals for Miami-Dade County.

Area	IR[b]	Number of Times MFL Criterion Was Exceeded[c]	Inundation/Duration Summary[c]			Number of High Water Events[c]	Number of Low Water Events[c]	Average Duration of Low Water Events[c] (weeks)
			Number of Flood Events[c]	Average Duration (weeks)[c]	Percent Change in Annual Flooding[c]			
Loxahatchee National Wildlife Refuge (WCA-1)	27	5/5	21/21 (3)	71/71	92/92	5/5	4/4	3/3
WCA-2A	24	14/14	23/23	60/60	86/86	0/0	16/16	5/5
WCA-2B	23	16/16	25/24	48/50	74/74	23/22	21/21	9/9
Northwestern WCA-3A	22	14/14	34/33	40/42	85/85	0/0	16/15	6/6
Northeastern WCA-3A	21	12/12	17/17	83/83	87/87	3/3	12/12	6/6
Central WCA-3A	17	8/8	17/17	88/88	93/93	5/5	8/7	4/4
Southern WCA-3A	14	1/2	10/8	158/198	98/98	19/17	1/0	1/0
WCA 3-B	16	10/10	21/19	68/76	88/90 (2%)	5/5	13/12	4/3
Northeastern Shark River Slough	11	11/11	23/20	61/72	87/89 (2%)	14/13	12/11	6/6
Central Shark River Slough	10	11/11	22/22	66/66	90/90	2/2	12/13	5/5
Southwestern Shark River Slough	9	10/10	20/21	71/68	89/89	0/0	16/16	4/4
Rockland Marl Marsh	8	21/20	35/37	27/26	58/60 (2%)	0/0	26/27	13/12
C-111 Perrine Marl Marsh	4	NA[d]	81/79	10/10	49/50 (1%)	0/0	43/48	34/30
Mid-Perrine Marl Marsh	3	NA[d]	48/48	18/18	52/53 (1%)	0/0	31/28	4/4
Taylor Slough	1	16/16	38/38	30/30	71/72 (1%)	1/1	27/27	4/4

a. Sites selected based on their potential for impact by a LEC wellfield withdrawal
b. IR = Indicator Region
c. First number in each box represents utility **Pumps On (full water use)**; second number represents **Pumps Off (a 30% cutback in water use by Miami-Dade County)**
d. NA = Not applicable

Review of stage hydrographs and stage duration curves for each of these three sites showed very minor differences in performance between the Pumps On and the 30 Percent Cutback modeling scenarios. Differences in performance between the two model simulations were small and included 1) a two percent improvement in hydroperiod (annual flooding), 2) a small increase in the number of continuous flooding events, and 3) a decrease in the number of times the MFL criteria were exceeded for the Rockland marl marsh recorded under the 30 Percent Cutback scenario (**Table 57).** The improvements identified under the 30 Percent Cutback scenario are very close to or within the assumed confidence limits of the SFWMM and, therefore, may not be significant.

It should also be noted that this modeling scenario implements a 30 percent, year-round cutback for Miami-Dade County for the 31-year simulation. It is unlikely the District would impose a 30 percent cutback in public water supply for Miami-Dade County during wet periods or under normal rainfall conditions. The only time a 30 percent cutback would actually be in effect would be during a major drought period. Therefore, impacts or improvements to Everglades wetland hydrology observed under an actual 30 percent cutback scenario may be considerably less than those shown in **Table 57**.

LEC-1 Revised Simulation with a 30 Percent Cutback. By 2020, most of the CERP water supply and natural system restoration projects will be built and operating. Comparison of the Pumps On and the 30 Percent Cutback scenarios showed that only two areas have experienced hydrologic differences by 2020. These areas were 1) the Rockland marl marsh (Indicator Region 8) and mid-Perrine marl marsh (Indicator Region 3), each located within eastern portion of Everglades National Park (**Table 58**).

The largest difference recorded was within the Rockland marl marsh where a three percent improvement in hydroperiod (average annual flooding) was observed under the 30 Percent Cutback scenario (**Table 58**). In addition, a small decrease in the number of MFL criteria violations for the Rockland marl marsh was observed under the 30 Percent Cutback scenario. In the mid-Perrine marl marsh, a two percent improvement in hydroperiod and a small increase in the number of continuous flooding events was observed when the 30 percent cutback was imposed (**Table 58**). Again, these results are close to the confidence limits of the SFWMM. It is unlikely the District would impose a 30 percent year-round cutback in public water supply for Miami-Dade County. Therefore, the observed differences between model simulations would more than likely be less than those presented in **Table 58**.

These cutbacks did not show a significant reduction in the number of times the MFL criteria were exceeded, suggesting that a 30 percent cutback would not be effective in improving the MFL performance in the Everglades. As a result, the recommended MFL recovery program for the Everglades does not incorporate cutbacks of consumptive use permits.

The District's current CUP criteria prohibits the issuance of permits that would cause harm to the water resources. As a result, in areas where the MFL criteria are being exceeded (significant harm occurring), no consumptive use permits could be issued that would cause an additional drawdown under the 1-in-10 year level of certainty.

Table 58. Results of the Model Simulation for Selected Everglades Sites[a]: LEC-1 Revised versus LEC-1 Revised with a 30 Percent Cutback in Public Water Supply Withdrawals for Miami-Dade County.

Area	IR[b]	Number of Times MFL Criterion Was Exceeded[c]	Inundation/Duration Summary[c]			Number of High Water Events[c]	Number of Low Water Events[c]	Average Duration of Low Water Events[c] (weeks)
			Number of Flood Events[c]	Average Duration[c] (weeks)	Percent Change in Annual Flooding[c]			
Loxahatchee National Wildlife Refuge (WCA-1)	27	1/1	12/12 (3)	129/129	96/96	7/7	1/1	1/1
WCA-2A	24	8/8	13/13	112/112	91/91	5/5	11/11	6/6
WCA-2B	23	8/8	19/18	71/75	83/84 (1%)	21/22	12/12	8/7
Northwestern WCA-3A	22	6/5	27/20	56/76	94/95 (1%)	0/0	4/4	4/3
Northeastern WCA-3A	21	15/14	26/26	52/52	83/84 (1%)	7/7	17/19	5/4
Central WCA-3A	17	4/4	16/16	96/96	95/96 (1%)	2/2	5/5	3/3
Southern WCA-3A	14	4/5	11/12	140/128	95/95	3/3	4/4	3/3
WCA 3-B	16	3/3	10/10	154/155	96/96	13/16	3/3	3/2
Northeastern Shark River Slough.	11	2/2	15/11	105/143	97/98 (1%)	8/10	2/3	3/2
Central Shark River Slough	10	2/2	9/10	175/158	98/98	3/3	2/2	3/2
Southwestern Shark River Slough	9	4/4	15/13	103/119	96/96	0/0	6/5	2/2
Rockland Marl Marsh	8	22/20	38/39	23/24	55/58(3%)	0/0	28/25	10/10
C-111 Perrine Marl Marsh	4	NA[d]	45/42	27/29	76/76	11/11	49/48	18/18
Mid-Perrine Marl Marsh	3	NA[d]	50/48	17/18	52/54 (2%)	0/0	34/33	4/4
Taylor Slough	1	16/16	37/36	31/32	71/71	5/5	28/28	4/4

a. Sites selected based on their potential for impact by a LEC wellfield withdrawal
b. IR = Indicator Region
c. First number in each box represents utility **Pumps On (full water use)**; second number represents **Pumps Off (a 30% cutback in water use by Miami-Dade County)**
d. NA = Not applicable

Consumptive uses that would cause an increase in the number of times the MFL criteria were exceeded within the Everglades would also not be permittable.

As a result of these factors, the main component of the MFL recovery plan for the Everglades is the construction and operation of the CERP and LEC regional water supply planning projects slated for completion between 2010 and 2020. In the interim, the plan recommends that the District conduct an annual assessment of the availability of water supply in regional storage available for releases to prevent the MFL criteria from being exceeded. To the degree practicable, the District's Governing Board shall authorize staff to make releases to prevent violations of the proposed MFL criteria.

With regard to the CUP process, no new uses or increased withdrawals, notwithstanding seasonal withdrawals for ASR storage that do not impact MFL criteria, that directly cause additional drawdowns beneath areas where MFL criteria are not met, will be permitted prior to the implementation of water resource development projects for recovery of these areas. The District will initiate rulemaking to reserve from allocation water intended for meeting hydropattern goals in the Everglades. These reservations will reflect initial limits on water availability in the regional system due to lack of storage, and will be revised or upgraded every five years, as needed, as CERP projects come on line. Finally, all CUP applicants will be required under District rule to demonstrate that their uses are efficient and consistent with the increase in water supplies as projects are implemented. To achieve this, the District will establish rules to further implement efficiency measures for use of water from the regional system, including criteria for capture of ASR water, and to limit by rule water allocations for new or increased cumulative demands from regional water supplies to five-year periods.

Biscayne Aquifer

Identified measures to prevent the MFL criteria from being exceeded for the Biscayne aquifer are as follows: 1) maintain coastal canal stages at the minimum operation levels shown in the MFL report; 2) implement CUP conditions for issuance to prevent harmful movement of saltwater intrusion up to a 1-in-10 year level of certainty; 3) maintain a ground water monitoring network and utilize data to initiate water shortage cutbacks should the threat of saline water movement become imminent; and 4) conduct research in high risk areas to identify where the position of the saltwater front is adjacent to existing and future potable water sources.

MFL Monitoring Systems (Recommendations 39)

Monitoring systems must be established in order to implement MFL recovery and prevention strategies and conduct research necessary to further refine the ability to project when significant harm could occur. The monitoring systems will collect water flow, water level, and water quality data. Monitoring data is necessary to affect interim operational strategies and to gage the success of MFL long-term recovery and prevention strategies.

Consumptive Use Permitting, Rulemaking, and Resource Protection Projects (Recommendations 40)

Specific rule provisions are necessary for implementation of the regulatory program, to be consistent with both the LEC Plan and localized resource protection standards. These are discussed below.

Level of Certainty

The level of assurance provided to consumptive users and the environment that water will be available to meet the reasonable demands up to specific hydrologic conditions must be defined by rule. The allocation methodologies and impact evaluations will be modified to reflect the 1-in-10 year level of certainty planning goal used in the water supply plan. For the purposes of determining allocation and evaluating the impacts of an allocation, the proposed rules will define 1-in-10 rainfall conditions across the entire district utilizing statistical methods and historic rainfall data (See **Proposed Methodology for Defining and Assessing the 1-in-10 Year Level of Certainty for the Lower East Coast Planning Area** in **Appendix I**).

Permit Duration

Section 373.236 (1), F.S., Duration of Permits, states the following in relevant part:

> Permits shall be granted for a period of 20 years, if requested for that period of time, if there is sufficient data to provide reasonable assurance that the conditions for permit issuance will be met for the duration of the permit; otherwise permits may be issued for shorter durations which reflect the period for which such reasonable assurances can be provided.

The District will define by rule the conditions for issuance of 20-year permits and permits for lesser durations when sufficient information exists to provide reasonable assurances that the use will continue to meet the initial conditions for issuance, pursuant to Section 373.239, F.S., This will incorporate phased increases in allocations to meet increasing reasonable-beneficial uses incrementally, with implementation of water resource development projects as recommended in the LEC Plan.

A conceptual framework for implementing the permit duration statute has been set forth by District staff, and will be further refined in the rule development and rule making processes. Within this framework, two basic permit duration scenarios have been developed. The first scenario applies to permits for use of a source that will continue to be available for the planning horizon (20 years). The second scenario is for permits for use of sources where water availability depends upon future water resource development, including augmentation to meet current and increased user demands. Issuance of permits which fall into the second scenario will be determined as follows: a) the water quantity initially available (from 2000 through 2005) to meet initial demands of consumptive uses will be allocated for a 20-year period; and b) when additional water allocations from the source are requested to meet increasing demands, water that may become available through water resource development projects and other measures will be allocated in five-year increments. Permit modification will be required to receive allocation for these increased demands. These permits will extend for 20-year periods.

Saltwater Intrusion Criteria

Hydrologic conditions under which harmful saline water intrusion will not occur as a result of cumulative existing and proposed consumptive use withdrawals during a 1-in-10 year drought need to be defined by rule. Existing water resource protection criteria for saltwater intrusion will remain and an additional method of analysis (flow vector analysis for net inflow during a 1-in-10 year drought) will be added. The vector analysis will be reflective of the evaluation conducted under the LEC Plan. In this process, the rules will be amended to require the applicant to measure the magnitude of ground water flow across the 250 milligrams per liter (mg/L) isochlor (saltwater-freshwater interface), assuming the maximum annual allocation withdrawal simulated during a 1-in-10 year drought event. For uses in which the net flow across the interface is either eastward or is zero for the drought event, the saltwater criteria will be met. Projects that produce a net westward flow of saline water will be denied.

Wetlands and Other Surface Waters Protection

Numeric drawdown criteria for defining hydrologic conditions under which harm to the water resource functions to wetlands and other surface waters is projected to occur have been under development for the last several years. These criteria will be finalized for evaluation of the potential drawdown impacts of cumulative existing and proposed consumptive use withdrawals during a 1-in-10 year drought. Criteria differentiating wetland types according to hydrologic characteristics will also be proposed. Special factors for consideration in the hydrologic impact analysis, such as listed species utilization in wetland areas, will be incorporated into the rule. Requirements for avoidance and minimization of harmful consumptive use impacts will be identified. In addition, circumstances for use of mitigation to offset projected harmful impacts will be explored for inclusion in the rule, consistent with FDEP policy direction on this issue. Finally, public interest considerations for identifying circumstances when application of proposed wetland drawdown parameters would cause undue hardship, inconsistent with Section 373.223, F.S, Conditions for Permit Issuance, will be explored and considered for adoption, as appropriate.

Permit Renewal Process

The timing of, and process for, the renewal of consumptive use permits must be identified. Staff contemplates that four years will be required to review all permits throughout the District, in the following order of planning areas: Upper East Coast, Lower West Coast, Lower East Coast, and Kissimmee Basin. In the interim period, public water supply permit durations will be linked to the date identified for renewal of irrigation permits.

Regional Water Availability Criteria

The CUP program contains water resource rules must protect against harmful withdrawals, but does not analyze the regional cumulative impact of allocating water from the C&SF Project, as a source of either surface or ground water (induced seepage under the levees). Up to now, this approach was considered adequate for protecting the water resources from harm. However, now that MFL criteria and Everglades Protection Area restoration projects are being implemented, along with the potential for increasing human demands from the regional system, regional criteria must be developed to assess how much water is available for allocation and to meet environmental demands from the regional system.

The LEC preferred alternative (LEC-1 Revised) estimates the amounts of water available for each service area upon implementation of the LEC Plan over the next 20 years. The model evaluations conducted for the interim periods (2005, 2010, and 2015) define the incremental availability of water to each county (Palm Beach, Broward, and Miami-Dade) and for the upper and lower Indian Prairie/Istakpoga Basin from the regional system during 1-in-10 drought conditions (from ground water seepage and surface water flows, as appropriate).

Improved Pasture Irrigation

Current allocation criteria for improved pasture irrigation are based on a volume of water needed to irrigate turf grass using a seepage irrigation method. The supplemental irrigation requirement in the existing *Basis of Review for Consumptive Use Permit Applications* (SFWMD, 1997d), is based on demands during a moderate drought condition, which would not be expected to occur once every five years. It is projected that the actual use of water for improved pasture is considerably below what this current allocation criteria allows. As a result, it is recommended that such criteria be revised to more accurately reflect actual irrigation practices and the amount of water necessary for pasture irrigation.

Water Shortage Plan

The District will develop and adopt water shortage triggers to avoid causing significant harm to water resources, in conjunction with the implementation of the *Water Shortage Plan* (Chapter 40E-21, F.A.C.). Water shortage triggers to implement natural system protection and water supply source protection have been identified in the planning process and integrated into the LEC-1 and LEC-1 Revised simulations.

Resource protection criteria are designed to prevent harm to the resources up to an 1-in-10 year drought event. For drought conditions greater than an 1-in-10 year event, it may be necessary to decrease water withdrawals to avoid causing significant or serious harm to the resource. Water shortage triggers, or water levels at which phased restrictions will be declared, are used to curtail withdrawals by water use types and avoid water levels declining to a minimum level where significant harm to the resource could potentially occur.

Water shortage rule revisions will include language which addresses the conditions by which cutbacks to rainfall-based water reservations would be required during Phase I or Phase II water shortage restrictions. During Phase III or greater conditions, no restrictions to the rainfall delivery schedule in the reservation rule will be imposed, unless specifically ordered by the Governing Board, after consideration of the conditions on a case-by-case basis, in consultation with the public, and upon a finding of an overriding public interest.

Even though water shortage triggers will be established, a case-by-case analysis for a given drought circumstance will continue to exist. Thus, prior to declaring a water shortage, the District will also analyze the factors listed in the *Water Shortage Plan* concerning such issues as 1) whether or not sufficient water will be available to meet the estimated and anticipated user demands and 2) whether serious harm to the water resource will occur.

Special Areas Designations

Two special area designations contained in the Water Use Permitting Program were reviewed based on the findings of this planning effort. Definitions of the designations and recommended changes, if any, are provided below.

Reduced Threshold Areas. Reduced Threshold Areas (RTAs) are areas of the District where the volume of usage delineating a general permit from an individual permit has been reduced from 100,000 gallons per day (GPD) to 10,000 GPD for average daily demand. RTAs have typically been designated in resource depleted areas that have an established history of substandard water quality, saline water movement, or the lack of water availability to meet the projected needs of a region. Results of the LEC Plan and increased impact analysis capabilities did not indicate significant potential problems. Assessment determinations are conducted for all consumptive use applications. For withdrawals less than 100,000 GPD, qualifying for a general permit versus an individual permit will be based on the potential cumulative impacts of the use.

Water Resource Caution Areas. Water Resource Caution Areas (WRCAs) were formerly referred to as Critical Water Supply Problem Areas and are described in Chapter 40E-23, F.A.C. WRCAs are defined as areas that have existing water resource problems or areas in which water resource problems are projected to develop over the next 20 years. Diversification of supply sources is currently occurring within some of these areas and it is anticipated these areas will change designation in the future once sufficient diversification has been realized. Water resource caution area boundaries will be redefined in the Lower West Coast (LWC) Planning Area pursuant to the results of the water supply plan analyses and evaluation. No changes in the boundaries in the LEC or Kissimmee planning areas are contemplated.

Reuse of Reclaimed Water

Legislation enacted in 1994 requires all water management districts to adopt reclaimed water rules that address use of water from other sources in emergency situations or when reclaimed water is unavailable. These rules are to be adopted for the implementation in the upcoming permit renewal process. In addition, existing rules regarding reuse feasibility will be considered for adoption.

Diversion and Impoundment

Allocation criteria for diversion and impoundment uses need to be identified. Criteria developed for allocation will consider efficiency in surface water delivery systems and recycling of water between crops. The allocation criteria will be primarily applicable to agricultural related systems.

CUP Model Applications

Ground water computer models used for the LWC and LEC regional water supply planning processes need to be modified for application in determining individual impacts of CUP applications. Rule changes identifying application of models in the CUP review process will be adopted, as appropriate.

Aquifer Storage and Recovery Permitting

Projects that involve diverting surface or ground water for storage underground in the Floridan Aquifer System must address the potential impacts of the use with regard to water resource protection and existing legal user protection. Prior to injecting the fresh water underground for storage, the applicant will be required to demonstrate that the fresh water stored will be protected from other users. Other users of the Floridan Aquifer System will seek assurances that the storage of fresh water and the resulting changes in the water chemistry and hydrostatic pressure within the aquifer will not be harmful to their proposed use. The ASR rule will address the impacts of initial diversion of water, the reasonable quantities necessary for the project, the impacts of injection on other existing legal users, the impacts of the withdrawals of water from storage in other existing legal user ASR projects, and interference caused by intermingling of water of differing water qualities on other uses. Criteria for the capture of water for storage during the wet times should be incorporated into the ASR allocation process through rulemaking.

BMP Makeup Water Rule Revisions

Previously, it had been estimated that the implementation of Best Management Practices (BMPs) in the EAA would reduce the volume of runoff available to be sent south into the Everglades by 20 percent. Since this rule was implemented in 1995, data collected and evaluated suggests that there is minimal reduction in runoff from the EAA due to BMP implementation. Therefore, it is recommended that the current BMP makeup water rule be revisited through a public rulemaking process to incorporate this new information

Other Water Resource Projects

This section includes a water conservation program. Also, through the planning process, several evaluation and feasibility projects have been identified which will be completed and used in the formulation of the next update of the LEC Plan.

Comprehensive Water Conservation Program (Recommendation 41)

Implementation of conservation measures by individual users is a water supply development activity, but these efforts need to be evaluated and supported as a water resource development project. Therefore, staff recommends establishing a comprehensive water conservation program. The program will both evaluate the implementation of existing conservation regulations and programs and conduct outreach to assure that all conservation opportunities are being implemented.

Seawater Reverse Osmosis Treatment Facilities (Recommendation 42)

Recently, Tampa Bay Water approved a plant to obtain water from seawater by direct osmosis treatment. Proposed costs were significantly lower than other seawater desalination costs to date, and apparently reflect energy and disposal cost reductions due to the colocation of the plant with an existing coastal power plant. This project will evaluate the feasibility of colocating similarly designed plants at existing power plants in the LEC Planning Area. The feasibility studies will seek to determine the likelihood that the large cost reductions estimated for the Tampa plant are achievable. The District is initiating the feasibility study during the present fiscal year (2000).

Obtaining treated seawater much more cheaply than has previously been experienced has significant water resource development implications. Taking into account the savings in conventional water treatment costs, the use of seawater reverse osmosis treatment facilities may provide significant net savings compared to proposed CERP projects, such as the wastewater reuse facilities in Miami-Dade County, as a means to capture or provide additional water.

Reclaimed Water System in Northern Palm Beach County (Recommendation 43)

This project will evaluate the feasibility of developing a regional irrigation water system for northern Palm Beach County and Martin County, utilizing reclaimed water from central Palm Beach County. Not only would this help meet future needs for irrigation water, but it would help recharge coastal aquifers, lessening saltwater intrusion threats, potential impacts on wetlands, and movement of existing pollutant plumes. It would also lessen the dependency of wastewater utilities on deep well disposal. The evaluation of this system will have to be coordinated with the CERP projects planned for this area.

Indirect Aquifer Recharge (Recommendation 44)

Large amounts of secondarily treated wastewater are generated by wastewater utilities. While programs to promote and encourage reuse have been in effect for many years, the amount of reuse has remained small relative to the water potentially available. This project will examine ways in which reuse of reclaimed water can be increased while assuring that the reuse systems contribute to meeting water supply and environmental restoration goals that are commensurate with the additional costs that will be incurred.

Four facilities, which will produce reclaimed water (wastewater reuse) are included in the CERP process. The two largest projects are located in Miami-Dade County and together are expected to provide by 2020 about 200,000 ac-ft (230 MGD) of advanced treated water to recharge the coastal canals and aquifer in Miami-Dade County. The remaining two projects are located in Palm Beach County. The Palm Beach County Wetlands-Based Water Reclamation Project will take advanced treated water which will be further treated in a series of rehydrated marshes and eventually used to recharge wellfields and other areas. The Winsburg Farm Constructed Wetland, will use reclaimed water to hydrate 175 acres of constructed wetlands. The efforts of the indirect aquifer recharge project will need to focus on issues not covered in these related CERP projects.

High Volume Surface Water ASR Testing in Taylor Creek (Recommendation 45)

An opportunity may exist to utilize the District-owned ASR well located by Taylor Creek in Okeechobee County to test the practicality of using injection/recovery rates of 20 MGD into a prolific zone of the Floridan aquifer. Permit and well repair issues need to be resolved as part of this effort.

WATER SUPPLY DEVELOPMENT OPTIONS

Water supply development options are discussed below in terms of the water sources on which they will rely. These sources are as follows:

- Conservation
- Ground Water (including the Biscayne/Surficial and the Floridan aquifer systems)
- Reclaimed Water
- Seawater Desalination
- Storage (including ASR and Reservoirs)
- Surface Water Sources

Water supply options which utilize each water source are discussed below with regard to their potential for use in the LEC Planning Area. For each option, the following information is presented: definition and discussion, estimated costs to develop that option and the quantity of water potentially available from that option, and conclusions regarding the potential of the water supply options which use each water source. This information is provided so that individual water users can better evaluate alternative water supply sources and select the alternative, or combination of alternatives, which best suit local conditions. That the water users conduct such an evaluation is the substance of **Recommendation 46** in **Chapter 6**.

Conservation

Definition and Discussion

This water supply option incorporates water conservation measures that address water demand reduction and capture of water that would otherwise be discharged to tide, including practices that achieve long-term permanent reductions in water use. Establishing a water conservation goal or conservation ethic was discussed by the LEC Regional Water Supply Plan Advisory Committee when goals and objectives were first considered for this plan. The following LEC Plan objectives were formed based on these discussions:

- Protect and conserve the water resources of South Florida to ensure their availability for future generations
- Provide for the equitable, orderly, cost-effective, and economical development of water supplies to meet South Florida's environmental, agricultural, urban, and industrial needs

The committee further discussed whether advanced levels of water conservation should be implemented beyond current mandatory requirements regardless of the cost, or whether advanced levels should be considered as a tool or source option to be evaluated with other source options to meet the water needs of a particular area.

Mandatory Requirements

In 1988, The District began working with utilities to implement a conservation program through the CUP process. In 1991, the program was incorporated by rule and became part of the permitting process. The water conservation plans must incorporate specific elements depending on the type of use. For public water suppliers, the elements are an irrigation hours ordinance, a Xeriscape™ landscape ordinance, an ultra-low volume fixture ordinance, a rain sensor device ordinance, a water conservation-based rate structure, a leak detection and repair program, a public education program, and a reclaimed water feasibility evaluation. For commercial and industrial users the requirements include a water use audit, an employee water conservation awareness program, and implementation of cost-effective conservation measures. For landscape and golf course users the requirements are Xeriscape™ landscaping, the use of rain sensor devices, and irrigation hour limitations. For agricultural users, the requirement is that micro irrigation systems be used for new citrus and container nursery projects. In addition to these CUP requirements, conservation requirements are also incorporated in Recommended Orders for Developments of Regional Impact (DRI).

Depending on the demographics and location of the service area, utilities can choose to demonstrate which water conservation activities are more cost-effective for their situation and emphasize implementation of those activities in their conservation plan. Four of the mandatory water conservation elements require adoption of an ordinance by local governments. Generally, because of the home rule autonomy of local governments, each ordinance has to be adopted by each unit of local government for the measure to be fully implemented. Investor-owned utilities (private) do not have the authority to pass ordinances, so they must request the adoption of appropriate ordinances by local governments who have jurisdiction in that utility's service area. Utilities are not required to have a leak detection program if their unaccounted for water is less than 10 percent. An integrated program between the CUP Program and local ordinances is created when local governments have adopted the ordinances and established a compliance program.

In the period from 1988, when these requirements were first implemented, to 1995, substantial reductions in per capita consumption of about 13 percent were achieved by water utilities and their customers. This reduction in per capita use translates to a savings of approximately 118 MGD for the utilities listed in **Table 59**. This evaluation compares

Table 59. Changes in Per Capita Water Use for Larger Utilities within the District.

UTILITY	1988			1992			1995			Percent Change in Per Capita Use
	MGD	Pop.	Per Capita Use	MGD	Pop.	PCUR	MGD	Pop.	Per Capita Use	
Miami-Dade Water and Sewer Department	152.8	715,000	214	168	810,000	207	168.2	933,000	180	-16%
Miami-Dade Water and Sewer Department	153.6	790,000	194	158.1	824,000	192	166.8	852,000	196	1%
Orlando Utilities Commission	67.25	309,800	217	74.6	339,700	220	78.48	353,300	222	2%
City of Fort Lauderdale	54.71	215,300	254	50.2	227,000	221	48.7	230,000	212	-17%
Palm Beach County Water Utilities	24.54	210,000	117	32.45	261,600	124	33.7	282,500	119	2%
City of Boca Raton	45	97,700	461	36.85	109,800	336	35.91	116,900	307	-33%
City of West Palm Beach										
Kissimmee	5.44	60,000	91	12.1	99,900	121	13.55	125,200	108	19%
City of Cape Coral	8.8	37,600	234	10	68,400	146	8.66	77,200	112	-52%
Town of Jupiter										
City of Sunrise	13.94	107,100	130	15.77	129,200	122	18.1	141,800	128	-2%
Reedy Creek Improvement District										
Collier County Water Sewer District	4.08	21,400	191	12.1	66,900	181	16.85	86,400	195	2%
City of Hollywood	20.2	128,300	157	18.9	140,300	135	19.3	140,700	137	-13%
Seacoast Utility Authority	14	56,600	247	13.9	71,300	195	13.9	72,000	193	-22%
City of Pompano Beach	18.83	83,300	226	16.25	73,000	223	16.23	74,000	219	-3%
City of Naples	18.37	49,600	370	16.25	53,174	306	15.81	55,600	284	-23%
City of North Miami Beach										
Broward County Office of Environmental Protection										
City of Plantation	10	59,300	169	12.3	67,500	182	13.9	73,600	189	12%
City of Delray Beach	11.2	60,400	185	12.16	63,100	193	12.13	65,300	186	-0%
Florida Keys Aqueduct Authority	13.2	129,500	102	12.99	139,100	93	14.08	144,300	98	-4%
Orange County Public Utilities	3.59	17,500	205	5.29	35,700	148	6.94	43,900	158	-23%
City of Boynton Beach	10.97	68,000	161	12.14	83,786	145	12.78	89,800	142	-12%
City of Pembroke Pines	6.1	59,000	103	7.44	70,100	106	9.33	87,900	106	3%
Collier County Utilities Division										
Lee County Board Of Commission	8.17	64,800	126	8.53	83,700	102	8.58	90,435	95	-25%
City of Homestead	6.96	30,400	229	6.1	30,100	203	6.47	32,300	200	-13%
City of Deerfield Beach	10.85	51,800	209	10.76	54,800	196	11.3	56,900	199	-5%
City of Fort Myers										
Broward County	13.97	65,200	214	13.65	87,700	156	14.55	91,900	158	-26%
Fort Pierce Utilities Authority	8.52	52,000	164	9.29	56,400	165	9.3	58,600	159	-3%
Average			**199**			**177**			**172**	**-13%**
Totals	**705.09**	**3,539,600**		**746.12**	**4,046,260**		**773.55**	**4,375,535**		

the actual water use against permanent populations of the service areas for utilities which use over four billion gallons per year. Some utilities were excluded from the evaluation because of changes in treatment efficiency and for other statistical and data availability reasons. Since these reductions are incorporated in the 1995 Base Case, the relevant issue for the LEC Plan is the additional conservation that can be achieved.

Supplemental Measures

There are also several supplemental water conservation measures that local users could implement if they deem any of the measures to be cost-effective. Measures for urban users include indoor and outdoor retrofits and landscape audit and retrofit; public water supply utilities include filter backwash recycling and distribution pressure control; and agricultural users include irrigation audits and improved scheduling, and retrofitting with a micro irrigation system.

Mobile Irrigation Labs

A conservation program implemented in several areas of the District, with District financial support, is deployment of Mobile Irrigation Labs (MILs). Labs are usually identified as agricultural MIL or urban MIL. Urban labs typically serve landowners with less than 10 acres of irrigated lands. These labs conduct performance evaluations for both agricultural and urban irrigation systems free of charge as a public service. The MIL program helps to develop a conservation ethic among water users while providing practical advice on how to achieve significant water savings.

Two MILs are currently serving the LEC Planning Area. An agricultural lab is headquartered at the South Dade Soil and Water Conservation District (SWCD) office in Homestead and serves Miami-Dade County. This lab also performs some urban evaluations. The other lab is headquartered at the SWCD office in West Palm Beach and performs urban evaluations in Palm Beach County. Funding for these labs has been provided by the District and the Natural Resource Conservation Service (NRCS). However, recent decisions by the Governing Board have indicated that this is not a core program for funding by the District. As a result, District participation in funding will be limited to providing staff to garner support from other agencies such as FDEP, Florida Department of Agriculture and Consumer Services (FDACS), and SWCDs, as well as users.

The annual operating cost for an urban MIL is approximately $70,000 and annual operating costs are $130,000 for an agriculture MIL. Both of these labs are working near their capacity in terms of the number of evaluations that can be performed in a year. As a result, it is recommended that an additional urban MIL should be established at the Broward County SWCD to serve the Fort Lauderdale area. Dedicated sources of funding need to be established for the existing, as well as the recommended MILs.

Cost-Effectiveness Analysis from the FY 1998 MIL Program. Typical costs and savings for urban and agricultural MILs such as those in Palm Beach and Miami-Dade counties are presented in **Table 60**. These costs are from the 1998 Annual

MIL Report (South Dade SWCD, 1998). The costs per 1,000 gallons saved compare favorably with alternative source development. This cost-effectiveness will be magnified to the degree that cost-savings from a single mobile lab visit extend over several years. Another environmental benefit of the urban and agricultural mobile lab program is the reduction of pollution from fertilizers and pesticides applied to urban landscapes and cropland. One of the key components of the MIL program, education, is not illustrated in this table.

Table 60. 1998 Mobile Irrigation Lab Costs and Estimated Water Savings.

Lab	Annual Cost	Potential Savings (1,000 gallons per year)	Total Cost (per 1,000 gallons saved)
Urban	$70,000	79,500	$0.88
Agriculture	$130,000	1,470,000	$0.09
Total	$200,000	1,549,500	$0.13

Conservation Estimated Costs

The estimated conservation costs are broken down into urban and agricultural measures. The information in this section should not be interpreted as a benefit-cost analysis of these conservation measures.

Urban Conservation Measures. Cost and water savings for several indoor and outdoor urban retrofit water conservation measures are provided in **Tables 61** and **62**. For urban water conservation methods, the analysis indicated the value of the savings is greater than the costs of the methods. The savings per unit of cost associated with outdoor conservation measures are generally greater than those for indoor conservation measures, primarily because of the larger volumes of water involved. Water savings associated with implementation of retrofit programs can be significant. For example, retrofitting 10,000

Table 61. Representative Water Use and Cost Analysis for Retrofit Indoor Water Conservation Measures.

	Toilet	Showerhead
Cost/unit	$200	$20
Flushes/day/person	5	--
Gallons saved/flush	1.9	--
Minutes/day/person	--	10
Gallons saved/minute	--	2
Persons/unit	2.5	2.5
Life	40 years	10 years
Savings/year/unit	8,670 gallons	9,125 gallons
Savings/unit over life	346,800 gallons	91,250 gallons
Cost/1,000 gallons saved	$0.58	$0.22
Gallons saved/dollar invested	1,730 gallons	4,560 gallons

Table 62. Representative Water Use and Cost Analysis for Retrofit Outdoor Water Conservation Measures.[a]

Cost/unit or visit	$68
Acres/unit	0.11 acres
Water savings (inches/year)	70 inches
Water savings (gallons/year)	209,070 gallons
Life	10 years
Water savings/life	2,090,700 gallons
Cost/1,000 gallons saved	$0.033
Gallons saved/dollar invested	30,750 gallons

a. Represents additional cost of site visit (currently compensated by NRCS and the District)

showerheads in an area could result in a water savings of 182 MGY (0.50 MGD). Likewise, if 10,000 irrigation systems were retrofitted with rain switches, the water savings could be more than 2,000 MGY (5.73 MGD). One potential urban conservation method is for local governments to adopt ordinances limiting the number of days per week a home can irrigate. Such ordinances may achieve the same results as a rain switch retrofit program at significantly less cost.

Agricultural Conservation Methods. Conversion of existing flood irrigated citrus to micro irrigation is another potential source of water savings (**Table 63**). It is estimated by the University of Florida's Institute of Food and Agricultural Sciences (IFAS) that the initial cost to install a micro irrigation system for citrus is $1,000 per acre and the system would have estimated annual maintenance costs of $25 per acre per year (University of Florida, 1993). The table summarizes the cost and potential water savings from one acre of conversion. This comparison used the modified Blaney-Criddle formula, and the only variable that changed between the two scenarios was the efficiency factor. Return flow for flood irrigation was not accounted for. The water savings from converting 25,000 acres of citrus from flood irrigation with a 50 percent efficiency to micro irrigation with an 85 percent efficiency could result in a water savings of approximately 6,000 MGY (15.8 MGD). The analysis illustrates that given the large volumes of water used for irrigation by agriculture, water conservation savings (which can be achieved at a reasonable cost) will often be extremely cost effective compared to the costs of developing additional water supplies.

In addition to the water savings associated with conversion of flood irrigated citrus to micro irrigation, IFAS also has indicated that prescriptive applications of water and fertilizer can be made throughout the crop growing season with micro irrigation. However, micro irrigation systems generally have greater maintenance requirements than flood irrigation systems.

Table 63. Irrigation Costs and Water Use Savings[a] Associated with Conversion from Flood Irrigation to Micro Irrigation.[b]

Initial cost/acre	$1,000
Operating cost/acre	$25
Water savings (inches per year)	8.519 inches
Water savings (gallons/year)	230,805 gallons
Life	20 years
Cost over life	$1,500
Water savings over life	4,616,100 gallons
Cost/1,000 gallons saved	$0.33

a. Addresses reductions in pumpage only and does not include return flow
b. Source: IFAS and SFWMD

Estimates of the Quantity of Water Potentially Available from Conservation

Estimates of the amount of water that could be saved (or made available) through the use of water conservation practices in the LEC Planning Area were developed as part of the Restudy, using a model developed by the Institute of Water Resources (IWR-MAIN) to simulate municipal and industrial use (USACE and SFWMD, 1999). The model was used to estimate water use to 2050, based on land use, economic, and demographic projections. Projections were made with and without the implementation of conservation practices. The projections without conservation are called Projection A. The only conservation practice they incorporate is the effect of increasing block rate structures. Conservation practices included in Projection B, the conservation projection, are that all new construction would incorporate water-conserving faucets, showerheads, and toilets, that local governments would implement ordinances to restrict lawn irrigation to the period from 9 p.m. to 5 a.m. and that irrigation systems would be equipped with rain sensors. All of these efforts represent the continued implementation of existing federal, state, and District regulations and programs. The resulting per capita consumptions are presented in **Table 64**.

Table 64. Average Per Capita Water Use Resulting From Projections A and B.[a]

Year	Gallons/Capita/Day	
	Projection A	Projection B
2000	226	214
2010	228	207
2030	220	189
2050	215	178

a. Source: USACE and SFWMD, 1999

Results of conservation analysis based on IWR-MAIN, as compared to the without conservation analysis, are shown in **Table 65**. The percentage reductions in total average use within each service area vary, but for 2020, the percentages would generally range from 12 to 13 percent. This represents an estimate of the potential savings that could result when utilities and local governments enforce existing conservation programs and regulations, especially the installation of water conserving indoor fixtures in all new and replacement installations. These estimates of significant future reductions in per capita use are in contrast to the estimates developed and used in the LEC Plan which are based on utility estimates of demand and population. On average no increase or decrease in per capita consumption is anticipated between 1995 to 2020. According to utility estimates, only a slight decrease in per capita demands is anticipated by 2020.

Table 65. Percent Reduction in Total Average Use Resulting from Conservation.[a]

Service Area	2000	2010	2030	2050
Northern Palm Beach County	4.96%	9.56%	14.32%	17.37%
LECSA 1	4.53%	8.66%	13.00%	15.76%
LECSA 2	6.18%	10.12%	14.92%	18.12%
LECSA 3	5.01%	9.26%	14.27%	17.71%
Total	5.25%	9.39%	14.16%	17.34%

a. Extent to which conservation water use projection with conservation features in place is lower than the projection of water use without conservation (USACE and SFWMD, 1999).

Water Conservation Conclusions

- Effective water conservation programs can provide a cost-effective means to increase available water supplies.
- Restudy efforts and water utility estimates (used in the LEC Plan) differ as to whether existing water conservation programs and laws will ultimately accomplish a reduction in per capita consumption. Efforts should be undertaken to determine if existing programs and rules are being effectively implemented and whether they are achieving the expected reduction in per capita consumption.
- Efforts should be made to increase awareness of this water supply option and help local governments, utilities, and consumers to develop a conservation ethic and implement cost-effective water conservation practices and technologies.
- Water conservation related reduction goals should be established on a user-by-user basis, considering the particular factors and opportunities that characterize each use.

Surficial Aquifer Resources

Definition and Discussion

The surficial aquifers are the major source of water in the LEC Planning Area. The Surficial Aquifer System (SAS) includes two major aquifers in the LEC Planning Area. The Biscayne aquifer is located within Miami-Dade, Broward, and southern Palm Beach counties. An undifferentiated surficial aquifer is found in the remainder of Palm Beach County. The entire SAS is unconfined, consisting of varying amounts of limestone and sediments that extend from the land surface to the top of an intermediate confining unit. This intermediate confining unit consists of several hundred feet of low-permeability clays and marls and effectively separates the SAS from the underlying Floridan Aquifer System (FAS) in much of the planning area. Almost all municipal and irrigation water is obtained from the SAS in South Florida.

The second aquifer system, the FAS, is divided into the upper and the lower Floridan aquifers by a middle confining layer. The Floridan aquifer is a source of fresh water north of Lake Okeechobee (e.g., Orlando area), but moving south of Lake Okeechobee and into South Florida, the aquifer deepens and becomes more mineralized. The upper Floridan aquifer along the lower east coast, from Jupiter to south Miami, is comprised of brackish water and in some cases is used as a source of water for reverse osmosis systems and for storage of potable water using ASR technology.

The lower Floridan is isolated from the upper Floridan by several hundreds of feet of confining units. The lower Floridan aquifer contains a highly transmissive, cavernous zone of limestone locally known as the boulder zone. Because this zone contains highly saline water, it is not used as a source of drinking water and is not considered as a potential source of water in this plan.

Alter Secondary Canal Operations to Capture, Store, and Utilize Additional Local Water

This water supply option includes structural and operational changes that allow capturing of additional runoff water which will be held in the secondary canal systems. A portion of the water captured in the secondary canal systems will come from excess water in the primary canal system, while some will be water captured within the secondary system itself. This option will also foster the utilization of this water by allowing appropriate reductions in water levels before water is obtained from regional sources to replenish water in the secondary canal systems. One objective of this option is to stabilize the salt front by holding higher surface and ground water levels in coastal areas. Higher ground water levels should also help to recharge wellfields and decrease the frequency of water shortages. Modifying secondary canal operations will improve local water use and recharge, and will help to reduce the need to bring water in from regional sources. If higher water levels will be held, the potential impacts on flood protection must be considered.

This Broward County Secondary Canal Network is currently being implemented as part of the LEC Interim Plan and this plan recommends continuation and completion of that effort. A similar component is recommended under the CERP to enhance secondary canal delivery capability in central and southeast coastal Broward County.

Utility Aquifer Storage and Recovery Systems

This water supply option involves the storage of surface water or surficial ground water in the upper Floridan aquifer during periods of abundant water, and recovery of that water during dry periods. Utility ASR systems, in most cases, involve the storage of treated water. Storage of water takes place during periods of low utility demands when excess treatment capacity is available. Recovery of the stored water takes place during periods of high demands to supplement treatment plant production.

Within the LEC Planning Area, this water supply option has been in use for several years by the City of Boynton Beach's water utility. In addition, the Miami-Dade Water and Sewer Department (WASD) has constructed several large ASR facilities which operate utilizing untreated ground water prior to treatment by the water plants. The LEC Interim Plan provided financial support for development of the Miami-Dade WASD ASR facilities because of their positive impact on the regional water resources of the area.

Relocation or Expansion of Surficial Wellfields

This water supply option involves the development of surficial wellfields, an option which is traditionally undertaken when developing or expanding surficial water treatment facilities Locations of surficial water withdrawals are permittable if they meet the reasonable-beneficial use test and will not cause saltwater intrusion or harm wetlands or adjacent legal water users.

Information provided to the District by water utilities in the LEC Planning Area, indicates that many utilities are planning for additional surficial aquifer wellfield expansion. Twenty utilities reported that they expected additional production only from existing wellfields, while five reported that they will be developing wellfield capacity at new locations. In addition, LEC planning efforts have identified a number of opportunities for wellfield relocation. Moving existing demands to new locations could reduce or eliminate potential saltwater intrusion problems during dry periods and greatly increase the ability to access water from the regional canal distribution system

Interconnections with Other Utilities

This water supply option makes use of interconnects between water utilities to deliver either raw or treated water from one utility to another. Interconnects are useful in moving raw water from an area with adequate water resources to one where water resources are limited. Utilities may also use treated water interconnections when one utility has inadequate treatment capacity to meet its demands. Forty-five utilities in the LEC Planning Area have some form of interconnection with other utilities to provide transfer of water.

Secondary Canal Interconnections to Improve Delivery of Regional Water

This water supply option includes the physical facilities that would increase the connectivity among and between the coastal drainage basins and the regional system. These facilities would be used to increase deliveries of regional water to locations where higher water levels are needed to recharge wellfields and prevent saltwater intrusion.

Lower Elevations of Existing Municipal Intake Structures

This water supply option applies to utilities which obtain their water from Lake Okeechobee and may have difficulty withdrawing water at lower lake levels. Lowering the elevations of intake structures will allow the utilities to continue to withdraw water during periods when Lake Okeechobee levels are abnormally low.

The cities of Belle Glade, South Bay, Pahokee, Okeechobee, and Okeelanta water utilities take water directly from Lake Okeechobee and should carefully evaluate the capability of their present water intakes to operated at low lake levels. The incremental evaluations conducted as a part of this plan indicate that until major storage components in the Lake Okeechobee Service Area (LOSA) come on-line, there is a significant possibility of very low lake levels during severe droughts.

Surficial Aquifer System Estimated Costs

The costs related to well construction for the SAS are provided in **Table 66**. There are additional costs for water treatment for potable uses. Many of the treatment facilities in the planning area use lime softening for surficial aquifer water. Lime softening's cost advantages are in operating and maintenance expenses (**Table 67**), where costs are typically 20 percent less than for comparable membrane technologies. However, membrane softening is being used by utilities to enhance or replace traditional lime softening due to more stringent water quality standards. The cost of membrane softening is indicated in **Table 68**. One significant advantage over lime softening is membrane softening's effectiveness at removing organic chemicals that function as precursors to the formation of disinfection by-products, such as trihalomethanes.

Table 66. Surficial Aquifer System Well Costs.[a]

	Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost (per well)	Operations and Maintenance Cost (per 1,000 gallon)	Energy Cost (per 1,000 gallon)
Costs	$45,000	$62,000	$16,000	$0.004	$0.025

a. Costs based on a 16-inch diameter well and a maximum well depth of 200 feet; Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Table 67. Lime Softening Treatment Costs.[a]

Facility Size (MGD)	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (acres)	Operations and Maintenance Cost (per 1,000 gallon)	Energy Cost (per 1,000 gallons)
3	$1.63	$0.25	1.5	$0.60	$0.023
5	$1.57	$0.24	2.5	$0.56	$0.023
10	$1.53	$0.23	4.0	$0.50	$0.021
15	$1.26	$0.19	6.0	$0.41	$0.020
20	$1.13	$0.16	8.0	$0.38	$0.020

a. Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Table 68. Membrane Softening Costs.[a]

Facility Size (MGD)	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (acres)	Operations and Maintenance Cost (per 1,000 gallon)	Energy Cost (per 1,000 gallons)
3	$1.67	$0.25	0.40	$0.55	$0.200
5	$1.52	$0.23	0.40	$0.53	$0.200
10	$1.41	$0.21	0.50	$0.50	$0.200
15	$1.38	$0.21	0.63	$0.48	$0.200
20	$1.33	$0.20	0.78	$0.46	$0.200

a. Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Quantity of Water Potentially Available from the Surficial Aquifer System

From a regional perspective, increases in production from the Biscayne aquifer along the coast beyond existing demands appears limited due to potential saltwater intrusion. Based on this assessment, it was concluded the Biscayne aquifer is, nevertheless, sufficient to meet urban and agriculture demand through 2020. Some further development of the aquifer can be accomplished at the local level through modifications to wellfield locations, configurations, and pumping regimes, and by increasing storage, such as through the use of reservoirs or ASR. Developing wellfield configurations and pumping regimes has been successfully used in most CUP activities to maximize use of the resource and avoid causing harm to natural systems. As a result, water availability will have to be evaluated on a project-by-project basis in some areas. The volume of water that could be withdrawn by any specific user must be determined through the District's CUP program.

Surficial Aquifer System Conclusions

- The SAS, including the Biscayne aquifer, is the primary source of water in the LEC Planning Area existing. Existing and new wellfields being developed are anticipated to provide most of the water needed in the future so that approximately 1,200 MGD can be consumed from this source for public water supply by 2020.

- This water is generally of excellent quality, wells have excellent yields, and treatment costs are low.
- In some areas, withdrawals from the SAS are periodically threatened by saltwater intrusion and there is limited or no access to water from the regional system. In areas where yields are limited by low production rates, aquifer contamination, or saltwater intrusion, alternative sources may be considered, including the need to relocate wellfields to safer and more productive locations.

Floridan Aquifer System

Definition and Discussion

The Floridan Aquifer System (FAS) underlies all of Florida and portions of southern Georgia and Alabama. It is the principal source of water in Central Florida, but yields only nonpotable water throughout most of the LEC Planning Area. The quality of water in the FAS deteriorates southward, increasing in hardness and salinity. With depth, the salinity increases, making the deeper producing zones less suitable for the water supply development than the shallower zones near the top of the aquifer. Within the planning area, the FAS is not influenced by variations in rainfall.

Water from the shallow zones must be treated by desalination to produce a potable product. The most productive zones in the FAS are the lower Hawthorn and Suwannee aquifers. Several utilities in the planning area are considering use of water from the FAS to meet their needs. Elsewhere in the planning area, these aquifers supply only a few agricultural irrigation wells. With continued growth and development in the LEC Planning Area, these aquifers may become a significant source of water to meet the demand. Although desalination of the water will be necessary for potable use, blending of the raw water with higher quality water could produce a product suitable for irrigation purposes.

In the deeper zone of the FAS, areas of extremely high transmissivity exist, termed boulder zones. These zones are not used for supply sources within the planning area due to high salinity and mineral content of the water. However, treated wastewater effluent and concentrate or residual brines from the desalination process are injected into this zone as a means of disposal. In addition, zones within the upper portion of the FAS are also used for ASR. Utilities in Palm Beach, Broward, and Miami-Dade counties are currently testing the feasibility of ASR.

Limited information, data, and experience are available regarding the use of the FAS within the LEC Planning Area. Some utilities are considering the use of the FAS to meet existing and future demands. While water quality and the long-term sustainability of the FAS are concerns, significant changes in water quality are not anticipated. Development of a comprehensive FAS ground water model by the District for Palm Beach, Broward, and Miami-Dade counties to be used for predictive analysis in the future is recommended. Currently, some local FAS models are being used. However, these models have very limited capabilities based on the available hydraulic information.

Currently, utilities are drilling into the FAS in the LEC Planning Area for water supply and wastewater disposal. The District should work in conjunction with water users and utilities to gain water quality and hydraulic information related to these FAS well drilling programs. Information could be gained via packer tests, coring/testing of specific intervals plus geophysical logging (e.g. permeability logs), and aquifer performance testing. In most cases, these activities would be nominal compared to the actual well drilling cost. The District should consider budgeting with utilities for this these items and cost-share for additional testing and data acquisition. It is also recommended that a FAS monitoring network be established to collect the data necessary to establish the relationships among water use, water levels, and water quality.

Recent improvements in low pressure membranes have reduced the electrical costs associated with reverse osmosis systems. Because reverse osmosis pump power consumption is directly proportional to pressure, the low pressure systems can require significantly less power. The reverse osmosis treatment costs presented herein do not reflect the recent improvements in membrane technology.

Floridan Aquifer System Blending

Under this water supply option, water utilities would blend brackish water from the FAS with Biscayne or surficial fresh water. Sodium concentration and other quality considerations would limit the amount of Floridan water used in blending. The FAS in the Lower East Coast Planning Area is a brackish aquifer that lies below the Biscayne aquifer and is separated from the Biscayne by approximately 700 feet of low permeability sediments. The ground water of the FAS is independent of the LEC Planning Area's surface water and SAS. The upper Floridan aquifer is preferred as a potential source of water for blending given its relatively low salinity.

Brackish Water Desalination

Under this water supply option, water utilities would use reverse osmosis or other appropriate treatment process (electrodialysis or ion exchange) to recover fresh water that meets drinking water standards from the brackish water of the FAS that underlies the LEC Planning Area. The FAS lies below the Biscayne aquifer and is separated from the Biscayne by approximately 700 feet of low permeability sediments. The ground water of the deeper FAS is independent of the planning area's surface water and the SAS. The upper Floridan is preferred as a potential source for reverse osmosis treatment because of its relatively low salinity levels. Reverse osmosis and distillation take the water out of the salt solution. Electrodialysis and ion exchange take the salt out of the salt solution. Reverse osmosis is presently being used by a number of utilities in the planning area and may become more common as it provides very good water and helps utilities meet drinking water standards that are sometimes difficult to meet using conventional treatment technologies.

Floridan Aquifer System Estimated Costs

The costs related to wellfield development of the FAS are provided in **Table 69**. Desalination treatment for potable water use, such as reverse osmosis (**Table 70**) and concentrate disposal, incur additional costs (**Table 71)**. Site-specific costs associated with reverse osmosis can vary significantly as a result of source water quality, concentrate disposal requirements, land costs, and use of existing water treatment plant infrastructure. As a general rule, reverse osmosis costs are 10 to 50 percent higher than lime softening depending on the water quality of the source water. For brackish water with total dissolved solids up to 10,000 mg/L, electrodialysis and electrodialysis reversal are generally effective, but cost about 5 to 10 percent higher than reverse osmosis treatment (Boyle Engineering, 1989).

Quantity of Water Potentially Available from the Floridan Aquifer System

Several utilities have recently considered use of the FAS. Limited information, data, and experience are available regarding the use of the FAS in the LEC Planning Area. Regional FAS ground water models do not exist for the LEC Planning Area. The assessments within this plan did not incorporate a water quality component nor does sufficient data exist to conduct such an analysis. However, based on the limited data, knowledge, and experience in the LEC Planning Area, as well as FAS experience in other areas, it was concluded that the FAS could support all of the existing and projected demands for the potable water utilities without causing significant changes in water quality in the FAS. As stated previously, development of a FAS ground water model and monitoring program are recommended for conducting predictive analyses in the future.

Table 69. Floridan Aquifer System Well Costs.[a]

	Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost (per well)	Operations and Maintenance Cost (per 1,000 gallon)	Energy Cost (per 1,000 gallon)
Costs	$115,000	$65,000	$18,000	$.004	$.040

a. Costs based on a 16-inch diameter well and a maximum well depth of 200 feet; Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Table 70. Reverse Osmosis Costs to Treat Water from the Floridan Aquifer System.[a]

Facility Size (MGD)	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (acres)	Operations and Maintenance Cost (per 1,000 gallon)	Energy Cost (per 1,000 gallons)
3	$1.76	$.26	.40	$.58	$.29
5	$1.59	$.24	.40	$.54	$.29
10	$1.47	$.23	.50	$.51	$.29
15	$1.43	$.21	.63	$.50	$.29
20	$1.46	$.20	.78	$.38	$.29

a. Costs based on 2,000 mg/L TDS, 400 PSI; Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Table 71. Concentrate Disposal Costs for Reverse Osmosis Disposal.[a]

Deep Well Disposal Facility (MGD)	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (acres)	Operations and Maintenance Cost (per 1,000 gallon)
3	$.73	$.109	0.5	$.040
5	$.55	$.083	0.5	$.030
10	$.50	$.075	1.0	$.028
15	$.46	$.070	2.0	$.025
20	$.38	$.056	3.0	$.020

a. Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Floridan Aquifer System Conclusions

- The FAS has the potential to yield large quantities of water for potable use, but the exact quantities are unknown at this time.
- Within the LEC planning Area, the FAS is not influenced by variations in rainfall and could be considered drought proof.
- Treatment costs are moderate and are declining as technology improves.
- Local water users could consider using the FAS as an alternative or supplemental source of water to reduce demands on conventional freshwater sources during dry periods.
- Any efforts to conduct FAS well drilling programs in the LEC Planning Area should be coordinated to facilitate collection of water quality and hydraulic information.

Reclaimed Water

Definition and Discussion

This section uses the following definitions of terms:

- Reclaimed water - Water that is reused for a beneficial purpose after flowing out of a wastewater treatment facility.
- Reuse - The deliberate application of reclaimed water for a beneficial purpose.
- Treatment Plant Capacity - The permitted capacity or maximum amount of wastewater that a wastewater treatment plant can treat.
- Treatment Plant Flow - The average annual flow or amount of wastewater that actually flows through a wastewater treatment plant.

- Reuse Capacity - The permitted capacity or maximum amount of reclaimed water that a reuse system can accommodate or distribute.
- Reuse Flow - The average annual flow or amount of reclaimed water actually being allocated or distributed to a reuse system or activity.

In 1997, wastewater facilities in Palm Beach, Broward, Miami-Dade, and Monroe counties treated an average of 673 MGD of wastewater, of which 48 MGD (about seven percent) was reused. The treatment capacities and flows for facilities that provided reuse water during 1997 are listed in **Table 72**. Reuse of reclaimed water takes place when

Table 72. Domestic Wastewater Treatment Facilities Providing Reuse.

Facility	Facility ID	Capacity (MGD)	Flow (MGD)
Palm Beach County			
A Garden Walk	FLA013735	0.10	0.08
Belle Glade Wastewater Treatment Plant (WWTP)	FLA027740	3.00	2.70
Bryant Village/US Sugar Corporation	FLA013704	0.17	0.07
City Of Boca Raton WWTP	FL0026344	17.50	13.89
East Central Regional Wastewater Treatment Facility (WWTF)	FLA013674	55.00	40.00
Loxahatchee Environmental Control District	FL0034649	8.00	4.96
Okeelanta Corporation	FLA013706	0.23	0.03
Palm Beach County Southern Regional Facility	FLA041424	30.00	18.81
Royal Palm Beach Village WWTF	FLA013749	2.20	1.73
Seacoast Utilities PGA	FL0038768	8.00	6.55
South Central Regional WWTF	FL0035980	24.00	16.50
Palm Beach County Total		148.20	105.32
Broward County			
Broward County North Regional	FL0031771	80.00	65.95
City of Hollywood	FL0026255	42.00	35.00
City of Sunrise SW WWTF	FLA013580	0.99	0.48
Plantation Regional WWTP	FL0040401	15.00	12.58
Pompano Beach	FLA013581	2.50	1.35
Broward County Total		140.49	115.36
Miami-Dade County			
Homestead	FLA013609	2.25	2.25
Krome Service Processing Center	FLA013605	2.25	2.47
Miami-Dade WASD Southern District WWTF	FL0042137	88.73	85.14
Miami-Dade Central District WWTF	FLA024805	150.84	132.24
Miami-Dade Northern District WWTP	FL0032182	116.94	98.77
Miami-Dade County Total		361.01	320.87
Monroe County			
Duck Key WWTF	FLA014772	0.10	0.10
Key West Resort Utility	FLA014951	0.50	0.19
Monroe County Total		0.60	0.29
LEC Planning Area Total		**650.30**	**541.84**

treated wastewater which would otherwise be disposed of in a way that represents a loss to the freshwater system is instead reapplied to that system. The reclaimed water may directly substitute for an existing use or it may indirectly make more water available for use by increasing the recharge of ground or surface waters. The benefits include enhancement to the water supply by the introduction of a new source that can help meet projected nonpotable demands. Reuse included irrigation of golf courses, residential lots, medians, and other green space and ground water recharge via percolation ponds.

Reclaimed water plays a significant role in meeting the needs of this region and this is expected to increase in the future. The amount of water reused by each utility and the type of reuse are shown in **Table 73**. Some options for reuse of reclaimed water at a regional-scale were mentioned previously under the description of CERP Projects. In addition, many jurisdictions or utilities in the LEC Planning Area presently use reclaimed water in a variety of ways, and additional applications are being investigated.

Table 73. Reclaimed Water Utilization.

Reuse System	Reuse Type[a]	Reuse Subtype[b]	Capacity (MGD)	Flow (MGD)	Area (acres)
Palm Beach County					
A Garden Walk	GWR&IPR	RIB	0.08	0.08	6
Belle Glade WWTP	GWR&IPR	RIB	0.07	1.23	7
Boca Raton (Project Iris)	PAA&LI	OPAA	2.10	0.75	
Boca Raton (Project Iris)	PAA&LI	RI	8.00	0.68	
Boca Raton (Project Iris)	PAA&LI	GCI	2.90	0.51	
Boca Raton (Project Iris)	IND	ATP	0.90	0.90	
East Central Regional WWTP	WL	NA	0.15	0.03	2
Loxahatchee Environmental Control District	IND	ATP	1.00	0.46	
Loxahatchee Environmental Control District	PAA&LI	RI	0.10	0.07	43
Loxahatchee Environmental Control District	PAA&LI	GCI	5.66	3.18	1300
Loxahatchee Environmental Control District	PAA&LI	OPAA	0.70	0.59	130
Okeelanta Corporation	GWR&IPR	RIB	0.23	0.03	3
Palm Beach County Southern Regional	PAA&LI	RI	1.32	1.32	
Palm Beach County Southern Regional	PAA&LI	GCI	0.84	0.84	
Palm Beach County Southern Regional	IND	ATP	3.70	3.70	
Palm Beach County Southern Regional	WL	NA	3.00	1.45	
Royal Palm Beach Village Utilities	GWR&IPR	RIB	1.24	0.76	20
Seacoast Utilities PGA	PAA&LI	OPAA	0.00	0.05	24
Seacoast Utilities PGA	PAA&LI	RI	0.00	0.18	63
Seacoast Utilities PGA	PAA&LI	GCI	8.00	2.10	1531
South Central Regional WWTP	IND	ATP	1.80		
South Central Regional WWTP	PAA&LI	GCI	0.57	1078	
U.S. Sugar Corp Bryant Village	GWR&IPR	RIB	0.17	0.07	
Palm Beach County Total			40.16	21.34	4206
Broward County					
Broward County North Regional	IND	AOF	1.31	1.31	

Table 73. Reclaimed Water Utilization.

Reuse System	Reuse Type[a]	Reuse Subtype[b]	Capacity (MGD)	Flow (MGD)	Area (acres)
Broward County North Regional	IND	ATP	3.29	3.29	
Broward County North Regional	PAA&LI	OPAA	1.74	1.74	30
City of Sunrise (South Broward)	GWR&IPR	RIB	1.00	0.48	5
Hollywood	PAA&LI	GCI	4.00	2.82	753
Plantation Regional	IND	ATP	2.16	0.73	
Pompano Beach	PAA&LI	GCI	2.05	1.10	323
Pompano Beach	PAA&LI	OPAA	0.45	0.25	76
Broward County Total			16.01	11.73	1188
Miami-Dade County					
Homestead	GWR&IPR	RIB	2.25	2.25	14
Krome Service Processing Center	GWR&IPR	AF	2.25	2.47	
Miami-Dade WASA Central District WWTF	IND	ATP	7.84	4.24	
Miami-Dade WASD N District WWTP	PAA&LI	OPAA	1.50	0.06	40
Miami-Dade WASD N District WWTP	IND	ATP	2.94	2.70	
Miami-Dade WASD South District WWTF	IND	ATP	3.73	3.40	
Miami-Dade County Total			20.51	15.12	54
Monroe County					
Duck Key Wastewater Cooperative	PAA&LI	OPAA	0.10	0.05	20
Key West Resort Utility	PAA&LI	GCI	0.50	0.19	60
Monroe County Total			0.60	0.24	80
LEC Planning Area Total			**227.28**	**48.43**	**5,528**

a. Reuse Types: PAA&LI - Public Access Areas and Landscape Irrigation; AI - Agricultural Irrigation; GWR&IPR - Ground Water Recharge and Indirect Potable Reuse; IND - Industrial; TF - Toilet Flushing; FP - Fire Protection; WL - Wetlands; OTH - Other

b. Reuse Subtypes; GCI - Golf Course Irrigation; RI - Residential Irrigation; OPAA - Other Public Access Areas; EC - Edible Crops; OC - Other Crops; RIB - Rapid Infiltration Basins; AF - Absorption Fields; SWA - Surface Water Augmentation; INJ - Injection; ATP - At Treatment Plant; AOF - At Other Facilities; NA - Not applicable

Potential uses of reclaimed water include landscape and agricultural irrigation, ground water recharge, industrial uses, and environmental enhancement. The ground water modeling associated with this plan found the existing and projected reuse of reclaimed water in the coastal portions of the planning area helped reduce the potential of exceeding wetland protection and seawater intrusion criteria. The volume of reclaimed water that is reused is projected to increase as wastewater flows increase due to development and as current/proposed reuse programs are implemented. In addition to supporting continuation of implementation of the utility plans, several options to increase the effectiveness and efficiency of these programs, especially during low rainfall periods, are discussed.

In addition to using reclaimed water for irrigation, reclaimed water has potential for use as a saltwater intrusion barrier. For the Biscayne aquifer, this use could be accomplished by applying reclaimed water at land surface through percolation ponds or trenches along the coast, or by discharge to coastal canals, thereby creating a freshwater mound that would impede the movement of salt water inland. Alternatively, a series of injection wells could be constructed along the coast to accomplish the same result. However, these methods would have to comply with federal and state underground injection requirements.

Reclaimed Water Estimated Costs

The costs associated with implementation of a reclaimed water program can vary significantly depending on the type of reuse system (i.e., ground water recharge, public access irrigation, etc.), the capacity of the reclamation facility, treatment components, the extent of the reclaimed water distribution system, and regulatory requirements. Cost savings include negating the need for, or reducing the use of, alternative disposal systems; reducing the demand on ground water systems; and reducing the volume of potable water used for irrigation.

For a reuse system that utilizes reclaimed water for public access irrigation, utility representatives indicated infrastructure cost would be approximately $1.00 per 1,000 gallons, while the operation and maintenance of the system would be approximately $0.21 per 1,000 gallons. For public access irrigation systems using reclaimed water, the infrastructure cost would include the costs associated with construction of advanced secondary treatment components including filtration, high level disinfection, online continuous water quality monitoring, storage, pumps, transmission, and distribution facilities. Operation and maintenance costs would include chemical, pumping, and maintenance for the treatment and distribution system.

Quantity of Water Potentially Available from Reclaimed Water

Table 73 indicates current wastewater facilities that are reusing wastewater have a reuse capacity of 227 MGD and a current reuse flow of 48 MGD. An additional 23 utilities in the LEC Planning Area, with 177 MGD capacity and average flow of 131 MGD, presently do not reclaim water for reuse (**Table 74**). Hence, a capacity for development of approximately 356 MGD presently exists within the region. Water use within the region was about 784 MGD in 1995 and is projected to increase to 1,213 MGD by 2020, which is an increase of about 55 percent. If wastewater flow increases proportionally, this corresponds to about 1,050 MGD of wastewater flow. If the proportion of wastewater that is reused remains the same, this translates to about 70 MGD. Present reuse capacity is about 34 percent of total wastewater flow. If this proportion remains the same in the future, wastewater treatment would represent a capacity of about 357 MGD by 2020.

The potential need in the future to integrate water conservation and reclaimed water systems has been considered. The concept is that reuse systems should be designed to apply reclaimed water to meet water supply needs and provide aquifer recharge, rather than as a system to make this water inaccessible.

Table 74. Disposal Facilities[a] with No Reuse.

Facility	Facility ID	Capacity (MGD)	Flow (MGD)
Palm Beach County			
Acme Improvement District	FLA042595	3.00	2.40
East Central Regional WWTP	FL0041360	55.00	40.00
Pahokee WWTP	FLA136778	1.20	1.08
Pratt and Whitney	FLA013693	0.22	0.09
South Bay WWTP	FLA021300	1.42	0.78
Palm Beach County Total		60.84	44.35
Broward County			
City of Margate East Plant	FL0169617	2.20	0.00
City of Margate WWTP	FL0041289	8.00	8.23
City of Miramar WWTF	FLA017025	8.90	0.00
City of Pembroke Pines	FLA013575	7.69	4.22
Cooper City West WWTP	FL0040398	2.50	2.90
Coral Springs Improvement District WWTF	FLA041301	5.50	5.00
Ferncrest	FLA013583	0.60	0.30
Fort Lauderdale - G.T. Lohmeyer	FL0041378	43.00	38.31
Sunrise No. 1 WWTF	FLA041947	9.00	7.07
Sunrise No. 2 WWTP	FLA042633	3.00	1.81
Sunrise No. 3 WWTP	FLA042641	13.75	9.05
Town of Davie WWTP	FL0040541	3.00	2.28
Broward County Total		107.14	79.17
Miami-Dade County			
American Village MHP	FLA013641	0.20	0.13
Cricket Club, The	FLA013637	0.10	0.07
Miami-Dade County Total		0.30	0.20
Monroe County			
Key Haven Utility	FLA014867	0.20	0.19
North Key Largo WWTP	FLA015009	0.55	0.29
Richard A. Heyman WWTP-Key	FL0025976	7.20	7.20
Monroe County Total		7.95	7.68
LEC Planning Area Total		**176.23**	**131.40**

a. Domestic Wastewater Treatment Facilities

Reclaimed Water Conclusions

- Only about 48 MGD of reclaimed water is used in the LEC Planning Area today, although the existing reuse capacity is about 227 MGD.
- Reclaimed water has the potential to help meet irrigation demands and to enhance regional resources, including wetlands and aquifer systems and to help meet the freshwater flow requirements of estuaries.
- If current trends continue, reuse capacity in the region could increase to 357 MGD by 2020.

- Supplemental sources and interconnection with other utilities may provide an effective means to improve the volume of reclaimed water reused.
- The cost of using reclaimed water for irrigation greatly exceeds the cost of available conventional supplies. However, in areas where conventional supplies are not available, reclaimed water use is cost-effective.
- Large-scale reclaimed water projects involving environmental hydropattern enhancement and/or aquifer recharge have regulatory issues which need to be carefully addressed for such projects to be cost-effective.

Seawater Desalination

Definition and Discussion

This water supply option involves using seawater from the Atlantic Ocean as a raw water source. The Atlantic Ocean appears to be an unlimited source of water from a quantity perspective; however, removal of the salts is required before that water can be used for potable or irrigation purposes. A desalination treatment technology would have to be used, such as distillation, reverse osmosis, or electrodialysis.

Seawater Estimated Costs

The cost of desalination of seawater is estimated to be significant, up to eight times the cost of reverse osmosis water from the FAS. In addition, reverse osmosis and facilities treating seawater would be expected to have an efficiency of 25 percent, resulting in increased concentrate/reject water disposal needs compared to desalination of the brackish water of the upper Floridan aquifer.

Tampa Bay Water, located in the Southwest Florida Water Management District, is moving ahead to construct a seawater desalination treatment facility initially capable of producing 25 MGD of drinking water with estimated first year costs as low as $1.71 per thousand gallons, significantly lower than originally assumed and significantly below the costs for water at similar plants under construction elsewhere. For example, in Singapore, a 36 MGD desalination plant is estimated to produce water that will cost between $7.52 and $8.77 per thousand gallons.

Some of the factors reducing the cost of this facility include colocating the water treatment plant with a power plant, using the power plant’s existing cooling water discharge system for concentrate disposal, and using the power plant’s existing facilities for the intake to the water treatment plant. The District is in the process of soliciting proposals to conduct a feasibility study of colocating seawater reverse osmosis water treatment facilities with coastal electrical power plants in the District's area of jurisdiction.

Seawater Desalination Conclusions

- Seawater desalination can provide an unlimited amount of high quality water for potable use.
- The costs of seawater desalination are generally high, depending on the quality of source water, due primarily to high energy costs associated with reverse osmosis. These costs are declining as reverse osmosis technology improves.
- Utilities considering seawater desalination should consider coordinating with the District and other agencies to examine the need for this alternative, current trends in technology, and options to combine this approach with other methods.

Aquifer Storage and Recovery

Definition and Discussion

Aquifer Storage and Recovery (ASR) can be treated as either a regional water resource project or as a local water supply option, depending on the project location, scale, and population served. Regional-scale applications of this technology were discussed previously. The following information provides general information that may be useful for planning efforts by local utilities.

ASR is the underground storage of high quality water in an acceptable aquifer (typically the upper Floridan aquifer in the LEC Planning Area) through a well during times when water is available, and the subsequent recovery of that water from that same well during high demand periods. In other words, the aquifer acts as an underground reservoir for the injected water, reducing water loss due to evaporation.

Current regulations require injected water to meet drinking water standards when the receiving aquifer is classified as an Underground Source of Drinking Water (USDW) aquifer, unless an aquifer exemption is obtained from the U.S. Environmental Protection Agency (USEPA). Obtaining an aquifer exemption is a rigorous process and few have been approved. However, the USEPA has indicated a willingness to utilize a more flexible permitting approach for proposed ASR systems that can meet all drinking water standards with the exception of coliform bacteria. This additional flexibility should assist in permitting raw water ASR facilities in the LEC Planning Area.

Treated Water ASR

Treated water ASR involves using potable water as injection water. Since potable water meets the drinking water standards, this type of ASR application is more easily permitted. There are many examples in Florida, including several in the LEC Planning Area, of utilities using treated water ASR. These include the city of Boynton Beach ASR facility which has been in successful operation for several years.

Raw Water ASR

The development of raw water as a source for ASR systems is under way by some utilities in the LEC Planning Area. The Miami-Dade WASD has constructed several ASR wells in their wellfields, which will store untreated surficial aquifer water until it is needed by the system's water treatment facilities. Currently, no operating, untreated, surface water ASR projects are located in Florida.

Reclaimed Water ASR

Reclaimed water ASR would involve using reclaimed water as the injection water. Currently, there are no operating, reclaimed water ASR projects in Florida. Several communities in Florida are interested in reclaimed water ASR and are investigating the feasibility of such a system.

Aquifer Storage and Recovery Estimated Costs

Estimated costs for an ASR system largely depend on whether the system requires pumping equipment. In **Table 75**, one system uses pressurized water from a utility, whereas the second ASR system uses unpressurized treated water, thus requiring pumping equipment as part of the system cost. The latter system with its associated pumping costs is more indicative of an ASR system in combination with surface water storage. Screening and filtering untreated surface water to remove floating and suspended matter may require additional costs.

Table 75. Aquifer Storage and Recovery System Costs.[a]

System	Cost				
	Well Drilling (per well)	Equipment (per well)	Engineering (per well)	Operations and Maintenance (per 1,000 gallon)	Energy (per 1,000 gallon)
Treated Water at System Pressure	$250,000	$40,000	$450,000	$.005	$.08
Treated Water Requiring Pumping	$250,000	$125,000	$500,000	$.008	$.08

a. Costs based on a 900-foot, 16-inch well, with two monitoring wells using treated water; Source: *Water Supply Cost Estimates* (PBS&J, 1991), converted to 1999 dollars

Quantity of Water Potentially Available from Aquifer Storage and Recovery

The volume of water that could be made available through ASR wells depends upon several local factors, such as well yield, water availability, variability in water supply, and variability in demand. Without additional information, it is not possible to accurately estimate the water that could be available through ASR in the LEC Planning Area. Typical storage volumes for individual wells range from 10 to 500 million gallons

(31 to 1,535 ac-ft) (Pyne, 1995). Where appropriate, multiple ASR wells could be operated as a wellfield, with the capacity determined from the recharge and/or recovery periods. All of the many applications of ASR store sufficient volumes (adequate volumes to meet the desired need) during times when water is available and recover it from the same well(s) when needed. The storage time is usually seasonal, but can also be diurnal, long-term, or for emergencies. The volume of water that could be made available by any specific user must be determined through the District's CUP program.

Aquifer Storage and Recovery Conclusions

- The primary options are underground (ASR) and aboveground (reservoir) facilities. Both options have significant costs for capital facilities. Exact costs and yields for these systems depend on site-specific conditions.
- ASR has the advantage of providing (at least theoretically) a larger proportion of carryover storage capacity from one year to the next. They have the disadvantage of only being able to handle a limited volume of flow.
- Combined systems that use ASR for long-term storage combined with reservoirs to capture large volume flows during storm events provide maximum flexibility.

Reservoirs

Construction of reservoirs can also be treated as either a regional water resource project or as a local water supply option, depending on the project location, scale, and population served. Regional scale applications of this technology were discussed previously. The following information provides general information that may be useful for planning efforts by local utilities.

Definition and Discussion

This water supply option involves the capture and storage of excess surface water during rainy periods and subsequent release during drier periods for environmental and human uses. Regionally, surface water storage could be used to attenuate freshwater flows to the St. Lucie or Caloosahatchee estuaries during rainy periods and meet minimum flows during drier periods. Similar facilities could also be used in the EAA to regulate the flow of water south into the Everglades. Such facilities, on a smaller scale, could increase surface water availability for current and projected uses, and decrease the demand on aquifer and regional systems. However, evaporative and seepage losses could significantly affect water availability and need to be considered.

Strategically located surface water storage (primarily storage in combination with improved storm water management systems) could recharge SAS wellfields, reduce the potential for saltwater intrusion, and reduce drawdowns under wetlands. On-site storage in agricultural areas may reduce the need for water from the regional canal system and withdrawals from other water source options. Storm water reservoirs could be located with ASR facilities, and provide a water source for the facility.

Reservoir Estimated Costs

Costs associated with surface water storage vary depending on site-specific conditions of each reservoir. A site located near an existing waterway will increase the flexibility of design and management and reduce costs associated with water transmission infrastructure. Another factor related to cost would be the existing elevation of the site. Lower site elevations would allow for maximum storage for the facility while reducing costs associated with water transmission and construction excavation. Depth of the reservoir will have a large impact on the costs associated with construction. Deeper reservoirs result in higher levee elevations that can significantly increase construction costs.

Costs associated with two types of reservoirs are depicted in **Table 76**. The first is a minor facility with pumping inflow structures and levees designed to handle a maximum water depth of four feet. It also has internal levees and infrastructure to control internal flows and discharges. The second type shown below is a major facility with similar infrastructure as the minor facility. The water design depths for this facility range from 10 to 12 feet. Costs increase significantly for construction of higher levees but can be offset somewhat by the reduced land requirements.

Table 76. Reservoir Costs.

	Cost ($/acre)				
Reservoir Type	**Construction**	**Engineering/ Design**	**Construction Administration**	**Land**	**Operations and Maintenance**
Minor Reservoir	2,842	402	318	3,000 - 6,000	118
Major Reservoir	7,980	904	451	3,000 - 6,000	105

Minor reservoir costs are based on actual construction bid estimates received and awarded for similar projects built in the EAA. Costs of these four STAs were averaged to develop the dollar per acre costs. Land costs have been changed to generally reflect land values in the Lower East Coast Planning Area ($3,000 for undeveloped/fallow land, $6,000 for land in citrus production). Major reservoir costs were developed based on the average cost estimates from the proposed Ten Mile Creek project in St. Lucie County and from the *Regional Attenuation Facility Task Force Final Report* (RAFTF, 1997) estimates for major Water Preserve Areas on the east coast.

Quantity of Water Potentially Available from Reservoirs

Reservoirs are considered more of a management option since that these systems allow more efficient use of other sources, such as surface water. Please refer to other source option descriptions for an estimate regarding the quantity of water that potentially could be made available.

Reservoir Conclusions

- Storage is used to provide carryover capacity so that excess water that falls on South Florida during the rainy season can be later used to meet water demands during the dry season.
- The primary options are underground (ASR) and aboveground (reservoir) facilities. Both options have significant costs for capital facilities. Exact costs and yields for these systems depend on site-specific conditions.
- ASR has the advantage of providing (at least theoretically) a larger proportion of carryover storage capacity from one year to the next. They have the disadvantage of only being able to handle a limited volume of flow.
- Surface water reservoirs can handle larger volumes of flow, but lose water over time to seepage and evaporation.
- Combined systems that use ASR for long-term storage combined with reservoirs to capture large volume flows during storm events provide maximum flexibility.

Surface Water

Definition and Discussion

This water supply option involves the use of surface water as a supply source. Surface water bodies in the LEC Planning Area include lakes, rivers, and canals. Lake Okeechobee is the largest lake within the planning area, and a primary source of water supply throughout South Florida, including the direct use by local utilities surrounding the lake and as a reservoir to supply the LEC Planning Area. Surface water is also used by the City of West Palm Beach through a system of lakes and wetlands that ultimately connects to the L-8 Canal and Lake Okeechobee. Surface water from Lake Okeechobee and the WCAs can be transported via the regional canal system to provide recharge for local wellfields.

No additional potential natural sources of surface water were identified in the region that should be considered to meet future demands. The LEC Planning Area has been impacted significantly by development of land for agricultural and urban uses. This development has changed the volume and timing of surface water runoff and had negative impacts on estuarine systems. This excess runoff is being evaluated throughout the planning area to increase water availability to meet current and future needs by capturing excess surface water that would otherwise harm South Florida's coastal resources.

In the future, extensive construction of reservoirs and man-made lakes has been proposed within the region in conjunction with the Everglades Construction Project, the CERP, and the Water Preserve Areas Feasibility Study. All of these systems have some potential capability to provide water supply benefits that will be evaluated and optimized during their design and construction. In addition, opportunities may exist for local governments and private interests to create surface water impoundments or reservoirs to meet localized water needs.

Other Potential Surface Water Sources

Another potential use for surface water systems in the LEC Planning Area is to provide supplemental sources to reclaimed water systems, when water is available, and as potential sources to capture and store (primarily through ASR) excess surface water during the wet season for use during the dry season.

Several considerations need to be addressed in evaluating surface water availability, including seasonal fluctuations, environmental needs both upstream and downstream, storage options, restoration efforts, and treatment costs. Several restoration projects are under way or proposed in the region that use natural or artificial lakes or wetlands as components of local water supply and treatment systems, or that use treated wastewater to supplement natural water flows.

Surface Water Conclusions

- No suitable natural surface water sources for water supply development have been identified in the region.
- MFLs are being developed that will greatly affect the amount and timing of water deliveries that can be obtained from natural systems.
- In the future, regional surface water man-made lakes, impoundments, and reservoirs may be constructed. The water supply capabilities of such systems will be evaluated in the process of their design and construction.
- Construction of smaller facilities may also be appropriate to meet localized needs.
- Utilities should consider using excess surface water as a means to supplement existing reclaimed water sources and maximize reclaimed water use.

CONCLUSIONS

The assessments presented in **Chapter 4** indicated that the proposed water resource development projects included in the alternatives, along with appropriate water supply development and operational assumptions would provide the target 1-in-10 year level of certainty. In this chapter, the water resource development projects were identified and described. It is these projects which will be recommended in **Chapter 6**. Additional information on a large set of water supply options is also provided. Water users can select from among the permittable implementations of these options in determining their preferred water supply development actions.

Water Resource Development Projects

LEC Interim Plan. The projects begun as part of the LEC Interim Plan need to be completed. In addition there are several projects which were developed based on the subregional, integrated, water supply planning processes undertaken as part of the LEC Interim Plan implementation.

Other Federal, State, or District Projects. The West Canal C-4 Canal Structure and the Western C-11 Water Treatment projects are critical projects which are being implemented in partnership with the federal government. Two other projects proposed in the CWMP address uncontrolled flows from abandoned wells and saltwater problems in the Caloosahatchee River. Permitting issues associated with ASR systems and reclaimed water and a specific water conservation effort, Mobile Irrigation Labs (MILs), suitable for implementation regionwide, are also included.

CERP Projects. These projects form the backbone of the water resource development projects included as part of the LEC Plan.

Recommendations to the CERP Program from the LEC Plan and the CWMP. Based on the modeling analyses performed for the LEC Plan and the CWMP, recommendations have been made regarding directions and approaches that should be included in the planning and design of CERP projects.

Operational Strategies. These projects will improve the water shortage policies and supply-side management to reduce the impacts of droughts on water users without compromising performance in meeting environmental goals. These recommendations are particularly important given the difficulties expected in meeting water supply performance goals until structural improvements included in this plan begin coming on-line after 2005. These difficulties are evidenced by the results of the incremental simulations (**Chapter 4**).

Consumptive Use Permitting and Resource Protection. These projects provide for reservations of water, develop MFLs, and specify MFL recovery and prevention strategies, as needed to meet legislative requirements and support the implementation of the LEC Plan.

Other Projects. These projects will provide key information to support the additional planning that will be undertaken for the update of the LEC Plan. The first project will evaluate the success of existing conservation programs, requirements, and regulations, as well as further promote implementation of conservation opportunities. The other three projects will provide key information regarding the feasibility of additional innovative reuse systems and saltwater reverse osmosis systems and their potential role in further water resource development.

Water Supply Development Options

Water supply development options presented in this chapter should serve as a menu that local water users can consider in determining their preferred water supply development actions. Information is provided on water supply development options that utilize conservation, SAS and FAS resources, reclaimed water, seawater desalination, storage, and surface water.

Chapter 6
RECOMMENDATIONS

INTRODUCTION

This chapter presents 46 recommendations that have been developed to implement the *Lower East Coast Regional Water Supply Plan* (LEC Plan). The preceding chapter identified water source options that form a basis for water resource development projects. Water resource development projects are generally those projects that are beyond the scope of traditional local water supply development efforts. **Chapter 5** described water resource development projects for the region and estimated the quantities of water that would be made available. The purpose of this chapter is to provide additional information regarding the resources needed to implement these projects and their expected outputs during the next five years.

Chapter 5 also described a number of water source options that can form a basis for water supply development projects. These options are available to water users to help meet their existing and future water supply needs. This chapter recommends that individual water users in locations where local water supplies are constrained evaluate these water source options for applicability to their local conditions.

Water Resource Development Projects

Water resource development projects for the Lower East Coast (LEC) Planning Area are grouped by the scope and nature of the recommended project as follows:

1. Ongoing projects from the *Interim Plan for Lower East Coast Regional Water Supply* (LEC Interim Plan) (SFWMD, 1998b)
2. Other federal, state, and South Florida Water Management District (District, SFWMD) projects
3. Comprehensive Everglades Restoration Plan (CERP) projects
4. Recommendations to the CERP resulting from analysis performed during the LEC regional water supply planning process
5. Recommendations to the CERP from the *Caloosahatchee Water Management Plan* (CWMP) (SFWMD, 2000d)
6. Operational recommendations resulting from LEC water supply planning process analysis
7. Consumptive use permitting and resource protection projects
8. Other water resource development projects

Potential funding sources for these projects were discussed and a funding strategy was proposed. The Florida Legislature passed the Everglades Restoration Investment Act of 2000, enacting the Governor's proposal for CERP funding. Funding will be consistent with the Governor's plan for CERP funding and will be approved by the District's Governing Board

At the District level, the recommendations of the final LEC Plan were approved by the Governing Board and incorporated into the *Five-Year Water Resource Development Work Program*, which documents the District's progress in water supply plan implementation. It must be submitted to the Florida Department of Environmental Protection (FDEP) annually (before October 1) for review and approval.

The *Five-Year Water Resource Development Work Program* will also be subject to District Governing Board approval and budgetary appropriation each Fiscal Year (FY)[1]. At this time, the implementation schedule for each recommendation has not taken into account other District financial and human resource commitments, as well as commitments that will be generated through approval of the other regional water supply plans currently under development. Thus, schedules identified in the LEC Plan are subject to change based on future District resource and budgetary constraints.

Water Supply Development Projects

Water supply development recommendations, or water source options, are provided for consideration by local governments, water users, and utilities, and are principally the responsibility of users. Water supply development projects may be eligible for District funding assistance, if they meet appropriate criteria explained in Section 373.0831, F.S., and the funding section of this chapter. Funding for water supply development projects is contingent upon the priorities of the Governing Board in light of all other resource or budgetary constraints.

WATER RESOURCE DEVELOPMENT PROJECTS

The water resource development projects are presented in the form of recommendations. Each recommendation, or project, contains a discussion; a list of subtasks (if applicable); the cost to nonfederal entities, which will primarily be borne by the District; total District FTEs[2]; funding sources, and implementing agencies. The costs and FTEs are also broken down by fiscal year and presented in a table.

Ongoing Projects from the LEC Interim Plan

Significant water supply planning projects were initiated with the completion of the LEC Interim Plan, approved by the Governing Board in March 1998. A number of

1. The District's fiscal year begins on October 1 and ends on September 30.
2. FTE = Full Time Equivalent, which is a worker who works 40 hours each week

these projects involve capital expenditures on the part of the District or its partners, and must be continued to completion. The majority of these projects will be concluding prior to the next update of the LEC Plan and the five-year projections reflect this fact.

Recommendation 1: Regional Saltwater Intrusion Management

Discussion

The water supply planning process requires that the position of the saltwater interface be monitored and the factors causing its movement to be understood. Historically, the District's objective for monitoring has been more to support the development of ground water flow models than to monitor inland saltwater intrusion. The LEC Interim Plan recommended the existing saltwater intrusion monitoring program be evaluated to ensure its reliability in detecting the movement of the saltwater interface and a sampling plan and maintenance schedule be proposed. As a result, six new wells were added to fill data gaps in Palm Beach County. Additional wells and other improvements, plus subsequent data collection, have been undertaken cooperatively with Broward and Miami-Dade counties. These improvements should continue and the data should be incorporated into the future LEC planning analyses, including additional ground water modeling for the future updates of the LEC Plan. The status of the monitoring network will be reassessed during the LEC Plan update and further improvements may be considered at that time.

The minimum Biscayne aquifer ground water levels which can be sustained without causing significant harm to the aquifer through saltwater intrusion are difficult to predict. Therefore, as recommended in the *Draft Minimum Flows and Levels for Lake Okeechobee, the Everglades, and the Biscayne Aquifer* (SFWMD, 2000e), further research will be conducted to refine the relationship between saltwater migration and stage elevations in the Biscayne aquifer. Additionally, a detailed model will be developed that can adequately simulate movement of the saline interface under transient conditions.

In addition, CERP's REstoration, COordination and VERification (RECOVER) team may develop updated surface and ground water flows for Biscayne Bay and Florida Bay that relate to ground water levels and saltwater intrusion. Aquifer monitoring associated with CERP may be eligible for federal cost sharing in future years.

Subtasks

Task 1a. Monitor new network

Task 1b. Develop model to simulate the movement of the saline interface

Summary Information

Cost: $973,000 over the first five years; $2,280,000 over the next 15 years

FTEs: 2.0 for the first five years

Funding Sources: SFWMD with local cost sharing by counties

Implementing Agency: SFWMD

Table 77. Estimated Schedule and Costs for Regional Saltwater Intrusion Management.

Recommendation Subtasks		Plan Implementation Costs ($1,000s and FTEs)													
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005		Total 2006-2020	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Monitor new network	130	0.1	135	0.1	140	0.1	146	0.1	152	0.1	703	0.5	2,280	
b	Develop model		0.3	100	0.3	100	0.3	70	0.3		0.3	270	1.5		
	TOTAL	130	0.4	235	0.4	240	0.4	216	0.4	152	0.4	973	2.0	2,280	

Recommendation 2: Floridan Aquifer System Ground Water Model

Discussion

The LEC Interim Plan determined that the use of alternative water supply sources of Aquifer Storage and Recovery (ASR), reverse osmosis, and Floridan aquifer blending depends on the development of a Floridan Aquifer System (FAS) model. Since then a preliminary model has been developed. However, the interim recommendation to construct a test well in the C-51 West region was not funded. A need for data collection and advanced model development continues in order to identify appropriate Consumptive Use Permitting (CUP) rulemaking and CUP application analysis for the FAS.

This recommendation is to refine the existing FAS ground water flow model using data collected from the construction of ASR projects associated with the CERP, as well as individual utilities with deep well injection facilities. This data would be used to reduce data gaps, support the development and calibration of the proposed model, and evaluate competing uses of the FAS as a water supply source. Following model refinement in 2004, this project is expected to conclude with rulemaking in 2005.

Subtasks

Task 2a. Review and document existing FAS data and identify data gaps

Task 2b. Collect additional data

Task 2c. Refine the existing LEC FAS ground water flow model with new data collected through cooperative agreements, the CUP process, and other available sources or develop a density-dependent model.

Task 2d. Develop rules

Summary Information

Cost: $555,000 over five years

FTEs: 8.5

Funding Sources: CERP (data collection from regional ASR facilities), SFWMD, water users, and utilities

Implementing Agency: SFWMD

Table 78. Estimated Schedule and Costs for Refining the FAS Ground Water Model.

Recommendation Subtasks		Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Data review and documentation		0.5										0.5
b	Collect additional data	125	1.6	75	0.8	10	0.2	10	0.2	10	0.2	230	3.0
c	Refine FAS model					200	2.0	75	1.0	50	0.5	325	3.5
d	Rule development										1.5		1.5
	TOTAL	125	2.1	75	0.8	210	2.2	85	1.2	60	2.2	555	8.5

Recommendation 3: Northern Palm Beach County Comprehensive Water Management Plan

Discussion

Since 1995, the city of West Palm Beach and the District have cofunded a cooperative planning effort to develop a comprehensive water management plan for much of northern Palm Beach County. The plan focuses primarily on land areas located within the Southern L-8 Basin, the city of West Palm Beach Water Catchment Area/water supply lake system, Loxahatchee Slough, and associated tributary areas (known collectively as the C-18 Basin). The theme of the plan is consistent with the LEC Plan and the CERP, but it also addresses concerns specific to the subregion.

The planning effort includes two phases. During Phase I, completed in 1997, a computer model was developed capable of evaluating the hydrologic, hydraulic, and water quality effects of conceptual water management options for the study area. Phase II water management options have been developed with input from interested and potentially affected stakeholders using the computer model developed in Phase I. The completion of the options analysis is forthcoming once additional modeling simulations have been completed.

Since the interim plan document was completed in March 1998, many planning and implementation efforts are moving forward in northern Palm Beach County. The following is a list of these efforts: continuation of annual water quality monitoring in the L-8 Basin; a contract for the M Canal widening which began in July 1999; surface and ground water modeling; discussion of private/public funding for the Loxahatchee Slough structure; and a General Reevaluation Report (GRR) for the L-8 Basin. The schedule for the completion of these are in **Table 79**. The schedule for the Palm Beach Aggregate GRR is found in Volume 9 of the *Central and Southern Florida Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement* (Restudy) (USACE and SFWMD, 1999).

The Northern Palm Beach County Comprehensive Water Management Plan will be completed in 2000. Development of Memorandums of Understanding (MOUs) among the northern Palm Beach County partners needs to be completed to aid in solidifying the operations of this plan. Additional ground water and surface water modeling simulations are also needed. Components of the Northern Palm Beach County Comprehensive Water Management Plan will be implemented through the CERP's Project Implementation Reports (PIRs), and the LEC Plan, with funding from other appropriate federal processes. The PIRs for features in northern Palm Beach County are scheduled to begin in 2002 and end in 2014.

Subtasks

Task 3a. Complete the Northern Palm Beach County Comprehensive Water Management Plan.

Task 3b. Continue the M Canal widening contract and complete the improvements to the Control 2 Structure

Task 3c. Identify private/local funding of the Loxahatchee Slough Structure

Task 3d. Continue annual L-8 Basin water quality monitoring

Task 3e. Develop MOUs between northern Palm Beach County partners to implement portions of the Northern Palm Beach County Comprehensive Water Management Plan

Task 3f. Complete construction of the Beeline Water Control Structure with local partner

Summary Information

Cost: $2,591,000 over three years

FTEs: 2.9

Funding Sources: City of West Palm Beach, Indian Trail Improvement District, Palm Beach County, CERP and other federal sources, and SFWMD

Implementing Agencies: City of West Palm Beach, Indian Trail Improvement District, and SFWMD

Table 79. Estimated Schedule and Costs for Completing the Northern Palm Beach County Comprehensive Water Management Plan.

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Complete North Palm Beach County Comprehensive Water Management Plan[a]												
b	Continue M Canal widening contract		0.25			400	0.25	400	0.25			800	0.75
c	Identify private/local funding of Loxahatchee Slough Structure	750	0.25	375	0.25	375	0.25					1,500	0.75
d	Continue yearly L-8 Basin water quality monitoring	30	0.10	30	0.10	30	0.10					90	0.30
e	Develop MOUs between northern county partners	1	0.20									1	0.20
f	Beeline Structure	100	0.30	50	0.30	50	0.30					200	0.90
	TOTAL	881	1.10	455	0.65	855	0.90	400	0.25			2,591	2.90

a. Scheduled for completion in FY2000

Recommendation 4: Eastern Hillsboro Regional ASR Pilot Project

Discussion

The LEC Interim Plan recommended a regional ASR pilot project (eastern site) to be located west of U.S. 441 along the Hillsboro Canal. The plan recommended that this be accomplished in cooperation with Palm Beach County.

This project is associated with the development of a new wellfield to serve Palm Beach County's Water Treatment Plant Number 9, which is located nearby. The new wellfield will consist of 10 surficial ground water wells to be located along the northern District right-of-way of the Hillsboro Canal. Five wells will be utilized to supply untreated ground water to a proposed five-million gallons per day (MGD) pilot ASR well. The ASR well will be operated to store and recover water that will be delivered to the water treatment plant and to the Hillsboro Canal. The remaining five wells will exclusively serve the water treatment plant and are not associated with the ASR pilot project at this time. If the operational results of this pilot project support the use of the ASR at this location, construction of an additional five-MGD ASR well will be considered.

This project supports the District's mission to manage water and related resources for the benefit of the public. Information relevant to the application of ASR on a regional-scale will be collected during the construction, testing, and operation of the pilot facility at the eastern site. Hydrogeologic information about the Upper Floridan Aquifer will be obtained and the suitability of the aquifer for ASR will be evaluated. Other issues related to ASR on a regional-scale, such as permitting constraints, water quality, and recovery efficiencies, will be assessed. This project, along with the Hillsboro Western Site (Site 1) pilot ASR project, initiated in the LEC Interim Plan and incorporated into the Restudy, will provide a wide cross-section of pertinent data to be used in evaluating the viability of large-scale, regional ASR systems as anticipated in the CERP.

Subtasks

Task 4a. Construction of the ASR well

Task 4b. Operational testing and operation permit submittal

Summary Information

Cost: $1,670,000 (SFWMD share)

FTEs: 1.7

Funding Sources: Palm Beach County and SFWMD

Implementing Agency: Palm Beach County

Table 80. Estimated Schedule and Costs for Continuing the Implementation of the Eastern Hillsboro Regional ASR Pilot Project.

		Plan Implementation Costs ($1,000s and FTEs)											
Recommendation Subtasks		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Construction	1,500	1.5	170	0.1							1,670	1.6
b	Operational testing/ operation permit submittal						0.1						0.1
	TOTAL	1,500	1.5	170	0.1		0.1					1,670	1.7

Recommendation 5: Hillsboro (Site 1) Impoundment Pilot Project

Discussion

The LEC Interim Plan recommended a small-scale pilot project impoundment be constructed to assess its performance and to obtain information for a proposed full-scale storage reservoir to capture water lost to tide and return flow to the Hillsboro Canal. The proposed Hillsboro reservoir has been incorporated into the CERP. Seepage rates will be measured and the resulting influence on surrounding ground water levels monitored to determine construction and operational criteria for the large-scale reservoir. The information will be used to determine the maximum storage depth, embankment geometry, size, and control level of seepage collection systems. Pilot seepage collection systems will be evaluated as source water for the Hillsboro pilot ASR wells.

Subtasks

Task 5a. Construction

Task 5b. Operation and testing

Summary Information

Cost: $3,420,000

FTEs: 3.1

Funding Source: SFWMD

Implementing Agency: SFWMD

Table 81. Estimated Schedule and Costs for the Hillsboro (Site 1) Impoundment Pilot Project.

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Construction	2,220	1.1	600	0.5							2,820	1.6
b	Operation and testing			200	0.5	300	0.5	100	0.5			600	1.5
	TOTAL	2,220	1.1	800	1.0	300	0.5	100	0.5			3,420	3.1

Recommendation 6: Lake Worth Lagoon Minimum/Maximum Flow Targets

Discussion

The LEC Interim Plan recommended hydrologic and ecologic studies be conducted to identify the appropriate freshwater flows to the Lake Worth Lagoon. These primarily contractual studies would be managed by the District in cooperation with Palm Beach County. The studies will include research and modeling to determine how to better manage freshwater flows, improve water quality, and reestablish seagrass communities. District staff are in the process of obtaining additional hydrodynamic/salinity data to complete the development of the model for Lake Worth Lagoon by February 2001. Basin boundaries for the model are being expanded to include the Lake Worth Creek/Intracoastal Waterway segment and south of Boynton Inlet to the bridge structure at Ocean Ridge/ Boynton Beach. The model is also being modified to recognize the location of the C-51

Divide Structure west of U.S. 441. The model will be used to analyze existing and future variable controlled freshwater flows from canal discharge, rainfall, runoff, ground water inflow, and tides. A major goal of these efforts is to manage freshwater flows to the lagoon in a manner that will improve water quality, reduce the transport and deposition of suspended solids in the lagoon, and provide for the reestablishment and sustainability of this ecosystem. With the completion of the model development phase, District staff will need to perform simulations, verify the results of the modeling efforts with current conditions within the biological communities of the lagoon, and monitor the performance of the recommended target flows and the effectiveness of implemented Lake Worth Lagoon Partnership Grant projects.

Additional studies will be considered after FY 2001 to better define relationships among canal discharges, local drainage, and storm water discharges, water quality, sediment deposition and distribution, and the distribution and composition of important biological communities in the lagoon. These studies will provide the background data and understanding needed to support the implementation of CERP Lake Worth Lagoon sediment removal efforts that are scheduled to begin in 2005.

Subtasks

Task 6a. Complete model simulations

Task 6b. Complete aerial photography of sea grasses in Lake Worth Lagoon

Task 6c. Digitize mapping of sea grasses based on aerial photography

Task 6d. Establish and monitor fixed transects to verify aerial photography signatures and monitor the impacts of controlled and noncontrolled releases and the implementation of storm water improvement projects affecting Lake Worth Lagoon

Task 6e. Publish the recommended flow targets in a peer reviewed, scientific journal.

Cost: $100,000 (SFWMD)

FTE: 1.0 (SFMWD)

Funding Sources: Palm Beach County and SFWMD

Implementing Agencies: SFWMD and Palm Beach County Department of Environmental Resources Management (DERM)

Table 82. Estimated Schedule and Cost for Developing Lake Worth Lagoon Minimum and Maximum Flow Targets.

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Develop Lake Worth Lagoon minimum and maximum flow targets	100	1									100	1.0

Recommendation 7: Northern Broward County Secondary Canals Recharge Network

Discussion

The LEC Interim Plan recommended the development of a master plan to complete the interconnection of surface water infrastructure to allow conveyance of water to maintain/enhance subregional ground water levels, benefit wellfields, and selected wetlands, and to prevent saltwater intrusion. The ultimate purpose of this project is to control coastal secondary canals at optimal seasonal levels for maintaining and improving ground water recharge and storage. The source of supply for the secondary canal recharge network is from regional surface water sources including aboveground reservoirs in the vicinity of the Hillsboro Impoundment, Lake Okeechobee, and Water Conservation Areas (WCAs), or ASR return flows into the Hillsboro Canal. The project includes construction of canal interconnections, conveyance improvements, pump stations, and monitoring stations. As a part of the Broward County Integrated Water Resource Plan, a master plan will be developed for the interconnection of secondary canals from the Hillsboro Canal Basin to the North New River Canal Basin within Broward County. The master plan, when implemented, will work in conjunction with and enhance the functionality of proposed CERP components. The master plan should be developed in phases and used to incrementally schedule the necessary capital improvements.

A surface water model has been completed. The S-46 Pump Station is scheduled for completion in July 2000. The S-1 Pump Station is expected to be operational in September 2001. The District has shared the cost of these improvements with Broward County and the city of Fort Lauderdale. The county and the District will develop a master plan for the interconnection of secondary canals from the Hillsboro Canal Basin to the North New River Canal Basin that will work in conjunction with and enhance the functionality of proposed CERP components. The master plan should be developed in phases and used to incrementally schedule the necessary capital improvements.

Subtasks

Task 7a. Develop a master plan

Task 7b. Implement the master plan

Task 7c. Design and build the C-12/C-13 Interconnect

Estimated costs: $1,900,000 for the initial phase

FTEs: 0.4

Funding Sources: Broward County, Fort Lauderdale, and SFWMD

Implementing Agencies: Broward County, Fort Lauderdale, SFWMD, and other local governments

Table 83. Estimated Schedule and Costs for the Northern Broward County Secondary Canals Recharge Network.

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Develop master plan	100	0.1									150	0.1
b	Implement master plan			550	0.1	600	0.1	600	0.1			1,750	0.3
c	Design and build C-12/C-13 Interconnect	50											
	TOTAL	150	0.1	550	0.1	600	0.1	600	0.1			1,900	0.4

Recommendation 8: Southeast Broward County Interconnected Water Supply System

Discussion

An interagency agreement for the development of an integrated water supply system between the service areas of Hollywood, Hallandale Beach, Dania Beach, Broward County, and possibly the Seminole Tribe of Florida and other communities will be developed through a mediated process. The agreement will result in a design study identifying the locations and costs of regional wellfield expansion and water treatment facilities. The analysis of the LEC Plan indicates that the existing coastal wellfields in southeast Broward County will be unable to provide a 1-in-10 year level of certainty. However, the analysis indicates that a 1-in-10 year level of certainty or higher can be obtained by using the Broward County South Regional Wellfield in the vicinity of Brian Piccolo Park in conjunction with continued use of some coastal wellfields. The final model simulations successfully met the demand of southeast Broward County using 22 MGD from coastal facilities and the remainder from the regional wellfield. Other combinations of options appear to be available to achieve this target.

Other water supply options, including Floridan systems, reuse, ASR, and other facilities could also be useful. The selection of a preferred solution for this subregion should be made by southeast Broward interests. This mediated process is an outgrowth from, and in support of, the District's CUP effort. The agreement will identify a combination of local and regional wellfield utilization, wellfield recharge, water treatment facilities, and/or alternatives sources, which will meet the future needs of the area.

Hollywood Reservation. The Seminole Tribe of Florida is currently reviewing its options to self-supply its Hollywood Reservation by shifting supply of its public water supply demands to its own utility system. The average and maximum daily demands associated with this facility during the planning horizon are expected to be approximately 1.5 MGD and 2.0 MGD, respectively. The modeling analyses performed to support the LEC regional water supply planning process did not include these demands in the model assumptions, but did evaluate withdrawals on the Hollywood Reservation at a rate of 0.88 MGD on average. It is staff's opinion that average withdrawals of 1.5 MGD and a maximum daily withdrawal of 2.0 MGD on the Hollywood Reservation are attainable. In addition, the Seminole Tribe has agreed to participate in the Southeast Broward County Interconnected Water Supply System discussions. These discussions will deal with developing water supply solutions for the water supply utilities of southeast Broward County, while protecting the water rights of the Seminole Tribe.

Summary Information

Cost: $400,000 over the next three fiscal years

FTEs: 1.1

Funding Sources: The cities of Hallandale Beach, Hollywood, and Dania Beach; Broward County; the SFWMD; and the Seminole Tribe of Florida

Implementing Agencies: The cities of Hallandale Beach, Hollywood, and Dania Beach; Broward County; the SFWMD; and the Seminole Tribe of Florida

Table 84. Estimated Schedule and Costs for the Southeast Broward County Interconnected Water Supply System.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Southeast Broward County Interconnected Water Supply System	300	0.5	50	0.5	50	0.1					400	1.1

Recommendation 9: Broward County Urban Environmental Enhancement

Discussion

The available sources and methods for distributing surface water to benefit specific wetland restoration systems will be examined in the Broward County Integrated Water Resource Plan. Local environmental demands will need to be assessed in terms of quantities and timing of deliveries. Once identified, the county and District are prepared to assess the availability of regional and alternative sources of water to meet this demand. Reservation of water will be addressed by the District, and the District will encourage development of alternative sources, such as the reuse of reclaimed water.

Subtasks

Task 9a. Work with county staff to identify wetland systems, sources of water supply, and timing of deliveries for augmentation, including reuse of reclaimed water

Task 9b. Conduct evaluation of availability of supplemental water from reuse and regional storage for average and 1-in-10 year drought conditions

Task 9c. Identify strategies to meet water demands where structural alternatives are necessary

Task 9d. Identify volumes and sources of supply to be covered by a reservation of water

Task 9e. Adopt rules to enact reservation if necessary

Summary Information

Cost: $200,000 within next three years

FTEs: 0.3

Funding Sources: Broward County and SFWMD

Implementing Agencies: Broward County and SFWMD

Table 85. Estimated Schedule and Costs for Broward County Urban Environmental Enhancement.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**
Broward County Urban Environmental Enhancement	100	0.1	50	0.1	50	0.1					200	0.3

Recommendation 10: Miami-Dade Water and Sewer Department Utility ASR

Discussion

The LEC Interim Plan recommended the development of local ASR in LEC Service Area 3 and provided funding to Miami-Dade County to begin constructing two 5.0-MGD wells. These will be complete by June 2000. These ASR wells use untreated water from the Biscayne aquifer and return water directly to Miami-Dade Water and Sewer Department (WASD) treatment plants. Miami-Dade WASD proposes to have 35 MGD of ASR capacity available in 2005 and 75 MGD of ASR capacity in 2020.

Summary Information

Cost: $7,500,000 over next five years (SFWMD share); $12,000,000 for the additional 40 MGD (eight additional wells)

FTEs: 0.1 per year; 0.5 total for the next five years

Funding Sources: Miami-Dade WASD, SFWMD, and the United States Environmental Protection Agency (USEPA)[1]

Implementing Agency: Miami-Dade WASD

Table 86. Estimated Schedule and Costs for Developing the Miami-Dade WASD Utility ASR.[a]

	Plan Implementation Costs ($1,000s and FTEs)													
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005		Total 2006-2020	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Miami-Dade WASD Utility ASR	1,500	0.1	1,500	0.1	1,500	0.1	1,500	0.1	1,500	0.1	7,500	0.5	12,000	1.5

a. Only average annual costs are reported. Several years may be combined into a single fiscal year.

Recommendation 11: Biscayne Bay Minimum and Maximum Flow Targets

Discussion

A major recommendation of the LEC Plan is to identify the freshwater flows that support the maintenance of environmentally desirable flow and salinity targets for Biscayne Bay. The completion of an ecological model for Biscayne Bay will complement the hydrodynamic model developed by the U.S. Army Corps of Engineers – Waterways Experiment Station (USACE-WES) and the ground water model developed for Biscayne Bay by the U.S. Geological Survey (USGS). The completion of these tools will enable

1. An additional $500,000 may be available in FY 2001 from the USEPA.

scenarios of varying freshwater inflows to be evaluated, resulting in recommendations for a salinity regime.

Subtasks

Task 11a. Interagency review of models, scenarios, and standards

Task 11b. Data processing

Task 11c. Conduct secondary review

Task 11d. Publish final report of recommended Minimum Flows and Levels (MFL) technical criteria

Task 11e. Develop a MFL recovery plan or prevention strategy for those areas that do not meet the proposed MFL criteria

Task 11f. Conduct rule development and rulemaking

Summary Information

Cost: $200,000

FTEs: 2.2

Funding Sources: Florida Forever Act, Surface Water Improvement Management (SWIM), and CERP

Implementing Agencies: SFWMD, Miami-Dade County DERM, and USACE

Table 87. Estimated Schedule and Costs for Developing Biscayne Bay Minimum and Maximum Flow Targets.

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Interagency review		0.1		0.1								0.2
b	Data processing	200	0.5									200	0.5
c	Secondary review		0.2		0.1								0.3
d	Final report				0.5								0.5
e	Recovery plan/prevention strategy				0.5								0.5
f	Rulemaking						0.2						0.2
	TOTAL	200	0.8		1.2		0.2					200	2.2

Other Federal, State, or District Projects

Recommendation 12: Critical Projects

Other federally cost-shared projects, as a group, include the critical projects in the LEC Planning Area for which the District is the local sponsor. These projects have been part of the without plan conditions in the 2020 Base Case (see **Chapter 4**). These projects are the West Canal Structure (C-4), Western C-11 Water Treatment, and the Lake Okeechobee Water Retention/Phosphorus Removal projects. Each of these was described in **Chapter 5**. **Table 88** provides annual estimates of nonfederal funding responsibility for 2001 to 2005 for the West Canal Structure (C-4) and Western C-11 Water Treatment projects. Costs for the Lake Okeechobee Water Retention/Phosphorus Removal Project have been included as part of the much larger Lake Okeechobee Water Quality Treatment Facilities Project, which is a CERP project (see **Table 93** later in this chapter).

Table 88. Estimated Schedule and Costs for the Critical Projects for which the District is the Local Sponsor.

Critical Project	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
West Canal Structure (C-4)	130	0.35									130	0.35
Western C-11 Water Treatment	2,000	0.85	2,115								4,115	0.85
TOTAL	2,130		2,115								4,245	1.20

Recommendation 13: Well Abandonment Program (Recommendation from the CWMP)

Discussion

The District administered a voluntary well abandonment program that identified abandoned artesian wells, geophysically logged them, and plugged or rehabilitated the wells, as necessary, to prevent deterioration of the Surficial Aquifer System (SAS) through upland leakage or discharge to land surface. This program ended in 1991. The program documentation indicates that there are unplugged wells remaining within the planning area and, if plugged, could contribute an estimated net flow of 50,000 acre-feet (ac-ft) per year to the water budget of the Caloosahatchee Basin. In addition, the Florida Geological Survey, Bureau of Oil and Gas, have identified larger oil test wells within the planning area that have not been adequately plugged.

Additional effort should be made to locate and properly plug the free flowing wells in the Caloosahatchee Basin. The District should work with local and state officials to locate uncontrolled abandoned wells and identify plugging strategies and applicable funding sources for proper plugging of the wells.

The District will coordinate with local and state agencies to identify abandoned, unplugged wells and to identify potential funding sources. This involves staff support and coordination only.

Summary Information

Cost: No direct cost associated with this recommendation

FTEs: 0.5

Funding Sources: Potential sources include landowners, local government, and water resource development funds

Implementing Agency: SFWMD

Table 89. Estimated Schedule and Costs for the CWMP Well Abandonment Program.

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Coordinate identification of unplugged wells		0.25		0.25								0.50

Recommendation 14: Saltwater Influence at S-79 (Recommendation from the CWMP)

Discussion

Saline water has been a recurring problem for the potable water intakes in the Caloosahatchee River. The potable water intakes are located approximately one mile upstream of the S-79 Structure. During extended periods of low flow, the chloride content of the shallow water increases well beyond the recommended limit of 250 milligrams per liter for drinking water. In response, releases have been made from Lake Okeechobee. A number of alternatives to refine these releases warrant further investigation and include moving the intake farther upstream, modifications to the structure, limiting lockages during low flow periods, improved maintenance and operation of the bubble curtain, and seasonal reductions in river withdrawals. Future freshwater releases for environmental purposes may also minimize saltwater influence. Additional analysis of the front migration should be initiated.

The District will coordinate additional analysis of the saltwater influence problem at the S-79 Structure. This recommendation involves staff support and coordination only.

Summary Information

Cost: No direct cost associated with this recommendation

FTEs: 0.5

Funding Sources: USACE and local government

Implementing Agency: SFWMD

Table 90. Estimated Schedule and Costs for the CWMP Saltwater Influence Analysis.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**
Coordinate identification of needed additional analysis		0.5										0.5

Recommendation 15: Permitting Issues Associated with ASR Systems and Reuse of Reclaimed Water

Discussion

In January 1999, FDEP adopted a new rule dealing with ASR (Section 610.466, F.A.C.). The District should continue working with the Florida Legislature, the USEPA, and the FDEP to explore rule changes to the federal and state Underground Injection Control Program to allow for, and encourage, injection of ground water or surface water for ASR. The level of treatment should be compatible with the water quality in the proposed storage zone. Existing rule criteria will be identified and modified to facilitate changes in ASR regulations that will, in turn, facilitate the development of water source options.

As a follow-up to the recent FDEP wastewater/reclaimed water rule revisions (Chapter 62-610, F.A.C.), the District and FDEP will work in partnership to explore and correct any possible remaining inconsistencies and conflicts within the goals, objectives, and rules of the various programs involved in wastewater and reuse of reclaimed water programs. The objectives of this effort should be to maximize the reuse of reclaimed water to increase the water resources of the District while protecting the quality of the ground and surface waters and protecting the natural resources of the area.

Summary Information

Cost: $0

FTEs: 0.13

Funding Sources: SFWMD and FDEP

Implementing Agencies: SFWMD and FDEP

Table 91. Estimated Schedule and Costs for Permitting Issues Associated with ASRs.

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Work with the Florida Legislature, FDEP, and USEPA		0.05		0.05		0.01		0.01		0.01		0.13

Recommendation 16: Mobile Irrigation Labs

Discussion

The Florida Department of Agriculture and Consumer Services (FDACS) should administer and fund the two existing and one additional Mobile Irrigation Labs (MILs) in the LEC Planning Area. To replace current District participation, additional funding sources need to be found. An additional urban MIL is recommended for Broward County.

Subtasks

Task 16a. Identify dedicated funding sources to support existing MILs

Task 16b. Maintain existing MILs in the LEC Planning Area

Task 16c. Establish an additional MIL to serve Broward County

Summary Information

Cost: $1,513,000 (none by SFWMD)

FTEs: 0.11 (none by SFWMD)

Funding Sources: Potential funding sources are FDEP, FDACS, Soil and Water Conservation Districts (SWCD), user fees, and utilities

Implementing Agencies: SWCD and FDACS

Table 92. Estimated Schedule and Costs for Establishing Mobile Irrigation Labs.[a]

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Identify funding sources		0.01		0.01		0.01		0.01		0.01		0.06
b	Maintain existing MILs[b]	200		200		200		200		200		1,000	
c	Establish additional urban MIL[b]	70	0.01	70	0.01	70	0.01	70	0.01	70	0.01	350	0.05
	TOTAL	270	0.02	270	0.02	270	0.02	270	0.02	270	0.02	1,350	0.11

a. The District is not funding MILs at this time. The costs and FTEs are included for informational purposes only.

b. Costs shown for the MILs include FTEs to operate.

Comprehensive Everglades Restoration Plan Projects

Recommendation 17: CERP Projects that Affect the LEC Planning Area and the Caloosahatchee Basin

The analysis completed as part of the LEC Plan confirms that the Restudy projects scheduled for completion by 2020 are extremely beneficial for meeting MFLs and natural system restoration targets, including reducing high water flows to estuaries, and providing water to meet demands in the LEC Planning Area. These projects are being refined and implemented in the CERP. The water resource development projects, operational changes, and environmental restoration projects listed in **Table 93** are CERP projects recommended for completion by 2020. These projects are described in detail in **Appendix C**. Completion of the CERP projects by 2020, and timely implementation according to the schedule in the Restudy (USACE and SFWMD, 1999) is crucial to meeting the objectives of the LEC Plan.

The CERP is considered in its entirety as one component of the LEC Plan's program of water resource development projects. Many of the proposed projects have significant water resource benefits that need to be considered in this plan. **Table 93** provides a list of all CERP projects in the LEC Planning Area with annual estimates of nonfederal funding responsibility for fiscal years 2001 to 2005 and the total cost through FY 2020. **Table 94** provides a similar list of all CERP projects in the Caloosahatchee Basin. **Table G-1** in **Appendix G** breaks down the total nonfederal and federal costs through 2050 of these projects into Project Implementation Report (PIR), real estate acquisition, design, plans and specifications, and construction costs. No attempt is made to provide a further breakdown of costs at this time as the resolution of state and federal agreements on funding is still pending.

Table 93. Nonfederal Funding Responsibility of CERP Projects in the Lower East Coast Planning Area.

Project	Cost for Fiscal Year (in 1999 dollars)							
	2001	2002	2003	2004	2005	Total 2001-2005	Total 2006-2020	Total 2001-2020
Lake Okeechobee ASR Pilot Project	5,066,667	1,532,308	401,539	293,846		7,294,359		7,294,359
Lakebelt Technology Pilot Project	572,650	2,230,770	2,230,770	2,239,317	2,230,770	9,504,275	995,727	10,500,002
Reuse Technology Pilot Project	514,520	410,158	2,793,843	4,578,736	5,691,534	13,988,790	494,231	14,483,021
Seepage Management Pilot Project	326,282	4,220,193	447,116	6,411		5,000,001		5,000,001
Hillsboro (Site 1) ASR Pilot Project	1,595,193	2,255,962	198,847			4,050,001		4,050,001
Lake Okeechobee ASR				1,560,123	5,735,099	7,295,221	541,360,780	548,656,001
Lake Okeechobee Watershed Water Quality Treatment Facility		494,395	546,680	7,345,724	7,180,656	15,567,455	15,556,046	31,123,501
North of Lake Okeechobee Storage Reservoir							142,427,001	142,427,001
L-8 Project				37,718	2,461,054	2,498,772	33,159,228	35,658,000
Lake Okeechobee Tributary Sediment Dredging		52,334	487,942	467,726	1,342,000	2,350,001		2,350,001
Taylor Creek/Nubbin Slough Storage Reservoir and Treatment Area	766,000	10,310,685	14,918,910	4,920,230	79,598	30,995,423	20,502,500	51,497,923
EAA Storage Reservoir, Phase 1	1,603,500	1,606,585	1,207,376	1,204,286	1,413,124	7,034,870	108,059,463	115,094,333
EAA Storage Reservoir, Phase 2							101,620,001	101,620,001
C-17 Backpumping and Treatment			3,209,550	3,548,110	3,425,414	10,183,074	-88,073[a]	10,095,002
Pal-Mar/J.W. Corbett WMA Hydropattern Restoration		3,953,899	3,923,666	8,435		7,886,000	-2,636,000[a]	5,250,000
C-51 and Southern L-8 Reservoir				153,330	10,004,740	10,158,070	153,869,931	164,028,001
Hillsboro (Site 1) Impoundment, Phase 1	14,948,261	4,271,899	4,239,560	51,104		23,510,825	-4,243,325[a]	19,267,500
Hillsboro (Site 1) ASR			637,773	705,049	702,358	2,045,179	44,376,821	46,422,000
Acme Basin B Discharge		4,339,627	4,306,681	39,693		8,686,000	1,364,000	10,050,000
C-51 Backpumping and Treatment			4,262,012	4,711,592	4,481,069	13,454,673	2,861,327	16,316,001
C-51 Regional Ground Water ASR				81,054	5,288,784	5,369,838	58,275,662	63,645,500
Lake Worth Lagoon Restoration							1,150,000	1,150,000
Winsburg Farms Wetlands	792,917	2,770,281	705,443	8,360	2,152,712	6,429,712	537,289	6,967,001
Protect Wetlands next to WCA-1	35,810,775	0	5,494,036	6,073,576	498,813	47,877,201	-21,491,200[a]	26,386,001

Table 93. Nonfederal Funding Responsibility of CERP Projects in the Lower East Coast Planning Area.

Project	Cost for Fiscal Year (in 1999 dollars)							
	2001	2002	2003	2004	2005	Total 2001-2005	Total 2006-2020	Total 2001-2020
Palm Beach County Agricultural Reserve Reservoir and ASR					1,604,874	1,604,874	59,074,626	60,679,500
Western C-11 Diversion Impoundment and Canal		41,039,740	40,726,379	144,381		81,910,501	-19,492,000[a]	62,418,501
C-9 STA/Impoundment		31,207,331	30,968,887	89,308		62,265,526	-17,692,525[a]	44,573,001
Broward County Secondary Canal System	37,750	151,581	415,662	509,514	1,193,509	2,308,016	4,140,985	6,449,001
North Lake Belt Storage Area (NLBSA), Phase 1							118,837,387	118,837,387
Central Lakebelt Storage Area (CLBSA), Phase 1							163,570,773	163,570,773
C-4 Control Structures	64,359	251,777	207,614	5,325	618,875	1,147,950		1,147,950
Pineland and Hardwood Hammock Restoration	8,334	7,190	3,993	73,010	140,288	232,813	67,188	300,000
Bird Drive Recharge Area				10,834,465	14,427,528	25,261,993	36,779,508	62,041,501
L-31N Levee Improvements for Seepage Management			217,539	237,480	236,573	691,591	32,199,409	32,891,000
Dade-Broward Levee/ Pennsuco Wetlands		4,402,418	4,368,948	34,235	0	8,805,600	583,400	9,389,000
Reroute Miami Canal Water Supply Deliveries		8,692,877	12,891,141	4,220,652	54,831	25,859,501	11,627,000	37,486,501
C-111 North Spreader Canal	3,151,565	15,097,629	15,097,629	12,352,339	134,716	45,833,876	737,150	46,571,027
South Miami-Dade County Reuse							181,512,002	181,512,002
West Miami-Dade County Reuse							218,618,501	218,618,501
WCA-1 Internal Canal Structures	187,412	738,350	2,807,104			3,732,866		3,732,866
Diverting Flows from WCA-2 to CLBSA							38,078,001	38,078,001
WCA-3A and B Levee Seepage Management		27,797,554	27,850,757	27,558,039		83,206,350	-33,352,850[a]	49,853,500
Additional S-345 Structures		112,708	167,141	167,781	167,141	614,770	22,611,731	23,226,501
Construction of S-356 Structures and Relocation of a Portion of L-31N Borrow Canal			28,154,278	31,124,139	30,972,344	90,250,762	-32,877,761[a]	57,373,001
Decompartmentalize WCA-3, Phase 1		250,301	371,184	180,690	1,507,295	2,309,470	10,618,031	12,927,501
Decompartmentalize WCA-3, Phase 2							29,602,000	29,602,000

Table 93. Nonfederal Funding Responsibility of CERP Projects in the Lower East Coast Planning Area.

Project	Cost for Fiscal Year (in 1999 dollars)							
	2001	2002	2003	2004	2005	Total 2001-2005	Total 2006-2020	Total 2001-2020
Flow to Northwest and Central WCA-3A	259,789	212,054	107,161	92,309	1,080,727	1,752,039	8,617,462	10,369,500
Divert flows from WCA-3 to CLBSA							382,501	382,501
Divert Flows from CLBSA to WCA-3B							3,272,000	3,272,000
G-404 Pump Station Modifications				140,405	95,323	235,728	4,833,272	5,069,000
Biscayne Bay Coastal Wetlands	16,667	176,749	630,918	633,335	8,477,416	9,935,084	139,835,456	149,770,540
Florida Keys Tidal Restoration	18,268	41,643	21,391	281,075	253,700	616,077		616,077
Big Cypress/L-28 Interceptor							21,375,501	21,375,501
Miccosukee Tribe Water Management Plan	312,334	1,841,522	117,701	88,111	1,238,693	3,598,360	8,553,058	12,151,418
Seminole Tribe Big Cypress Water Conservation Plan	716,750	1,517,397	3,166,194	2,404,712	358,019	8,163,071	29,480,930	37,644,001
Melaleuca Eradication Project and other Exotic Plants							2,886,001	2,886,001
PIR for Storage and ASR Storage[b]		3,947,458	3,947,458	3,902,085		11,797,000		11,797,000
PIR for Lake Belt Storage and Conveyance[b]							17,521,500	17,521,500
PIR for WCA Connectivity[b]	1,300,500	425,164				1,725,664		1,725,664
PIR for Levee Seepage Management[b]	955,251	1,837				957,088		957,088
Comprehensive Ecosystem Water Quality Improvement Study	639,607	642,067	642,067	644,527	642,067	3,210,333	787,208	3,997,541
Florida Bay Feasibility Study	461,539	501,923	501,923	503,846	30,770	2,000,000		2,000,000
RECOVER	4,985,060	5,004,233	5,004,233	5,023,407	5,004,233	25,021,166	75,025,151	100,046,316
Total for CERP Projects in the LEC Planning Area	75,111,944	182,510,599	228,399,042	139,279,580	120,926,642	746,227,802	2,335,963,999	3,082,191,801

a. While overall CERP project costs are shared 50-50 with the USACE, the timing of the payments varies, as do the activities for which the local sponsor is fully responsible. The local sponsor is generally responsible for 100 percent of the land acquisition costs, but the credit, for purposes of calculating the 50-50 share, is not given until the end of the project, resulting in situations where the local sponsor has spent more than the 50 percent requirement at the end of the project, and must get reimbursed by the USACE, hence the apparent negative funding requirement.

b. In most cases, a PIR will be developed for each project and the cost of the PIR is included in the project costs. This PIR will address several related projects (see **Table G-1** in **Appendix G** for more details).

Table 94. Nonfederal Funding Responsibility of CERP Projects in the Caloosahatchee Basin.

Project	Cost for Fiscal Year (in 1999 dollars)							
	2001	2002	2003	2004	2005	Total 2001-2005	Total 2006-2020	Total 2001-2020
Caloosahatchee River ASR Pilot Project	250,000	2,298,077	278,846	83,975	83,654	2,994,552	5,448	3,000,000
C-43 Basin Storage Reservoir and ASR	2,154,334	2,162,620	23,925,026	66,386,023	43,465,970	138,093,972	81,282,655	219,376,628
Caloosahatchee Backpumping with STA							41,447,501	41,447,501
Southwest Florida Study	1,000,000	1,800,000	1,800,000	1,000,000	500,000	6,100,000	-6,100,000[a]	
Total for CERP Projects in the Caloosahatchee Basin	3,404,334	6,260,697	26,003,872	67,469,997	44,049,624	147,188,524	116,635,604	263,824,129

a. While overall CERP project costs are shared 50-50 with the USACE, the timing of the payments varies, as do the activities for which the local sponsor is fully responsible. The local sponsor is generally responsible for 100 percent of the land acquisition costs, but the credit, for purposes of calculating the 50-50 share, is not given until the end of the project, resulting in situations where the local sponsor has spent more than the 50 percent requirement at the end of the project, and must get reimbursed by the USACE, hence the apparent negative funding requirement.

Recommendations to the CERP from the LEC Plan

LEC Plan analysis indicates refinement of some of the CERP projects may improve their performance. These suggestions for further refinement are discussed below. The LEC Plan recommends that these modifications be analyzed in the planning and design of CERP projects during the PIR and RECOVER process and in any operational changes for these features.

Recommendation 18: S-155A

The LEC Plan recommends that additional analysis in the design phase of CERP determine the most effective method to provide water to the C-51 Backpumping and Treatment component, while continuing to provide benefits to the Lake Worth Lagoon without affecting the location of S-155A as designed for the Everglades Construction Project.

Recommendation 19: Everglades Hydropatterns within WCA-2B

Results of regional modeling efforts performed as part of the LEC Plan identified WCA-2B as the only area of the northern Everglades that received an unacceptable score for the incremental (2005, 2010, and 2015) and LEC-1 Revised simulations, as well as for the LEC-1 simulations. These results indicate this area of the Everglades fails to meet LEC regional water supply planning targets, and ecosystem recovery is not likely to occur unless significant hydrologic improvements are made to the area. These results are similar to the modeling results recorded in Appendix D of the Restudy (USACE and SFWMD, 1999).

It is the intent of the LEC regional water supply planning process to implement the recommendations of the CERP's RECOVER teams to restore or improve Everglades hydropatterns within WCA-2B. The RECOVER teams will have the lead responsibility for identifying potential improvements in design or operations that will resolve any remaining performance problems currently predicted for both the CERP and the LEC Plan for this area of the Everglades Basin.

The approach, which will be used by the RECOVER teams to improve WCA-2B, will be to review and refine, where necessary, the performance measures and indicator regions used to evaluate hydrological performance. An increase in the number of indicator cells in WCA-2B may be required to better understand the nature of the hydrological performance problem and potential solutions. Once performance measures are reviewed, additional structural improvements and operational features will be suggested and modeled to determine potential solutions to WCA-2B performance. Once these improvements have been identified, they will be presented to the LEC Regional Water Supply Plan Advisory Committee and the District's Governing Board for review and approval and implemented as part of the next update of the LEC Plan.

Recommendation 20: Everglades Agricultural Area Storage Reservoirs

This feature as designed in the Restudy includes aboveground reservoir(s) with a total storage capacity of approximately 360,000 ac-ft located in the Everglades Agricultural Area (EAA) in western Palm Beach County and conveyance capacity increases for the Miami, North New River, Bolles, and Cross canals. The initial design for the reservoir(s) assumed 60,000 acres, divided into three, equally-sized compartments (1, 2A, and 2B), with the water level fluctuating up to six feet above grade in each compartment. The final size, depth, and configuration of this facility will be determined through more detailed planning and design.

The purpose of this CERP feature is to improve the timing of environmental deliveries to the WCAs, including reducing damaging flood releases from the EAA to the WCAs, reducing Lake Okeechobee regulatory releases to the estuaries, meeting EAA irrigation and Everglades water demands, and increasing flood protection in the EAA.

Runoff from the EAA, the Miami Canal Basin, and the North New River Canal Basin and regulatory releases from Lake Okeechobee will be pumped into the reservoirs. Compartment 1 discharges will be used to meet EAA irrigation demands. Compartment 2A discharges will be used to meet environmental demands as a priority and can be used to supply a portion of agricultural demands if the environmental demands equal zero. Compartment 2B discharges will be used to meet environmental demands.

The LEC Plan recommends investigating four changes to this feature be considered in the future CERP analyses as a means of optimizing EAA water supply without adversely impacting water deliveries to the natural system. First, the sizes of the reservoirs would be modified. This change would enable more water supply demands in the EAA to be met. Compartment 1 could be increased to 30,000 acres to meet EAA irrigation demands; Compartment 2A would remain the same size (20,000 acres), and Compartment 2B would be decreased to 10,000 acres. Second, the runoff from the portion of the Hillsboro Canal Basin within the EAA could be captured and routed to the enlarged Compartment 1. Third, Compartment 1 could be used to meet demands in the West Palm Beach Canal Basin, as well as the other EAA basins. By implementing these changes, a greater percentage of future EAA demands can be met. Fourth, structural and conveyance changes may be necessary to implement these modifications. Excess water available in ASR facilities in LEC Service Area 1 will be diverted, when possible, to partially meet its demands to the EAA.

The following discussion compares the flows from the LEC-1 simulation to the flows from the LEC-1 Revised simulation. In the LEC-1 simulation, the compartments were all the same size, as recommended in the Restudy. The altered compartment sizes were incorporated into the LEC-1 Revised simulation. The flows discussed below were generated from the standard budget ASCII (American Standard Code for Information Interchange) files and are the mean values of the 31-year simulation.

EAA runoff into Compartment 1 of the EAA Storage Reservoirs was 45,000 ac-ft per year more in LEC-1 Revised simulation than in the LEC-1 simulation. Furthermore, 18,000 ac-ft per year was routed from excess water in regional ASR in LEC Service Area 1 to Compartment 1. In the LEC-1 Revised simulation, water supply to the EAA was 47,000 ac-ft per year more from Compartment 1 than in the LEC-1 simulation. In the LEC-1, this additional supply was used to meet needs in the West Palm Beach Canal Basin, in addition to meeting the needs in the Miami and North New River canal basins. Total flow from Lake Okeechobee to Compartments 2A and 2B was 11,000 ac-ft per year more in the LEC-1 Revised than in the LEC-1. Total supply from Compartments 2A and 2B to meet environmental needs was 23,000 ac-ft per year more in the LEC-1 Revised than in the LEC-1. Modifications to the EAA Storage Reservoirs had no effect on performance of the natural system, which were the same in both the LEC-1 and LEC-1 Revised simulations under average conditions (31-year mean) and drought conditions (five driest years).

The flows discussed above should not be considered measures of performance. In the revised simulations, changes due to the EAA reservoir modifications were not analyzed independently of other changes made in the revised simulations. Instead, performance of these modifications should be measured in terms of impacts on Lake Okeechobee, hydroperiods in the Everglades, and on water supply performance.

Recommendation 21: L-8 Project

This Restudy component was designed to include a combination of aboveground and in-ground reservoirs with a total storage capacity of approximately 48,000 ac-ft located immediately west of the L-8 Borrow Canal and north of the C-51 Canal in Palm Beach County. Other construction features include ASR wells with a capacity of 50 MGD, a series of pumps, water control structures, and canal capacity improvements in the

M Canal. The initial design assumed a 1,800-acre reservoir with 1,200 usable acres with the water level fluctuating from 10 feet above grade to 30 feet below grade. The initial design assumed 50 wells, each with a capacity of five MGD with chlorination for pretreatment and aeration for posttreatment.

The purpose of this feature is to increase water supply availability and flood protection for northern Palm Beach County areas. It will also provide flows to enhance hydroperiods in the Loxahatchee Slough, increase base flows to the Northwest Fork of the Loxahatchee River, and reduce high discharges to the Lake Worth Lagoon.

In the Restudy it was assumed water will be pumped into the reservoir from the C-51 Canal and Southern L-8 Borrow Canal during the wet season, or periods when excess water is available, and returned to the C-51 and Southern L-8 canals during dry periods. Additional features will also direct excess water into the West Palm Beach Water Catchment Area. During periods when the West Palm Beach Water Catchment Area is above desirable stages, 50 MGD will be diverted to Lake Mangonia for storage in the ASR wells. The reservoir portion of this component may be implemented under a previously authorized project.

Modeling completed for the LEC Plan optimized the operation of the ASR portion of this feature by utilizing stored ASR water more often and redirecting where the water was distributed. Water stored in excess of a selected threshold could be conveyed to the EAA to meet irrigation demands. Utilizing this water could prevent the volume of water stored from accumulating in excessive volumes, optimize its beneficial use, and reduce demands on the Lake Okeechobee. The LEC Plan recommends development of an operating schedule that can optimize the use of the stored ASR water to meet EAA demands.

Recommendation 22: C-51 Regional Ground Water Projects ASR Facilities

The purpose of this feature is to capture and store excess flows from the C-51 Canal currently discharged to the Lake Worth Lagoon for later use during dry periods. This feature was designed to include a series of ASR wells with a capacity of 170 MGD to be constructed along the C-51 Canal in Palm Beach County. The initial design of the wells assumed 34 well clusters, each with a capacity of five MGD with chlorination for pretreatment and aeration for posttreatment.

The design includes facilities used to inject and store surficial aquifer ground water adjacent to the C-51 Canal into the Upper Floridan aquifer instead of discharging the canal water to tide. Water will be returned to the C-51 Canal to help maintain canal stages during the dry season. If water is not available in the system, existing rules for water delivery to this region will be applied.

The analysis performed during the LEC regional water supply planning process optimized the operation of the ASR features by utilizing stored ASR water more often and redirecting where it is distributed. Water stored in excess of the water requirements to maintain the C-51 Canal and Lake Worth Drainage District could be conveyed to the EAA to meet irrigation demands. Utilizing this water prevents the volume of water stored from accumulating in excessive volumes and optimizes its beneficial use.

Recommendation 23: West Miami-Dade Reuse Feasibility Study

This feature was designed to produce superior, advanced treatment of wastewater from a future wastewater treatment plant in western Miami-Dade County. The plant will be located in the Bird Drive Basin in Miami-Dade County. The initial design assumed a potential discharge volume of 100 MGD from the wastewater treatment plant. The final configuration of these facilities will be determined through more detailed planning and design to be completed in the ongoing West Miami-Dade Water Reuse Feasibility Study authorized in Section 413 of the Water Resources Development Act of 1996. Superior water quality treatment features would be based on appropriate pollution load reduction targets necessary to protect downstream receiving surface waters.

The purpose for the feature is to meet the demands for the Bird Drive Recharge Area, the South Dade Conveyance System, and Northeast Shark River Slough. When all demands have been met, the plant would stop treatment beyond secondary treatment standards and will dispose of the secondary treated effluent into deep injection wells.

In the Restudy, it was recognized that further study would look at other options and consider cost-effective alternatives. In the models used during the LEC regional water supply planning process, the quantity of reuse being produced was assumed to be only 50 MGD. The LEC Plan recommends that, as part of the West Miami-Dade Reuse Feasibility Study, the volume of reuse water needed to meet identified demands should be reevaluated, that other beneficial uses of reclaimed water should also be considered, and that alternative sources of water should be analyzed.

Recommendation 24: Lake Okeechobee Regulation Schedule

Modifications to the Lake Okeechobee regulation schedule, Run 25, were recommended in the Restudy. These modifications would take advantage of the additional storage facilities identified in the construction features. Two additional zones will be added to the schedule. The first zone will trigger discharges to the North of Lake Okeechobee Storage Reservoir and the EAA Storage Reservoir. The second higher zone will trigger the Lake Okeechobee ASR facilities to begin injecting water from the lake. Climate-based forecasting will be used to guide management decisions regarding releases to the storage facilities.

As part of the analysis performed for the LEC Plan, a Water Supply and Environmental (WSE) schedule with modifications to accommodate additional storage features, showed superior performance in meeting environmental and water supply demands on the lake. The WSE schedule was recommended by the LEC Interim Plan and continues to perform better than the modified Run 25 schedule used in the Restudy. The WSE schedule is able to meet a greater percentage of water supply demands in the LEC Planning Area and the Lake Okeechobee Service Area (LOSA), while providing environmental deliveries to the estuaries and the Everglades. Increased storage and demands on the lake alters operations. The schedule should be updated as major new storage features are constructed or at least every five years over the next 20 years.

Recommendation 25: Lake Belt Storage Area Projects

The Lake Belt storage areas are expected to be complete in 2036. They will extend beyond the 2020 time frame used in the LEC regional water supply planning process. Modeling and analysis for the LEC Plan has shown that completing 50 percent of the planned reservoir capacity is critical in meeting the multiple water resource objectives in the region by 2020. The construction of seepage barriers, which are necessary for this design, will require careful coordination with the limestone mining industry in order to obtain a portion of reservoir capacity before mining is complete. Likewise, pilot studies to test the feasibility of some aspects of the concept are critical and will require ongoing coordination with the mining industry. The LEC Plan recommends the identification of seepage barrier locations early on and coordination with the mining industry on the timing of mining so that blasting will not cause damage to seepage barriers.

Recommendation 26: Everglades Rain-Driven Operations

Modifications to the regulation schedules for WCAs 2A, 2B, 3A, 3B, and the current rainfall delivery formula for Everglades National Park were recommended in the LEC Interim Plan and in the Restudy to implement rain-driven operations for all of these areas. These new operational rules are intended to improve timing and range of water depths in the WCAs and Everglades National Park to restore more natural hydropatterns, as well as meet MFLs for these areas.

The rain-driven operational concept is a basic shift from the current operational practice, which uses calendar-based regulation schedules for the WCAs. Regulation schedules, also referred to as rule curves, or flood control schedules, typically specify the release rules for a WCA based on the water level at one or more key gages. Regulation schedules do not typically contain rules for importing water from an upstream source. The regulation schedules also repeat every year and make no allowance for interannual variability. The rain-driven operational concept includes rules for importing and exporting water from the WCAs in order to mimic a desired target stage hydrograph at key locations within the Everglades system. The target stage hydrographs mimic an estimate of the predrainage Everglades water level response to rainfall.

Analysis of incremental runs performed as part of the LEC regional water supply planning process indicate that rain-driven operations for WCAs 2B, 3A, 3B, and Everglades National Park could be developed and implemented by 2005. The rain-driven operations for WCA-2A should be developed and implemented by 2010. The rain-driven operations are key to providing additional water when needed prior to construction of the major storage features recommended in the Restudy. The schedules need to be updated as major storage features are constructed or at least every five years. Additionally, a methodology to transform concepts applied during regional model simulations to rainfall formulas that can be applied during daily operation of the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) should be developed by

2003. WCA-1 is recommended to retain its latest regulation schedule until comprehensive analysis be undertaken to determine whether a future rain-driven schedule will be beneficial.

Recommendation 27: Change Coastal Wellfield Operations

Shifting demands from eastern facilities to western facilities, away from the saltwater interface, was recommended for some coastal public water supply utilities in the LEC Planning Area, which are expected to experience an increased threat of saltwater intrusion. The Restudy recommended that a portion of demand should be shifted inland for the following utilities: Riviera Beach, Lake Worth, Lantana, Manalapan, Boca Raton, and Florida City. The volume shifted depended upon the degree of saltwater intrusion, but is generally proportional to the increase in demands between the 1995 existing conditions and the projected 2050 future without plan conditions. Eastern wellfields at Miramar, Hollywood, Broward County 3A, 3B, and 3C, Dania Beach, and Hallandale are assumed to be on standby with the entire demand met from western facilities.

The coastal wellfield operations evaluated as part of the LEC Plan indicate that fewer utilities and less demand may need to be shifted inland or to alternative sources of water to avoid an increased threat of saltwater intrusion. The wellfields that continue to indicate an increased threat of saltwater intrusion or that may not be able to meet a 1-in-10 year level of certainty in 2020 are Lantana, Lake Worth, Manalapan, Boca Raton, Broward 3A, 3B, and 3C, Hollywood, Dania Beach, Hallandale Beach, North Miami, and North Miami Beach. Their projected 2020 demands may not be able to be met at their current wellfield locations. Additionally, the incremental runs of 2005, 2010, and 2015 indicated superior performance when utilizing the same wellfield distribution in LEC-1. To meet the 1-in-10 year level of certainty and reduce the threat of saltwater intrusion in the near-term, the identified demands may need to be shifted from coastal wellfields as soon as possible. The individual utilities may consider other water supply options and the District is proposing a water resource development project in which the utilities in southeastern Broward County cooperatively develop additional wellfield and treatment capacity.

Recommendations to the CERP from the CWMP

The Caloosahatchee Water Management Project (CWMP) identified the need for storage within the basin using a regional optimization approach with underground storage of such amount that the ASR systems will tolerate extended withdrawals of 220 MGD and 220,000 ac-ft in aboveground storage (reservoirs plus other storage options). The analysis in the CWMP indicates that more detailed evaluation using more site-specific information may result in changes to the sizing and combination of this storage and recommends that the detailed evaluation be continued as part of the Southwest Florida Study (SWFS).

Five types of potential storage options or components were identified: regional and distributed reservoirs, ASR, backpumping to Lake Okeechobee, in-river storage due to structure S78.5, and water table harvesting. The five storage components were combined into nine alternatives that were evaluated utilizing reduced flows from Lake Okeechobee as modeled in the LEC 2020 with Restudy alternative simulation. Of these components, model results indicate that backpumping has limited utility or benefit and, therefore, is not practical, based on the assumptions in the CWMP. Addition of a structure in the Caloosahatchee River (S78.5) and water table management showed minimal benefit, but may be considered as part of an overall storage strategy. Regional and distributed reservoirs and ASR systems showed the greatest potential for meeting the storage needs in the Caloosahatchee Basin and are recommended for additional investigation and pilot testing within the basin.

A detailed assessment of the potential storage components is needed to identify a preferred alternative for meeting the demands in the Caloosahatchee Basin in 2020. It is recommended that the detailed assessment be completed as a part of the implementation of the SWFS.

The modeling conducted, as part of the CWMP, to evaluate the performance of various storage components utilized revised Caloosahatchee Basin hydrology and demands from those used in the Restudy. This assessment showed higher demands and lower runoff from the basin, and consequently less water was available to be placed in storage. The CWMP evaluated options that focused on additional storage within the basin coupled with limited water supply deliveries (matching the results of the Restudy) from Lake Okeechobee. Under these assumptions the proposed water supply backpumping option performed poorly. It is recommended that the SWFS and the analysis by the CERP RECOVER process further investigate the recommendations of the CWMP concerning in-basin storage and backpumping for storage in Lake Okeechobee (coupled with reasonable assurances of adequate deliveries from the lake to the Caloosahatchee Basin) to confirm the best combination that meets the cost-effectiveness, water supply, and environmental goals recommended in the Restudy for the Caloosahatchee Basin.

The SWFS needs to be completed and implemented to address freshwater discharges to the Caloosahatchee Estuary and increase surface water availability for water use. The recommendations of the CWMP and the Restudy, and associated funding, should be pursued after detailed modeling is performed.

An evaluation of projected flows to the Caloosahatchee River was conducted via the LEC Plan and the CWMP for 1990 and 2020 base case conditions. The results of these evaluations indicate that the proposed MFL criteria and the restoration base flow needs of the Caloosahatchee Estuary are not being met. Pursuant to the direction provided in Section 373.042, F.S., a recovery plan is provided in the LEC Plan. The recovery plan consists of design and construction of enhanced basin storage capacity using surface water, ASR, and reservoirs as described in the Restudy and refined through the CERP and SWFS.

Based on the recommended development of water management and storage infrastructure to effectively capture and store the surface water flows in the Caloosahatchee Basin, the projected surface water needs of the basin and the estuary can be met. Supplemental agricultural demands from surface water sources within the basin are estimated to increase from 230,000 ac-ft per year (200 MGD) based on 1995 land use, to approximately 320,000 ac-ft per year (285 MGD) on average based on 2020 projected land use. Public water supply needs from the Caloosahatchee River are projected to increase from 13,000 (12 MGD) in 1995 to 18,000 ac-ft per year (16 MGD) on average by 2020. The environmental needs of the Caloosahatchee Estuary have been estimated at 450,000 ac-ft (400 MGD) while average flows to the estuary are estimated to be approximately 650,000 ac-ft per year (580 MGD) on average. Flow to the estuary in excess of needs can, therefore, be as high as 200,000 ac-ft per year (180 MGD) on average, that is adequate, to meet increased demand through 2020. It was also concluded that the evaluated components, once constructed, would be adequate to meet the demands in the basin during a 1-in-10 year drought event.

The CWMP has identified that the future environmental, agricultural, and public water supply needs of the Caloosahatchee Basin and Estuary can be met from a combination of basin storage options with deliveries of water from Lake Okeechobee as identified in the South Florida Water Management Model (SFWMM) LEC 2020 with Restudy components. The evaluation of storage components conducted as part of the study show that components capable of providing short-term and long-term storage are required. The finding suggests that regional and distributed reservoirs, as well as ASR systems, would form an integral part of any successful storage development within the basin. A pilot testing program should be developed to verify the feasibility and effectiveness of these storage methods within selected sites in the Caloosahatchee Basin through the SWFS.

Recommendation 28: Caloosahatchee River ASR Pilot Project

Discussion

The District should work cooperatively with the USACE to site, design, construct, and operate a pilot regional ASR project. Recovery performance and additional information obtained from the construction of and cycle testing at this facility will guide the design of the regional ASR wellfield.

Summary Information

Cost: $2,998,000 (SFWMD portion only)

Funding Sources: SFWMD and USACE

Implementing Agencies: SFWMD and USACE

Table 95. Estimated Schedule and Costs for the Implementation of the Caloosahatchee River ASR Pilot Project.[a]

Recommendation	Plan Implementation Costs ($1,000s)					
	FY01	FY02	FY03	FY04	FY05	Total 2005-2020
Caloosahatchee River Pilot ASR Project	250	2,300	280	84	84	2,998

a. Inkind service includes FTEs for design and implementation of the ASR Pilot Project and will be applied against the District's portion of the 50/50 cost-share requirement.

Recommendation 29: C-43 Basin Storage Reservoir and ASR Project

Discussion

The District should cooperate with the USACE in development of the Project Implementation Report (PIR), design, construction, and operation of a regional reservoir and ASR project within the Caloosahatchee Basin. A comprehensive geologic and geotechnical investigation should be completed, as a part of the PIR to provide the information needed to size and design the reservoir. Development of the PIR, land acquisition, design, and plans and specifications should be completed by 2005 and construction should be initiated in 2005.

Summary Information

Cost: $138,094,000 (SFWMD portion only)

Funding Sources: SFWMD and USACE (50/50 cost share)

Implementing Agencies: SFWMD and USACE

Table 96. Estimated Schedule and Costs for the C-43 Basin Storage Reservoir and ASR Project.[a]

Recommendation	Plan Implementation Costs ($1,000s)					
	FY01	FY02	FY03	FY04	FY05	Total 2001-2005
C-43 Basin Storage Reservoir and ASR	2,154	2,163	23,925	66,386	43,466	138,094

a. Inkind service includes FTEs for design and implementation of the PIR and will be applied against the District's portion of the 50/50 cost share requirement.

Recommendation 30: Southwest Florida Study

Discussion

The District should work in cooperation with the USACE to initiate and complete the SWFS by 2005 as recommended in the CERP. The modeling work that has been completed as a part of the CWMP should be used as the basis for development of a preferred alternative to meet the demands within the Caloosahatchee Basin in 2020.

The primary purpose of the SWFS should be to provide a framework in which to address the health of aquatic ecosystems; water flows; water quality (including appropriate pollution reduction targets); water supply; flood protection; wildlife and biological diversity; and natural habitat. Evaluations involving surface water availability for water supply purposes should be based on providing a 1-in-10 year level of certainty from surface water as an optimal goal.

Subtasks

Task 30a. Complete problem identification/Project Study Plan phase by October 2000.

Task 30b. Complete development of a preferred alternative for the Caloosahatchee Basin by 2003.

Task 30c. It is recommended that the demand projections that were developed for the CWMP form the basis for evaluation of demands for the Caloosahatchee Basin in the SWFS.

Task 30d. The Integrated Surface Water Ground Water Model (ISGM) and other models that were developed to model the Caloosahatchee Basin should be incorporated into the SWFS and be utilized to evaluate the performance of water supply storage options, such as a distributed reservoir system. During the SWFS analysis, the CWMP demands and ISGM should be refined and updated as needed for evaluation of alternatives for meeting demands in the Caloosahatchee Basin in 2020.

Task 30e. Continue development of the modeling tools that were developed for the CWMP. These tools include the ISGM (MIKE SHE), Agricultural Field-Scale Irrigation Requirements Simulation (AFSIRS)/Water Balance Component (WATBAL), and optimization models that were developed for the Caloosahatchee Basin.

Task 30f. Continue the seepage study that was initiated during development of the CWMP.

Task 30g. The Plan of Study for the SWFS should include an evaluation of the feasibility of constructing a distributed reservoir system. In addition, the District should investigate the feasibility of public/private partnerships for funding and implementing a distributed reservoir system.

Task 30h. In some areas immediately adjacent to the CWMP Planning Area, distributed, small-scale reservoirs could be developed that can offer improved water resource management through increased environmental and flood protection, and increased surface water resource availability. This should be investigated in the SWFS.

Summary Information

Cost: $5-6,100,000 (estimated) (SFWMD portion only)

Funding Sources: SFWMD and USACE

Implementing Agencies: SFWMD and USACE (50/50 Cost Share)

Table 97. Estimated Schedule and Costs for the Southwest Florida Study.

	Plan Implementation Costs ($1,000s)					
Recommendation	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**	**Total 2001-2005**
Complete Southwest Florida Study	1,000	1,800	1,800	1,000	500	6,100

Operational Recommendations

Systemwide Operational Protocols and Periodic Operational Deviation Process

In addition to changes in the operation of the C&SF Project necessary to accommodate the future construction of proposed major water resource development features, revised systemwide operational protocols will be required in order to meet the increasing human and environmental water demands of the region over the next five to 10 years. Consistent operation of the C&SF Project in compliance with the revised systemwide operational protocols will be a critical factor in assuring projected water supply plan performance targets are met, and the expected water resource benefits to the region are provided.

It is also recognized that certain portions of the system may undergo periods of stress that are either unrelated to system operations or are caused, in part, by meteorological events which exhibit extreme high or low rainfall conditions that may exceed the design assumptions in the plan. A process which periodically reviews and recommends potential short-term deviations to the systemwide operational protocols are prudent. The process would be used to analyze the impacts of variations in weather and hydrologic conditions and identify opportunities for short-term operational deviations which will offset, to some extent, the identified impacts. Therefore, it is desirable to include a measure of operational flexibility. This process will include public input and Governing Board approval prior to implementation. This process will complement the systemwide operational protocols by determining periodic operational deviations that could be applied to avoid or reduce potential impacts associated with extreme meteorological conditions.

District staff should reevaluate systemwide structure operations within the context of the proposed water supply plan assumptions. These systemwide operations will also need to be modified from time to time to take into account the construction of new water resource development projects. This reevaluation should incorporate the flexibility to facilitate short-term operational deviations to address extreme meteorological events or unanticipated negative ecological responses. This reevaluation should also incorporate the use of a wide range of environmental, water supply (e.g., ASR), flood control and water quality performance measures that can be used to make real time system operational decisions. Furthermore, the implementation of these new criteria should be accompanied with the development of statistical risk assessment procedures and other real time decision support tools.

Recommendation 31: Systemwide Operational Protocols

Discussion

The District needs to develop a comprehensive set of revised operational protocols that cover all of the existing components of the South Florida Water Resource Management System (SFWRMS). The SFWRMS covers the entire District area and includes the original components of the C&SF Project, as well as supplemental project structures constructed by the District and the Everglades Construction Project. Periodic operational revisions to this protocol through time will also incorporate future structures proposed by the District's water supply plans and the CERP. Furthermore, these protocols will implement recent and proposed programs and policies such as the following:

- MFLs
- Rain-Driven Deliveries to the Everglades
- Water Shortage Plan
- Water Supply Plan Elements
- Modified Water Deliveries Project
- C-111 Project
- Everglades Construction Project
- CERP
- Lake Okeechobee Construction Project

Operational criteria incorporates a number of interrelated elements into a comprehensive set of information that is used to develop real time operational strategies and implement changes in structure operations in response to changing meteorological conditions:

Operational Goals and Objectives. To ensure successful operation of the SFWRMS, a set of goals and objectives, which are consistent with the water supply planning processes, is required. When exercising any available flexibility contained within the operational criteria, it is important to ensure that decisions on specific structure operations are focused to meet the stated objectives of the system. Therefore, a clear and concise set of goals and objects are critical to the successful implementation of the SFWRMS operational protocols.

Real Time Performance Measures. Performance measures are a critical component to the success of the overall water resource planning process. They are used as a means to evaluate and select a preferred water resource plan based on hydrologic simulations. Likewise, real time operations require a set of performance measures, consistent with the water supply planning processes, that can be used to insure the successful implementation of the selected plan. These real time measures can be used to identify problem areas and guide staff in the development of real time operational strategies that consider existing conditions in the context of changing meteorological and climatological outlooks. The performance measures should include success criteria for all significant environmental components, water shortage implementation, flood control management, and water quality assessment.

Decision Support. Real time operational decisions are predominantly risk-based assessments that utilize probabilistic estimates of rainfall and other relevant hydrologic and climatological conditions to develop the most prudent set of actions anticipated to meet the objectives of the water resource system. Therefore, a comprehensive decision support system that includes statistical position analysis tools, and other risk-based assessment protocols is required.

Flexible Operating Criteria. Criteria governing individual structure operations are the most basic element of any water resource operating system. Generally, these criteria are very specific and contain limited flexibility. The criteria developed in support of the original C&SF Project accepted that there would be few and relatively infrequent meteorological conditions that would impose serious environmental and socioeconomic impacts to the region. However, because of the state of technology available in the 1950s and 1960s, little could be done to foresee and react to environmental impacts that have driven much of today’s efforts to improve the water resource system’s performance. Future development of operational criteria must provide the capability to proactively react to rapidly changing climatological outlooks and environmental conditions. This flexibility should be guided by the goals and objectives of the various system element through the application of comprehensive performance measures. Decisions regarding changes in operations will require concurrence from the Executive Director and Governing Board depending on the situation. Public input should be frequently solicited on a periodic basis.

Subtasks

Task 31a. Complete the ongoing series of regional water supply plans through Governing Board approval

Task 31b. Develop public input process

Task 31c. Develop systemwide operational policies that meet the stated goals and objectives of the various programmatic efforts

Task 31d. Develop performance measures suitable for use in real time operational decisions, which incorporate environmental, water supply, flood control, and water quality elements

Task 31e. Develop a suite of decision support tools that incorporate a probabilistic, risk-based assessment methodology

Task 31f. Finalize systemwide operational policies

Task 31g. Conduct public workshops on the proposed operational alternatives and seek a Governing Board decision

Summary Information

Cost: $0 (FTEs only)

FTEs: 5

Funding Source: SFWMD

Implementing Agency: SFWMD

Table 98. Estimated Schedule and Costs for Developing Systemwide Operational Protocols.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Develop systemwide operational protocols		5										5

Recommendation 32: Periodic Operational Flexibility

Discussion

The District needs to develop a process to identify and implement short-term deviations to existing operational protocols that consider all of the existing and proposed components of the SFWRMS. These periodic operational deviations in process and review will cover the following geographic subregions:

- Upper Kissimmee Chain of Lakes
- Kissimmee River
- Lake Okeechobee
- Caloosahatchee River/Estuary
- St. Lucie River/Estuary
- Everglades
- Upper East Coast Planning Area
- LEC Planning Area
- Lower West Coast Planning Area
- Lake Okeechobee Service Area (LOSA)
- South Miami-Dade Agricultural Area
- Loxahatchee Slough and River
- Biscayne Bay
- Florida Bay

The regional hydrologic simulations were not structured to accurately consider short-term operational deviations that might be required to offset specific subregional environmental, water supply, flood control, or water quality situations. Therefore, a process to develop and implement short-term operational deviations must be initiated to ensure that every effort is made to meet the regional water resource goals in the next 20 years as the major elements of the LEC Plan and CERP are implemented. These deviations would be applied in a proactive manner utilizing long-range climate forecasts and real time performance measures. This flexibility will consider both high water and low water conditions, and include temporary modifications to the Supply-Side Management Plan for Lake Okeechobee. The development, implementation, and effectiveness of these deviations would be formatted by staff and, prior to implementation, discussed with the public and include periodic public workshops, Executive Office review, and Governing Board approval.

Subtasks

Task 32a. Review target performance measures of the subregion, compare them against actual performance, and, if stressed, determine probable cause, effect, and severity

Task 32b. Develop alternative short-term operational policies to evaluate the feasibility of various options that might be applied

Task 32c. Finalize a suite of alternatives and short-term operational policies

Task 32d. Coordinate with appropriate state and federal agencies

Task 32e. Conduct a public workshop on the proposed short-term operational alternatives and seek a Governing Board decision

Summary Information

Cost: $0 (FTEs only)

FTEs: 12.5

Funding Source: SFWMD

Implementing Agency: SFWMD

Table 99. Estimated Schedule and Costs for Developing Periodic Operational Flexibility.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Develop periodic operational flexibility		2.5		2.5		2.5		2.5		2.5		12.5

Recommendation 33: Lake Okeechobee Vegetation Management Plan

Over the last six years, extreme wet periods have resulted in abnormally high lake levels for long periods of time. These extreme high water levels have resulted in impacts to lake water quality, loss of important littoral zone vegetation communities, and have been reported to affect its sport fishery. The majority of scientists who have conducted research on the lake generally agree that a natural drought period or drawdown of the lake induced by man over the next several years would provide a number of ecological benefits to the ecosystem. These benefits would include improved water quality, reestablishment of damaged littoral zone habitat, and improved wildlife utilization of the littoral zone.

The only negative environmental issue associated with a potential drawdown of the lake over the next five years is the near certainty of torpedo grass and melaleuca expansion within upper elevations of the littoral zone. Currently, over 16,000 acres of torpedo grass infest the western littoral zone of the lake. These plants offer poor habitat for fish and wildlife due to their dense growth form and result in low oxygen levels within the water column. Researchers have speculated that if Moonshine Bay should become dry (lake stages less than 11 ft NGVD) this would allow the rapid expansion of this introduced exotic throughout this pristine area of the lake (SFWMD, 2000e).

The first sweep of melaleuca control efforts have been made throughout most of the littoral zone, but viable seeds remain in seed banks and within remaining melaleuca stands. In comparison to torpedo grass, melaleuca poses less of a threat to the lake since it is currently under an advanced level of management and has a slower rate of expansion.

To address this issue, the LEC Plan recommends the formation of a Lake Okeechobee Vegetation and Fire Management Team (LOVFMT) that will work in cooperation with the existing South Florida Interagency Fire Management Council. It will the be responsibility of the LOVFMT to develop a Lake Okeechobee Vegetation Management Plan designed to manage torpedo grass and melaleuca expansion within the lake by providing increased opportunity for control of the invasive species in anticipation of dry periods. This plan would consist of organizing the LOVFMT to take advantage of future predicted low lake stages through a combination of burn management and disking programs designed to remove old growth, which renders the plant more susceptible to herbicide treatment.

The District in cooperation with the FDEP and the USACE will develop an approved work plan to deploy helicopters, spray boats, and herbicide field teams, as necessary, to conduct a large-scale torpedo grass and melaleuca eradication program within the western littoral zone of the lake (including Moonshine Bay) in the event the lake levels fall below 12 ft NGVD. This program will be implemented over the next five years to address the torpedo grass expansion problem and ensure that melaleuca will not become reestablished if the opportunity for low lake stages becomes eminent.

Summary Information

Cost: $750,000 (District share only)

FTEs: 2.5

Funding Sources: SFWMD, FDEP, and USACE. Funding will be coordinated with the State of Florida’s fire permitting agency (Division of Forestry, Florida Department of Agriculture and Consumer Services). It is estimated that total funding for this program from all sources for this effort would be about $2.5 million.

Implementing Agencies: SFWMD, FDEP, and USACE

Table 100. Estimated Schedule and Costs for the Lake Okeechobee Vegetation Management Plan.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Lake Okeechobee Vegetation Management Plan	150	0.5	150	0.5	150	0.5	150	0.5	150	0.5	750	2.5

Consumptive Use Permitting and Resource Protection Projects

Implementation of the LEC Plan through CUP and resource protection actions will take place consistent with Florida law, utilizing the assurances framework developed by the Governor's Commission for a Sustainable South Florida and included in the CERP.

As one of the tools for plan implementation, rulemaking to implement the regulatory recommendations of the LEC Plan will constitute a significant effort during the next several years. Rulemaking will include water reservations and numerous CUP criteria, which are interrelated and cumulatively define the availability of water for consumptive uses and water resource protection. As a result, it is recommended in the LEC Plan that certain rulemaking efforts be grouped in phases to allow for the cumulative analysis of the water resource and consumptive use implications of the regulatory program.

Another goal of the rulemaking schedule is to adopt rules as the technical information becomes available. As a result, it is recommended in this plan that initial rulemaking proceed for concepts that were sufficiently identified and evaluated in the planning process. These include establishment of MFLs for the Everglades, Lake Okeechobee, the Biscayne Aquifer, and the Caloosahatchee River.

In addition, uncertainties in the rulemaking process, such as delays for development of supporting technical data or rule challenges, may conflict with the proposed schedule for rule development provided in this plan. The proposed schedule will be adapted to account for such delays, while considering the need to develop associated rules through a coordinated rulemaking process. The contingency process identified in the plan, along with input from the LEC Regional Water Supply Plan Advisory Committee, other members of the public, and the Governing Board may be used to identify necessary changes to the rulemaking schedule.

Recommendation 34: Water Reservations

Discussion

Water reservations need to be established where necessary to assure the public of the availability of water specific to locations for the protection of fish and wildlife or protection of public health and safety based on the discussion in **Chapter 5**. In **Chapter 5**, a legal, policy, and technical description of reservations and necessary implementation actions is provided.

Subtasks

Task 34a. For all reservation locations, quantify water for reservation, based on incremental increases in water availability associated with the proposed implementation of water resource development projects; identify assumptions used in incremental reservation increases, including water resource development projects proposed to augment or create reservation water supplies;

identify a process for updating reservation rules in five-year increments if reservation-based assumptions are changed or prove to be inaccurate

Task 34b. Conduct rulemaking necessary to implement the reservations

Task 34c. Conduct additional research to identify freshwater flow needs and define reservation demands for the Biscayne Bay, Florida Bay, the Loxahatchee River, and subregional wetland systems in Broward and Palm Beach counties (**Table 101**)

Task 34d. Update the LEC Plan in 2005 to incorporate the projected reservation demands and to identify additional implementation measures for reservations

Table 101. Target Dates for Establishing MFLs and Reservation Rules.

Priority Water Body	Target Date for Establishment of MFL Rule	Target Date for Establishment of Reservation Rule
Lake Okeechobee	December 2000	NA
Water Conservation Areas	December 2000	December 2003
Holey Land and Rotenberger WMAs	December 2000	December 2003
Everglades National Park	December 2000	December 2003
Rockland Marl Marsh in Everglades National Park	December 2005	December 2005
St. Lucie Estuary	December 2001	December 2001
Caloosahatchee River and Estuary	December 2000	December 2000
Stormwater Treatment Areas	NA	March 2001
Loxahatchee River	December 2001	December 2001
Biscayne Bay	December 2004	December 2004
Florida Bay	December 2003	December 2003
Biscayne Aquifer	December 2000	NA
Southern Biscayne Aquifer	December 2003	NA
Subregional Wetlands	NA	December 2003

Summary Information

Cost: The initial reservation rulemaking will involve existing technical, regulatory, and legal staff at a total of 1.7 FTEs over the first two quarters of FY 2001. Additional research for the definition of reservations for Biscayne Bay, Florida Bay, the Loxahatchee River, and subregional wetland restoration, are funded under other initiatives in this plan. However, staff to support rulemaking for adoption of reservations for these additional areas is expected to be 0.5 FTEs by 2004. The $125,000 estimated for the five-year duration of this program is directed towards the development of operation criteria for delivering the reservation water included in the rule(s).

FTEs: 1.7

Funding Source: SFWMD

Implementing Agency: SFWMD

Table 102. Estimated Schedule and Costs for Reservation of Water.

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Water Reservations	50	0.7		0.3			75	0.5		0.2	125	1.7

Recommendation 35: Establish MFLs

Discussion

Establish MFLs by rule by December 2000 for Lake Okeechobee, Everglades National Park, and the WCAs, the Biscayne aquifer (north of the C-2 Canal), and the Caloosahatchee River and Estuary. Develop and establish MFLs for the Loxahatchee River and St. Lucie Estuary by 2001, the southern Biscayne aquifer by 2003, and for Biscayne Bay by 2004. Funding and manpower estimates are associated with the rulemaking and peer review process only. Funding and manpower associated with data collection and research are incorporated as separate recommendations.

Subtasks

Task 35a. Complete research on Biscayne Bay, St. Lucie Estuary, and the southern coastal Biscayne aquifer

Task 35b. Finalize the MFL criteria development process

Task 35c. Incorporate proposed MFLs and recovery and prevention strategies into the rulemaking process consistent with the dates for establishment identified above (**Table 101**)

Task 35d. Conduct public workshops on rule language, notice draft rule with FAW, and seek Governing Board authorization of rule

Summary Information

Cost: $80,000 over five years (peer review and rulemaking process only)

FTEs: 1.3

Funding Source: SFWMD

Implementing Agency: SFWMD

Table 103. Estimated Schedule and Costs for Establishing MFLs.

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Establish MFLs	40	0.5				0.3	40	0.5			80	1.3

Recommendation 36: MFL Criteria for the Rockland Marl Marsh

Discussion

Everglades National Park staff has suggested the proposed interim MFL criteria for the Rockland marl marsh within the park may not sufficiently protect these wetlands from significant harm. Additional wetland research is proposed to confirm or refine the MFL return frequency criteria that will not cause significant harm to marl-forming wetland plant and animal communities. As part of the LEC regional water supply planning process, the District, Everglades National Park, and USGS staff will jointly develop a work plan to conduct the necessary research needed to confirm or refine the proposed MFL return frequency criteria for the Rockland marl marsh. This work will also help to determine appropriate levels for reservations of water.

Subtasks

Task 36a. Select an interagency working group, with public input, to develop the Rockland marl marsh MFL research plan

Task 36b. Develop the draft research plan and have it independently peer reviewed by November 2001

Task 36c. Once the research plan has been approved, the District will include its portion of the cooperative agreement in its 2002 budget for Governing Board approval

Task 36d. Implement the research plan by September 2002 with a final report delivered to the District by July 2005

Summary Information

Cost: $115,000

FTEs: 0.5

Funding Sources: SFWMD

Implementing Agencies: SFWMD, Everglades National Park, and USGS

Table 104. Estimated Schedule and Cost for MFL Research for the Rockland Marl Marsh.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**
MFL Research for the Rockland Marl Marsh	15	0.1	100	0.1		0.1		0.1		0.1	115	0.5

Recommendation 37: MFLs for Florida Bay

Discussion

In response to recommendations made by Everglades National Park staff, Florida Bay was placed on the District's Priority Water Body List for establishment in 2003. A sufficiency review of the necessary technical information needed to develop MFLs for Florida Bay has been completed and is under review. A number of research projects are currently under way that will provide data for developing initial MFLs for Florida Bay. In addition, conceptual models of Florida Bay are being developed by the CERP RECOVER Team and may be used as a starting point for developing MFL criteria for Florida Bay. The District expects to develop initial MFL criteria for Florida Bay by 2003.

Subtasks

Task 37a. Complete the MFL sufficiency review for Florida Bay

Task 37b. Complete the work plan for Florida Bay MFL development

Task 37c. Utilize existing research programs to collect the necessary stage, flow, and salinity data needed to establish flow-salinity relationships for Florida Bay

Task 37d. Utilize existing salinity response information on seagrasses and evaluate high salinity response (up to 70 ppt) experiments in Key Largo mesocosms

Task 37e. Finalize the development of conceptual models and use them as a starting point for the development of MFL criteria for Florida Bay

Task 37f. Utilizing the above information, develop and publish initial MFL technical criteria for Florida Bay, and have this technical document peer reviewed by an independent scientific peer review panel by March 2003

Task 37g. Establish initial MFLs (Phase 1) for Florida Bay by December 2003. Identify minimum flows and/or levels needed to prevent significant harm, and identify the amount of water needed to restore Florida Bay and establish a reservation of water to protect the ecosystem

Task 37h. Develop a Florida Bay water quality model and incorporate trophic level responses

Task 37i. Utilize water quality models to establish Phase 2 MFLs for Florida Bay

Summary Information

Cost: $850,000

FTEs: 11.5

Funding Source: SFWMD

Implementing Agencies: SFWMD and Everglades National Park

Table 105. Estimated Schedule and Cost for MFLs for the Florida Bay.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
MFLs for the Florida Bay	200	2.5	250	2.5	150	2.5	125	2.0	125	2.0	850	11.5

Recommendation 38: MFL Recovery Strategies

Pursuant to the requirements of the MFL statute, analyses of current and future conditions were conducted for each of the priority water bodies where MFLs were defined. When the evaluation showed MFLs are not or will not be met in the future, recovery or prevention strategies, as appropriate, were developed. See **Chapter 5**, **page 227**, for a more detailed discussion of MFL recovery strategies.

Subtasks

Task 38a. Complete the design, permitting, and construction of CERP related long-term recovery strategies

Task 38b. Develop and implement operational protocols for releasing water from regional storage, as conditions warrant, to prevent the MFL criteria from being exceeded prior to implementation of long-term recovery measures. See **Recommendation 31** and **32** for more information.

Task 38c. Complete rulemaking that: a) defines regional water supply to coastal service areas during 1-in-10 year drought conditions consistent with environmental restoration and water resource development implementation schedules; b) addresses permit duration and limits on the amounts of reasonable new demands on regional water supply in five-year increments; c) establishes enhanced water conservation measures for water users; and d) establishes water reservations for the Everglades system.

Summary Information

Cost: $200,000

FTEs: 1

Funding Source: SFWMD

Implementing Agencies: SFWMD

Table 106. Estimated Schedule and Cost for MFL Recovery Strategies.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
MFL recovery strategies	75	0.2	50	0.2	25	0.2	25	0.02	25	0.2	200	1.0

Recommendation 39: MFL Monitoring Systems

Discussion

Monitoring systems must be established in order to implement MFL recovery and prevention strategies and conduct research necessary to further refine the ability to project when significant harm could occur. The monitoring systems will collect water flow, water level, and water quality data. Monitoring data is necessary to affect interim operational strategies and to gage the success of MFL long-term recovery and prevention strategies.

Subtasks

Task 39a. Identify appropriate locations within the LEC planning area to establish a long-term MFL monitoring network. Review and evaluate the location of current water management gages. Relocate and/or install appropriate lake, estuary, marsh, and canal gaging stations and associated telemetry within each identified MFL priority water body

Task 39b. Develop an interactive database to collect and store MFL data that will provide water managers with real time information that can be used to make operational decisions

Task 39c. Conduct field and laboratory research and monitoring programs designed to evaluate the effects of implementing the proposed MFL criteria proposed as part of this plan. Include both long-term and short-term projects that will evaluate the effects of the proposed criteria at scales ranging from laboratory studies to field monitoring at specific sites. Provide summaries of the results of this research for incorporation into the next update of the LEC Plan.

Summary Information

Cost: $550,000

FTEs: 1.5

Funding Source: SFWMD

Implementing Agencies: SFWMD

Table 107. Estimated Schedule and Cost for Establishing a MFL Monitoring System.

	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
Recommendation	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**	**$**	**FTE**
Establish a MFL Monitoring System	50	0.2	200	0.4	200	0.5	50	0.2	50	0.2	550	1.5

Recommendation 40: Consumptive Use Permitting, Rulemaking, and Resource Protection Projects

Discussion

The District will continue conducting the rule development and rulemaking processes for the subjects listed in **Chapter 5** in the section on **Consumptive Use Permitting and Resource Protection Projects**. These concepts are conceptually laid out in a series of white papers produced in 1999[1] and Districtwide rule development workshops were conducted on these rule concepts in February 1999.

Subtasks

Task 40a. Develop draft rules for public review

1. These white papers can be obtained by contacting the District's Office of Counsel.

Task 40b. Conduct rulemaking workshops

Task 40c. Revise draft language per public comments and Governing Board direction in order to produce a final draft of the rule

Task 40d. Notice final draft of the rule in FAW and schedule Governing Board adoption of the final draft rule in the fall of 2000[1]

Task 40e. Modify ground water models for application to the CUP review process.

Summary Information

Cost: $0

FTEs: 0.5

Funding Source: SFWMD

Implementing Agency: SFWMD

Other Water Resource Projects

Recommendation 41: Comprehensive Water Conservation Program

Discussion

The District will develop and implement a comprehensive water conservation program to cultivate a conservation ethic in cooperation with water users, utilities, and local governments to promote water conservation and more efficient use of the water resources in the LEC Planning Area. The conservation program will incorporate continued development and compliance with water conservation ordinances, development and implementation of public education programs, use of alternative water sources, other conservation methods, and document new and existing water conservation efforts. The conservation program will encompass all uses, but should provide emphasis on the outside use of water and Xeriscape™ principles. This program and position will be implemented Districtwide and focus on urban areas and outdoor uses.

The creation of a water conservation coordinator position and provisions for fiscal incentives are envisioned as potential tools to establish the water conservation plan. This position will be created from an existing position. It will focus on the development of a comprehensive water conservation program and establishment of a strong water conservation ethic. The coordinator will also assist water users and utilities to further public education and to develop their own customized water conservation program and establish numeric efficiency goals that are cost-effective and achievable.

1. The schedule for rule adoption will be subject to possible third party challenges and concerns.

Subtasks

Task 41a. Redirect an existing position to a water conservation coordination position

Task 41b. Develop a comprehensive conservation plan in cooperation with water users, utilities, and local governments, including development of a goal and objectives, by September 2001, capable of the following:

- Identification of inefficiencies in water use
- Identification of projects and programs to improve water use efficiency through incentive and regulatory approaches
- An evaluation of the effectiveness of various options in meeting the existing and projected needs of the project area
- Identification of specific conservation measures that should be incorporated in the update to this plan
- Development and implementation of public education programs
- Assistance to local governments in development of water conservation ordinances, land use regulations, and compliance programs
- Optimization of use of the CUP Program and Development of Regional Impacts (DRI) review abilities to implement conservation

Task 41c. Identification of cost sharing or incentive programs

Task 41d. Development of numeric efficiency goals for each major user/project area

Summary Information

Cost: $250,000 per year for 2001-2004 (LEC Planning Area portion only)

FTEs: 3.75 (75 percent of Districtwide total)

Funding Source: SFWMD

Implementing Agency: SFWMD

Table 108. Estimated Schedule and Costs for the Conservation Program.[a]

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Redirect evaluator/coordinator position	250	0.75	250	0.75	250	0.75	250	0.75		0.75	1,000	3.75

a. Costs associated with the Alternative Water Supply Funding Program are addressed in the funding section of this chapter.

Recommendation 42: Seawater Reverse Osmosis Treatment Facilities

The District will conduct a study to determine the feasibility of colocating seawater reverse osmosis treatment facilities with coastal electrical power plants located within the District. This technology may ultimately prove to be an alternative technology to the current sources under consideration in this plan. It could possibly provide significant volumes of drinking water at moderate cost. Because the water source (seawater) is not affected by seasonal weather conditions, it provides a secure and stable source of potable water even during drought events.

The cost-effectiveness of this alternative will be compared to CERP components such as reuse and conventional ground water withdrawal and treatment. If costs prove favorable, a recommendation to begin implementation of the technology will be included in a future LEC Plan update.

Subtasks

Task 42a. Review existing seawater Reverse Osmosis (RO) data

Task 42b. Identify potential power plants within the LEC Planning Area

Task 42c. Evaluate water quality considerations of source, product, cooling, and reject waters

Task 42d. Determine compatibility of the reject water and discharge location with existing surface water bodies

Task 42e. Identify site environmental issues

Task 42f. Identify potential users/partners of the product water in proximity of the RO plant.

Task 42g. Evaluate costs

Summary Information

Cost: $250,000

FTEs: 0.5

Funding Source: SFWMD

Implementing Agencies: SFWMD with participation by interested public water utilities

Table 109. Estimated Schedule and Costs for a Feasibility Study for Reverse Osmosis Treatment of Seawater.

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Review and evaluate existing seawater RO data, and operating costs of proposed Florida seawater RO facilities[a]												
b	Identify potential coastal power plants within District[a]												
c	Evaluate water quality considerations of source, product, cooling, and reject waters	50	0.1									50	0.1
d	Determine compatibility of the reject water and discharge location with existing surface water bodies	50	0.1									50	0.1
e	Identify site environmental issues	50	0.1									50	0.1
f	Identify potential users/ partners of the product water in proximity of the RO plant	50	0.1									50	0.1
g	Evaluate cost			50	0.1							50	0.1
	TOTAL	200	0.4	50	0.1							250	0.5

a. To be completed in FY2000

Recommendation 43: Reclaimed Water System in Northern Palm Beach County

This project will examine the feasibility of meeting the unmet future demands for irrigation water in northern Palm Beach County and coastal Martin County by conveying reclaimed water from central Palm Beach County. If determined feasible, an implementation project will be included when this plan is updated.

The District anticipates assuming the role of establishing the capital facilities to transport irrigation quality reclaimed water for private/public distribution and sale in areas of northern Palm Beach County and coastal Martin County. Local utilities will develop the end user distribution network and sale of the water.

Subtasks

Task 43a. Develop a Statement of Work (SOW) to conduct feasibility analysis with input from representatives of local utilities and users

Task 43b. Conduct an evaluation with local governments to determine feasibility of establishing building regulations for hookup where appropriate

Task 43c. Contract feasibility analysis

Task 43d. Review results of feasibility analysis and identify preferred alternative with input from representatives of local utilities and users

Summary Information

Cost: $250,000

FTEs: 0.3

Funding Sources: SFWMD, water users, and utilities in Palm Beach and Martin counties

Implementing Agency: SFWMD

Table 110. Estimated Schedule and Costs to conduct a Feasibility Study for a Reclaimed Water System for Northern Palm Beach County.

Recommendation Subtasks		Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Develop SOW	50	0.1									50	0.1
b-c	Conduct feasibility analysis			100	0.1							100	0.1
d	Review results of feasibility analysis					100	0.1					100	0.1
	TOTAL	50	0.1	100	0.1	100	0.1					250[a]	0.3

a. Costs for implementation to be determined in the feasibility study

Recommendation 44: Indirect Aquifer Recharge

Discussion

The feasibility of recharging primary or secondary canals with wastewater treated to Advanced Wastewater Treatment (AWT) standards in conjunction with a cooperative utility will be explored. The focus of this project will be on issues not currently considered in related CERP projects. If economical feasibility is found, a pilot project will be recommended in the update of this plan. Success of the pilot project will ultimately lead to the development of full-scale projects throughout the region.

This source of water is expected to reduce the dry season demands on the regional system and serve as a source of water for recharging ground water and/or meeting local environmental demands. The project will be developed to identify and address regulatory requirements to move this use of water forward. FDEP will be part of the project team seeking to determine the appropriate treatment and timing of reclaimed water use. The reclaimed water recharge sources would be used only during dry conditions. Alternative, environmentally accepted disposal methods will continue to be necessary during the wet season.

Subtasks

Task 44a. Form interagency project team consisting of the FDEP, Broward, Palm Beach, and Miami-Dade counties, and the District

Task 44b. Identify data collection needs

Task 44c. Collect data

Task 44d. Determine feasibility

Summary Information

Cost: $250,000

FTEs: 0.3

Funding Sources: FDEP, SFWMD, county, or utility

Implementing Agencies: FDEP, SFWMD, county, or utility

Table 111. Estimated Schedule and Costs for the Aquifer Recharge Study.

Recommendation	Plan Implementation Costs ($1,000s and FTEs)											
	FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
Aquifer Recharge Study	100	0.1	100	0.1	50	0.1					250[a]	0.3

a. Implementation costs will be determined by the study

Recommendation 45: High Volume Surface Water ASR Testing in Taylor Creek

Discussion

Currently the only ASR well with an USEPA authorized, aquifer exemption covering primary water quality parameters is owned by the District and is located by Taylor Creek in Okeechobee County. The well was permitted, constructed, and tested at a capacity of five-MGD during the late 1980s. Results of that testing suggest the mid-Floridan aquifer may be capable of receiving and storing surface water at much large injection rates than five MGD. It is recommended that the well be modified to support injection/recovery testing at rates of 20 MGD. The ability for wells constructed into the mid-Eocene portion of the Floridan aquifer to operate at 20 MGD versus five/ten MGD represents potential to save time and cost from the Lake Okeechobee ASR system recommended in the CERP.

The well is currently in disrepair and needs a FDEP underground injection operation permit, at a minimum, prior to additional testing. It is estimated that the cost to acquire permits, refurbish the well, and upgrade the pumping capacity would be $750,000 and would take 12 months to complete. The costs to conduct the high capacity testing would be approximately $100,000.

Subtasks

Task 45a. Conduct a baseline assessment of the well including compilation of all existing data, conduct a casing integrity test on the production well, determine the feasibility to proceed, and file applications for FDEP permits

Task 45b. Prepare specifications for well rehabilitation, injection pump upgrade, and testing protocol

Task 45c. Contract for either construction or abandonment, based on above evaluations

Task 45d. Conduct high capacity testing

Task 45e. Incorporate results into CERP designs

Costs: $900,000

FTEs: 0.7

Table 112. Estimated Schedule and Costs for High Volume Surface Water ASR Testing for Taylor Creek.

	Recommendation Subtasks	Plan Implementation Costs ($1,000s and FTEs)											
		FY01		FY02		FY03		FY04		FY05		Total 2001-2005	
		$	FTE	$	FTE	$	FTE	$	FTE	$	FTE	$	FTE
a	Baseline assessment	100	0.1									100	0.1
b	Prepare specifications	50	0.1									50	0.1
c	Construct facilities			700	0.1							700	0.1
d	High capacity testing					50	0.2					50	0.2
e	Incorporate results into CERP						0.2						0.2
	TOTAL	150	0.2	700	0.1	50	0.4					900	0.7

WATER SUPPLY DEVELOPMENT PROJECTS

Some wellfields continue to indicate an increased threat of saltwater intrusion may not be able to meet a 1-in-10 year level of certainty in 2020. These are Lantana, Lake Worth, Manalapan, Boca Raton, Broward 3A, 3B, and 3C, Hollywood, Dania Beach, and Hallandale Beach. Their projected 2020 demands may not be able to be met at their current wellfield locations. Additionally, a few utilities may meet the 1-in-10 year level of certainty goal, but may not meet CUP criteria. These include Seacoast, Jupiter, Riviera Beach, Pompano Beach, Boca Raton, Miami-Dade's proposed South Regional and West wellfields, North Miami Beach, North Miami, and Homestead. The 2005, 2010, and 2015 incremental simulations indicated superior performance when utilizing the same wellfield distribution in the LEC-1 simulation. To meet the 1-in-10 year level of certainty and reduce the threat of saltwater intrusion in the near-term, the identified demands may need to be shifted from coastal wellfields. The individual utilites may consider other water supply options. Modeling confirmed that alternative sources are available. **Chapter 5** also identified quantities of water available for each water supply option. The analysis concludes that the water supply options can be considered a menu from which local water users can select a combination of sources to meeting their individual water needs.

Recommendation 46: Water Supply Development

The recommendation of this plan is that individual water users evaluate alternative water supply sources and select the alternative, or combination of alternatives, which best suits local conditions. The District will continue to evaluate consumptive uses for their impacts on both the regional system and local resources on a case-by-case basis.

RELATIONSHIP OF PROJECTS TO THE FIVE-YEAR WORK PROGRAM

The District is required to prepare a five-year water resource development work program every year. This report, submitted to FDEP, documents the District's progress in implementing water supply plan recommendations. The time frame for the work program is a five-year minimum. For each recommendation or strategy, the work program will provide the following information:

- The total cost to the District of the project
- An estimate of the amount of water to become available by implementation of a project
- Funding source(s)
- Implementing agency or agencies
- A summary of any changes to the recommendation since the plan was implemented
- Timetables

The recommendations in this plan have been incorporated into the *2000 Five-Year Water Resource Development Work Program*.

FUNDING

This section addresses the funding strategy and options for implementation of the LEC Plan. The approach takes into account the requirements of Chapter 373, F.S., feedback and comments from the LEC Regional Water Supply Plan Advisory Committee, and input from District staff. Chapter 373, F.S., requires water supply plans to include a funding strategy that is reasonable and sufficient to pay the costs of constructing or implementing all of the water resource development projects.

In general, the funding approach is divided into two major categories: water resource development and water supply development. The water resource development category addresses funding for projects that are primarily the responsibility of the District. Water supply development projects, on the other hand, are primarily the responsibility of local governments, utilities, and other water users. However, information is included on programs that target funding of water supply development projects in general.

Water Resource Development

Water resource development projects are generally regional in nature and are primarily the responsibility of the District. The water resource development projects for the LEC Planning Area were itemized earlier in this chapter. Pursuant to Chapter 373, F.S., each water management district governing board is required to include in its annual budget the amount needed for the fiscal year to implement water resource development projects, as prioritized in its regional water supply plans. In addition to this plan, the District is also completing regional water supply plans for two other planning areas (Lower West Coast and Kissimmee Basin planning areas) while approaching the third year of implementation of the Upper East Coast Water Supply Plan.

Besides implementation of the water supply plans, the District is initiating implementation of the $7.8 billion CERP, a cost-shared effort with the USACE. It is anticipated that most of the District's financial resources will be used for this project. The Florida Legislature passed the Everglades Restoration Investment Act of 2000, enacting the Governor's proposal for CERP funding. An independent state process has been created under Section 373.1501, F.S., for authorizing CERP projects at the state level. A five-year funding plan will be established and administered by FDEP.

Current ongoing projects may qualify for a portion of the Districts funding responsibilities through the identification as in-kind contributions. It is not known, at this time, the impact that these efforts will have on the District's resources in the future. Consequently, this plan is unable to commit to implementation strategies beyond the current budget year. The recommendation tables in the plan show the costs of the projects and potential sources of funding. Furthermore, taxing strategies exist that have not been implemented or identified as potential sources of funding. Time frames for completing the projects are preliminary and are subject to funding availability in the future years.

Total cost to the District of the water resource development projects for this plan is dollars plus FTEs. The traditional funding source for these types of projects has been primarily ad valorem taxes. The non-CERP projects (most of those listed in this plan) will be ranked and prioritized along with projects in all other regional water supply plans during the annual District budget preparation, and funded as money is available. Priority considerations for a project include availability of a cost-share partner and if a project makes new water available. Sustainability of the regional system is also an important consideration of project prioritization.

Some of the recommendations in this plan are studies. These studies may result in construction projects at a later date. Funding associated with these will be addressed at that time. Potential funding sources for water resource development include funds provided on a project-by-project basis by the District's budget.

Water Supply Development

Water supply development projects are local in nature and generally involve the withdrawal, treatment, and distribution of water. Chapter 373 states that, "local governments, regional water supply authorities, and government owned and privately owned water utilities take the lead in securing funds for and implementing water supply development projects. Generally, direct beneficiaries of water supply development projects should pay the costs of the projects from which they benefit, and water supply development projects should continue to be paid for through local funding sources." It is not the intent that regional water supply plans mandate actions to be taken by local agencies, utilities, and other water users. Therefore, the overall theme of this section is to provide direction and assistance, but not to mandate directives to local governments or utilities.

Chapter 373 requires water supply plans to identify potential sources of funding for water supply development projects. In addition to funding the projects through utility rates, several other funding programs exist to assist local entities.

Water Resource Protection and Restoration Projects Funding Program

On January 18, 2000, Governor Jeb Bush announced his proposal to finance the protection and preservation of Florida's water resources. The Governor's approved budget provides $73 million to fund water resource restoration projects, which include wastewater treatment plant upgrades and STAs. This represents an increase of 38 percent over last year's water project funding.

Projects eligible for the funding must address such criteria as resolving violations of state water quality standards, preventing drainage and flood control problems, and resolving public health threats. Projects requesting funding for surface water restoration and wastewater improvements will be reviewed by the Water Advisory Panel to ensure eligibility.

The Governor created the Water Advisory Panel to ensure that efforts to protect and preserve Florida's water resources is priority-driven, objective, and policy-based. Projects determined by the panel as meeting the criteria will be forwarded to the Florida Legislature for funding consideration. This process ensures that state dollars are providing needed and meaningful improvements to state water resources.

The featured project must be identified in a water management district or FDEP plan as part of a surface water restoration effort. In addition, storm water related restoration projects that have a flood component must be identified in a storm water mitigation master plan and have quantifiable flood protection targets. For wastewater facilities projects, grant recipients must have, or agree to adopt, an ordinance requiring mandatory waste management hookup upon failure of individual systems. The sponsor, or recipient, of the wastewater facilities projects is expected to fund at least 25 percent of the total project costs.

Alternative Water Supply Grant Program

Vastly increased demands on natural supplies of fresh water led the Florida Legislature in 1995 to enact the Alternative Water Supply Grant Program to increase the potential for the development of alternative water supplies in the state; help utilities develop cost-effective reclaimed water supplies; and fulfill a public purpose to fund such programs. Since FY 1997, the District has funded 82 projects in its Water Resource Caution Areas (WRCAs) for a total of approximately $20 million.

The Alternative Water Supply Grant Program is a cost-share program which provides a portion of funding for alternative water supply projects built by local, county, or private water purveyors. Since FY 1997, the District has provided funds for projects that save or offset millions of gallons of water everyday.

To be considered for this funding support, the project must be consistent with local government plans and must be located in a WRCA. The local government must require all appropriate new facilities within the project service area to connect and use the project's alternative water supplies. Funding support shall be applied only for the capital or infrastructure costs for the construction for alternative water supply systems and the project must fall within guidelines established by the District. The LEC Plan recognizes the importance of this program in meeting the future needs of the region.

Drinking Water State Revolving Fund Program

The 1996 Amendments to the Safe Drinking Water Act authorized USEPA to award grants to states for capitalization of Drinking Water State Revolving Funds. These are intended to be a source of financial assistance to public water systems to achieve compliance with Drinking Water Regulations and protecting public health. States must provide matching funds equal to at least 20 percent of the grant.

The Drinking Water State Revolving Fund Program consists of two elements. The first element is establishment of a loan fund enabling a state to make below-market loans to public water systems for the construction of projects (a public water supply utility can be publicly or privately owned, but some states have statutory or constitutional restrictions limiting funding for privately owned systems). States must adopt a priority system, ranking projects based on considerations of public health, compliance, and affordability, and are required to fund to the maximum extent practical in priority order. The second element is the ability to set aside money to assist public water supply in meeting regulatory requirements through direct assistance, loans, and/or state grants funding capacity development, source water assessment, source water protection, and operator certification.

SUMMARY OF RECOMMENDATIONS

Table 113 summarizes the costs of the recommendations. Each water resource development project has a projected start and finish date as shown in **Figure 36**.

Table 113. Costs of Recommendations by Fiscal Year ($1,000s).

	Recommendation	FY2001	FY2002	FY2003	FY2004	FY2005	Total 2001-2005	Total 2006-2020	Total 2001-2020
	Ongoing Projects from the LEC Interim Plan								
1	Regional Saltwater Intrusion Management	130	235	240	216	152	973	2,280	3,253
2	Floridan Aquifer System Ground Water Model	125	75	210	85	60	555	[a]	[a]
3	Northern Palm Beach County Comprehensive Water Management Plan	881	455	855	400		2,591	[a]	[a]
4	Eastern Hillsboro Regional ASR Pilot Project	1,500	170				1,670	[a]	[a]
5	Hillsboro (Site 1) Impoundment Pilot Project	2,220	800	300	100		3,420		3,420
6	Lake Worth Lagoon Minimum/ Maximum Flow Targets	100					100	[a]	[a]
7	Northern Broward County Secondary Canals Recharge Network	150	550	600	600		1,900	[a]	[a]
8	Southeast Broward County Interconnected Water Supply System	300	50	50			400	[a]	[a]
9	Broward County Urban Environmental Enhancement	100	50	50			200	[a]	[a]
10	Miami-Dade Water and Sewer Department Utility ASR	1,500	1,500	1,500	1,500	1,500	7,500	12,000	19,500
11	Biscayne Bay Minimum and Maximum Flow Targets	200					200	[a]	[a]
	Subtotal	7,206	3,885	3,805	2,901	1,712	19,509	14,280	33,789
	Other Federal, State, or District Projects								
12	Critical Projects	2,130	2,115				4,245	[a]	[a]
13	Well Abandonment Program (Recommendation from the CWMP)	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
14	Saltwater Influence at S-79 (Recommendation from the CWMP)	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
15	Permitting Issues Associated with ASR Systems and Reuse of Reclaimed Water	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
16	Mobile Irrigation Labs	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
	Subtotal	2,130	2,115				4,245		
	CERP Projects (Nonfederal Share)								
17	CERP in the LEC Planning Area	75,112	182,510	228,399	139,280	120,927	746,228	2,335,964	3,082,192
18-27	LEC Recommendations to CERP	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
28-30	CERP in the Caloosahatchee Basin/CWMP Recommendations to CERP	3,404	6,261	26,004	67,470	44,050	147,189	122,735	269,924
	Subtotal	78,516	188,771	254,403	206,750	164,977	893,417	2,458,699	3,352,116
	Operational Projects								
31	Systemwide Operational Protocols	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
32	Periodic Operational Flexibility	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]

Table 113. Costs of Recommendations by Fiscal Year ($1,000s). (Continued)

	Recommendation	FY2001	FY2002	FY2003	FY2004	FY2005	Total 2001-2005	Total 2006-2020	Total 2001-2020
33	Lake Okeechobee Vegetation Management Plan	150	150	150	150	150	750	a	a
	Subtotal	150	150	150	150	150	750		
	Consumptive Use Permitting and Resource Protection Projects								
34	Water Reservations	50			75		125	a	a
35	Establish MFLs	40			40		80	a	a
36	MFL Criteria for the Rockland Marl Marsh	15	100				115	a	a
37	MFLs for Florida Bay	200	250	150	125	125	850	a	a
38	MFL Recovery Strategies	75	50	25	25	25	200	a	a
39	MFL Monitoring Systems	50	200	200	50	50	550		550
40	Consumptive Use Permitting, Rulemaking, and Resource Protection Projects	b	b	b	b	b	b	b	b
	Subtotal	430	600	375	315	200	1,920		1,920
	Other Projects								
41	Comprehensive Water Conservation Program	250	250	250	250		1,000	a	a
42	Seawater Reverse Osmosis Treatment Facilities	200	50				250	a	a
43	Reclaimed Water System in Northern Palm Beach County	50	100	100			250	a	a
44	Indirect Aquifer Recharge	100	100	50			250	a	a
45	High Volume Surface Water ASR Testing in Taylor Creek	150	700	50			900	a	a
46	Water Supply Development	b	b	b	b	b	b	b	b
	Subtotal	750	1,200	450	250		2,650		2,650
TOTAL		**89,132**	**196,771**	**259,183**	**210,366**	**167,039**	**922,491**	**2,472,979**	**3,395,470**

a. Long-term cost projections dependent on the LEC Plan update in Fiscal Year 2005.

b. No District costs other than FTEs.

Task Name	Rec	Start	Finish
Ongoing Projects from the LEC Interim Plan			
Regional Saltwater Intrusion Mgmt	1	Thu 5/15/97	Fri 9/30/05
Floridan Aquifer System GW Model	2	Fri 1/2/98	Fri 9/30/05
N Palm Beach Co Comp Water Mgmt Plan	3	Mon 6/3/96	Thu 9/30/04
Eastern Hillsboro ASR Pilot Project	4	Thu 9/9/99	Fri 7/25/03
Hillsboro (Site 1) Impoundment Pilot Project	5	Mon 1/5/98	Fri 12/24/04
Lake Worth Lagoon Min/Max Flow Targets	6	Mon 3/2/98	Fri 5/31/02
N Broward Co Secondary Canals Recharge Network	7	Mon 7/1/96	Tue 4/6/04
SE Broward Co Interconnected WS System	8	Thu 4/20/00	Fri 7/18/03
Broward Co Urban Envir Enhancement	9	Thu 4/20/00	Fri 8/15/03
Miami-Dade WASD Utility ASR	10	Wed 10/1/97	Fri 9/23/05
Biscayne Bay Min/Max Flow Targets	11	Mon 6/22/98	Fri 6/20/03
Other Federal, State, or District Projects			
Critical Projects	12	Fri 6/20/97	Thu 6/20/02
Well Abandonment Program (CWMP)	13	Thu 4/20/00	Wed 4/18/01
Saltwater Influence at S-79 (CWMP)	14	Thu 4/20/00	Wed 4/18/01
Permitting Issues for ASR and Reclaimed Water	15	Thu 4/20/00	Wed 4/20/05
Mobile Irrigation Labs	16	Thu 4/20/00	Mon 4/18/05
CERP Projects			
Lake Okeechobee ASR Pilot	17	Thu 7/1/99	Wed 6/23/04
Caloosahatchee River ASR Pilot	17, 28	Wed 11/1/00	Tue 10/25/05
Lake Belt Technology Pilot	17	Thu 7/1/99	Wed 12/14/11
Reuse Technology Pilot	17	Fri 10/1/99	Thu 9/20/07
Seepage Mgmt Pilot	17	Wed 11/1/00	Tue 10/28/03
Hillsboro (Site 1) ASR Pilot	5, 17	Thu 7/1/99	Fri 11/1/02

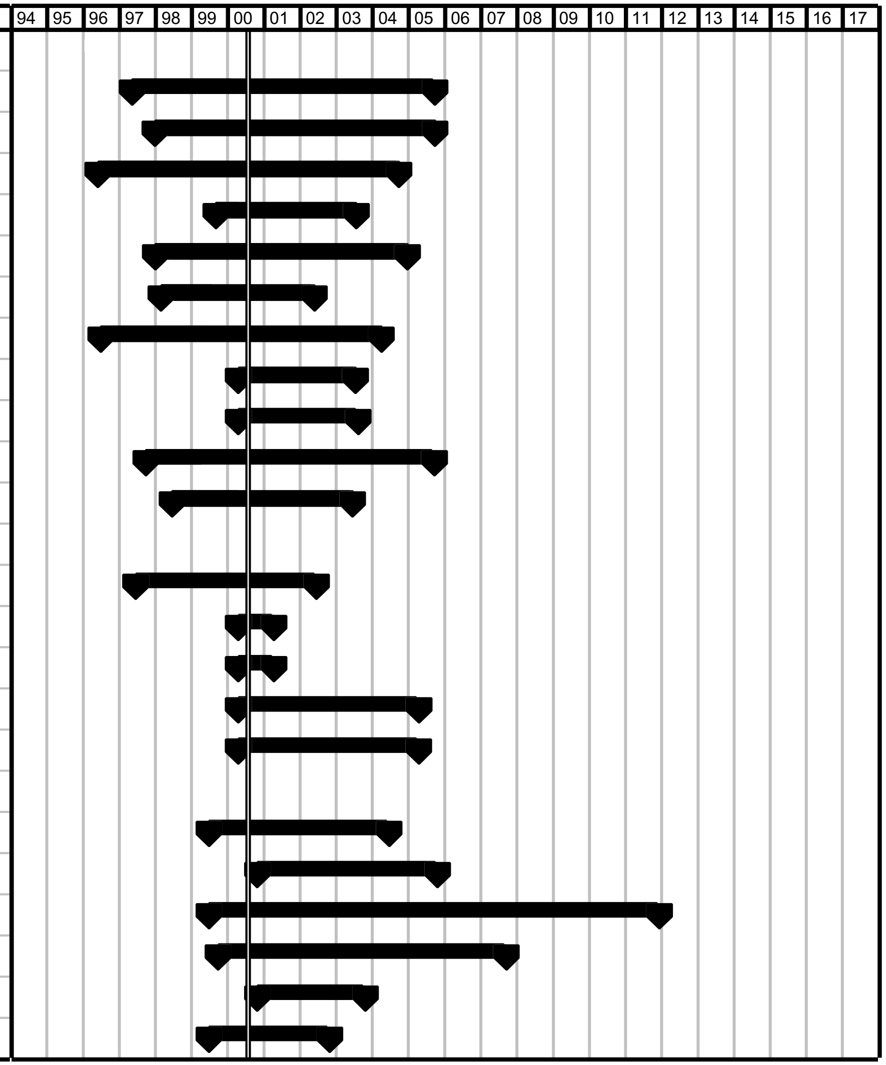

Figure 36. Implementation Schedule for the Recommendations made within the LEC Plan.

Task Name	Rec	Start	Finish
Lake Okeechobee ASR	17	Thu 6/24/04	Wed 6/17/20
Lake Okee Water Quality Treatment	17	Mon 10/1/01	Fri 9/17/10
North of Lake Okee Storage/STA	17	Mon 10/3/05	Fri 9/18/15
C-43 Basin Storage Reservoir/ASR	17, 29	Thu 6/1/00	Thu 3/22/12
C-43 Basin Backpumping/STA	17	Mon 10/3/05	Fri 9/18/15
L-8 Project	17, 21	Mon 9/27/04	Fri 9/16/11
Lake Okee Trib Sediment Dredging	17	Tue 10/2/01	Mon 9/26/05
Taylor Ck/Nubbin Slough Storage/STA	17	Mon 1/31/00	Fri 1/16/09
EAA Storage Reservoirs	17, 20	Thu 7/1/99	Fri 12/25/15
C-17 Backpumping and Treatment	17	Mon 11/4/02	Fri 10/24/08
Pal Mar/Corbett Hydropattern Rest	17	Mon 10/1/01	Fri 9/22/06
C-51 and Southern L-8 Reservoir	17	Mon 9/27/04	Fri 9/12/14
Hillsboro (Site 1) Impoundment/ASR	17	Fri 9/28/01	Fri 10/17/14
ACME Basin B Discharge	17	Mon 10/1/01	Fri 9/22/06
C-51 Backpumping and Treatment	17, 18	Mon 11/4/02	Fri 10/24/08
C-51 Regional Ground Water ASR	17, 22	Mon 9/27/04	Fri 9/13/13
Lake Worth Lagoon Restoration	17	Tue 10/4/05	Mon 3/28/11
Winsburg Farms Wetlands	17	Mon 1/3/00	Fri 12/23/05
Protect Wetlands near WCA-1 (Strazulla)	17	Fri 9/28/01	Fri 10/26/07
PBC Ag Reserve Reservoir/STA	17	Thu 9/1/05	Wed 8/21/13
Western C-11 Diversion	17	Mon 10/1/01	Fri 9/19/08
C-9 STA/Impoundment	17	Mon 10/1/01	Fri 9/21/07
Broward Secondary Canals	17	Mon 7/2/01	Fri 6/12/09
North Lake Belt Storage Area (NLBSA)	17, 25	Mon 2/27/12	Fri 6/20/36
Central Lakebelt Storage Area (CLBSA)	17, 25	Mon 2/27/12	Fri 12/19/36

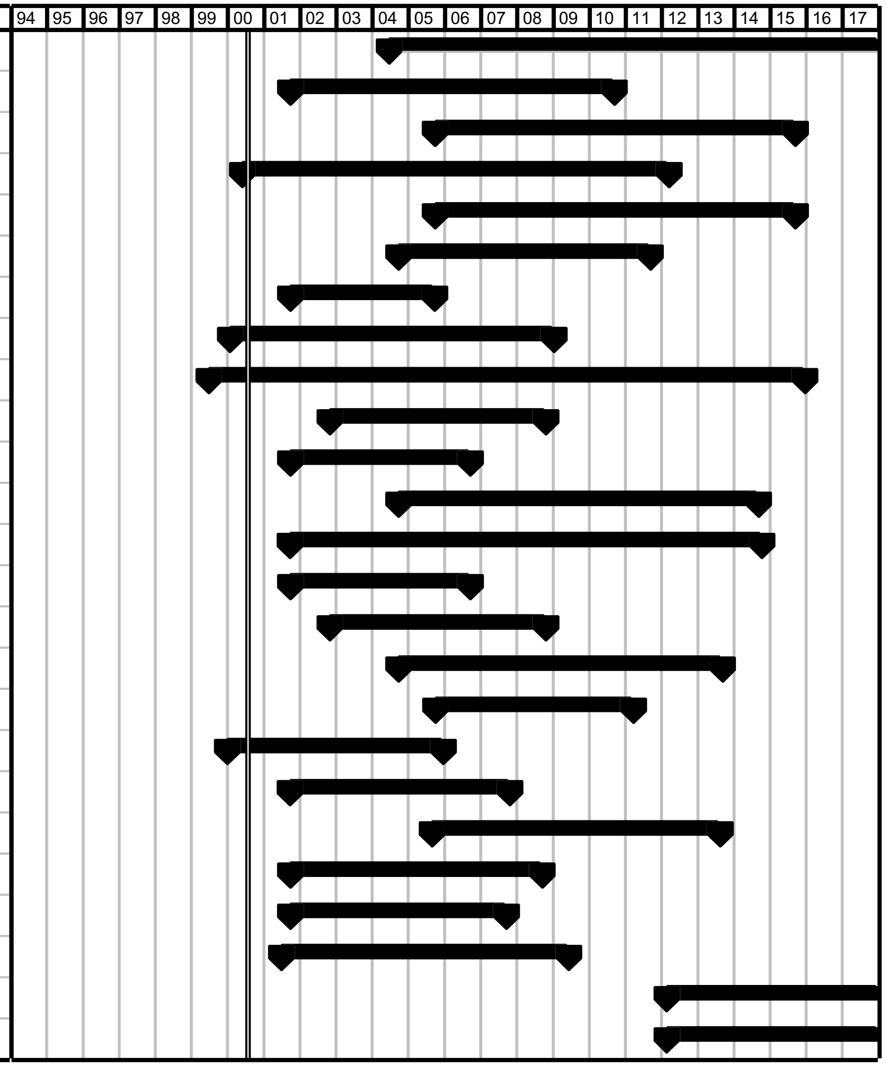

Figure 36. (Continued) Implementation Schedule for the Recommendations made within

Task Name	Rec	Start	Finish
C-4 Control Structures	17	Mon 1/31/00	Fri 7/22/05
Pineland/Hardwood Restoration	17	Mon 10/2/00	Fri 3/24/06
Bird Drive Recharge Area	17	Thu 1/1/04	Wed 12/18/13
L-31N Levee Improvement	17	Wed 10/30/02	Tue 10/19/10
Dade-Broward Levee/Pennsuco	17	Mon 10/1/01	Fri 9/19/08
C-111 Operations Modifications	17	Wed 5/1/02	Thu 4/1/04
Reroute Miami Canal Wat Sup Del	17	Mon 1/28/02	Fri 1/16/09
C-111N Spreader Canal	17	Mon 1/31/00	Fri 7/18/08
South Miami-Dade County Reuse	17	Mon 7/4/11	Fri 6/19/20
West Miami-Dade County Reuse	17, 23	Mon 7/4/11	Fri 6/19/20
WCA-1 Internal Structures	17	Mon 1/31/00	Fri 7/25/03
Divert WCA-2 Flows to CLBSA	17	Mon 4/1/02	Fri 9/17/10
WCA 3A and 3B Seepage Mgmt	17	Tue 10/2/01	Mon 9/22/08
Additional S-345 Structures	17	Mon 1/28/02	Fri 1/16/09
Construction of S-356 Structures	17	Mon 11/4/02	Fri 10/26/07
Decompartmentalize WCA-3	17	Mon 1/28/02	Fri 1/4/19
Flows to NW/Central WCA-3A	17	Thu 11/2/00	Wed 4/22/09
Divert WCA-3 Flows to CLBSA	17	Mon 4/1/02	Fri 9/19/08
Divert Flows from CLBSA to WCA-3B	17	Mon 2/27/12	Fri 2/17/17
Modify G-404 Pump Station	17	Wed 10/1/03	Tue 3/24/09
Biscayne Bay Coastal Wetlands	17	Thu 7/1/99	Wed 5/9/18
Florida Keys Tidal Restoration	17	Mon 3/6/00	Fri 8/26/05
Big Cypress/L-28 Interceptor	17	Mon 10/2/06	Fri 9/16/16
Miccosukee Water Mgmt Plan	17	Mon 7/3/00	Fri 12/19/08
Seminole Water Conservation Plan	17	Mon 1/1/01	Fri 6/20/08

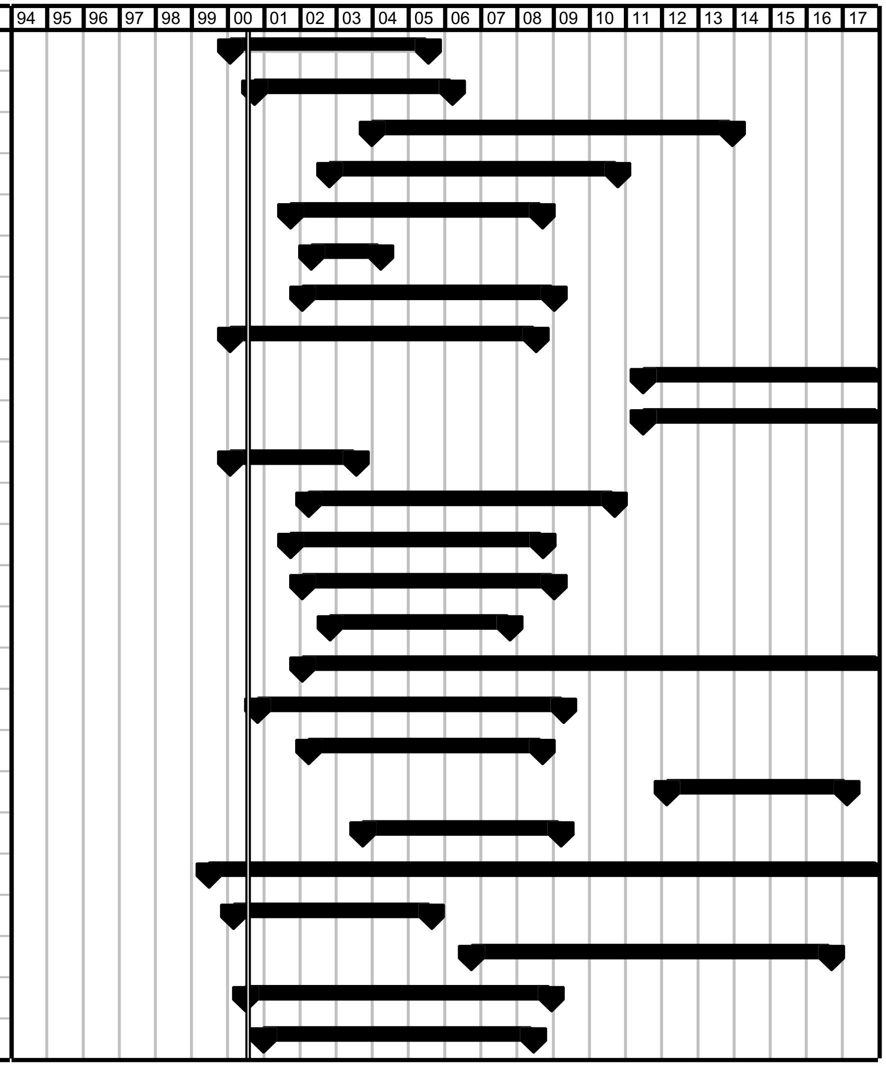

Figure 36. (Continued) Implementation Schedule for the Recommendations made within

Task Name	Rec	Start	Finish
Melaleuca/Exotic Plant Eradication	17	Mon 10/2/06	Fri 9/23/11
Southwest Florida Study	17, 30	Thu 4/1/99	Wed 3/24/04
Comprehensive Water Quality Plan	17	Fri 10/1/99	Fri 12/22/06
Florida Bay/Keys Feasibility Study	17	Fri 10/29/99	Fri 10/22/04
RECOVER/Monitoring/Operational Changes	17, 19, 24, 27	Thu 7/1/99	Wed 12/22/38
Operational Recommendations			
Systemwide Operational Protocols	**31**	**Thu 5/11/00**	**Fri 6/1/01**
Complete Regional Water Supply Plans		Thu 5/11/00	Thu 5/11/00
Develop Real Time Performance Measures		Thu 5/11/00	Mon 10/2/00
Develop Systemwide Operational Policies		Tue 10/3/00	Mon 12/4/00
Develop Risk Based Decision Support Tools		Tue 10/3/00	Tue 4/3/01
Finalize Systemwide Operational Policies		Mon 1/1/01	Fri 6/1/01
Develop Public Input System		Thu 5/11/00	Wed 11/1/00
Periodic Operational Flexibility	**32**	**Thu 4/20/00**	**Wed 4/21/04**
Periodic Operational Flexibility		Mon 10/2/00	Fri 2/2/01
Finalize Suite of Alt. Short-Term Policies		Mon 2/5/01	Tue 4/3/01
Conduct Public Work Shops		Mon 2/5/01	Tue 4/3/01
Apply Short-Term Operational Policies		Thu 4/20/00	Wed 4/21/04
Lake Okeechobee Vegetation Mgmt Plan	**33**	**Mon 10/2/00**	**Fri 9/30/05**
Form Veg and Fire Mgmt Team		Mon 10/2/00	Fri 9/28/01
Develop Lake Vegetation Mgmt Plan		Mon 10/1/01	Fri 9/27/02
Utilize Burn Mgmt & Disking Program		Tue 10/1/02	Fri 9/30/05
Conduct Torpedo Grass/Melaleuca Erad		Tue 10/1/02	Fri 9/30/05
FDACS Coordination		Tue 10/1/02	Fri 9/30/05

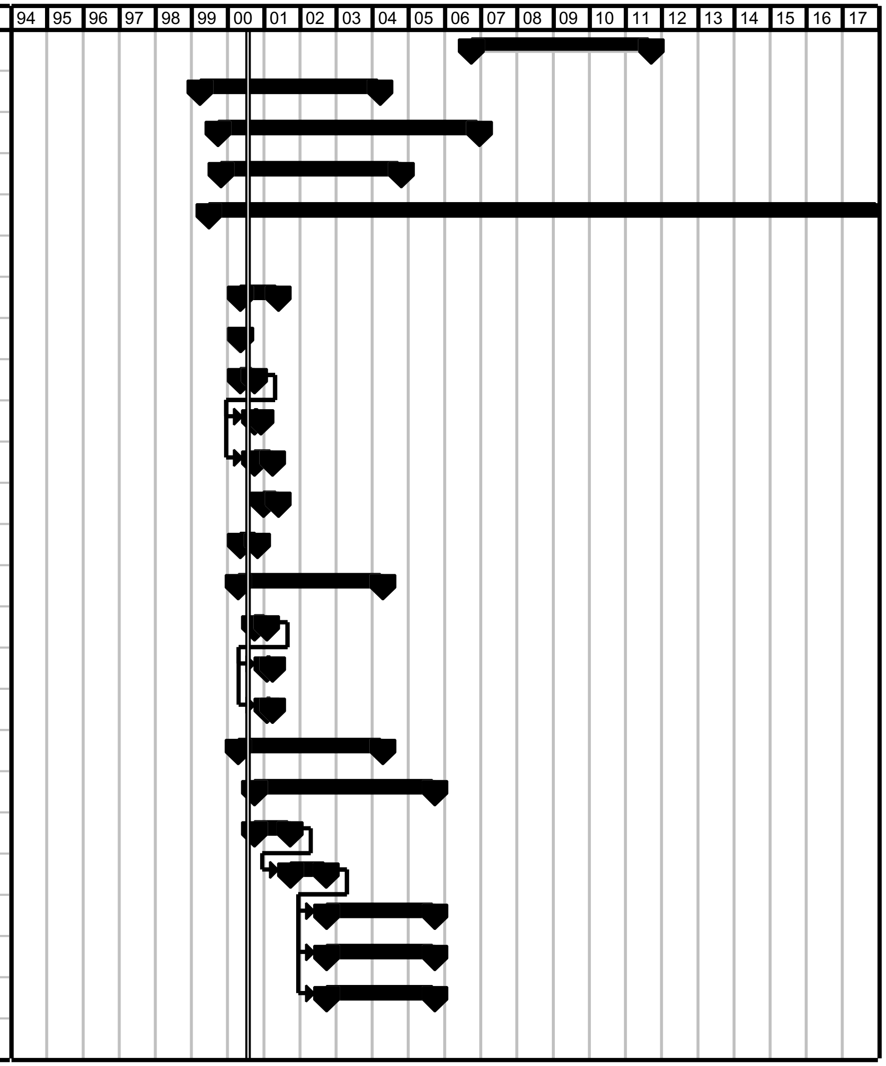

Figure 36. (Continued) Implementation Schedule for the Recommendations made within

Task Name	Rec	Start	Finish
CUP and Resource Protection Projects			
MFLs/Water Reservations			
Lake Okeechobee	**35**	**Mon 2/1/99**	**Fri 12/29/00**
Establish MFLs Rule		Mon 2/1/99	Fri 12/29/00
Biscayne Aquifer	**35**	**Mon 2/1/99**	**Fri 12/29/00**
Establish MFLs Rule		Mon 2/1/99	Fri 12/29/00
Southern Biscayne Aquifer	**35**	**Mon 2/1/99**	**Wed 12/31/03**
Conduct Research		Mon 2/1/99	Fri 12/27/02
Establish MFLs Rule		Thu 1/2/03	Wed 12/31/03
Caloosahatchee Estuary	**34, 35**	**Mon 2/1/99**	**Fri 12/29/00**
Establish MFLs Rule		Mon 2/1/99	Fri 12/29/00
Develop Reservation Rule		Wed 7/5/00	Fri 12/29/00
St. Lucie Estuary	**34, 35**	**Mon 2/1/99**	**Fri 12/28/01**
Conduct Research		Mon 2/1/99	Fri 12/29/00
Establish MFLs Rule		Thu 3/1/01	Fri 12/28/01
Develop Reservation Rule		Thu 3/1/01	Fri 12/28/01
Loxahatchee River	**34, 35**	**Mon 2/1/99**	**Fri 12/28/01**
Conduct Research		Mon 2/1/99	Fri 12/29/00
Establish MFLs Rule		Thu 3/1/01	Fri 12/28/01
Develop Reservation Rule		Thu 3/1/01	Fri 12/28/01
Florida Bay	**34, 37**	**Fri 9/1/00**	**Fri 12/26/03**
Conduct Research		Fri 9/1/00	Mon 12/30/02
Establish MFLs Rule		Mon 3/3/03	Fri 12/26/03
Develop Reservation Rule		Mon 3/3/03	Fri 12/26/03

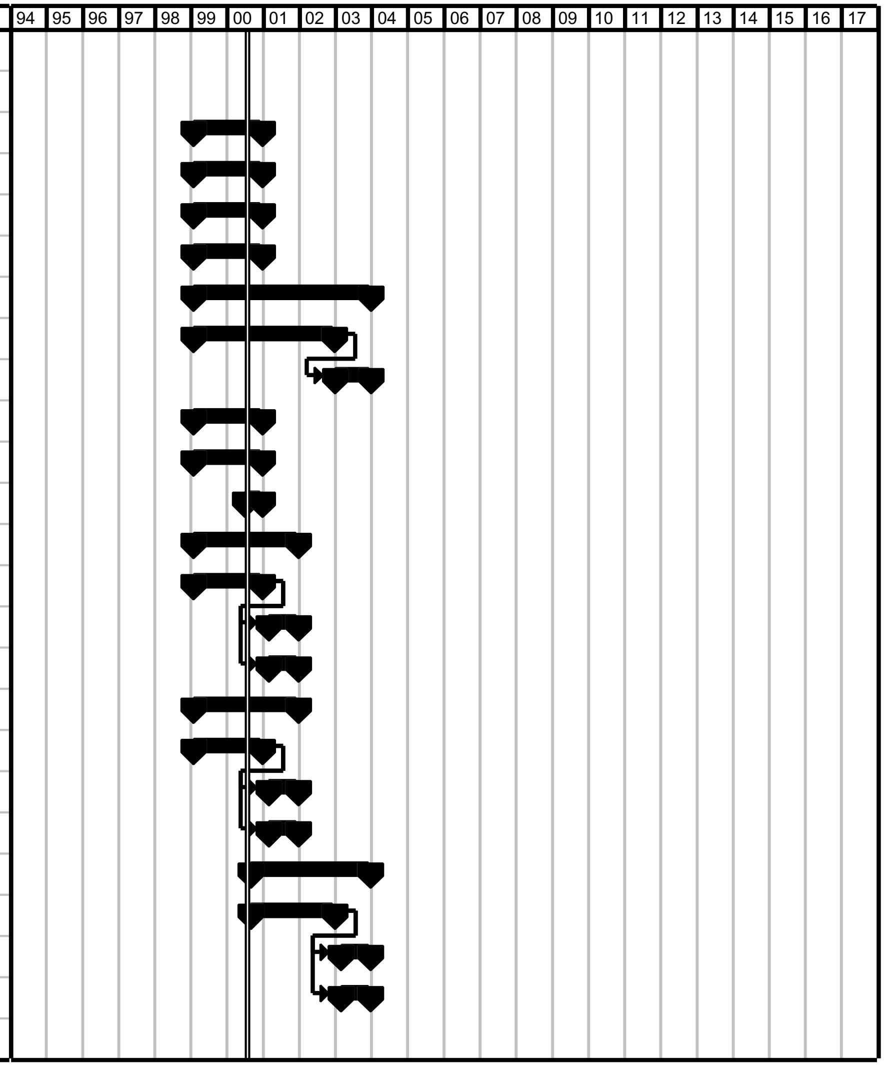

Figure 36. (Continued) Implementation Schedule for the Recommendations made within

Task Name	Rec	Start	Finish
Biscayne Bay	**34, 35**	**Thu 4/20/00**	**Fri 12/26/03**
Conduct Research		Thu 4/20/00	Mon 12/30/02
Establish MFLs Rule		Tue 5/27/03	Fri 12/26/03
Develop Reservation Rule		Tue 5/27/03	Fri 12/26/03
Everglades/WCA/WMAs	**34, 35**	**Mon 2/1/99**	**Mon 6/2/03**
Establish MFLs Rule		Mon 2/1/99	Fri 12/29/00
Develop Reservation Rule		Thu 4/20/00	Mon 6/2/03
Stormwater Treatment Areas	**34**	**Fri 9/1/00**	**Fri 3/30/01**
Develop Reservation Rule		Fri 9/1/00	Fri 3/30/01
Subregional Wetlands	**34**	**Thu 4/20/00**	**Fri 12/26/03**
Develop Reservation Rule		Thu 4/20/00	Fri 12/26/03
Rockland Marl Marsh Research	**36**	**Thu 4/20/00**	**Fri 7/29/05**
Select Interagency Working Group		Thu 4/20/00	Fri 6/30/00
Develop Research Plan		Wed 7/5/00	Wed 11/1/00
Research and FY2002 Budget		Thu 2/1/01	Fri 9/28/01
Implement Research Plan		Mon 10/1/01	Fri 7/29/05
MFLs Recovery and Monitoring	**38, 39**	**Mon 10/2/00**	**Fri 9/30/05**
CERP RECOVER Monitoring		Mon 10/2/00	Fri 9/30/05
Implement Operational Protocols		Mon 10/2/00	Fri 9/30/05
CUP Rulemaking	**40**	**Mon 1/3/00**	**Fri 12/30/05**
Develop Draft CUP Rules		Thu 4/20/00	Mon 6/2/03
Public Review Workshops		Mon 7/17/00	Mon 6/2/03
Revise Draft CUP Rules		Tue 9/5/00	Mon 6/2/03
Adopt CUP Rules		Thu 4/20/00	Mon 6/2/03
Modify GW Models		Mon 1/3/00	Fri 9/28/01

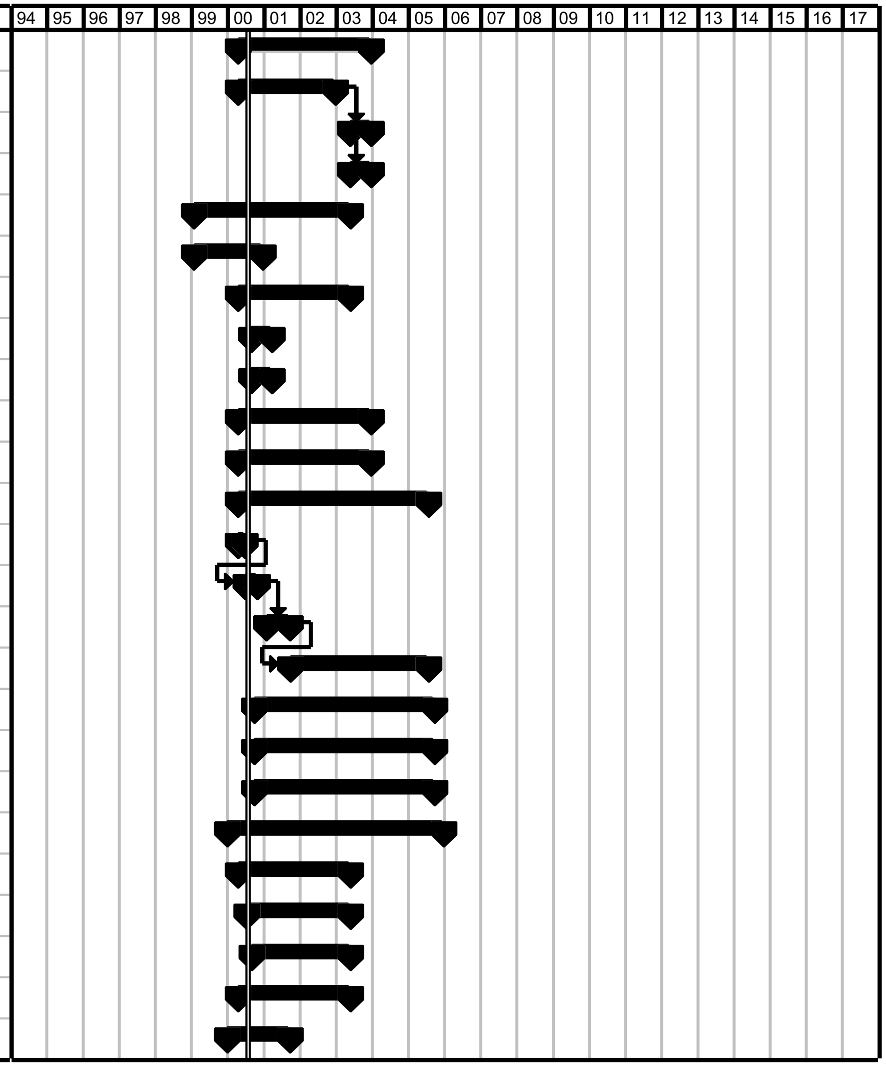

Figure 36. (Continued) Implementation Schedule for the Recommendations made within

Task Name	Rec	Start	Finish
LEC Permit Renewal		Mon 12/1/03	Fri 12/30/05
Other Water Resource Projects			
Comprehensive Water Conservation Program	41	Thu 4/20/00	Fri 11/7/03
Seawater Reverse Osmosis Treatment Facilities	42	Thu 4/20/00	Tue 10/8/02
Reclaimed Water System in N. Palm Beach Co	43	Thu 4/20/00	Wed 5/15/02
Indirect Aquifer Recharge	44	Thu 4/20/00	Wed 10/16/02
High Volume ASR Testing at Taylor Creek	45	Thu 4/20/00	Fri 4/19/02

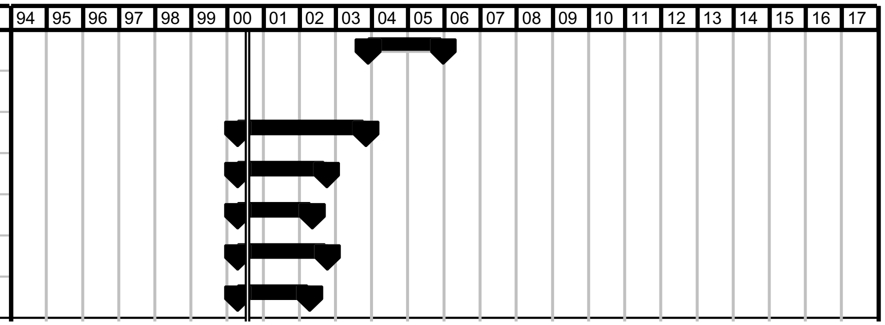

Figure 36. (Continued) Implementation Schedule for the Recommendations made within

GLOSSARY

1995 Base Case A model simulation which provides an understanding of the how the 1995 water management system with 1995 land use and demands responds to historic (1965-1995) climatic conditions.

1995 Revised Base Case The 1995 Base Case model simulation revised to make comparisons to the incremental simulations valid. This is the beginning point for the incremental simulations.

1-in-10 Year Drought A drought of such intensity, that it is expected to have a return frequency of once in 10 years. A drought in which below normal rainfall, which has a 90 percent probability of being exceeded over a twelve-month period. This means that there is only a ten percent chance that less than this amount of rain will fall in any given year.

1-in-10 Year Level of Certainty Probability that the needs for reasonable-beneficial uses of water will be fully met during a 1-in-10 year drought.

2020 Base Case A model simulation which provides information of how the 1995 water management system would respond to anticipated future operations and demands under historic (1965-1995) climatic conditions with currently authorized restoration projects implemented, but without Restudy features.

2020 with Restudy A model simulation which provides information on how the water management system will perform with the implementation of the Restudy projects that would be completed by 2020 along with 2020 demands and operating criteria.

2005 Supply-Side Management Scenario A model simulation that used a modified version of the 2005 incremental simulation to determine the response of the regional system to modifications in Lake Okeechobee's Supply-Side Management criteria.

Acre-foot The volume of water that would cover one acre to a depth of one foot; 43,560 cubic feet; 1,233.5 cubic meters; 325,872 gallons.

Agricultural Field Scale Irrigation Requirements Simulation A simple water budget model for estimating irrigation demands that estimates demand based on basin specific data.

Agricultural Self-Supplied Water Demand The water used to irrigate crops, to water cattle, and for aquaculture (fish production), that is not supplied by a public water supply utility.

Aquifer A portion of a geologic formation or formations that yield water in sufficient quantities to be a supply source.

Aquifer Storage and Recovery (ASR) The injection of freshwater into a confined saline aquifer during times when supply exceeds demand (wet season), and recovering it during times when there is a supply deficit (dry season).

Aquifer System A heterogeneous body of intercalated permeable and less permeable material that acts as a water-yielding hydraulic unit of regional extent.

Artesian When ground water is confined under pressure greater than atmospheric pressure by overlying relatively impermeable strata.

Available Supply The maximum amount of reliable water supply including surface water, ground water and purchases under secure contracts.

Average Daily Demand A water system's average daily use based on total annual water production (total annual gallons or cubic feet divided by 365).

Average Irrigation Requirement Irrigation requirement under average rainfall as calculated by the District's modified Blaney-Criddle model.

Average Rainfall Year A year having rainfall with a 50 percent probability of being exceeded over a twelve-month period.

Backpumping The practice of pumping water that is leaving the area back into a surface water reservoir.

Basin (Ground Water) A hydrologic unit containing one large aquifer or several connecting and interconnecting aquifers.

Basin (Surface Water) A tract of land drained by a surface water body or its tributaries.

Best Management Practices (BMPs) Agricultural management activities designed to achieve an important goal, such as reducing farm runoff, or optimizing water use.

Biscayne Aquifer A portion of the Surficial Aquifer System, which provides most of the fresh water for public water supply and agriculture within Miami-Dade, Broward, and southeastern Palm Beach County. It is highly susceptible to contamination due to its high permeability and proximity to land surface in many locations.

Boulder Zone A highly transmissive, cavernous zone of limestone within the lower Floridan aquifer.

Brackish Water with a chloride level greater than 250 mg/L and less than 19,000 mg/L.

C&SF Project Comprehensive Review Study (Restudy) A five-year study effort that looked at modifying the current C&SF Project to restore the greater Everglades and South Florida ecosystem while providing for the other water-related needs of the region. The study concluded with the Comprehensive Plan being presented to the Congress on July 1,

1999. The recommendations made within the Restudy, that is, structural and operational modifications to the C&SF Project, are being further refined and will be implemented in the Comprehensive Everglades Restoration Plan (CERP).

Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) A complete system of canals, storage areas, and water control structures spanning the area from Lake Okeechobee to both the east and west coasts, and from Orlando south to the Everglades designed and constructed during the 1950s by the U.S. Army Corps of Engineers (USACE) to provide flood control and improve navigation and recreation.

Commercial and Industrial Self-Supplied Water Demand Water used by commercial and industrial operations using over 0.1 MGD.

Comprehensive Everglades Restoration Plan (CERP) The recommendations made within the Restudy, that is, structural and operational modifications to the C&SF Project are being further refined and will be implemented through this plan.

Cone of Influence The area around a producing well which will be affected by its operation.

Control Structures A man-made structure designed to regulate the level and/or flow of water in a canal (e.g., weirs, dams).

Consumptive Use Use that reduces an amount of water in the source from which it is withdrawn.

Consumptive Use Permit A permit issued by the SFWMD allowing utilities to withdraw ground water for consumptive use.

Demand The quantity of water needed to be withdrawn to fulfill a requirement.

District Water Management Plan (DWMP) Regional water resource plan developed by the District under Ch. 373.036, F. S.

Districtwide Water Supply Assessment (DWSA) This document includes water demand assessments and projections, and descriptions of the surface water and ground water resources within each of the SFWMD's four planning areas.

Domestic Self-Supplied Water Demand The water used by households whose primary source of water is private wells and water treatment facilities with pumpages of less than 0.5 MGD.

Domestic Use Use of water for the individual personal household purposes of drinking, bathing, cooking, or sanitation.

Drawdown The drawdown at a given point is the distance the water level is dropped.

Estuary A water passage where the ocean or sea meets a river

Evapotranspiration Water losses from the surface of soils (evaporation) and plants (transpiration).

Everglades Agricultural Area (EAA) The area of histosols (muck) predominantly to the Southeast of Lake Okeechobee which is used for agricultural production.

Everglades Construction Project The foundation for the largest ecosystem restoration program in the history of Florida. It is composed of 12 inter-related construction projects located between Lake Okeechobee and the Everglades, including over 47,000 acres of Stormwater Treatment Areas (STAs).

Exotic Nuisance Plant Species A non-native species which tends to out-compete native species and become quickly established, especially in areas of disturbance or where the normal hydroperiod has been altered.

Florida Department of Agricultural and Consumer Services (FDACS) FDACS communicates the needs of the agricultural industry to the Legislature, the FDEP, and the water management districts, and ensures participation of agriculture in the development and implementation of water policy decisions. FDACS also oversees Florida’s soil and water conservation districts, which coordinate closely with the federal Natural Resources Conservation Service (NRCS).

Florida Department of Environmental Protection (FDEP) The District operates under the general supervisory authority of the FDEP which includes budgetary oversight.

Floridan Aquifer System A multiple-use aquifer system composed of the upper Floridan and lower Floridan aquifers. It is the principal source of water supply north of Lake Okeechobee and the upper Floridan aquifer is used for drinking water supply in parts of Martin and St. Lucie counties. From Jupiter to south Miami, water from the Floridan Aquifer System is mineralized (total dissolved solids are greater than 1,000 mg/L) along coastal areas and in southern Florida.

Florida Water Plan State-level water resource plan developed by the FDEP under Ch. 373.036 F.S.

F.S. Florida Statutes.

FY Fiscal Year; the District’s fiscal year begins on October 1 and ends on September 30 the following year.

Governing Board Governing Board of the South Florida Water Management District.

Ground Water Water beneath the surface of the ground, whether or not flowing through known and definite channels.

Ground Water Heads Elevation of water table

Harm *(Term will be defined during proposed Rule Development process)* An adverse impact to water resources or the environment that is generally temporary and short-lived, especially when the recovery from the adverse impact is possible within a period of time of several months to several years, or less. Water shortage declarations are used to manage and mitigate such adverse impacts.

Hydropattern The pattern of inundation or saturation of an ecosystem.

Hydroperiod The frequency and duration of inundation or saturation of an ecosystem. In the context of characterizing wetlands, the term hydroperiod describes that length of time during the year that the substrate is either saturated or covered with water.

IFAS The Institute of Food and Agricultural Sciences, that is the agricultural branch of the University of Florida, performing research, education, and extension.

Incremental Simulations Model simulations performed to understand how the system would perform with partial completion of the Restudy projects and if the ability to meet the 1-in-10 year level of certainty criteria improves over time. Incremental years selected were, 2005, 2010, and 2015.

Indicator Region A grouping of model grid cells within the SFWMM consisting of similar vegetation cover and soil type. By grouping cells, the uncertainty of evaluating results from a single two by two, square mile grid cell that represents a single water management gage is reduced.

Infiltration The movement of water through the soil surface into the soil under the forces of gravity and capillarity.

Irrigation The application of water to crops, and other plants by artificial means.

Irrigation Audit A procedure in which an irrigation systems application rate and uniformity are measured.

Lake Okeechobee This lake measures 730 square miles and is the second largest freshwater lake wholly within the United States.

Leak Detection Systematic method of using listening equipment to survey the distribution system, identify leak sounds, and pinpoint the exact locations of hidden underground leaks.

LEC-1 A model simulation which provides information on how additional changes to model assumptions may alter hydrologic performance. This simulation was the first alternative plan simulated.

LEC-1A The LEC-1 simulation without consumptive water users to assist in understanding the impact that permitted consumptive uses might have on the regional system.

LEC-1 Revised This is the LEC-1 model simulation revised to include further improvements. This simulation is the end point for comparing incremental simulations.

Levee An embankment to prevent flooding, or a continuous dike or ridge for confining the irrigation areas of land to be flooded.

Marsh A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions.

Micro Irrigation The application of water directly to, or very near to the soil surface in drops, small streams, or sprays.

MIKE SHE An integrated surface water/ground water model, which includes a module for estimating supplemental irrigation requirements based upon land use, soil type, crop type, rainfall, and evapotranspiration.

Minimum Flows and Levels (MFL) The point at which further withdrawals would cause significant harm to the water resources.

Mobile Irrigation Laboratory A vehicle furnished with irrigation evaluation equipment which is used to carry out on-site evaluations of irrigation systems and to provide recommendations on improving irrigation efficiency.

MODFLOW A fine-scale model code created by the U.S. Geological Survey. The District uses it for subregional and ground water modeling.

NGVD National Geodetic Vertical Datum, a nationally established references for elevation data.

Natural Resources Conservation Service (NRCS) An agency of the U.S. Department of Agriculture (USDA) that provides technical assistance for soil and water conservation, natural resource surveys, and community resource protection.

Organics Being composed of or containing matter of, plant and animal origin.

Per Capita Use Total use divided by the total population served.

Permeability Defines the ability of a rock or sediment to transmit fluid.

Point Source Any discernible, confined and discrete conveyance from which pollutants are or may be discharged, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

Potable Water Water that is safe for human consumption.

Potentiometric Head The level to which water will rise when a well is pierced in a confined aquifer.

Process Water Water used for nonpotable industrial usage, e.g., mixing cement.

Public Water Supply Demand All potable water supplied by regional water treatment facilities with pumpage of 0.5 million gallons per day (MGD) or more to all customers, not just residential.

Public Water Supply Utilities Utilities that provide potable water for public use.

Rapid Infiltration Basin (RIB)

Reasonable-Beneficial Use Use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest.

Reclaimed Water Water that has received at least secondary treatment and basic disinfection and is reused after flowing out of a domestic wastewater treatment facility.

RECOVER A comprehensive monitoring and adaptive assessment program formed to perform the following for the Comprehensive Everglades Restoration Program: REstoration, COordination, and VERification.

Recreational Self-Supplied Water Demand The water used for landscape and golf course irrigation. The landscape subcategory includes water used for parks, cemeteries, and other irrigation applications greater than 0.1 MGD. The golf course subcategory includes those operations not supplied by a public water supply or regional reuse facility.

Reduced Threshold Areas (RTAs) Areas established by the District for which the threshold separating a General Permit from an Individual Permit has been lowered from the maximum limit of 100,000 GPD to 20,000 GPD. These areas are typically resource-depleted areas where there have been an established history of sub-standard water quality, saline water movement into ground or surface water bodies, or the lack of water availability to meet projected needs of a region.

Regional Water Supply Plan Detailed water supply plan developed by the District under Ch. 373.0361, F.S.

Reservoir A man-made or natural lake where water is stored.

Retrofit The replacement of existing equipment with equipment that uses less water.

Retrofitting The replacement of existing water fixtures, appliances and devices with more efficient fixtures, appliances and devices for the purpose of water conservation.

Reuse The deliberate application of water that has received at least secondary treatment, in compliance with the Florida Department of Environmental Protection and water management district rules, for a beneficial purpose.

Reverse Osmosis (RO) Common process used to produce deionized water from municipal water.

Saline Water Water with a chloride concentration greater than 250 milligrams per liter. The term saline water includes brackish water and seawater.

Saline Water Interface The hypothetical surface of chloride concentration between fresh water and seawater where the chloride concentration is 250 mg/L at each point on the surface.

Saline Water Intrusion This occurs when more dense saline water moves laterally inland from the seacoast, or moves vertically upward, to replace fresher water in an aquifer.

Seepage Irrigation Systems Irrigation systems which convey water through open ditches. Water is either applied to the soil surface (possibly in furrows) and held for a period of time to allow infiltration, or is applied to the soil subsurface by raising the water table to wet the root zone.

SEEPN A two-dimensional (vertical plane) finite element model developed at the USACE Waterways Experiment Station. It simulates steady-state subsurface flow through a multilayered aquifer system.

Semi-Confining Layers Layers with little or no horizontal flow that can store ground water and also transmit it slowly from one aquifer to another. The rate of vertical flow is dependent on the head differential between the semi-confining beds and those above and below them, as well as the vertical permeability of the sediments.

Sensitivity Analysis An analysis of alternative results based on variations in assumptions (a "what if" analysis).

Serious Harm (*Term will be defined during proposed Rule Development process)* An extremely adverse impact to water resources or the environment that is either permanent or very long-term in duration. Serious harm is generally considered to be more intense than significant harm.

Significant Harm *(Term will be defined during proposed Rule Development process)* An adverse impact to water resources or the environment, relating to an established minimum flow or level for a water body; generally temporary but not necessarily short-lived, especially when the period of recovery from the adverse impact exceeds several months to several years in duration; more intense than harm, but less intense than serious harm.

Slough A channel in which water moves sluggishly, or a place of deep muck, mud or mire. Sloughs are wetland habitats that serve as channels for water draining off surrounding uplands and/or wetlands.

South Florida Water Management Model (SFWMM) An integrated surface water-ground water model that simulates the hydrology and associated water management schemes in the majority of South Florida using climatic data from January 1, 1965, through December 31, 1995. The model simulates the major components of the hydrologic cycle and the current and numerous proposed water management control structures and associated operating rules. It also simulates current and proposed water shortage policies for the different subregions in the system.

Stage The elevation of the surface of a surface water body.

Standard Project Flood (SPF) A mathematically derived set of hydrologic conditions for a region that defines the water levels that can be expected to occur in a basin during an extreme rainfall event, taking into account all pertinent conditions of location, meteorology, hydrology, and topography.

Storm Water Surface water resulting from rainfall that does not percolate into the ground or evaporate.

Stormwater Treatment Area (STA) A system of large treatment wetlands that use naturally occurring biological processes to reduce the levels of phosphorus from agricultural runoff prior to it being released to the Everglades.

Subregional Ground Water Model A computer model that is used to simulate impacts on a smaller scale than the SFWMM, such as effects within public water supply service areas and impacts of individual wellfields.

Subsidence An example of subsidence is the lowering of the soil level caused by the shrinkage of organic layers. This shrinkage is due to biochemical oxidation.

Supply-Side Management The conservation of water in Lake Okeechobee to ensure that water demands are met while reducing the risk of serious or significant harm to natural systems.

Surface Water Water that flows, falls, or collects above the surface of the earth.

Surficial Aquifer System (SAS) The SAS is the major source of water in the LEC Planning Area. It is unconfined, consisting of varying amounts of limestone and sediments that extend from the land surface to the top of an intermediate confining unit.

SWIM Plan Surface Water Improvement and Management Plan, prepared according to Ch. 373, F. S.

Thermoelectric Self-Supplied Water Demand The difference in the amount of water withdrawn by electric power generating facilities for cooling purposes and the water returned to the hydrologic system near the point of withdrawal.

Transmissivity A term used to indicate the rate at which water can be transmitted through a unit width of aquifer under a unit hydraulic gradient. It is a function of the permeability and thickness of the aquifer, and is used to judge its production potential.

Turbidity The measure of suspended material in a liquid.

Wastewater The combination of liquid and waterborne discharges from residences, commercial buildings, industrial plants and institutions together with any ground water, surface runoff or leachate that may be present.

Water Budget An accounting of total water use or projected water use for a given location or activity.

Water Conservation Any beneficial reduction in water losses, wastes, or use.

Water-Conserving Plumbing Fixtures Fixtures that meet the standards at a test pressure of 80 psi listed below.

- Toilets - 1.6 gal/flush
- Shower Heads - 2.5 gal/min.
- Faucets - 2.0 gal/min.

Water Resource Caution Areas Areas that have existing water resource problems or are placed where water resource problems are projected to develop during the next 20 years (previously referred to as critical water supply problem areas).

Water Resource Development The formulation and implementation of regional water resource management strategies, including: the collection and evaluation of surface water and ground water data; structural and nonstructural programs to protect and manage the water resource; the development of regional water resource implementation programs; the construction, operation, and maintenance of major public works facilities to provide for flood control, surface and underground water storage, and groundwater recharge augmentation; and, related technical assistance to local governments and to government-owned and privately owned water utilities.

Watershed The drainage area from which all surface water drains to a common receiving water body system.

Water Shortage Declaration (Rule 40E-21.231, Florida Administrative Code) "If …there is a possibility that insufficient water will be available within a source class to meet the estimated present and anticipated user demands from that source, or to protect the water resource from serious harm, the Governing Board may declare a water shortage for the affected source class." Estimates of the percent reduction in demand required to match available supply is required and identifies which phase of drought restriction is implemented. A gradual progression in severity of restriction is implemented through increasing phases. Once declared, the District is required to notify permitted users by mail of the restrictions and to publish restrictions in area newspapers.

Water Supply Development The planning, design, construction, operation, and maintenance of public or private facilities for water collection, production, treatment, transmission, or distribution for sale, resale, or end use.

Weir A barrier placed in a stream to control the flow and cause it to fall over a crest. Weirs with known hydraulic characteristics are used to measure flow in open channels.

Wetlands Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

Xeriscape™ Landscaping that involves seven principles: proper planning and design; soil analysis and improvement; practical turf areas; appropriate plant selection; efficient irrigation; mulching; and appropriate maintenance.

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