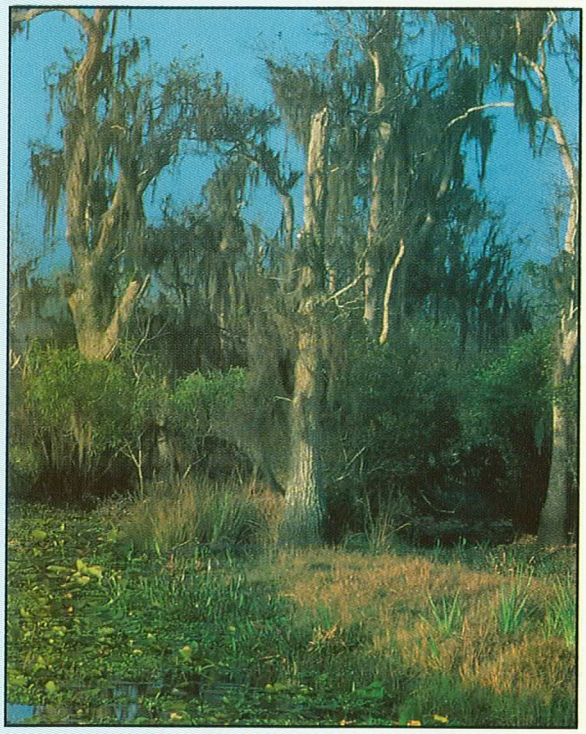
Lower West Coast WATER SUPPLY PLAN



PLANNING DOCUMENT

Volume I

Prepared by the Planning Department Staff

SOUTH FLORIDA
WATER MANAGEMENT DISTRICT

WEST PALM BEACH, FL

February 1994

LOWER WEST COAST

WATER SUPPLY PLAN

Volume I:
Planning Document

by

Upper District Planning Division

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West Palm Beach, Florida

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EXECUTIVE SUMMARY

The Lower West Coast (LWC) Water Supply Plan is a guide for addressing future water demands within the LWC Planning Area. This planning area extends across 4,300 square miles in Southwest Florida. The LWC Planning Area includes all of Lee County and portions of Charlotte, Collier, Glades, Hendry, Dade, and Monroe counties.

The plan is intended to set a framework around which water use decisions in the LWC Planning Area can take place within the plan's time horizon between now and the year 2010. The plan's goal is to ensure an adequate supply of water in the LWC Planning Area for all competing water uses deemed reasonable-beneficial, while maintaining the functions of natural systems and the overall quality of water resources.

Total water demand within the planning area is projected to increase by approximately 55 percent from 307 billion gallons per year in 1990 to 475 billion gallons per year in 2010. Urban demand is projected to increase by 90 percent from 72 to 137 billion gallons per year. Agricultural demand is projected to increase by 44 percent from 235 to 338 billion gallons per year. Growth in public water supply is anticipated to be the largest component of increased urban demand. Growth in citrus acreage is projected to be the largest component of increased agricultural demand.

The major factors influencing the availability of water in the LWC Planning Area include: (1) dependency upon rainfall falling within the planning area, (2) limited surface water sources, (3) protection of water resources and associated natural systems, and (4) pressure on these resources from increasing urban and agricultural demands. Competition among users of water is potentially another factor. These issues were addressed in a series of 12 meetings with the LWC Advisory Committee that included 49 people representing environmental groups, local governments and water users in the planning area.

Increasing urban and agricultural water demands have the potential to adversely impact the region's environment and water resources. Resource protection criteria were developed for this plan to address three potential problems related to increasing ground water demand. These problems are wetland protection, intrusion of seawater into aquifers, and general protection of aquifers from excessive drawdowns. The resource protection criteria were used with ground water flow models to evaluate: (1) the potential areal extent where resource protection criteria could not be met in the future using different water demand levels, and (2) the effectiveness of several alternative water supply scenarios in reducing the total area where resource protection criteria had not been met.

The resource protection criteria established limits for the severity and duration of declines in ground water levels based on a drought of a prescribed return frequency. The drought event selected for all of the resource protection criteria had a return frequency of one in ten years. The criteria specified that ground water levels should not decline below each of the criteria levels except for limited durations of time.

Ground water flow models were used to evaluate the extent to which the resource protection criteria could be met while satisfying the urban and agricultural water demands. Model simulations were made for average rainfall conditions and for drier conditions representing a drought with a return frequency of approximately one in

ten years. The models simulated ground water levels in the shallow aquifers (Surficial and Intermediate aquifer systems) of Lee, Collier, and Hendry counties because most of the growth in urban and agricultural water demand is projected to be supplied from these sources.

Two water demand levels were examined using the ground water models: (1) the 1990 permitted demand level, and (2) the 2010 projected demand level. The 1990 permitted demand level represents the total water demand that was permitted by the District through the end of 1990. The urban demand component of the 1990 permitted demand level was approximately equivalent to the actual urban demand in 1990; however, the calculated agricultural demand component was considerably higher than the actual agricultural demand because more agricultural acreage was permitted in 1990 than was actually planted. The 2010 projected demand level is based on estimates of population and the acreage that will actually be irrigated in 2010. The total agricultural demand component of the 2010 projected demand level is only slightly higher than the total agricultural demand component of the 1990 permitted demand level.

The modeling results showed areas where the resource protection criteria were not met for both the 1990 permitted demand level and the 2010 projected demand level (see note at end of Executive Summary). The wetland protection criterion was exceeded during the 1-in-10 drought for approximately 50,000 acres of wetlands (9 percent of total wetland area) at the 1990 permitted demand level and approximately 73,000 acres (13 percent of total) at the 2010 projected demand level. The seawater intrusion criterion was exceeded in several coastal areas during average and 1-in-10 drought conditions for both the 1990 permitted demand level and the 2010 projected demand level. The general aquifer protection criterion was met at both demand levels for average and 1-in-10 drought conditions with only a few exceptions in the Sandstone aquifer of Lee and Hendry counties.

A number of alternative modeling scenarios utilizing modified supply and demand assumptions were selected for computer simulations using the 2010 projected demand level with both average rainfall and 1-in-10 drought conditions. These modeling scenarios included: (1) removing either all or future public water supply demands from the shallow aquifers; (2) reducing agricultural water use by increasing irrigation efficiency for small vegetables, citrus, or both small vegetables and citrus; (3) increasing use of reclaimed water where it is available; (4) implementing proposed long-term modifications to surface water management in the Big Cypress Basin, (5) removing either all or future public water supplies from the shallow aquifers in addition to increased use of reclaimed water (a combination of alternatives 1 and 3); and (6) removing either all or future public water supplies from the shallow aquifers, increasing agricultural efficiency for small vegetables and citrus, and increasing use of reclaimed water.

None of the individual modeling scenarios were successful in eliminating all problems in meeting the resource protection criteria in the modeled portion of the LWC Planning Area. However, the modeling results showed that all of the scenarios, either individually or in combination with other scenarios, did help to meet one or more of the resource protection criteria.

All of the modeling scenarios resulted in decreases in the wetland problem areas within the LWC Planning Area. Scenario 6 was the most effective modeling scenario in reducing the total area of wetlands not meeting the wetland protection criterion in both Collier and Lee counties (reductions of 39 percent in Collier County and 70

percent in Lee County compared to their respective 2010 base case runs). Scenario 1 yielded a 38 percent reduction in wetland problem areas if all public water supply demands were removed from the shallow aquifers. A 19 percent reduction in wetland problem areas resulted when only future public water supply demands were removed from the shallow aquifers. Modeling scenario 2 reduced wetland problem areas by 7 percent in the planning area if small vegetables increased their irrigation efficiency, and by only 1 percent if citrus irrigation efficiency was improved. Wetland problem areas were reduced by 8 percent if both small vegetables and citrus increased their irrigation efficiency. Scenarios 3 and 4 reduced wetland problem areas in the planning area by 6 and 2 percent respectively. Scenario 5 reduced wetland problem areas by 39 percent if all public water supplies were excluded from the shallow aquifers and by 22 percent if only future public water supplies were excluded from the shallow aquifers. Scenario 6 reduced wetland problem areas by 48 percent if all public water supplies were excluded from the shallow aquifers and by 31 percent if only future public water supplies were excluded from the shallow aquifers.

Seawater intrusion problems were significantly reduced by modeling scenarios 1, 3, 5, and 6. Scenarios 2 and 4 had little effect upon seawater intrusion. None of the modeling scenarios had any significant effect in reducing problem areas with the general aquifer protection criteria; however, these problem areas were of very limited extent.

This plan makes a number of recommendations for consideration by the District, local governments, and water purveyors in the LWC Planning Area. Four categories of recommendations are provided to address: (1) new water source development, (2) water use efficiency, (3) modification of planning and regulatory strategies to protect water resources and the environment, and (4) research to provide a greater understanding of water resources and the environment.

The following is a preliminary list of recommendations, they are not self-executing and are subject to further refinement as defined throughout this plan. The plan sets the course for staff to explore the recommendations with the understanding that staff will return to the Governing Board with more specific recommended actions upon which the Board will be requested to act. The Board, by directing staff to further explore and develop these recommendations is **not** requiring any member of the regulated community to take any action in response to these recommendations. The recommendations are preliminary in nature.

New sources of water to be explored include:

- the Floridan Aquifer System,
- aquifer storage and recovery projects,
- increased use of reclaimed water, and
- capture of additional surface water runoff.

Water can be used more efficiently by:

- increasing urban and agricultural water conservation,
- eliminating inefficient water use practices,
- revising drainage management systems,

- fostering additional cooperation among local governments and water purveyors, and
- the District identifying specific projects and developing cost-sharing partnerships with public and private water suppliers and local governments.

Potential modifications to planning and regulatory strategies to protect water resources and the environment include:

- identifying and mapping the large, relatively intact natural systems in the planning area and designating these areas as Outstanding Natural Systems,
- in individual cases where competition among users occurs and alternative management techniques are not appropriate, reserving certain sources of water for use by specific user classes in geographically specific areas,
- developing environmental mitigation banks that target ONS lands for protection when other natural lands cannot be adequately protected from development and on-site mitigation is not feasible, and
- revising the District's Basis of Review (BOR) for water use permits to reflect new resource protection criteria.

Additional research should be considered to:

- better understand potential impacts to natural systems,
- better quantify the cost information for certain water supply options, and
- develop water shortage management strategies that are directly tied to the permitting and allocation process.

Note: The planning process includes the evaluation of potential regional impacts of presently permitted and projected demands. This regional perspective does not allow the same level of detail that is inherent to the site-specific regulatory process. The intent of the regulatory process is to ensure that the proposed resource protection criteria will not be violated. Each permit allocation is renewed on a case-by-case basis using detailed analysis to minimize adverse impacts. If a permit allocation violates the resource protection criteria, several steps are taken. First, the withdrawal point is shifted to a new location, and the demand is reduced through application of conservation measures. Next, other sources and/or mitigation could be required. If the resource protection criteria still cannot be met, the allocation must be denied for that location.

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I. INTRODUCTION

PLAN DEFINITION AND PURPOSE

The Lower West Coast (LWC) Water Supply Plan is a guide for addressing future water demands in Southwest Florida. The purpose of the plan is to set a framework around which future water use decisions in the LWC Planning Area can take place.

The plan is to be used as a tool to guide decisions regarding planning, research, funding, and regulatory issues related to water supply in the LWC Planning Area. It is not intended to be implemented in and of itself. Although this plan does contain recommendations, each of these recommendations must be considered and implemented by a corresponding action taken at a later time. The LWC Water Supply Plan makes future water demand projections and sets a water use framework which is to be implemented by the District through regulatory, research, planning, construction, operational, land management, and acquisition actions. It will also be implemented through actions taken by other governmental entities and public or private organizations.

This plan does not guarantee water for specific users or uses, nor does it supersede or override the District's permitting process. Instead, the plan projects water demands and recommends certain actions take place within the planning horizon -- between now and the year 2010. This plan is not self-executing. The plan represents overall approaches and guidelines for integrating water resource management activities. Implementation of all programs and projects identified in the plan will require specific actions through public processes, such as SFWMD board approval, permits, rulemaking, and interagency agreements.

PLANNING AREA DESCRIPTION

The LWC Planning Area includes all of Lee County, most of Collier and Hendry counties, and portions of Charlotte, Glades, Dade, and Monroe counties. Only Lee County is entirely within the planning area; the remaining counties are partially within other regional planning areas of the SFWMD (Figure 1). The portions of these counties within the LWC Planning Area are referred to as the Collier, Hendry, Charlotte, Glades, Dade, and Monroe "County Areas." The boundaries of the LWC Planning Area generally reflect the drainage patterns of the Caloosahatchee River basin and the Big Cypress Swamp. The northern boundary corresponds to the drainage divide of the Caloosahatchee River, which is also the SFWMD/SWFWMD jurisdictional boundary in Charlotte County, while the eastern boundary delineates the divide between the Big Cypress Swamp and Everglades system. The area east of this divide is in the Lower East Coast Planning Area.

The LWC Planning Area covers approximately 4,300 square miles and has a humid, subtropical climate. It is characterized by low topographic relief and a high water table. General types of land use in the planning area include agriculture, urban areas, wetlands, forest, and rangeland. A more detailed description of the planning area is provided in Chapter I of the LWC Background Document.

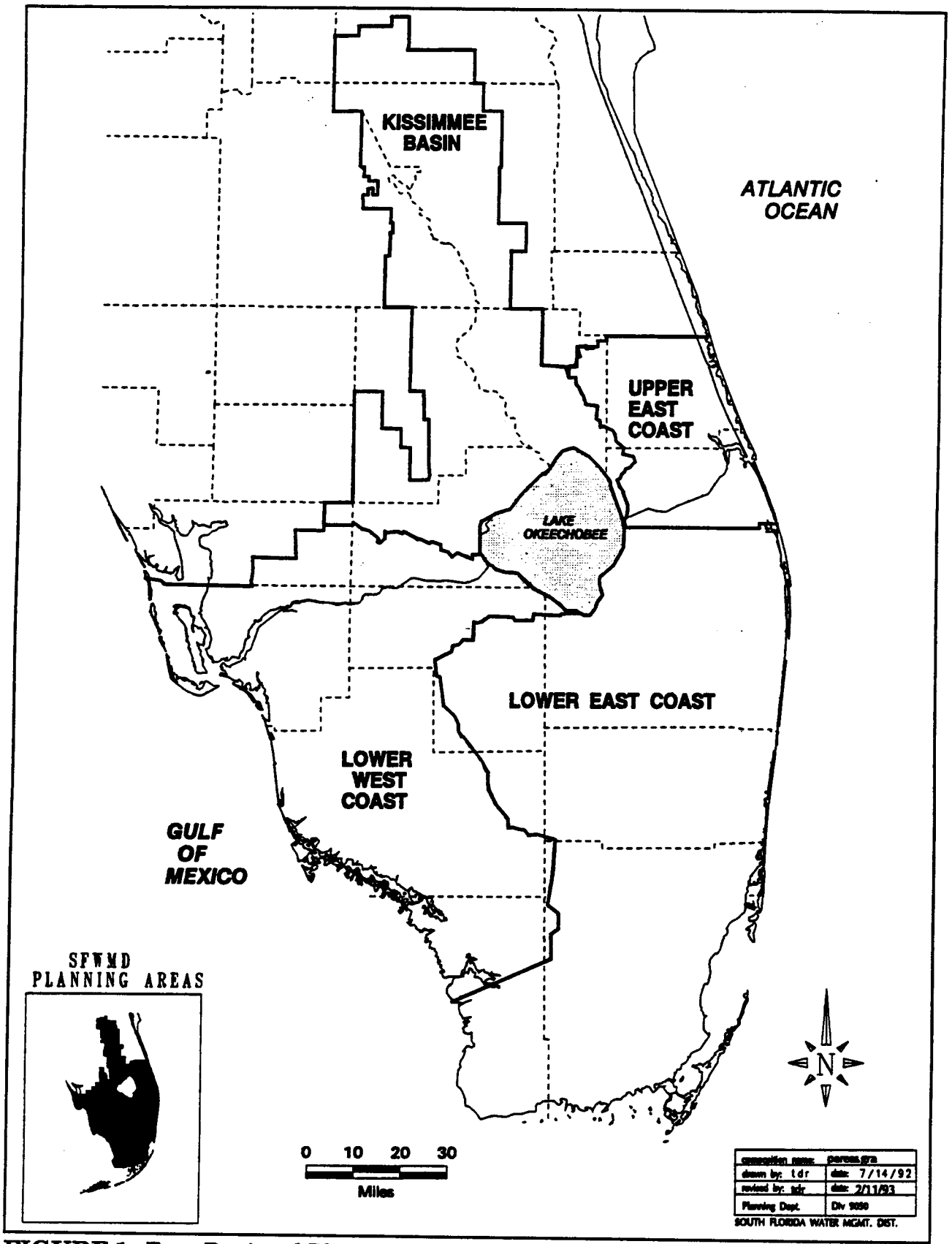

FIGURE 1. Four Regional Planning Areas.

GOALS, DIRECTIVES AND POLICIES

A critical component in the development of the LWC Water Supply Plan was the establishment of its guiding goals, directives and policies. Acknowledging the highly interdependent and rigorous data requirements of a comprehensive water management plan, this initial LWC Water Supply Plan was to focus foremost on the primary water supply and demand characteristics of the planning area. In so doing, the quantification of current and future uses (predominantly ground water), simulation of these ground water uses (modeling) and generation of variable alternatives to alleviate problem areas is the singular emphasis of this initial plan. Thus this plan's primary purpose is to identify the most significant short- and long-term water resource problems and to lay out the initial recommended steps needed to ensure an adequate availability of water supply. Future updates to this plan will incorporate greater emphasis on issues of surface water management, water quality, flood protection, and economic and feasibility analyses.

With the focus of the plan being aimed at assuring availability of an adequate water supply for all reasonable-beneficial uses (see Goal, below), the applicable water supply plan guiding directives and policies were selected. These directives and policies were chosen from the Water Supply Policy Document (SFWMD, 1991), State Water Policy (Chapter 17-40 F.A.C.) and Chapter 373, Florida Statutes (F.S.). These select guiding directives and policies are the underlying themes of this plan, those directions and activities which are most applicable and prudent at this preliminary stage of water supply planning for the LWC Planning Area. The overall goal together with the guiding directives and policies are the targets toward which this plan is aimed. However, as previously noted, the goal, directives, and policies of this plan are not self-executing. The SFWMD Governing Board, by accepting this plan, is directing staff to develop more detailed information for future board actions related to budgeting, operations, and the initiation of the rulemaking process. The potential impacts, if any, to certain water users, or classes of water users, related to these future board actions cannot be determined at this time.

GOAL

To assure the availability of an adequate supply of water for all competing uses in the Lower West Coast Planning Area deemed reasonable and beneficial while maintaining the functions of natural systems.

Water Supply Plan Guiding Directives and Policies

The District should seek to:

- Prevent wasteful, uneconomical, impractical or unreasonable uses of the water resources.

- Examine whether it is reasonable to continue to protect the inefficient withdrawal practices of some presently existing legal users.

- Maximize levels of certainty for legal water users through defining certainties which a legal user can expect a permitted allocation to be protected from interference by other legal users, or from reduction by climatic events or other water shortages, for the duration of the permitted allocation.

- Protect and enhance environmental resources while providing appropriate levels of service for drainage, flood control, water storage and water supply.

- Prohibit practices which result in aquifer compaction and aquifer dewatering to preserve productivity and quality of water supply.

- Manage water withdrawals to minimize salt water intrusion or upconing of saline water.

- Flood protection shall be implemented within the context of other interrelated water management responsibilities (Section 17-40.450, F.A.C.)

Community and Governmental Relations Guiding Directives and Policies

- Provide guidance to local governments to ensure that water resource impacts are considered in land use decision-making.

- Encourage regional planning to develop solutions to water supply problems. When appropriate, this will include the utilization of local source such as utility interconnects, regional water supply planning, regional well fields, regional water authorities or other measures which diversify supply sources without adding new demands on the regional supply system.

- Engage in planning to assist counties, municipalities, regional water supply authorities, private utilities, and others in meeting water supply needs. Strongly encourage local governments to give priority to implementing water conservation measures, reducing or eliminating adverse environmental effects that may result from improper or excessive withdrawal of water from concentrated areas, and diversifying supply sources to reduce demand-related stress on natural systems.

- Municipalities, counties and regional water supply authorities are to have the primary responsibility for water supply, and water management districts and their basin boards are to engage only in those functions that are incidental to the exercise of their flood control and water management powers.

The implementation of the LWC Water Supply Plan will require a series of future decisions by the Governing Board of the South Florida Water Management District on policy issues. These issues are anticipated to include: (1) revisions to the District's Basis of Review for water use permits; (2) allocation of water among competing classes of water users; (3) program funding for recommended research and testing and cooperative projects with local governments; and (4) adoption of minimum flows and levels.

PLAN COMPONENTS

The LWC Water Supply Plan includes three documents:

- *Planning Document (Volume I):* This document describes the results of the ground water modeling process and presents recommendations that address potential problems identified by the modeling.

- *Background Document (Volume II):* This document provides data, assumptions, and potential water supply options for use by the District, the Advisory Committee, other agencies, counties, municipalities, individual utilities, and various interested parties in the development and implementation of the LWC Planning Document. In addition, the water resource modeling and impact evaluation procedures used in the Planning Document are introduced. Volume II contains a list of references for all LWC Water Supply Plan Documents.

- *Appendices (Volume III):* This document provides technical information that supports the Planning and Background Documents.

MAJOR FACTORS INFLUENCING THE PLAN

The major factors influencing this plan are those that influence the availability of water. Ground water availability is defined by proposed State Water Policy as the potential quantity of ground water which can be withdrawn without resulting in significant harm to the water resources or associated natural systems. Surface water availability is similarly defined by State Water Policy as the potential quantity of surface water which can be removed or retained without significant harm to the water resources or associated natural systems [Section 17-40.210, (13) and (33), respectively (draft State Water Policy of December 6, 1993)].

The major factors influencing the availability of water in the LWC Planning Area include: (1) dependency upon rainfall falling within the planning area, (2) limited surface water sources, (3) protection of water resources and associated natural systems, and (4) pressure on these resources from increasing urban and agricultural demands. Competition among users of water is potentially another factor.

The factors introduced in this section are considered to be most influential in the development of the LWC Water Supply Plan. Some of these factors form the cornerstone of the resource protection criteria that are discussed later in this chapter.

Rainfall Dependency

Water availability in the LWC Planning Area depends primarily upon rainfall incident upon the planning area. This water is stored mostly in wetlands and the Surficial Aquifer System. Average annual rainfall in the LWC Planning Area ranges from 51.8 inches in Hendry County to 54.5 inches in Collier County. However, the distribution of rainfall changes from season to season and year to year. Nearly two-thirds of annual rainfall occurs during the May to October wet season when demands are moderate. The remaining third occurs during the dry season months (November through April), when the demands are largest.

Surface Water Availability

The Background Document reports that the only significant source of surface water in the planning area is the Caloosahatchee River (C-43). This source of water, however, is unreliable during the dry season or extended periods of deficient rainfall, when releases are required from Lake Okeechobee to meet demand. The C-43 is managed by the U.S. Corps of Engineers via a regulation schedule which presently accommodates navigational, flood protection, water supply, and environmental needs. It is possible that the C-43 may be able to yield additional amounts of water during the wet season for aquifer storage and recovery (ASR), a technique which stores excess water by injecting it into an aquifer, where it can later be recovered when needed. However, there is significant institutional and technical uncertainty regarding the feasibility of untreated surface water ASR from the standpoints of water quality and permitting.

The LWC Planning Area contains large expanses of wetlands and natural surface water systems; however, with the exception of the Caloosahatchee River (C-43 Canal), which provides water to the City of Fort Myers and portions of Lee and Hendry counties, there is no regional surface water delivery system to bring water from outside the region into the planning area. Therefore, there are currently few regional opportunities to supplement surface water or recharge ground water with deliveries via a regional canal system.

Protection of Water Resources and Associated Natural Systems

Ground water is the principal source of supply in the planning area. Ground water availability in this plan is evaluated with respect to resource protection criteria. The resource protection criteria described in this plan were designed to prevent significant harm to water resources and associated natural systems. Excessive declines in ground water levels adversely impact the quality and quantity of water available from an aquifer or aquifer system. Examples of this include saltwater intrusion, aquifer compaction, and decreased well yields. Excessive declines may also cause a decrease in the hydroperiod of wetland systems which leads to the displacement of plant and animal species.

Current and Future Demand

Southwest Florida is one of the fastest growing regions in the nation. The estimate of total population of the LWC Planning Area for 1990 was 513,000. The total population is projected to increase 90 percent to 976,000 in 2010. During the 20-year period, overall water demand (predominantly ground water) is projected to increase by approximately 54 percent from 307,000 to 472,000 million gallons per year (MGY). Public water supply (defined as urban users who are not self supplied) has the largest projected increase of 97 percent, as public utilities intend to serve a larger portion of the region's population. However, agricultural water demand is projected to remain the single largest category of use. (Refer to Chapter IV of the LWC Background Document for further information on demand estimates and projections).

Citrus demand is the largest category of agricultural use in the LWC Planning Area, which has the fastest growing citrus acreage of any area in Florida. The initial clearing, draining, and planting, and subsequent water withdrawals required to establish agricultural operations replaces natural habitats and modifies the natural hydrology of the area. However, a recent study performed by the University of

Florida Institute of Food and Agricultural Sciences (IFAS) indicates that citrus groves and their water management systems may provide significant value as habitat.

Urban growth in Lee and Collier counties also has the potential to impact the region's environmental and water resources. Drainage of wetlands for urban expansion, loss of natural surface water storage areas, and contamination from urban land use (e.g., storm water runoff and industrial pollution), are the major water-related issues in urban areas. In the densely populated coastal areas, seawater intrusion has forced some of the water treatment facilities to relocate their water supply well fields further inland.

As a result of the existing and potential water supply problems, most of the LWC Planning Area is designated as a Critical Water Supply Problem Area. Proposed revisions to State Water Policy will change this designation to Water Use Caution Area, with wastewater reuse required in these areas through the District's consumptive use permitting process. There are also two other specially designated areas in the planning area: Reduced Threshold Areas and Areas of Special Concern. In Reduced Threshold Areas, the threshold separating a general permit from an individual permit has been lowered from the average daily allocation of 100,000 GPD to 10,000 gallons per day (GPD). Areas of Special Concern are designated in areas where either there are limitations on water availability or there are other potentially adverse impacts associated with a proposed withdrawal.

The modeling analysis of water supply alternatives for this plan focused upon Lee County and those portions of Collier and Hendry counties within the LWC Planning Area because most of the current and projected demand occurs in these areas. However, agricultural demand estimates were developed for the Charlotte County and Glades County portions of the planning area. There are no agricultural or urban demands for the Dade and Monroe county areas because these areas entirely consist of portions of Everglades National Park and the Big Cypress National Preserve. The portion of Dade County within the LWC Planning Area is too small to effectively be represented in the LWC Water Supply Plan. More detailed information on the water demand for these areas is contained in the Background Document.

ROLE OF THE LWC ADVISORY COMMITTEE

One important aspect of the water supply plan development for the LWC Planning Area was the formation of a broad-based advisory committee consisting of 49 representatives from interested and affected parties in the study area. Committee participants included representatives from utilities, agribusiness, government, environmental interest groups and others. The responsibility of this committee was to review and comment on the LWC Background Document, and to advise and participate in development of the LWC Planning Document. The advisory committee provided an effective forum for all interested parties to participate in plan development. The committee met 12 times and all meetings were advertised and open to any interested members of the public that wished to attend.

OUTSTANDING NATURAL SYSTEMS

The Outstanding Natural Systems (ONS) concept and map (Figure 21 on p. 65) were developed as a result of public input to the LWC Water Supply Planning process. The January 1992 draft of the LWC Water Supply Plan projected that drawdown levels for the water table aquifer through the year 2010 would result in impacts to natural systems within the region. As a protection strategy, the draft plan recommended that no drawdowns be allowed to occur beneath natural systems. The LWC Advisory Committee expressed concern that the "no drawdown" restriction would eliminate further development of the water resources; yet they recognized the need to ensure protection of certain large natural systems (i.e., Big Cypress National Preserve, Fakahatchee Strand, Corkscrew Sanctuary, Okaloacoochee Slough, etc.) from the impacts of ground water withdrawals. Therefore, the Advisory Committee requested that District staff re-evaluate ways to protect the large natural systems from unacceptable impacts resulting from ground water withdrawals while allowing further development of the water resources of the region.

To address the advisory committee concerns, District staff proposed two levels of protection (from ground water withdrawals) for natural systems: (1) the "base" level that all natural systems are subject to, and (2) an "elevated" level for the large, relatively pristine natural systems within the LWC Planning Area. The elevated level of protection will be provided through implementation of recommendations 19, 20, and 21 on page 64. The areas to receive the elevated level of protection would be known as "Outstanding Natural Systems" (ONS).

The LWC Advisory committee endorsed the "ONS" concept and appointed a subcommittee to identify and map the large, natural systems (ONS lands) which should be preserved to ensure the ecological integrity of the region. The subcommittee was comprised of representatives from public utilities, environmental groups, the agricultural community, Big Cypress Basin, the SFWMD, the Florida Game and Fresh Water Fish Commission, U.S. Geological Survey, and county governments. Meetings were held every two to three weeks for a nine month period until the map was completed.

Initial meetings focused on developing criteria for preparing the ONS map. The group agreed that large areas which could be considered relatively pristine natural systems should be included within the ONS boundary. It was agreed that ONS areas should be predominately wetlands, due to their sensitivity to hydrologic changes. However, uplands would also be included where they formed a mosaic with wetlands, provided corridor links between wetlands, or were known to support endangered species. Additionally, the group agreed that all Outstanding Florida Waters (OFWs), estuaries, and large tracts of lands (public and private) purchased for conservation/preservation purposes would automatically be included within the ONS boundary (i.e., Rookery Bay Aquatic Preserve, Big Cypress National Preserve, Corkscrew Sanctuary, etc.).

The criteria used to prepare the ONS map include:

<u>Automatic Inclusion Criteria</u>

(1) Lands purchased with public funds for conservation/preservation purposes;

(2) Large wetland and/or upland areas, purchased with private funds for conservation/preservation purposes;

(3) Outstanding Florida Waters (includes Aquatic Preserves); or

(4) Estuaries.

Automatic Exclusion Criteria

(1) Existing natural areas which have been permitted for development. (Only permitted areas known to work group members were excluded; a systematic search of permit files was not conducted).

Other Inclusion Criteria

(1) Large - wetland and/or upland areas greater than 300 acres (based on analysis of the ONS map);

(2) Relatively pristine natural systems - lands composed mostly of native vegetation or areas where man has replaced the native community with non-native vegetation but the replacement community (i.e., pastures) still provides valuable habitat for native animals;

(3) Connected - physical connections of wetlands and/or uplands via hydrologic or biological corridors; or biological connections of isolated ONS lands (i.e., "stepping stones" for native fauna);

(4) Corridors - areas which are at least 100 meters wide (based on analysis of the ONS map) and which hydrologically and/or biologically link other ONS lands;

(5) Endangered, threatened or species of special concern - Significant natural areas inhabited by species listed by the Florida Game and Fresh Water Fish Commission within or connected to the larger systems. Note not all listed species or their habitats are contained within the ONS boundaries.

Lands that are large, relatively pristine, and connected, as defined above, were included within the ONS boundary. In a few instances, lands adjacent to the ONS boundary known to support endangered species, threatened species, and/or species of special concern were included within the ONS boundary. Additionally, agricultural reservoirs were evaluated by the work group on a "case-by-case" basis. A limited number of reservoirs were included because of their location and/or habitat quality.

Through group consensus, it was decided that the ONS lands would be divided into two categories to reflect current land uses. The ONS lands that have been purchased for environmental preservation/conservation purposes would be designated as ONSe lands. The ONS lands that are currently used for multiple purposes (i.e., agriculture, residential, water supply, surface water management, etc.) would be designated ONSm lands.

Once the general criteria were agreed to, the map was prepared by analysis of high altitude, color infrared aerial photographs (Winter 1990-91; Scale = 1:40,000) based on vegetation, visible hydrology, local knowledge of the region, and limited ground truthing. Copies of the aerial photographs were pieced together, mounted on foam board, and covered with mylar. Subcommittee members delineated ONS boundaries on the mylar covers with grease pencils. All ONS lines were agreed to through a consensus process. The boundaries were then digitized in AutoCAD and converted to ArcInfo coverages. Due to the scale of the map and inherent limitations of using aerial photographs, developed and agricultural lands exist within the ONS

boundary. In addition, certain natural areas that have significant ecological value lie outside the ONS boundary.

Implementation strategies for the ONS map include, use as: (1) a planning tool, (2) a focus for research efforts, and (3) a guide for identifying appropriate off-site regional mitigation areas. The ONS map will serve as a planning tool in guiding compatible uses in and adjacent to ONS lands. For example, Lee County Regional Water Supply Authority used an initial version of the ONS map in conjunction with transmissivity maps to avoid locating future wellfields and their associated drawdowns within or adjacent to ONS lands.

ONS lands will be targeted for District research. The ONS research will focus on developing a better understanding of the relationship between ground water withdrawals and wetland impacts in order to ensure an acceptable level of protection to natural systems while allowing reasonable use of the ground water resources.

Additionally, the ONS map will be used to identify regional off-site mitigation areas. Areas within or adjacent to the ONS boundaries that have been impacted by human activities will be identified as potential regional mitigation sites. Assessments will be conducted to determine the type and amount of restoration and/or enhancement activities needed. Ultimately, a master plan of the regions mitigation sites will be developed based upon the ONS map.

RESOURCE PROTECTION CRITERIA

The resource protection criteria developed for this plan are standards to prevent significant harm to wetlands and ground water resources caused by the pumping of ground water. These criteria were developed through a process that included: (1) consultation with District staff professionals who had years of experience in permitting of water uses in the LWC Planning Area, (2) input from members of the LWC Advisory Committee and the Outstanding Natural Systems Subcommittee, and (3) consultation with recognized environmental specialists from the region. The resource protection criteria define the severity, duration, and frequency of declines in ground water levels.

Ground water levels decline to their lowest levels during extremely dry periods, making it difficult to satisfy resource protection criteria for wetlands and ground water while meeting all water demands. Because of this difficulty, the District's water supply planning efforts and its regulatory program for water use permits are directed to: (1) meet demands for reasonable-beneficial uses of water during average to moderately dry conditions, and (2) manage water shortages during extremely dry conditions. For the purposes of this plan, extremely dry conditions (or deficit conditions) are defined to be droughts that occur no more frequently than once in ten years on the average.

Wetland Protection Criterion

This criterion applies to the shallow aquifer system in areas that have been classified as a wetland according to the National Wetlands Inventory. The wetland criterion is generally defined as follows: *Ground water level drawdowns induced by pumping withdrawals should not exceed 1 foot for more than 1 month during any drought event that occurs as frequently as once every ten years in areas that are classified as a wetland.*

Seawater Intrusion Protection Criterion

This criterion applies to selected locations along the Gulf Coast in Lee and Collier counties based on evidence of historical seawater intrusion or upon geologic evidence of susceptibility to seawater intrusion at these locations. Minimum allowable ground water levels in the intermediate and shallow aquifer systems were chosen for these locations to prevent seawater intrusion except during more extreme drought events. The seawater intrusion criterion is generally defined as follows: *Ground water levels should not decline below the selected, site-specific level for any period of time during any drought event that occurs as frequently as once every ten years.* Appendix K shows the locations where the seawater intrusion protection criterion were defined for ground water modeling.

General Aquifer Protection Criterion

The general aquifer protection criterion is defined as follows: *Ground water levels should not decline below the selected, site-specific level for any period of time during any drought event that occurs as frequently as once every ten years.* It applies to all confined aquifers in the LWC Planning Area, and is based on recognition of the fact that reduction of ground water levels below certain stages produces undesirable results. Such 'undesirable results' may include: aquifer compaction and dewatering, reduced well yields, land subsidence, upconing of saline water, and adverse impacts on existing water users. Of the possible impacts listed, only the most extreme, aquifer compaction and dewatering and the resultant reduction in well yields, are directly addressed in this stage of the plan.

To prevent these impacts, ground water levels must not be allowed to fall below the elevation of the top of the aquifer. The minimum allowable ground water levels (criteria levels) were set at the estimated location of the top of the aquifer plus a safety buffer equivalent to the approximate uncertainty of the estimate. For example, if the top of the aquifer is estimated to be at an elevation of 50 feet below sea level (-50 ft NGVD) with an uncertainty of 10 feet, then the criteria level would be set at 40 feet below sea level (-40 ft NGVD). The general aquifer protection and seawater intrusion protection criteria water levels represent minimum levels beyond which serious adverse impacts to ground water resources are likely to occur. It is the District's intent not to allow water levels to fall below these levels under any conditions. In contrast, the wetland protection criterion levels can be viewed as environmental resource management levels: The cumulative impacts of allocations using the wetland protection criteria based on a 1-in-10 drought should not result in water level declines that will significantly harm the ground water resource. Appendix K shows the general aquifer protection criterion levels that were used for ground water modeling.

The general aquifer protection criterion levels applied in this document should be thought of as the minimum allowable water levels. The levels for protecting the resource may need to be higher when other potential impacts not currently considered by this criterion (e.g., upconing of saline water and impacts to existing users) are evaluated. At present, there is insufficient data available within the planning area regarding the location, quality, and movement of saline waters to establish any quantitative criteria for protection against upconing. Collecting information sufficient for this purpose should be among the District's other research efforts for the LWC Planning Area. Identification of adverse impacts to existing users is not feasible at the regional scale of the water supply plan, and is best left to the regulatory process.

MINIMUM FLOWS AND LEVELS CONCEPT

The native ecosystems of South Florida have been heavily impacted by alterations designed to increase the amount of land suitable for agricultural use and residential, commercial, and industrial development. Drainage and land-filling activities have lowered water tables, substantially modified natural hydroperiods, eliminated wetlands, degraded water quality, and diminished critical habitat for fish and wildlife.

State policy establishes the goal that land and water development occur in a manner that does not degrade environmental quality. The establishment of the minimum flows for surface water courses and levels for surface waters and aquifers is critical to maintaining environmental quality. In recognition of this fact, the Florida Legislature has mandated that all water management districts establish minimum flows and levels for water bodies within their jurisdictions (Section 373.042, F.S.). Minimum flows of water bodies represent the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area; minimum levels are the level of ground water in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources.

Environmentally defined minimum flows and levels will be set by the SFWMD to protect water bodies, water courses, associated wetlands, and aquifers from significant harm caused by water withdrawal or diversion. Minimum flows and levels will be established on a priority basis which will be more fully defined in the District Water Management Plan and future regulatory criteria. As required by s. 17-40.473, F.A.C., established minimum flows and levels will be protected through water use permitting, water shortage declarations, and through construction and operation of water resource projects. Moreover, establishment of minimum flows and levels is only one source of statutory authority by which the goal of environmental protection can be achieved. Additional provisions of Chapter 373, F.S., direct the water management districts to reserve water for environmental purposes such as fish and wildlife. These additional sources combined with the minimum flow and level directive yield a package of provisions aimed at reserving water for environmental demands. The resource protection criteria detailed in this plan are, once adopted through rulemaking, intended to implement these statutory authorizations.

The definition of minimum flows and levels is a complex legal issue, but the underlying concept is relatively simple. Natural systems are adapted to certain patterns of freshwater flows. Changes in flows can alter and degrade these systems. The purpose of reserving water for the environment is to avoid uses of water that would cause significant harm to natural areas. A decline in the functions and values of wetland systems is interpreted to be significant harm.

While the need to avoid significant degradation of natural systems is important, it must be accomplished in a world where human uses occur. In addition to considering the benefits of environmental protection and enhancement to an area, the District must consider its other water management objectives in setting minimum flows and levels. A balance between the objectives of environmental enhancement, flood protection, and providing water for other beneficial uses must be achieved. This balance must reflect the need to provide environmental protection while allocating water for human needs with a consumptive use permitting system that is based on a specified drought event.

It is the District's intention not to allow flows and levels to decline below minimum flows and levels, because such declines would cause significant harm to water resources and/or the environment. However, water flows and levels are likely to fall below those flows and levels that would occur during the specified drought event that is used as the basis for allocating water (issuing permits). In some cases, flows and levels could potentially decline below minimum flows and levels in the absence of a water shortage plan to prevent such declines. Water shortage plans should explicitly recognize certain warning flows and levels that are above the minimum flows and levels. These warning levels can be used as thresholds, or triggers, below which cutbacks in water use must occur in order to maintain flows and levels above the minimum flows and levels. A series of progressively more stringent cutbacks can be correlated with a series of progressively declining water flows or levels. These thresholds, or triggers, will need to be developed in the rulemaking process using the criteria levels in this plan as a guide.

Reservation of water for environmental purposes in South Florida must incorporate the natural variation in hydrologic conditions that occurs on a seasonal and annual basis. Native ecosystems have evolved life cycles based on this fluctuation. The establishment of minimum flows and levels in a manner that disregards natural hydrologic fluctuations could create serious environmental problems. For example, water deliveries to Everglades National Park across the Tamiami Trail were at one time regulated by a minimum delivery schedule that changed by month, but did not vary from year to year. Better results have been obtained with a more complex schedule that is adjusted on the basis of actual rainfall measurements. This rainfall-based approach reflects the natural situation where flow would have occasionally stopped entirely.

Minimum flows and levels are important in the assessment of water supply sources because they effectively limit the cumulative or temporal quantities of water which may be withdrawn. For this reason, estimates of the water needs of natural systems will occur as part of the development of the water supply plans for each of the regions within the District. As was the case with the resource protection criteria that were used for analytical purposes in this plan, minimum flows and levels which will be developed through future rulemaking are likely to incorporate the three conditions of frequency, duration, and severity.

Water supply within the LWC Planning Area is derived primarily from ground water. Accordingly, the Lower West Coast Water Supply Plan generally focuses on ground water-related issues and impacts of increased water use on wetlands. Because of the reliance on ground water as a supply within the LWC Planning Area, minimum flows for the Caloosahatchee River will not be addressed in the Lower West Coast Water Supply Plan; these will be developed as part of the Lower East Coast Regional Water Supply Plan since the major source of water for the Caloosahatchee is Lake Okeechobee. Climatic conditions and the operation of Lake Okeechobee directly influence releases to the Caloosahatchee and St. Lucie Estuaries and the Lower East Coast. Recommended minimum flows for the Caloosahatchee River will be presented in the Lower East Coast Regional Water Supply Plan. The draft Lower East Coast Water Supply Plan is scheduled for completion in October 1994.

Minimum Levels - LWC Aquifer Systems

On the Lower West Coast, sensitive environmental areas that are likely to be impacted by future ground water level drawdowns have been identified and resource

protection criteria have been generated to ensure that water resource development activities do not jeopardize hydroperiods or related habitats.

Upon acceptance of this plan by the SFWMD Governing Board, rulemaking will be initiated to adopt the resource protection criteria; resource protection criteria will not be implemented in advance of final rule adoption. The seawater intrusion and general aquifer protection criteria will define the minimum level to avoid harm to the ground water resources of the region. The wetland protection criteria will prevent significant harm to wetland systems due to the impacts of ground water withdrawals.

Along with the initial analyses involving hydrologic and hydrogeologic models, a longer term effort to develop analytic tools and monitoring programs which can further link changes in water flows and levels to changes in habitat will be developed. The successful development of these tools will allow the enhancement of measures to protect wetlands from ground water drawdowns.

Minimum Flows and Levels - LWC Surface Water Systems

As outlined in the LWC Background Document, the majority of the surface water bodies in the region are canals that were constructed for drainage purposes or tidally influenced creeks and rivers. Minimum flows and levels for these systems will be established on a priority basis. Priorities will be based on the potential for significant harm to natural systems resulting from alterations in quantities and/or timing of flows. Man-made canals will be prioritized based on the extent to which they contribute to downstream and upstream impacts. Tidally influenced creeks and rivers will be evaluated with respect to historic flows. A comprehensive schedule for developing surface water minimum flows and levels in the LWC Planning Area will be included in the District Water Management Plan. As discussed above, minimum flows for the most significant surface water resource in the planning region, the Caloosahatchee River, will be established as part of the Lower East Coast Water Supply Plan.

GROUND WATER MODELING

Base Case Model Runs

Ground water flow models of the shallow aquifers (Surficial and Intermediate aquifer systems) in Collier, Lee and Hendry counties were used to evaluate how well resource protection criteria could be met for future water demands under average and deficit rainfall conditions. Based on these results, water supply problem areas were delineated. Problem areas are defined as areas where the resource protection criteria were not met. Alternative water supply/demand modeling scenarios were developed to examine how well they might reduce the extent of the problem areas.

All three flow models use the U.S. Geologic Survey "Modular Three-Dimensional Finite-Difference Ground-Water Flow" (MODFLOW) code. The Collier and Hendry models were previously developed by the SFWMD and the Lee model was developed by a consultant under contract to the Lee County Regional Water Supply Authority. The models simulate ground water flow and associated ground water levels within the Surficial, lower Tamiami, Sandstone, and mid-Hawthorn aquifers for any given set of well withdrawals, canal configurations and precipitation.

Two water demand levels were examined using ground water flow models: (1) The 1990 permitted demand level, and (2) the 2010 projected demand level. The 1990 permitted demand level represents the total urban and agricultural water demand that was permitted by the District through the end of 1990. The 2010 projected demand level is based on estimates of population in 2010 and acreage that will actually be irrigated in 2010.

The 1990 permitted demand level is considerably higher than actual 1990 demand level because considerably more agricultural acreage was permitted in 1990 than was actually planted. Actual crop acreages are usually less than the permitted acreages due to the normal lags between permitting and planting. These lags vary in length, based on planting schedules, fluctuation in current and anticipated crop prices, long-range expansion plans, and short-term management decisions made by the growers.

Permitted acreage may run far ahead of the actual acreage in an area experiencing high growth in agricultural acreage. The difference between permitted acreage and actual acreage is somewhat smaller in areas experiencing slower growth in agriculture, such as Lee County. Because the 1990 permitted demand level is so much greater than the actual 1990, the projected 2010 demand level is only slightly higher than the 1990 permitted demand level.

All simulated irrigation demands varied with rainfall conditions based on meeting irrigation requirements as defined by the modified Blaney-Criddle method in the Basis of Review Permit Information Manual, Volume III (SFWMD, 1993). Public water supply and domestic self supply demands varied on a monthly basis based on historic monthly distribution patterns.

Two rainfall conditions were simulated to identify the difference between likely chronic problems, occurring under average rainfall conditions, versus problems expected only during droughts. Drought conditions were simulated for each county using the historic 12 month rainfall event causing simulated water level declines expected to be equaled or exceeded approximately once every 10 years on average. This rainfall event is called a 1-in-10 drought condition.

"Base case" model runs were simulated using both the 1990 permitted demand level (1990 base case) and the 2010 projected demand level (2010 base case). Assumptions for the 2010 base case represent what was expected to occur in the future without any additional water supply planning and regulation. The 2010 base case model runs assumed that future water users would obtain their water from the same aquifers as existing users. It also assumed that existing water users would utilize the same aquifers for both their current and future demands.

Base case model run results were evaluated to determine how well resource protection criteria had been met. The wetland protection criterion utilizes drawdowns in layer one of the model and is applicable only under wetlands. Water levels from a model run with no wells pumping (well package turned off) were compared to water levels with the wells pumping to determine drawdowns in each of the layer one model cells. Drawdowns in layer one of the model were evaluated to determine in which model cells the wetland criterion drawdown limit (one foot for more than one month) had not been met. Wetlands overlying these model cells were identified, and the total area of the wetlands where the criteria had not been met was calculated for each model run. The total area in which wetland criteria had not been

met (expressed in acres) was used to compare how well various model runs met the wetland protection criterion.

The seawater intrusion and general aquifer protection criteria specify minimum water levels for model cells. Model run results were checked for compliance with these criteria by directly comparing the water levels from each model run with the criteria levels. The model cells in which criterion levels had not been met were identified. Additionally, the number of months during a model run in which a criterion level had not been met within each model cell was observed and assigned to each cell as a weighting factor. The weighting factors from each model run were summed and then used as a relative index for comparing how well the various model runs had met the seawater intrusion and general aquifer protection criteria. Dimensionally, this relative index may be expressed in units of "cell months." For example, a model run in which water levels fell below a criterion level in one model cell for two months was reported to have a relative index of two cell months. A model run in which water levels fell below criterion levels in two model cells for two months in one cell and three months in the other cell would have a relative index of five cell months.

Alternative Modeling Scenarios

In addition to the base case model runs, several alternative water supply/demand modeling scenarios were simulated using the 2010 projected demand level. These alternative modeling scenarios were evaluated for their effectiveness in meeting the resource protection criteria in the same way as the base case model runs. The results from each alternative modeling scenario were compared to the results from the base case model run at the 2010 projected demand level. The effectiveness of each scenario compared to the base case was expressed as a percentage reduction in the total area not meeting the wetland protection criterion or as a percentage reduction in the relative index for the seawater intrusion and general aquifer protection criteria. For example, the total area where wetlands had not met the wetland protection criterion for each alternative modeling scenario was compared to the total wetland problem area for the base case model run at the 2010 projected demand level. The result was expressed as a percentage reduction in total wetland problem area compared to the base case model run.

Scenario 1 - Evaluate reduction of public water supply demands from the shallow aquifers

Two variations on this model scenario were simulated for both Collier and Lee counties. Public water supply demand is a relatively small component of the total demand in Hendry County, so scenario 1 was not simulated for Hendry County. All public water supply withdrawals were removed from the shallow aquifers in scenario 1a. This scenario eliminated any problems in not meeting the resource protection criteria due to public water supply withdrawals. In scenario 1b, the increase in public water supply withdrawals between the 1990 permitted demand level and 2010 projected demand level was removed from the shallow aquifers. Scenario 1b isolates the effect of the increased public water supply demand with respect to meeting the resource protection criteria. Although both modeling scenarios 1a and 1b remove the current or future public water supply demand from the shallow aquifers, neither scenario specifies nor simulates an alternative source for these demands. The most probable alternative source for these demands is the Floridan Aquifer System; however, simulation of flow in the Floridan cannot be done with the existing models.

A more detailed analysis must be performed with shifting the withdrawals of different user classes (agricultural, urban) to different sources.

Scenario 2 - Evaluate reduction of agricultural water use by increased irrigation efficiency

Three variations of this modeling scenario were simulated. In scenario 2a, the irrigation efficiency for small vegetable crops was increased to 75 percent for all users currently below that efficiency level. In scenario 2b, the irrigation efficiency for citrus was increased to 85 percent for all users currently below that level. Scenario 2c was a combination of scenarios 2a and 2b. All three model scenarios were simulated by reducing irrigation withdrawals for small vegetable and/or citrus crops in the model runs.

Scenario 3 - Evaluate increased use of reclaimed water

Scenario 3 assumed that all of the available supply of reclaimed water in the LWC Planning Area would be utilized to meet irrigation demands. The available supply of reclaimed water was defined as average of the three minimum flow months for each regional wastewater treatment plant in Lee County and the modeled portion of Collier County for the year 2010. This scenario was simulated by reducing well withdrawals and replacing them with reclaimed water.

Nearly all of the projected supply of reclaimed water in the LWC Planning Area is in Collier and Lee counties. Scenario 3 was not simulated in the Hendry County model because the projected reuse in Hendry County is insignificant.

Scenario 4 - Evaluate implementation of proposed long-term modifications of the Big Cypress Basin canal system

Simulated modifications to the Big Cypress canal system for scenario 4 included elimination of canals in the Golden Gate Estates South area and addition of control structures on the Miller and Faka Union canals directly north of Alligator Alley. Control elevations for the new structures were set at one foot below land surface to maintain higher water levels north of I-75. This scenario is specific to Collier County and was simulated with the Collier County model by adjusting the simulated canal levels accordingly. The proposed modifications to the Big Cypress canal system include facilities for backpumping water to the Golden Gate Estates North area and other routing of surface water through the canals; however, these modifications cannot be fully represented in the ground water model. This modeling scenario did not evaluate any flood protection aspects of the proposed modifications to the Big Cypress Basin canal system, but rather was an evaluation of ground water levels as related to water supply and wetland impacts only.

A watershed management plan will be developed by the Big Cypress Basin Board within the next year. This watershed management plan should be able to provide more detailed evaluations of the benefits of the proposed modifications.

Scenario 5 - Evaluate combination of Scenarios 1 and 3

This scenario has two variations. Scenario 5a combines scenario 1a, in which all water supply withdrawals were removed from the shallow aquifers, with scenario 3, in which irrigation withdrawals were partially replaced by reclaimed water. Scenario 5b combines scenario 1b, in which the increase in public water supply

withdrawals between 1990 and 2010 were removed from the shallow aquifers, with scenario 3.

Scenario 6 - Evaluate combination of Scenarios 1, 2c, and 3

Modeling scenario 6 had two variations: (1) scenario 6a, which combined modeling scenario 1a (remove all public water supply from the shallow aquifers), modeling scenario 2c (improving the irrigation efficiency of both small vegetables and citrus), and modeling scenario 3 (increase use of reclaimed water); and (2) scenario 6b, which combined modeling scenario 1b (remove **future** public water supplies from the shallow aquifers), modeling scenario 2c, and modeling scenario 3. Modeling scenarios 1a, 1b, and 3 involved urban water supplies and reclaimed water, neither of which are very large in Hendry County. Scenarios 1a, 1b, and 3 were not simulated for Hendry County. Similarly, modeling scenarios 6a and 6b were not modeled for Hendry County.

II. MODELING RESULTS

BASE CASE MODELING RESULTS

The results of the base case ground water simulations showed problem areas where the resource protection criteria were not met because the severity and/or duration of a water-level decline exceeded the resource protection criteria levels. Problem areas where resource protection criteria were exceeded occurred at both the 1990 permitted demand level and 2010 projected demand level. Some problem areas occurred under both 1-in-10 drought conditions and average rainfall conditions.

The modeling results showed that the area estimated to exceed the wetland protection criterion increased significantly from the 1990 permitted demand level to the 2010 projected demand level. There are approximately 558,000 acres of wetlands within the LWC Planning Area (447,000 acres in Collier County; 63,000 acres in Lee County; and 48,000 in the Hendry County Area). The wetland protection criterion was not met within the modeled portion of the LWC Planning Area for 50,000 acres of wetlands (9% of total wetlands) at the 1990 permitted demand level, and for 73,000 acres (13% of total wetlands) at the 2010 projected demand level (figures 2-7). It is important to note that the actual difference in potential wetland impacts between 1990 and 2010 may be considerably greater than the simulated differences due to the discrepancy, approximately 40 percent overall, between actual 1990 demands, based on planted acres, and modeled demands, based on permitted acres.

The seawater intrusion protection criterion was exceeded along portions of the coast in the water table and lower Tamiami aquifers in the base case model runs for both the 1990 permitted demand level and the 2010 projected demand level. However, there was not a large difference in the occurrences.

The general aquifer protection criterion was generally met in the base case model runs with the exception of small areas of the Sandstone aquifer in eastern Lee and western Hendry counties. There was only a minor difference in areas not meeting the general aquifer protection criterion between the 1990 permitted demand level and 2010 projected demand level. Figures 8 and 9 show the areas where the general aquifer protection criterion was not met in the Sandstone aquifer at the 2010 projected demand level.

ALTERNATIVE MODELING SCENARIO RESULTS

Alternative modeling scenarios 1a (remove all public water supplies from shallow aquifers), 1b (remove future public water supplies from shallow aquifers), and 3 (increase use of reclaimed water) involve urban water demand and reclaimed water. Urban water demand is only a very small portion of the total demand in Hendry County, and nearly all of the reclaimed water available in the LWC Planning Area occurs in Collier and Lee counties. Because of this, alternatives 1a, 1b, and 3 were not simulated for Hendry County. Alternative modeling scenarios 5a, 5b, 6a, and 6b include combinations with modeling scenarios 1a, 1b and 3; therefore, modeling scenarios 5a, 5b, 6a, and 6b were also not simulated for Hendry County.

Alternatives 2a, 2b, and 2c involve increases in agricultural efficiency; these three scenarios were simulated for Collier, Lee, and Hendry counties. Alternative modeling scenario 4 involved proposed modifications of the Big Cypress Basin canal

system in Collier, and was only applicable to Collier County. Scenario 4 was not simulated for Lee and Hendry counties.

Scenario 1 - Evaluate reduction of public water supply demands from the shallow aquifers

Results for modeling scenario 1 are reported for Collier and Lee counties; however, since public water supply is such a relatively small component of total demand in Hendry County, modeling scenario 1 was not simulated for Hendry County. Two variations of scenario 1 were simulated: (1) scenario 1a, in which all public water supply demands were removed from the shallow aquifers, and (2) scenario 1b, in which only future public water supply demands were removed from the shallow aquifers.

Effectiveness for the Wetland Protection Criterion. Scenario 1a reduced wetland problem areas compared to the 2010 base case by 26 percent in Collier County and by 60 percent in Lee County. The reduction in wetland problem areas in Collier and Lee counties from scenario 1a yielded a 38 percent reduction in total wetland problem areas for the modeled portion of the LWC Planning Area. The modeled portion of the LWC Planning Area includes all of Lee County and those portions of Collier and Hendry counties that lie within the LWC planning Area. Figures 10 and 11 show the modeling results from scenario 1a for Collier and Lee counties, respectively.

Scenario 1b reduced wetland problem areas compared to the 2010 base case by 10 percent in Collier County and by 32 percent in Lee County. The reduction in wetland problem areas in Collier and Lee counties from scenario 1b yielded a 19 percent reduction in total wetland problem areas for the modeled portion of the LWC Planning Area. Figures 12 and 13 show the modeling results from scenario 1b for Collier and Lee counties, respectively.

Effectiveness for the Seawater Intrusion Protection Criterion. Scenario 1a reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer compared to the 2010 base case by approximately 40 percent in both Collier and Lee counties. Scenario 1a also reduced the relative index for the seawater intrusion criterion in the water table aquifer by 27 percent and 1 percent in Collier County and Lee counties, respectively.

Scenario 1b reduced the relative index for seawater intrusion in the lower Tamiami aquifer by 9 percent and 5 percent for Collier County and Lee counties, respectively. Scenario 1b reduced the relative index for seawater intrusion in the water table aquifer by 27 percent in Collier County, but had no effect on the relative index for seawater intrusion in water table aquifer of Lee County.

Effectiveness for the General Aquifer Protection Criterion. The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so scenario 1 simulations were not needed to achieve compliance with the general aquifer protection criterion in Collier County. Only a few cells in the layer representing the Sandstone aquifer of eastern Lee County and western Hendry County had failed to meet the general aquifer protection criterion. Scenario 1a caused a small improvement in meeting the general aquifer protection criterion for the Sandstone aquifer layer in Lee County. Scenario 1b did not yield any significant change in meeting the general aquifer protection criterion for Lee County. Scenarios 1a and 1b were not simulated for Hendry County.

Scenario 2 - Evaluate reduction of agricultural water use by increased irrigation efficiency

Scenario 2 included three variations: (1) scenario 2a, improving the irrigation efficiency of small vegetables, (2) scenario 2b, improving the irrigation efficiency of citrus, and (3) scenario 2c, improving the irrigation efficiency of both small vegetable and citrus. The three variations of scenario 2 were primarily effective in reducing the total area that did not meet the wetland protection criterion. Scenarios 2a, 2b, and 2c had little effect on the relative index for the seawater intrusion or general aquifer protection criteria. Scenario 2c was more effective than either scenarios 2a or 2b in reducing wetland problem areas.

Effectiveness for the Wetland Protection Criterion. Scenario 2c (increasing the efficiency of both small vegetables and citrus) was, as expected, more effective in reducing wetland problem areas than either scenario 2a (improving the irrigation efficiency of small vegetables) or 2b (improving the irrigation efficiency of citrus). Scenario 2c caused an 8 percent reduction in total wetland problem areas for the modeled portion of the LWC Planning Area compared to the 2010 base case. Scenario 2c caused reductions in wetland problems areas of 11 percent and 7 percent for Collier and Lee counties, respectively. Scenario 2c did not yield any significant change in wetland problem areas within Hendry County. This may be due to several factors, including fewer acres of small vegetables in Hendry County. Also, many of the citrus orchards in Hendry County are relatively new and are permitted with relatively high efficiencies. Figures 14 and 15 show the modeling results from scenario 2c for Collier and Lee counties, respectively.

Scenario 2a (increasing the efficiency of small vegetables only) was only slightly less effective than scenario 2c, indicating that most of the effectiveness of scenario 2c in meeting the wetland protection criterion was due to increasing the efficiency for small vegetables. Scenario 2a caused a 7 percent reduction in total wetland problem areas for the modeled portion of the LWC Planning Area compared to the 2010 base case. Scenario 2c caused reductions in wetland problems areas of 10 percent and 5 percent for Collier and Lee counties, respectively. As was the case for scenario 2c, scenario 2a did not yield any significant change in wetland problem areas within Hendry County.

Scenario 2b (increasing the efficiency of citrus alone) only decreased wetland problem areas by 1 percent in Collier County and by 2 percent in Lee County compared to their respective 2010 base case model runs.

Although the variations of scenario 2 did provide some improvement in meeting the wetland protection criterion, they were not as effective as might be expected considering the relatively large irrigated area and associated irrigation demands. This is no doubt due in part to the simulated return of a portion (75%) of the irrigation inefficiency to the water table as recharge. Thus while increasing the irrigation efficiency causes a large reduction in the total ground water withdrawals, it also causes a reduction in recharge to the water table.

Effectiveness for the Seawater Intrusion Protection Criterion. The three variations of modeling scenario 2 had no significant effect in changing the relative index for the seawater intrusion criterion in either the lower Tamiami aquifer or the water table aquifer layers of Collier and Lee counties. The lack of effectiveness in improving the relative index for seawater intrusion from scenario 2 is interpreted to be related to the distribution of irrigated demands. Most of the irrigated demands are

not located near the coast. These results suggest that only demands located near the coast are significant in causing seawater intrusion.

Effectiveness for the General Aquifer Protection Criterion. The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so the three variations of scenario 2 did not need to be simulated to achieve compliance with the general aquifer protection criterion in Collier County. Only a few cells in the layer representing the Sandstone aquifer of eastern Lee County and western Hendry County had failed to meet the general aquifer protection criterion. The three variations of modeling scenario 2 had no significant effect in changing the relative index for the general aquifer protection criterion in the Sandstone aquifer of Lee and Hendry counties.

Scenario 3 - Evaluate increased use of reclaimed water

Scenario 3 assumed that all of the available supply of reclaimed water in the LWC Planning Area would be utilized to meet irrigation demands. The available supply of reclaimed water was defined as average of the three minimum flow months for each regional wastewater treatment plant in Lee County and the modeled portion of Collier County for the year 2010. This scenario was simulated by reducing well withdrawals and replacing them with reclaimed water.

Nearly all of the projected supply of reclaimed water in the LWC Planning Area is in Collier and Lee counties. Scenario 3 was not simulated in the Hendry County model because the projected reuse in Hendry County is insignificant.

Effectiveness for the Wetland Protection Criterion. Scenario 3 reduced wetland problem areas by 6 percent in Collier County and by 9 percent in Lee County compared to their respective 2010 base case runs. Scenario 3 reduced wetland problem areas for the modeled portion of the LWC Planning Area by 6 percent.

Effectiveness for the Seawater Intrusion Protection Criterion. Scenario 3 reduced the relative index for seawater intrusion in the lower Tamiami aquifer by 22 percent in Collier County and by 29 percent in Lee County compared to the 2010 base case. The improvement in the relative index for seawater intrusion in the Lower Tamiami aquifer was 24 percent for these two counties combined. Scenario 3 reduced the relative index for seawater intrusion in the water table aquifer of Lee County by 13 percent, but had to significant effect on the relative index for seawater intrusion in the water table aquifer of Collier County.

Effectiveness for the General Aquifer Protection Criterion. The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so scenario 3 simulations were not needed to achieve compliance with the general aquifer protection criterion in Collier County. Only a few cells in the layer representing the Sandstone aquifer of eastern Lee County and western Hendry County had failed to meet the general aquifer protection criterion. Scenario 3 had no significant effect in changing the relative index for the general aquifer protection criterion in the Sandstone aquifer of Lee County. This is not especially surprising for two reasons: (1) the problem areas in the Sandstone aquifer are not near the areas where reuse is projected to occur, and (2) the increased use of reclaimed water is likely to mostly affect layers one and two of the model. The Sandstone aquifer is layer 3 of the model. Scenario 3 was not simulated for Hendry County, because there the potential supply of reclaimed water in Hendry County is so small.

Scenario 4 - Evaluate implementation of proposed long-term modifications of the Big Cypress Basin canal system

All of the proposed long-term modifications of the Big Cypress Basin are in Collier County, so scenario 4 was not simulated with the models for Lee and Hendry counties. In general, scenario 4 affects only that portion of Collier County where the Big Cypress Basin canal system is located. Simulated modifications to this canal system included elimination of canals in the Golden Gate Estates South area and addition of control structures on the Miller and Faka Union canals directly north of Alligator Alley. Control elevations for the new structures were set at one foot below land surface to maintain higher water levels north of I-75.

Effectiveness for the Wetland Protection Criterion. Scenario 4 reduced the area in Collier County where wetlands did not meet the wetland protection criterion by 5 percent compared to the 2010 base case.

Effectiveness for the Seawater Intrusion Protection Criterion. Scenario 4 caused no significant reduction in the relative index for seawater intrusion in either the lower Tamiami or water table aquifers of Collier County.

Effectiveness for the General Aquifer Protection Criterion. The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so scenario 4 simulations were not needed to achieve compliance with the general aquifer protection criterion in Collier County.

Scenario 5 - Evaluate combination of Scenarios 1 and 3

Modeling scenario 5 had two variations: (1) scenario 5a, which combined modeling scenario 1a (remove all public water supply from the shallow aquifers) with modeling scenario 3 (increase use of reclaimed water); and (2) scenario 5b, which combined modeling scenario 1b (remove **future** public water supplies from the shallow aquifers) with modeling scenario 3.

Modeling scenarios 1a, 1b, and 3 involved urban water supplies and reclaimed water, neither of which are very large in Hendry County. Scenarios 1a, 1b, and 3 were not simulated for Hendry County. Consequently, modeling scenarios 5a and 5b were also not modeled for Hendry County.

Effectiveness for the Wetland Protection Criterion. Scenario 5a reduced wetland problem areas in Collier County by 26 percent compared to the 2010 base case. Scenarios 1a and 3 had caused reductions of 26 percent and 6 percent, respectively, compared to the 2010 base case for Collier County. Scenario 5a reduced wetland problem areas in Lee County by 64 percent compared to the 2010 base case. Scenarios 1a and 3 had caused reductions of 60 percent and 9 percent, respectively, compared to the 2010 base case for Lee County.

Scenario 5b reduced wetland problem areas in Collier County by 13 percent compared the 2010 base case. Scenarios 1b and 3 had caused reductions of 10 percent and 6 percent, respectively, compared to the 2010 base case for Collier County. Scenario 5b reduced wetland problem areas in Lee County by 36 percent compared to the 2010 base case. Scenarios 1b and 3 had caused reductions of 32 percent and 9 percent, respectively, compared to the 2010 base case for Lee County.

Effectiveness for the Seawater Intrusion Protection Criterion. Scenario 5a reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 61 percent in Collier County and 73 percent in Lee County compared to their respective 2010 base case runs. Scenario 5a reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 64 percent for Collier and Lee counties combined. Scenarios 1a and 3 had reduced the relative index for seawater intrusion in the lower Tamiami aquifer (for Collier and Lee counties combined) by 40 percent and 24 percent, respectively.

Scenario 5a reduced the relative index for the seawater intrusion criterion in the water table aquifer by 30 percent in Collier County and 13 percent in Lee County compared to their respective 2010 base case runs. Scenario 5a reduced the relative index for the seawater intrusion criterion in the water table aquifer by 17 percent for Collier and Lee counties combined. Scenarios 1a and 3 had reduced the relative index for seawater intrusion in the water table aquifer (for Collier and Lee counties combined) by 4 percent and 12 percent, respectively.

Scenario 5b reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 37 percent in Collier County and 44 percent in Lee County compared to their respective 2010 base case runs. Scenario 5b reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 39 percent for Collier and Lee counties combined. Scenarios 1b and 3 had reduced the relative index for seawater intrusion in the lower Tamiami aquifer (for Collier and Lee counties combined) by 8 percent and 24 percent, respectively.

Scenario 5b reduced the relative index for the seawater intrusion criterion in the water table aquifer by 27 percent in Collier County and 13 percent in Lee County compared to their respective 2010 base case runs. Scenario 5b reduced the relative index for the seawater intrusion criterion in the water table aquifer by 15 percent for Collier and Lee counties combined. Scenarios 1b and 3 had reduced the relative index for seawater intrusion in the water table aquifer (for Collier and Lee counties combined) by 3 percent and 12 percent, respectively.

Effectiveness for the General Aquifer Protection Criterion. The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so scenario 5a and 5b simulations were not needed to achieve compliance with the general aquifer protection criterion in Collier County. Only a few cells in the layer representing the Sandstone aquifer of eastern Lee County and western Hendry County had failed to meet the general aquifer protection criterion. Scenario 5a caused a small improvement in meeting the general aquifer protection criterion for the Sandstone aquifer layer in Lee County. Scenario 5b did not yield any significant change in meeting the general aquifer protection criterion for Lee County. Alternatives 1a, 1b, and 3 were not simulated for Hendry County; consequently, the combination alternative modeling scenarios 5a and 5b could not be simulated for Hendry County.

Scenario 6 - Evaluate combination of Scenarios 1, 2c, and 3

Modeling scenario 6 had two variations: (1) scenario 6a, which combined modeling scenario 1a (remove all public water supply from the shallow aquifers), modeling scenario 2c (improving the irrigation efficiency of both small vegetables and citrus), and modeling scenario 3 (increase use of reclaimed water); and (2) scenario 6b, which combined modeling scenario 1b (remove future public water supplies from the shallow aquifers), modeling scenario 2c, and modeling scenario 3.

Modeling scenarios 1a, 1b, and 3 involved urban water supplies and reclaimed water, neither of which are very large in Hendry County. Scenarios 1a, 1b, and 3 were not simulated for Hendry County. Similarly, modeling scenarios 6a and 6b were not modeled for Hendry County.

Effectiveness for the Wetland Protection Criterion. Scenario 6a reduced wetland problem areas in Collier County by 39 percent compared the 2010 base case. Scenarios 1a, 2c, and 3 had caused reductions of 26 percent, 11 percent, and 6 percent, respectively, compared to the 2010 base case for Collier County. Scenario 6a reduced wetland problem areas in Lee County by 70 percent compared to the 2010 base case. Scenarios 1a, 2c, and 3 had caused reductions of 60 percent, 7 percent, and 9 percent, respectively, compared to the 2010 base case for Lee County.

Scenario 6b reduced wetland problem areas in Collier County by 22 percent compared to the 2010 base case. Scenarios 1b, 2c, and 3 had caused reductions of 10 percent, 11 percent, and 6 percent, respectively, compared to the 2010 base case for Collier County. Scenario 6b reduced wetland problem areas in Lee County by 48 percent compared to the 2010 base case. Scenarios 1b, 2c, and 3 had caused reductions of 32 percent, 7 percent, and 9 percent, respectively, compared to the 2010 base case for Lee County.

Effectiveness for the Seawater Intrusion Protection Criterion. Scenario 6a reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 69 percent in Collier County and 83 percent in Lee County compared to their respective 2010 base case runs. Scenario 6a reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 72 percent for Collier and Lee counties combined. Scenarios 1a, 2c, and 3 had reduced the relative index for seawater intrusion in the lower Tamiami aquifer (for Collier and Lee counties combined) by 40 percent, 3 percent, and 24 percent, respectively.

Scenario 6a reduced the relative index for the seawater intrusion criterion in the water table aquifer by 47 percent in Collier County and 5 percent in Lee County compared to their respective 2010 base case runs. Scenario 6a reduced the relative index for the seawater intrusion criterion in the water table aquifer by 10 percent for Collier and Lee counties combined. Scenarios 1a, 2c, and 3 had reduced the relative index for seawater intrusion in the water table aquifer (for Collier and Lee counties combined) by 4 percent, 0 percent, and 12 percent, respectively.

Scenario 6b reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 41 percent in Collier County and 56 percent in Lee County compared to their respective 2010 base case runs. Scenario 6b reduced the relative index for the seawater intrusion criterion in the lower Tamiami aquifer by 45 percent for Collier and Lee counties combined. Scenarios 1b, 2c, and 3 had reduced the relative index for seawater intrusion in the lower Tamiami aquifer (for Collier and Lee counties combined) by 8 percent, 3 percent, and 24 percent, respectively,

Scenario 6b reduced the relative index for the seawater intrusion criterion in the water table aquifer by 27 percent in Collier County and 4 percent in Lee County compared to their respective 2010 base case runs. Scenario 6b reduced the relative index for the seawater intrusion criterion in the water table aquifer by 7 percent for Collier and Lee counties combined. Scenarios 1b, 2c, and 3 had reduced the relative index for seawater intrusion in the water table aquifer (for Collier and Lee counties combined) by 3 percent, 0 percent, and 12 percent, respectively.

Effectiveness for the General Aquifer Protection Criterion. The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so scenario 6a and 6b simulations were not needed to achieve compliance with the general aquifer protection criterion in Collier County. Only a few cells in the layer representing the Sandstone aquifer of eastern Lee County and western Hendry County had failed to meet the general aquifer protection criterion. Scenarios 6a and 6b caused small improvements in meeting the general aquifer protection criterion for the Sandstone aquifer layer in Lee County. Alternatives 1a, 1b, and 3 were not simulated for Hendry County; consequently, the combination alternative modeling scenarios 6a and 6b could not be simulated for Hendry County.

1990 Base Case Versus 2010 Base Case

Figures 2 through 9

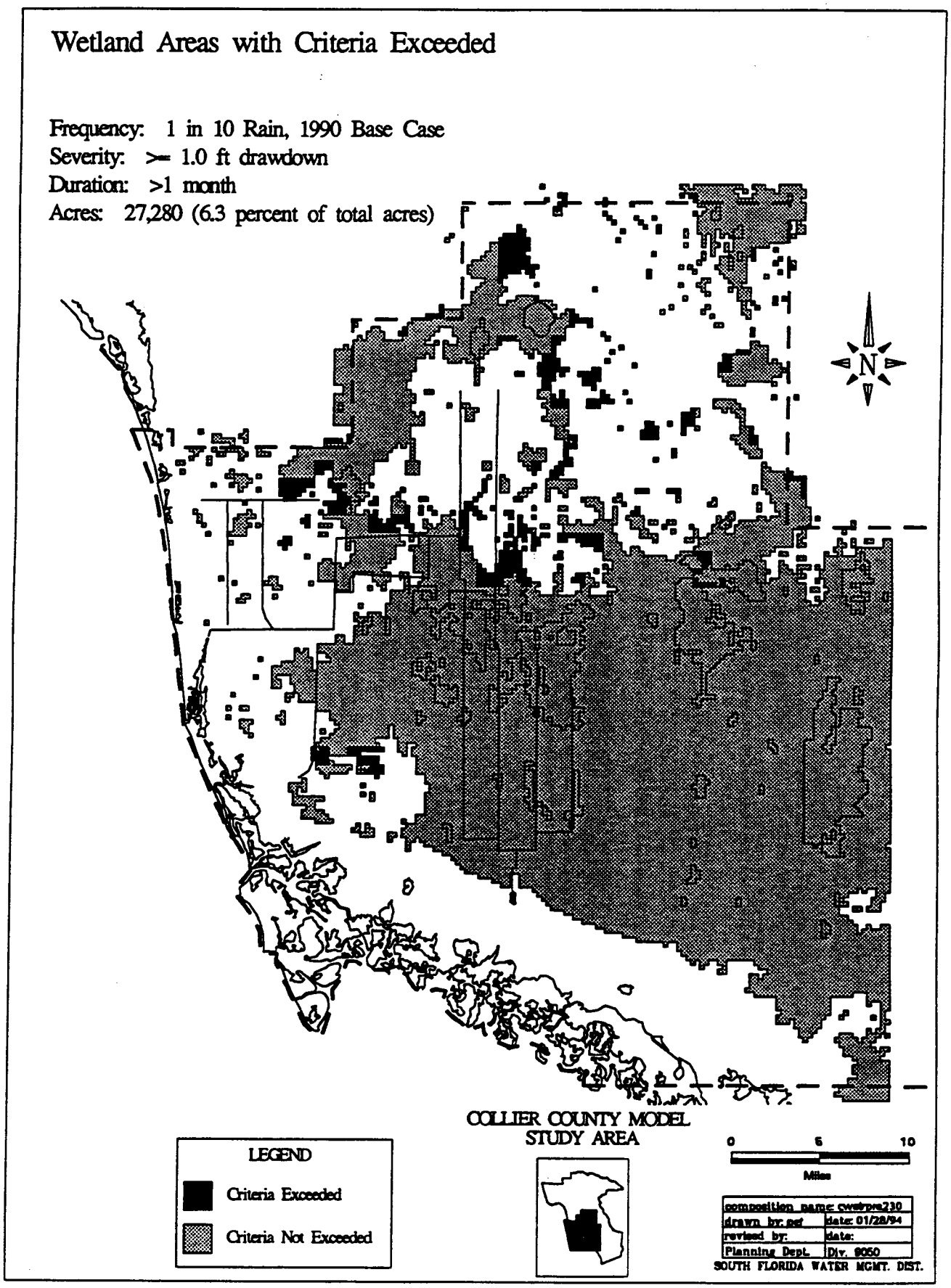

FIGURE 2. Collier County Model Wetlands Criteria, 1990 Base Case.

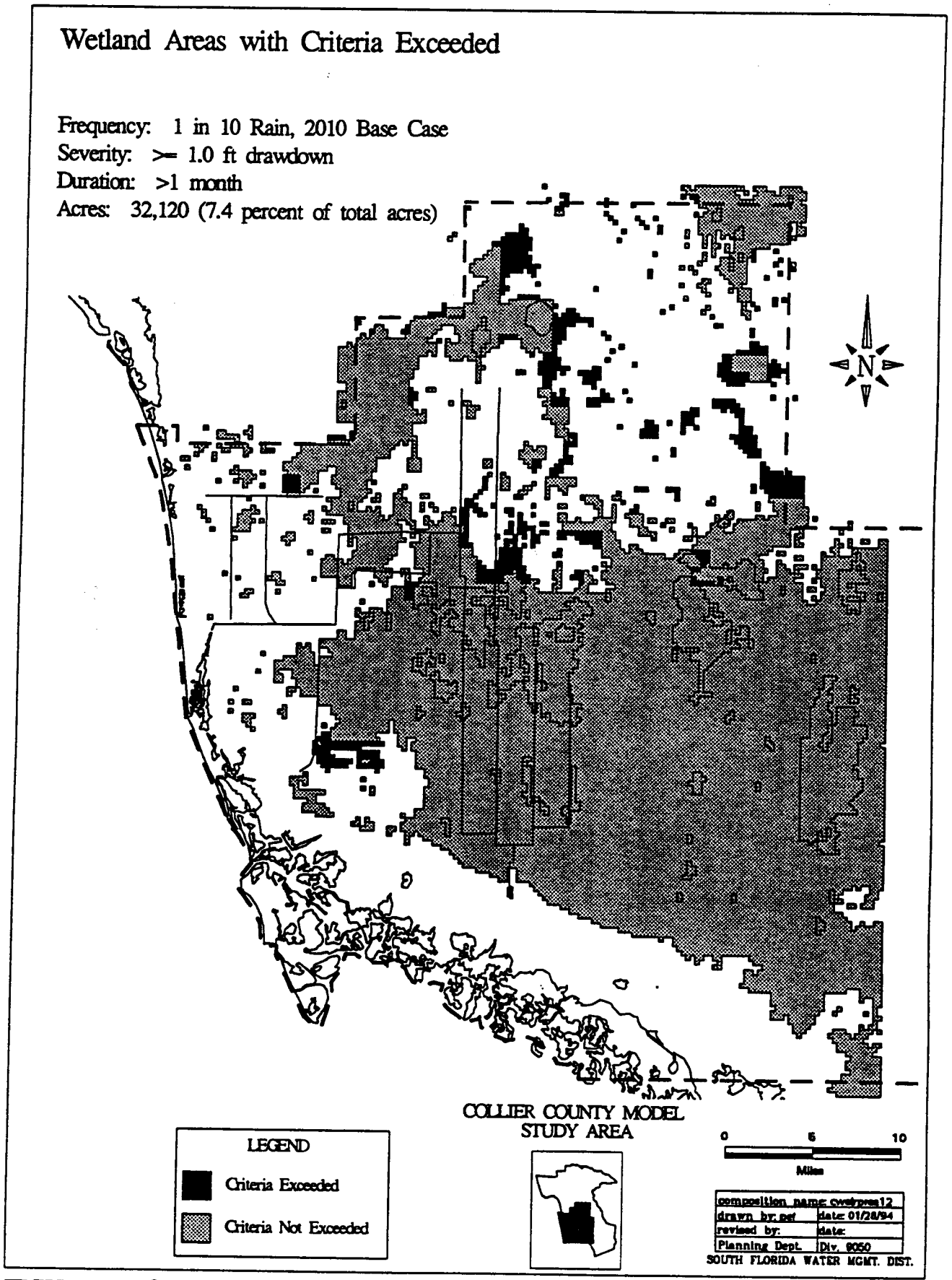

FIGURE 3. Collier County Model Wetlands Criteria, 2010 Base Case.

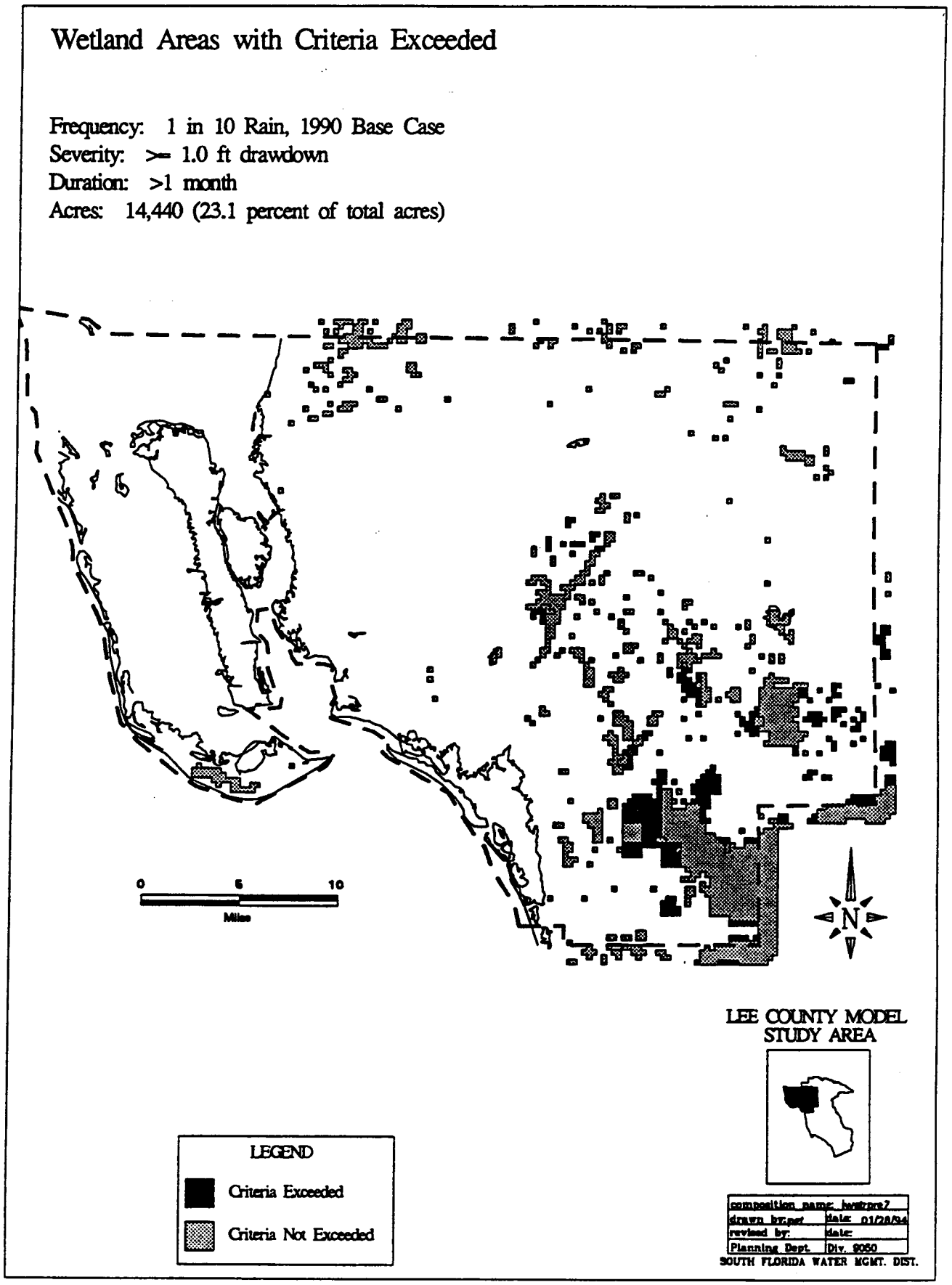

FIGURE 4. Lee County Model Wetlands Criteria, 1990 Base Case.

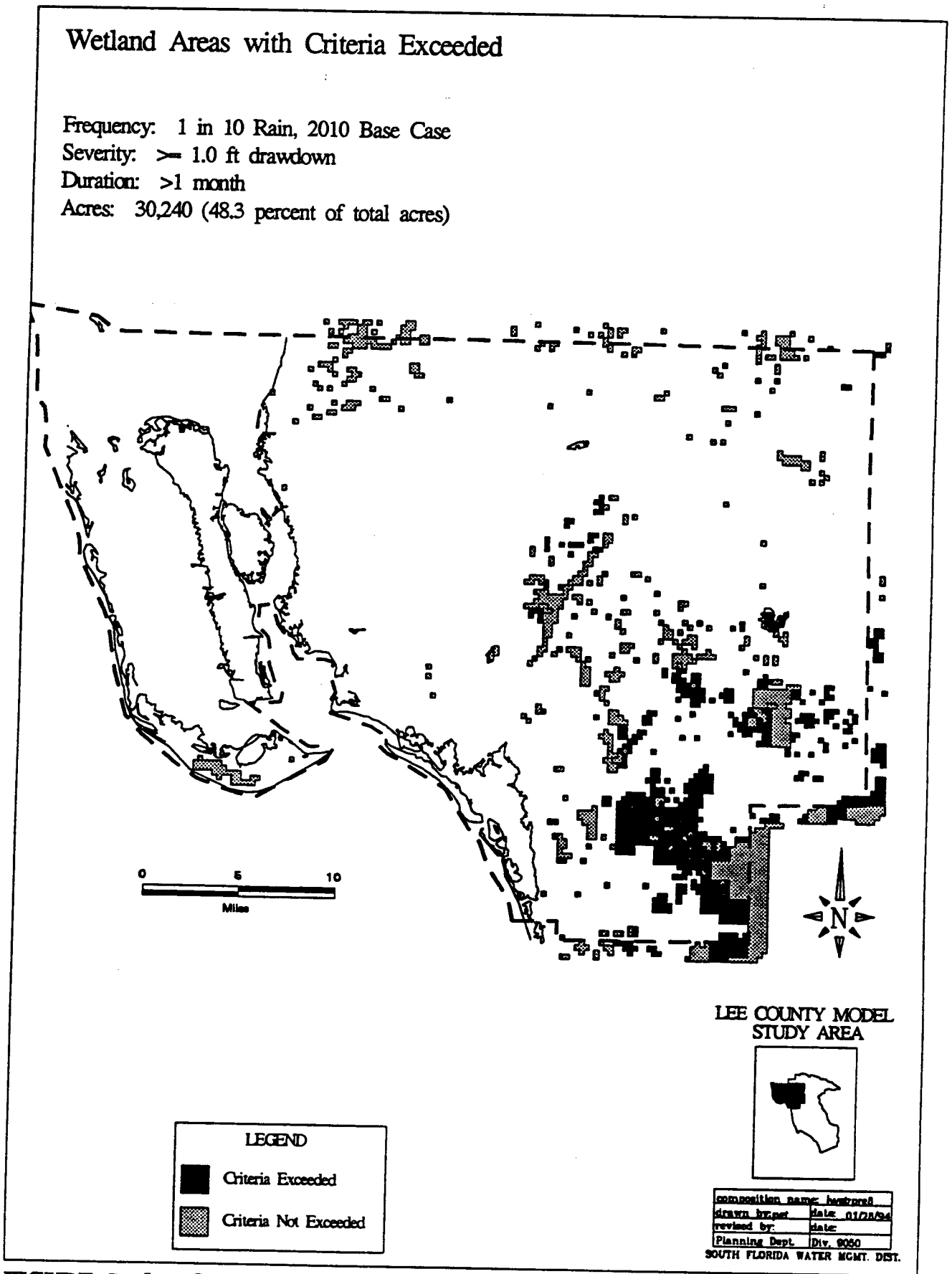

FIGURE 5. Lee County Model Wetlands Criteria, 2010 Base Case.

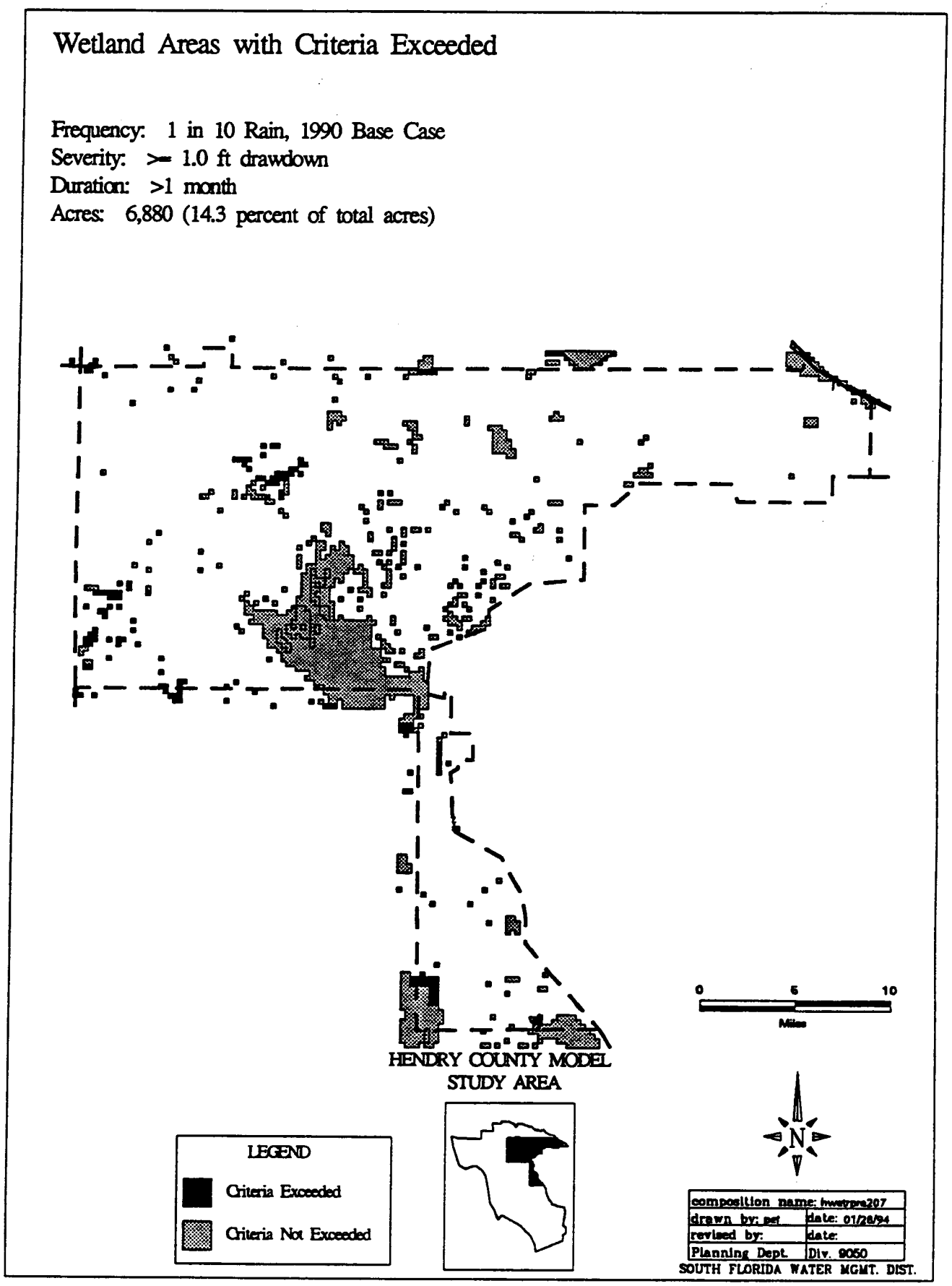

FIGURE 6. Hendry County Model Wetlands Criteria, 1990 Base Case.

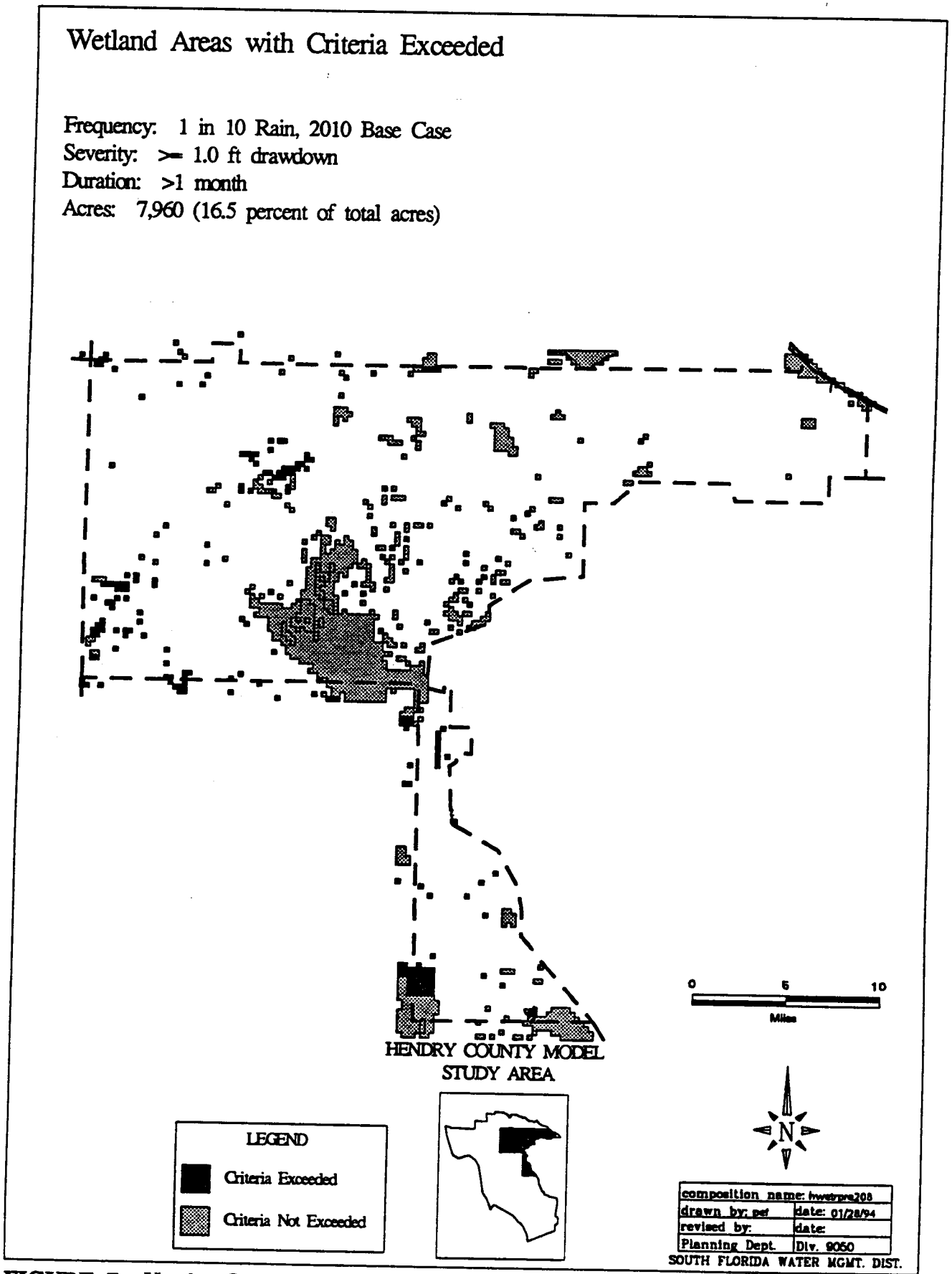

FIGURE 7. Hendry County Model Wetlands Criteria, 2010 Base Case.

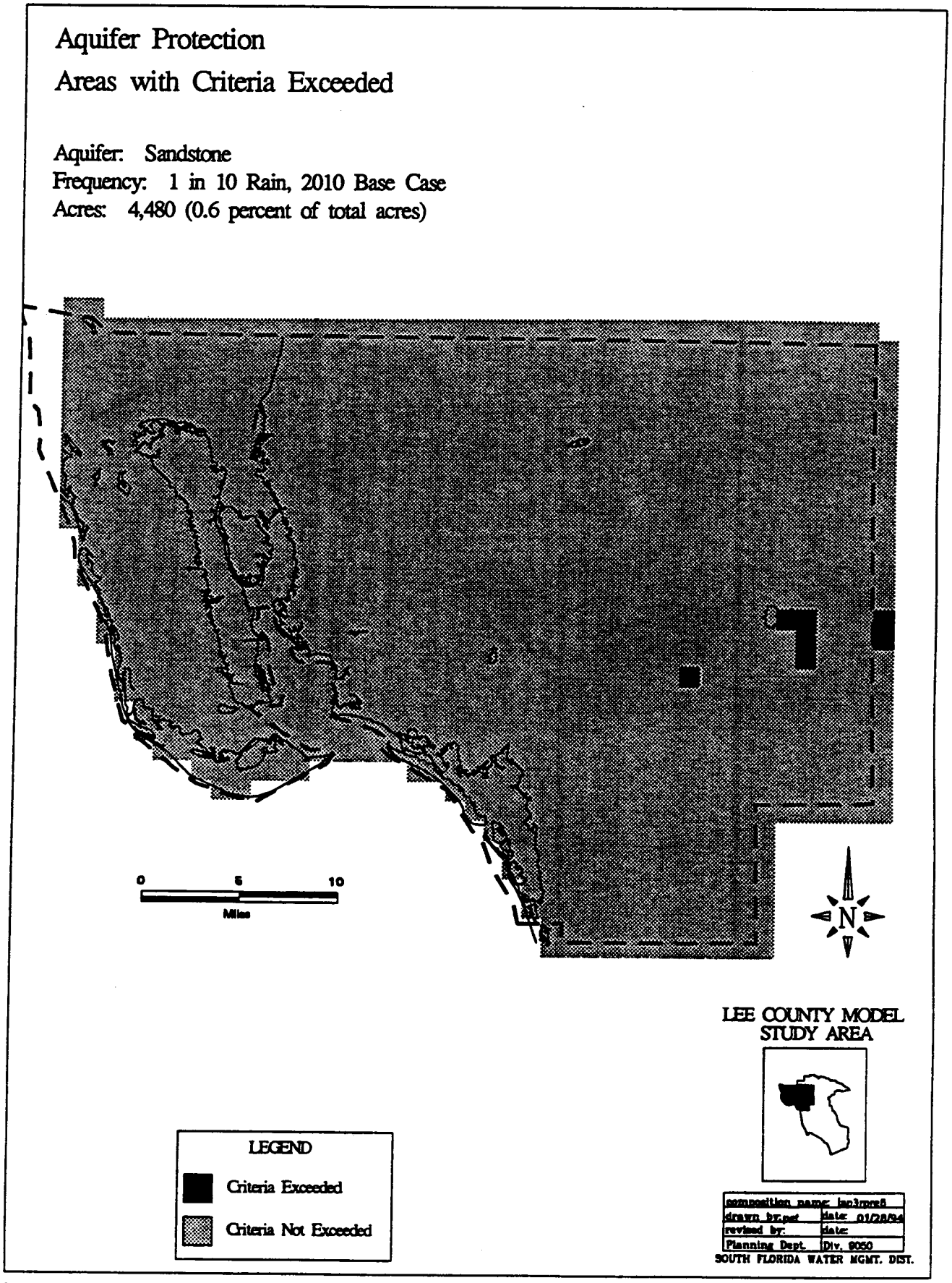

FIGURE 8. Lee County Model Sandstone Aquifer Protection Criteria, 2010 Base Case.

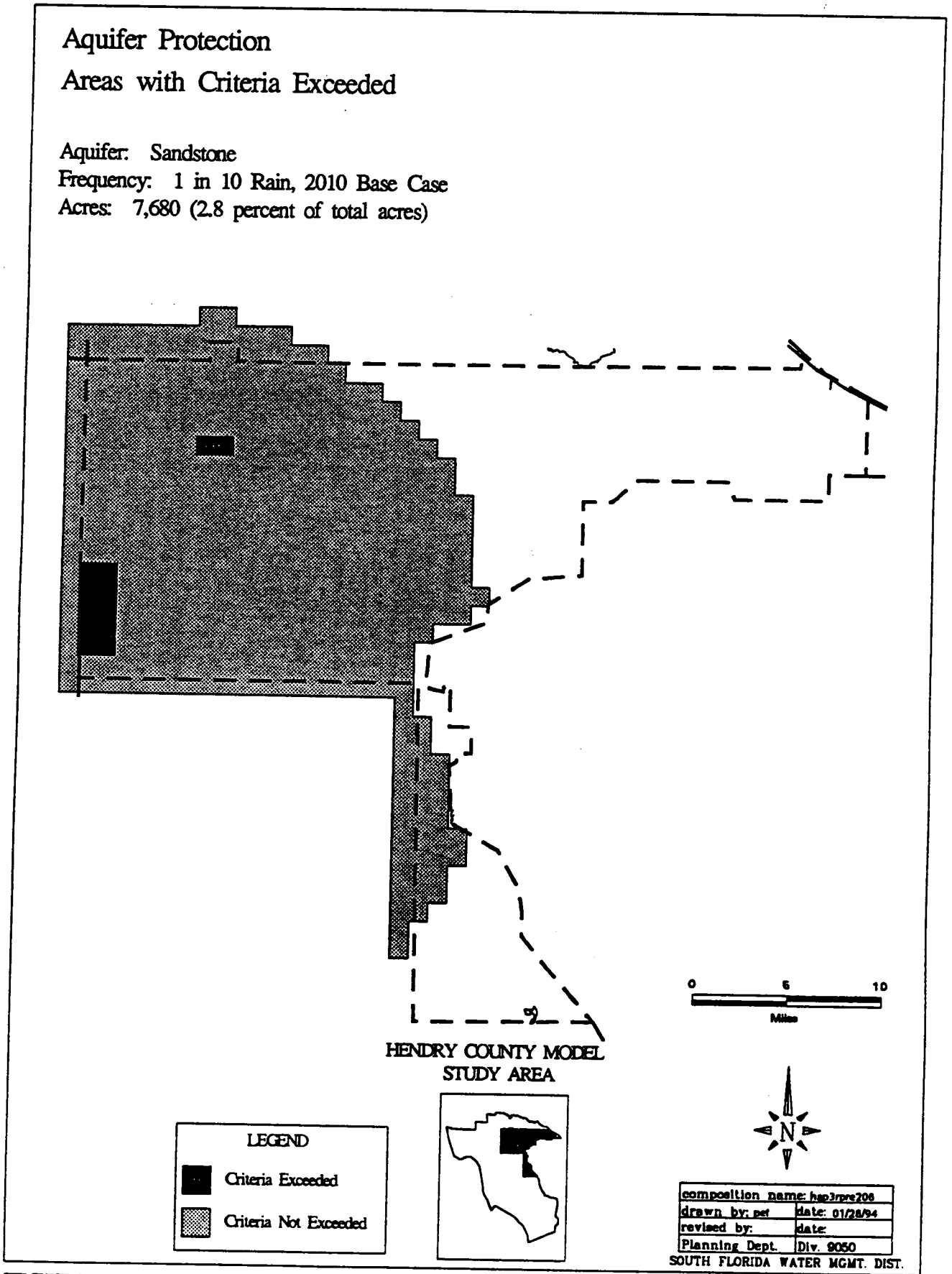

FIGURE 9. Hendry County Model Sandstone Aquifer Protection Criteria, 2010 Base Case.

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Scenario 1

Figures 10 through 13

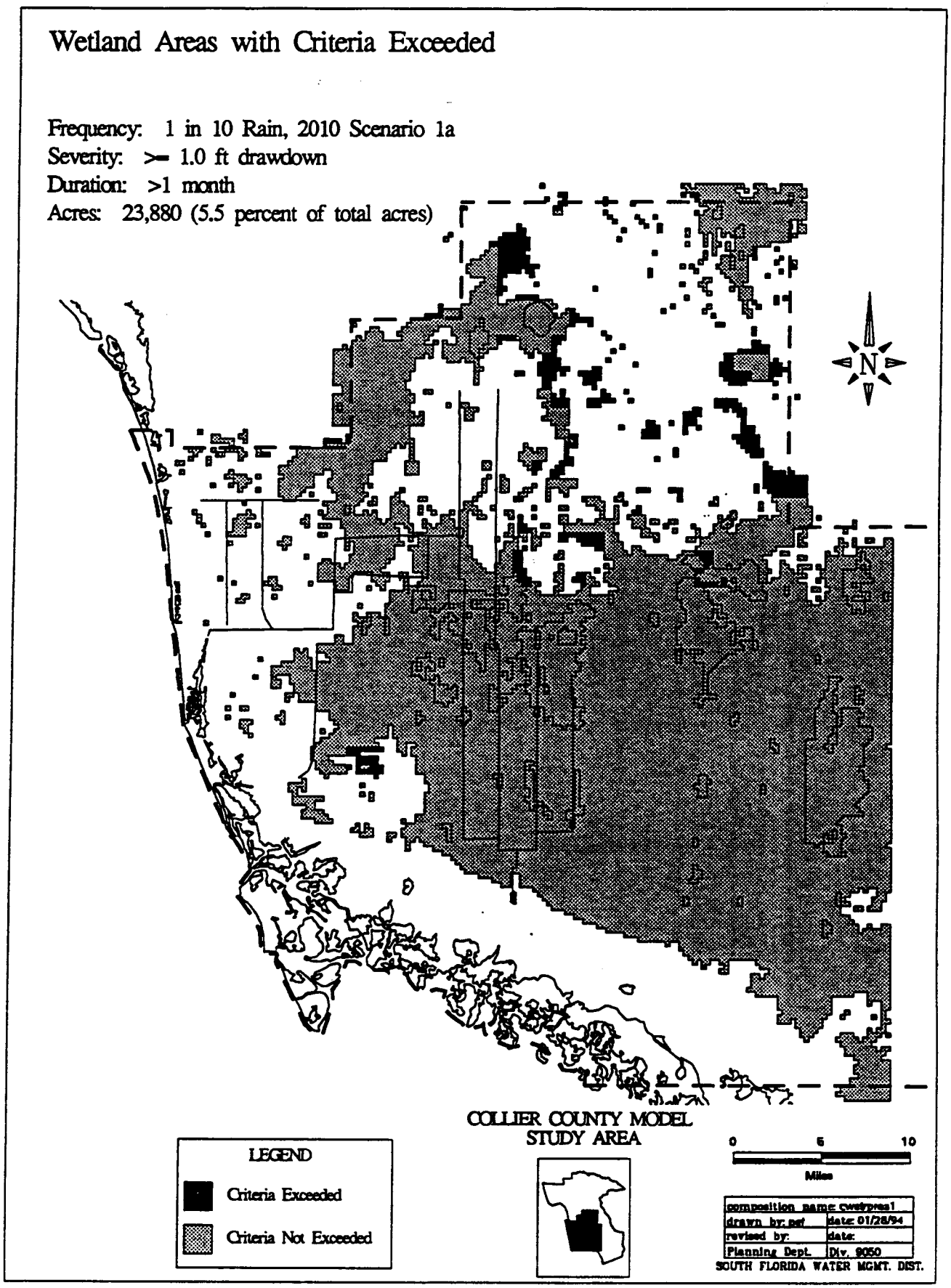

FIGURE 10. Collier County Model Wetlands Criteria, 2010 Scenario 1a.

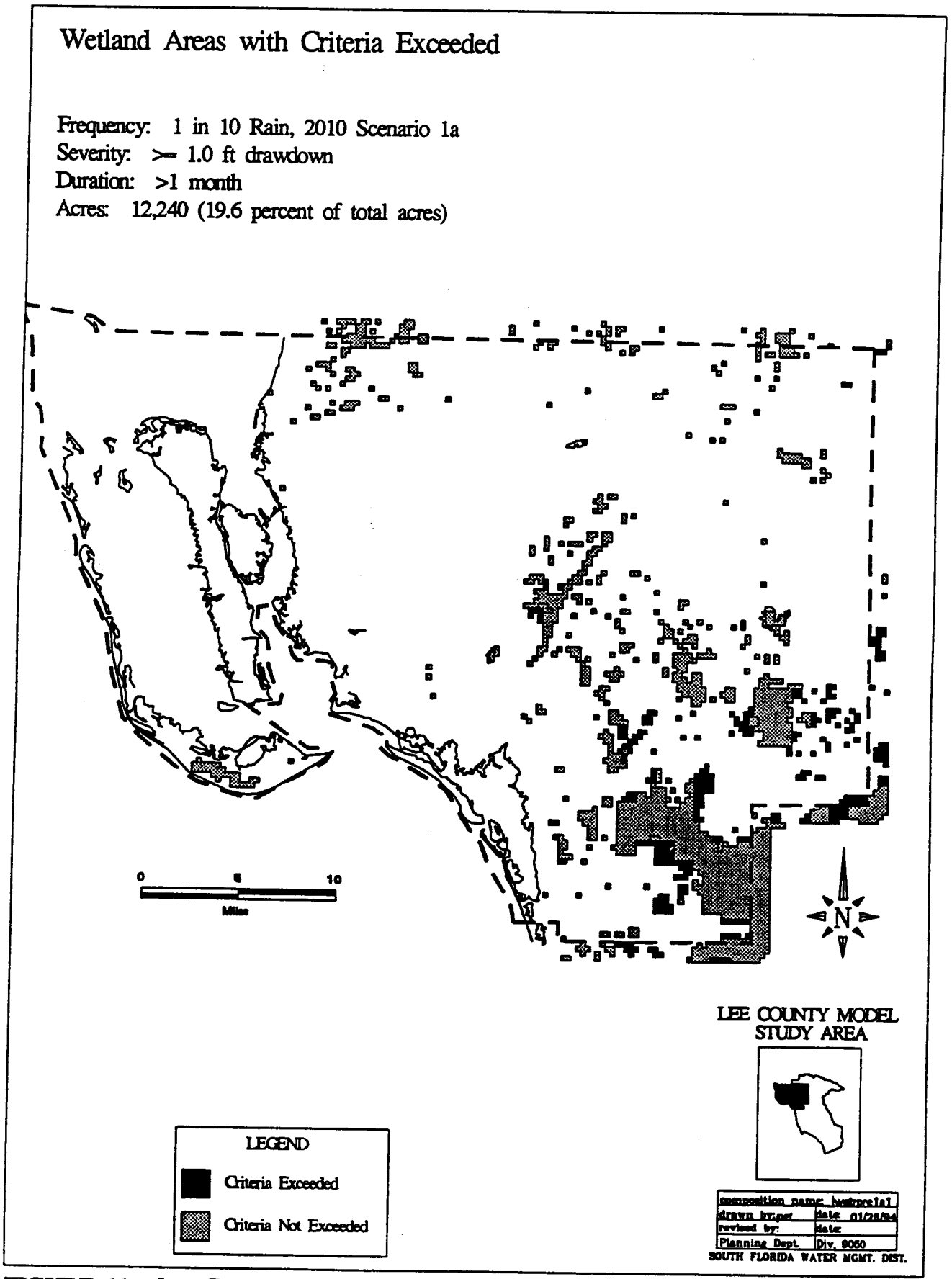

FIGURE 11. Lee County Model Wetlands Criteria, 2010 Scenario 1a.

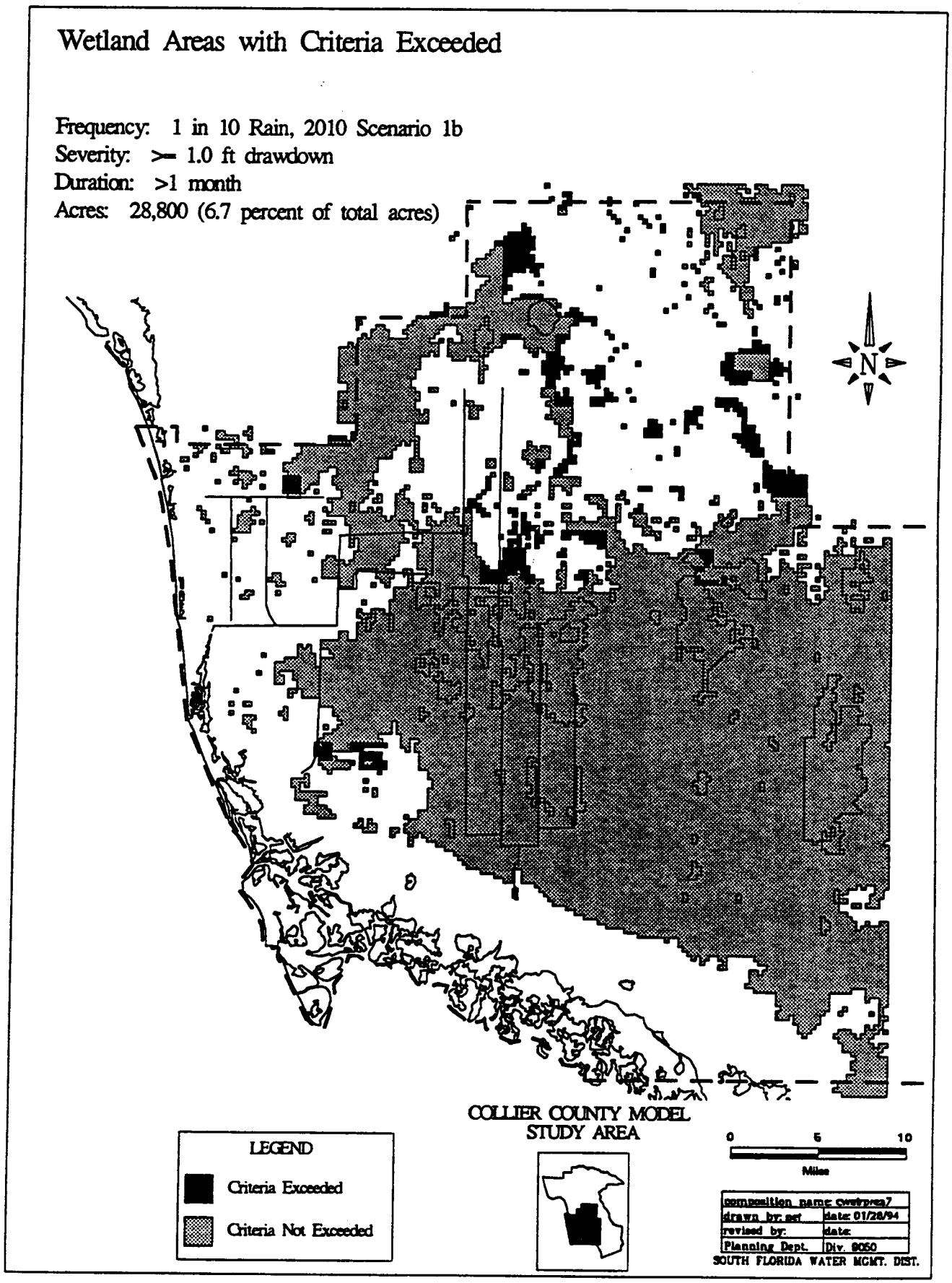

FIGURE 12. Collier County Model Wetlands Criteria, 2010 Scenario 1b.

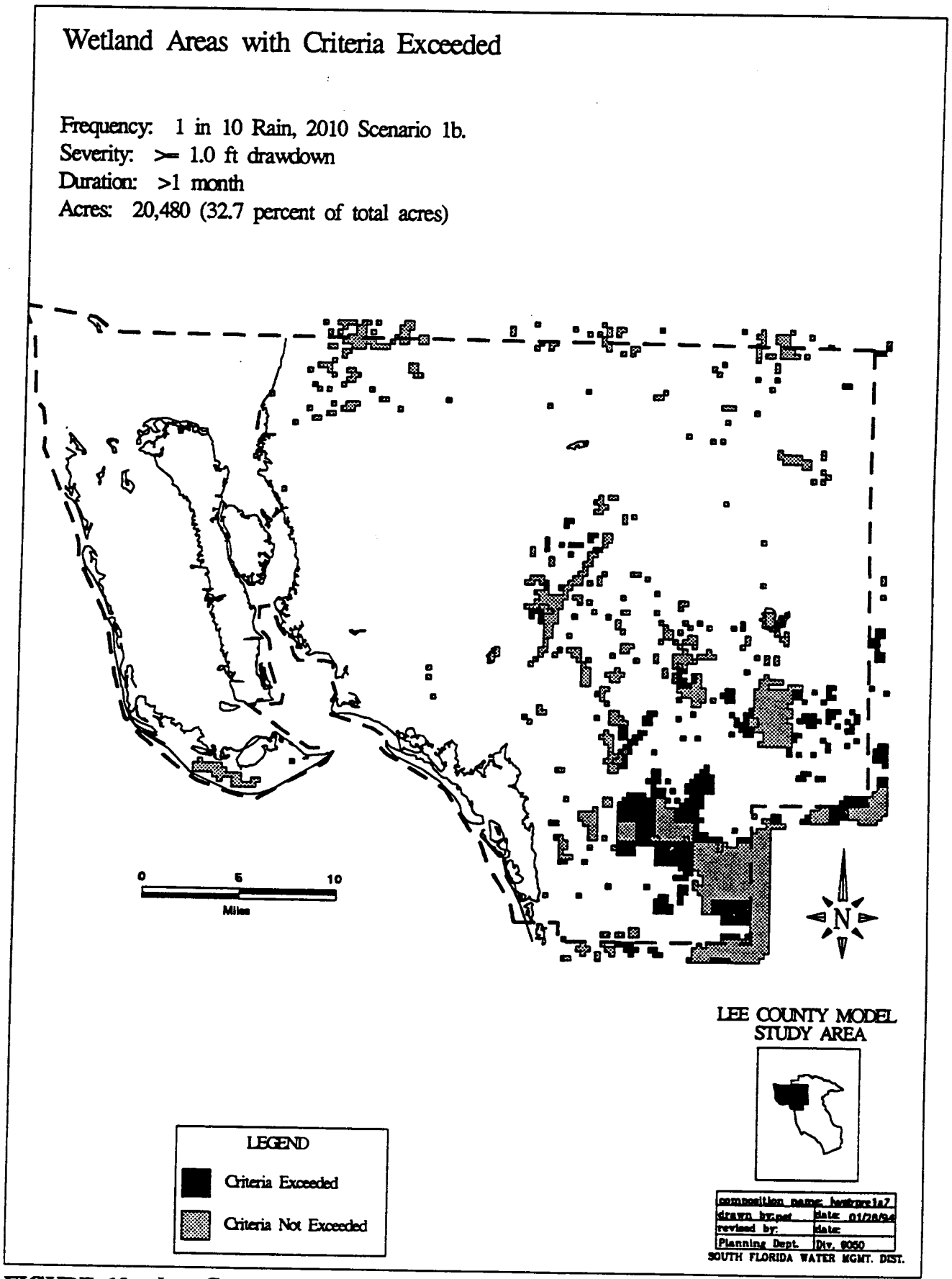

FIGURE 13. Lee County Model Wetlands Criteria, 2010 Scenario 1b.

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Scenario 2

Figures 14 through 15

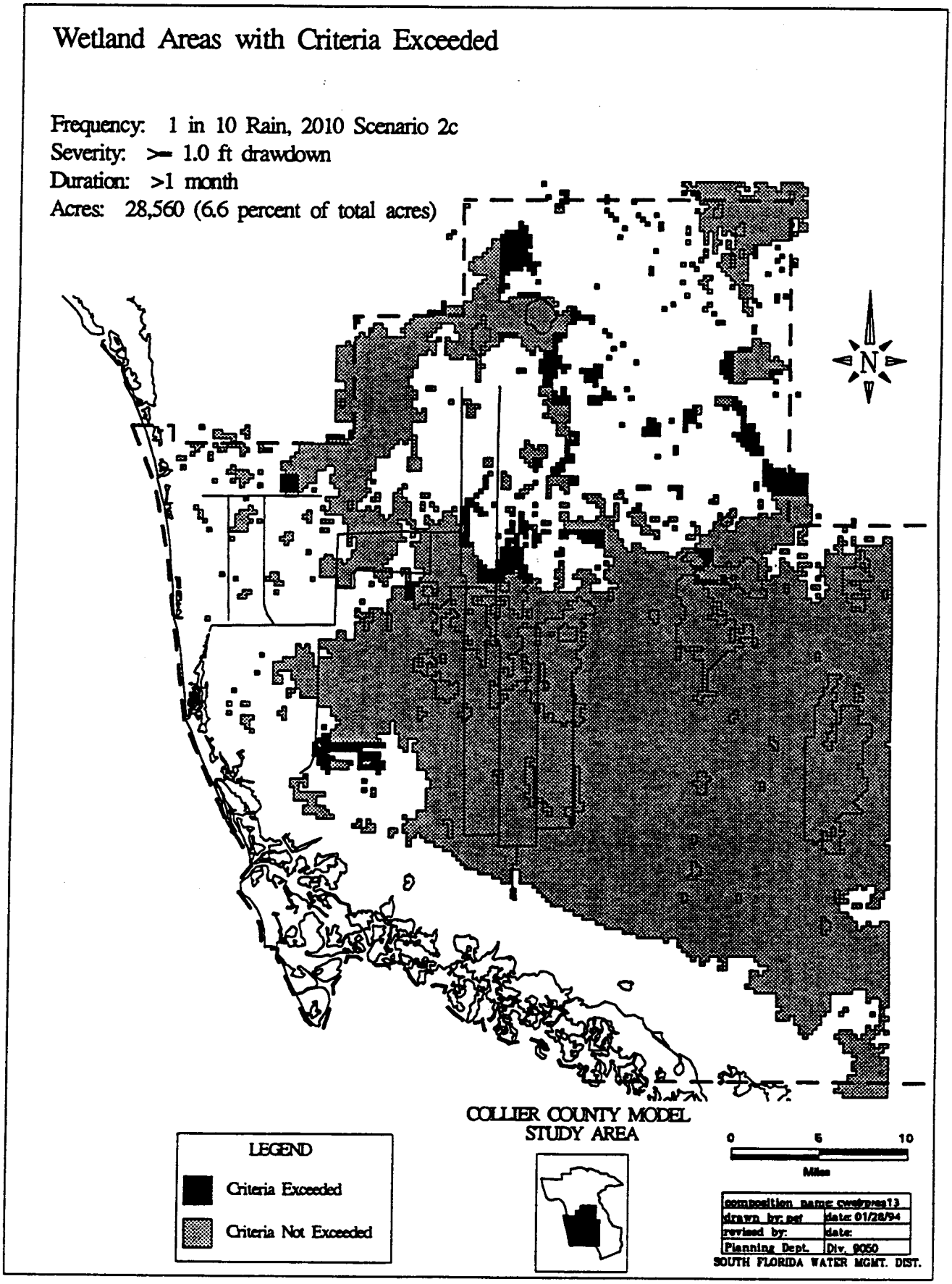

FIGURE 14. Collier County Model Wetlands Criteria, 2010 Scenario 2c.

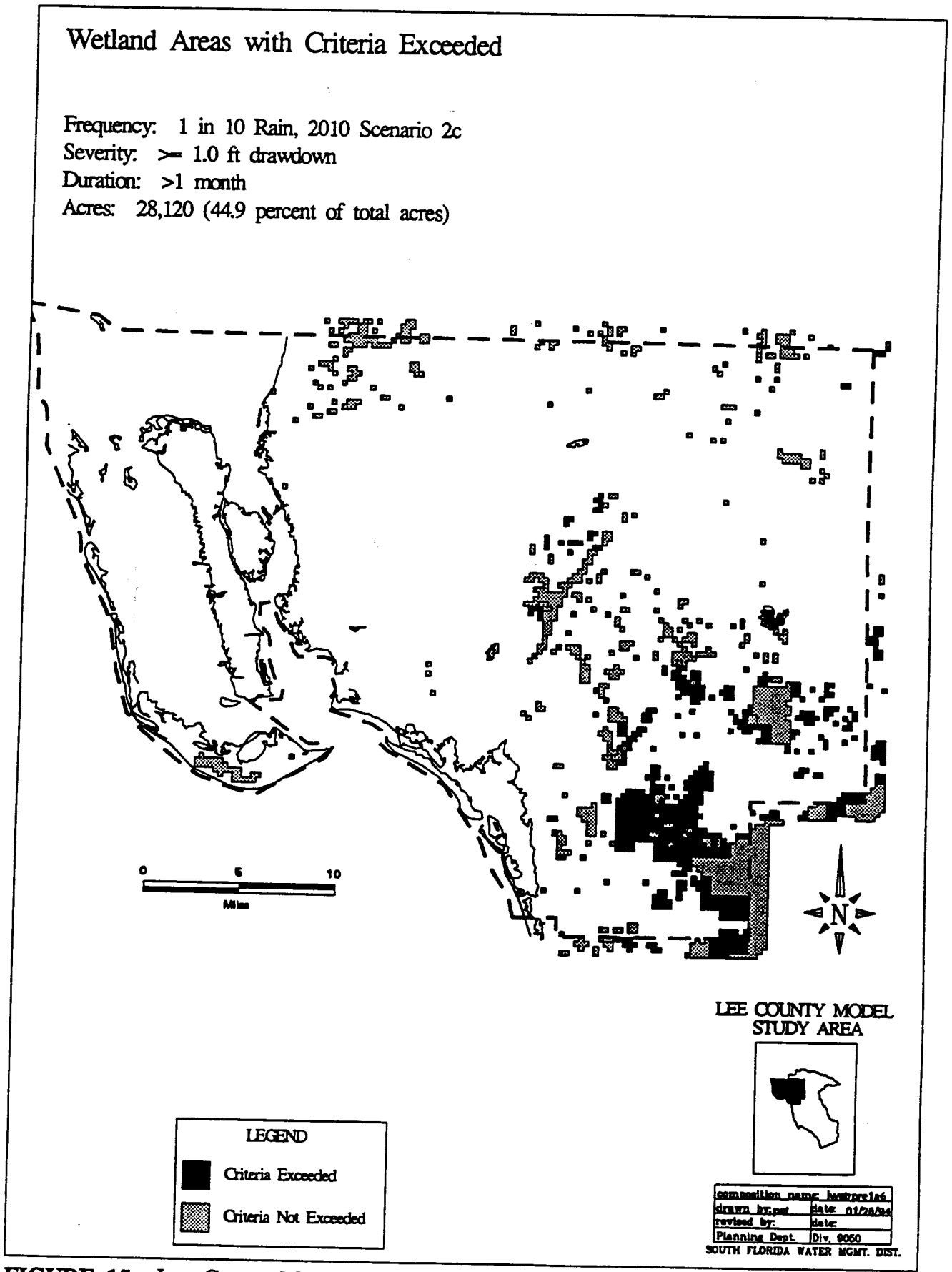

FIGURE 15. Lee County Model Wetlands Criteria, 2010 Scenario 2c.

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SUMMARY OF MODELING RESULTS

The base case model runs indicated that there were problems in meeting the wetland protection criterion as well as the seawater intrusion protection criterion at both the 1990 permitted demand level and at the 2010 projected demand level. Wetland problem areas occurred in Lee County and in the modeled portions of Collier and Hendry counties. Problems in meeting the seawater intrusion criterion occurred in both the lower Tamiami aquifer and the water table aquifer of both Collier and Lee counties. The general aquifer protection criterion was met with the exception of small areas of the Sandstone aquifer layer of eastern Lee and western Hendry counties.

Eleven different alternative modeling scenarios or combination scenarios were simulated to help reduce problems in meeting the resource protection criteria. These included 7 individual modeling scenarios (1a, 1b, 2a, 2b, 2c, 3, and 4) and 4 combination modeling scenarios (5a, 5b, 6a, and 6b). All 11 scenarios were simulated for Collier County. Modeling scenario 4 was only applicable to Collier County; however, the remaining 10 scenarios were simulated for Lee County. Only the scenarios involving agricultural efficiency (2a, 2b, and 2c) were simulated for Hendry County. Scenarios 1a, 1b, and 3 involved public water supply demands and reclaimed water, neither of which are very large in Hendry County. Alternatives 5a, 5b, 6a, and 6b involved combinations with scenarios 1a, 1b, and 3; thus, they were also not simulated for Hendry County.

Effectiveness for the Wetland Protection Criterion

Figures 16 through 19 present a summary of the modeling results pertaining to the wetland protection criterion in the modeled portion of the LWC Planning Area and in Collier, Lee, and Hendry counties. All of the modeling scenarios produced reductions in wetland problem areas in Collier and Lee counties. Only modeling scenarios 2a, 2b, and 2c were simulated for Hendry County; these scenarios did not cause any reduction in wetland problem areas in Hendry County.

The combination modeling scenarios (5a, 5b, 6a, and 6b) were, in general, more effective than the individual modeling scenarios (1a, 1b, 2a, 2b, 2c, 3, and 4) in reducing wetland problem areas. Scenario 6a was the most effective modeling scenario in reducing the total area of wetlands not meeting the wetland protection criterion in both Collier and Lee counties (reductions of 39 percent in Collier County and 70 percent in Lee County compared to their respective 2010 base case runs).

The individual modeling scenarios involving removal of public water supply demands from the shallow aquifers (scenarios 1a and 1b) were more effective in helping to meet the wetland protection criterion than the individual modeling scenarios involving agricultural efficiency (scenarios 2a and 2b) or involving reclaimed water (scenario 3).

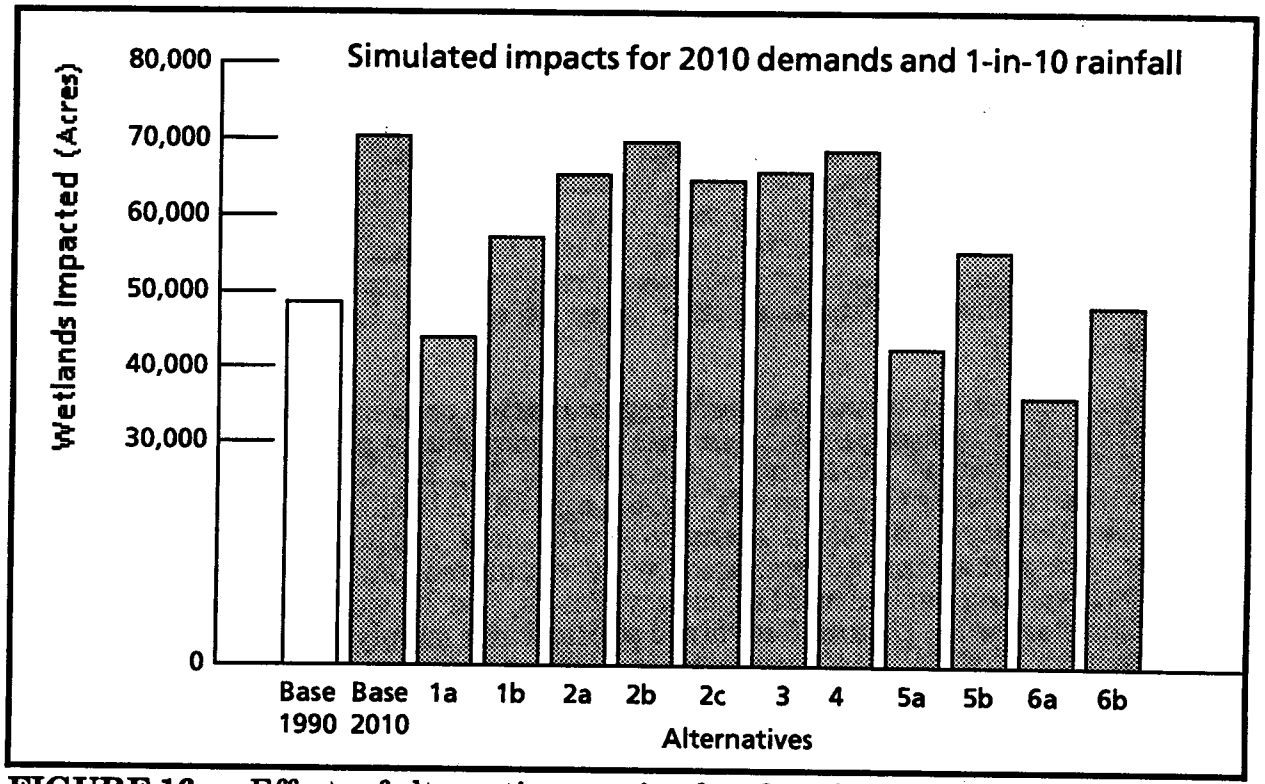

FIGURE 16. Effects of alternatives on simulated wetland impacts in the Lower West Coast Planning Area.

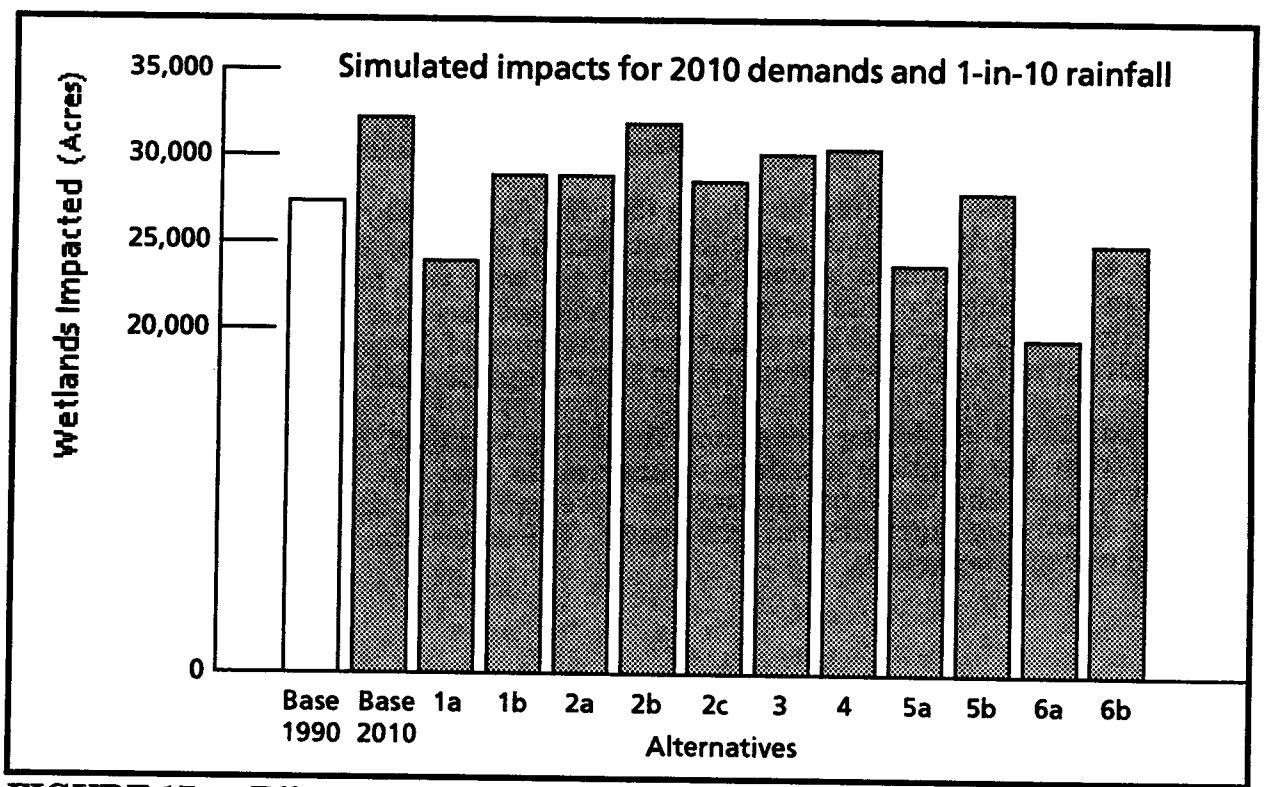

FIGURE 17. Effects of alternatives on simulated wetland impacts in the Collier County Area.

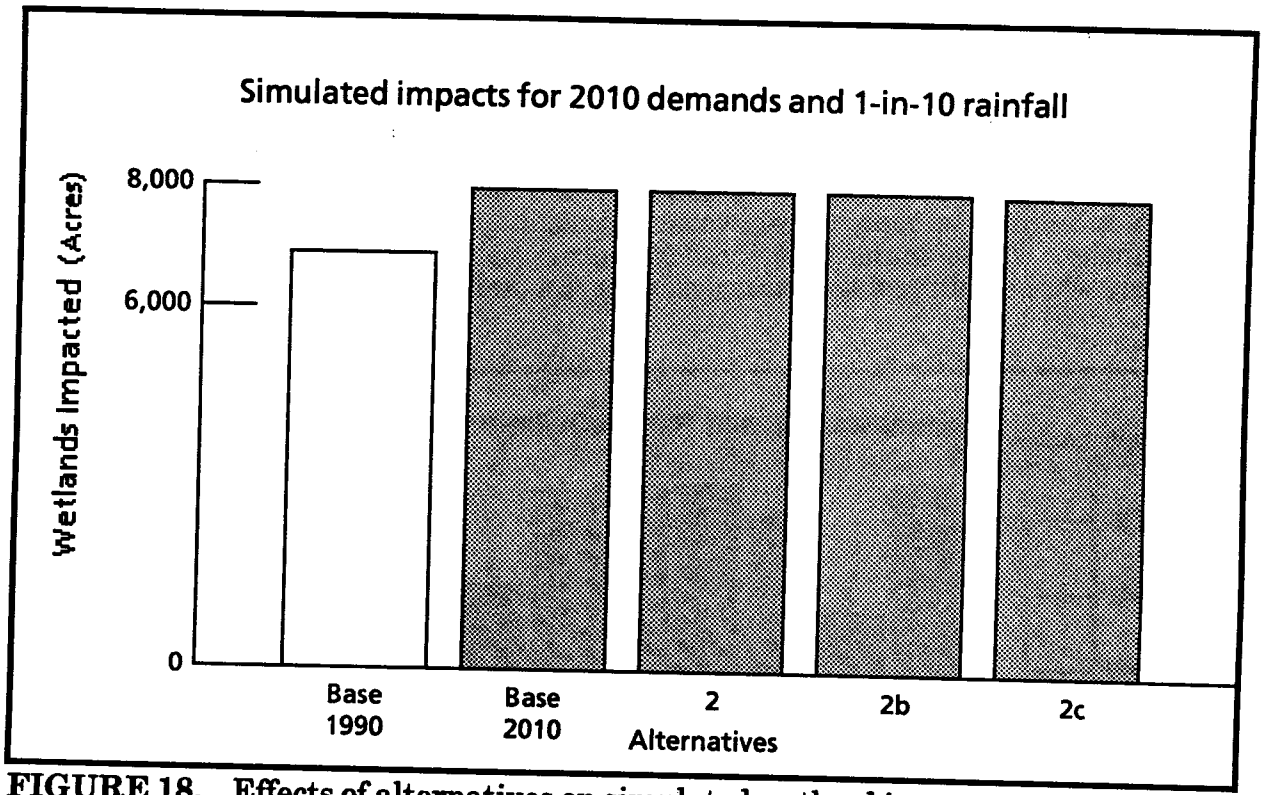

FIGURE 18. Effects of alternatives on simulated wetland impacts in the Hendry County Area.

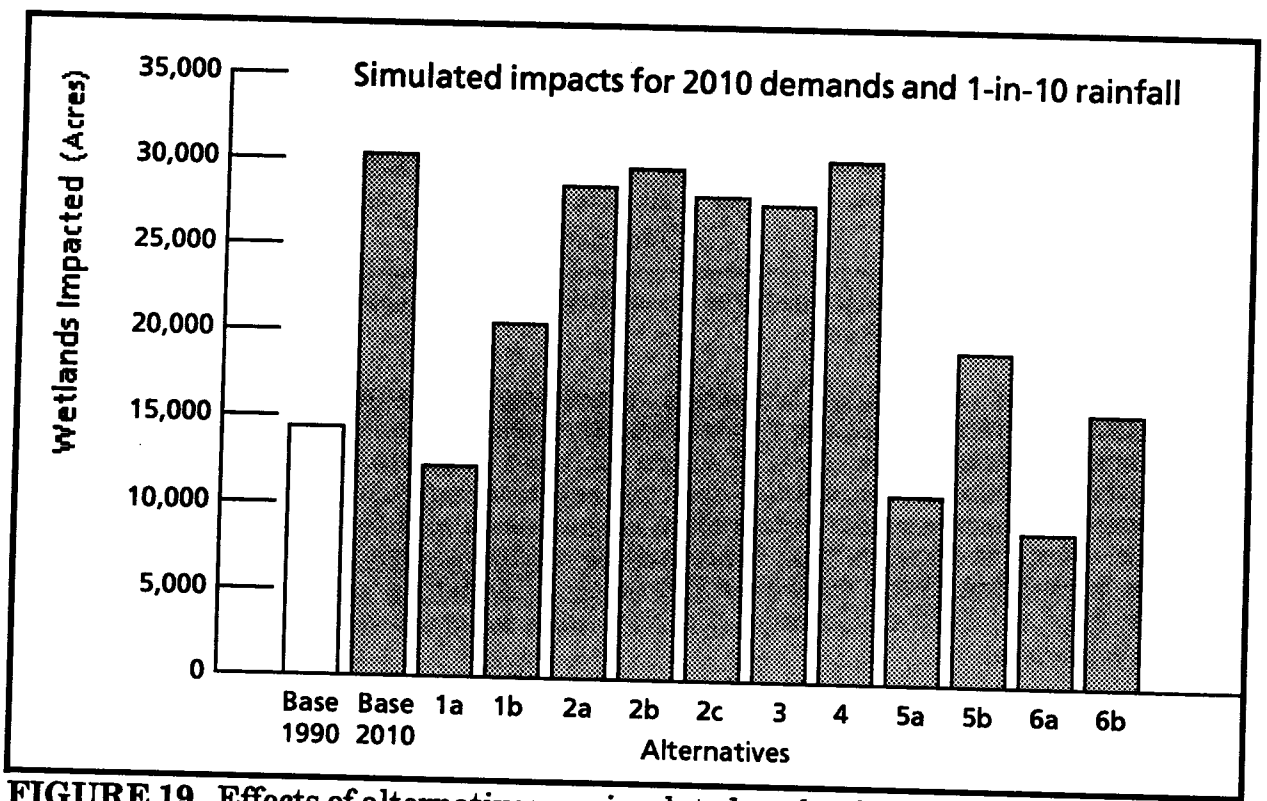

FIGURE 19. Effects of alternatives on simulated wetland impacts in Lee County.

Effectiveness for the Seawater Intrusion Protection Criterion

Figure 20 presents a summary of the modeling results pertaining to the seawater intrusion protection criterion in Collier and Lee counties. In general, the individual modeling scenarios involving both the removal of public water supply demands from the shallow aquifers (scenarios 1a and 1b) and reclaimed water (scenario 3) were effective in helping to meet the seawater intrusion protection criterion in Collier and Lee counties. These same individual modeling scenarios were even more effective when they were combined as scenarios 5a, 5b, 6a, and 6b.

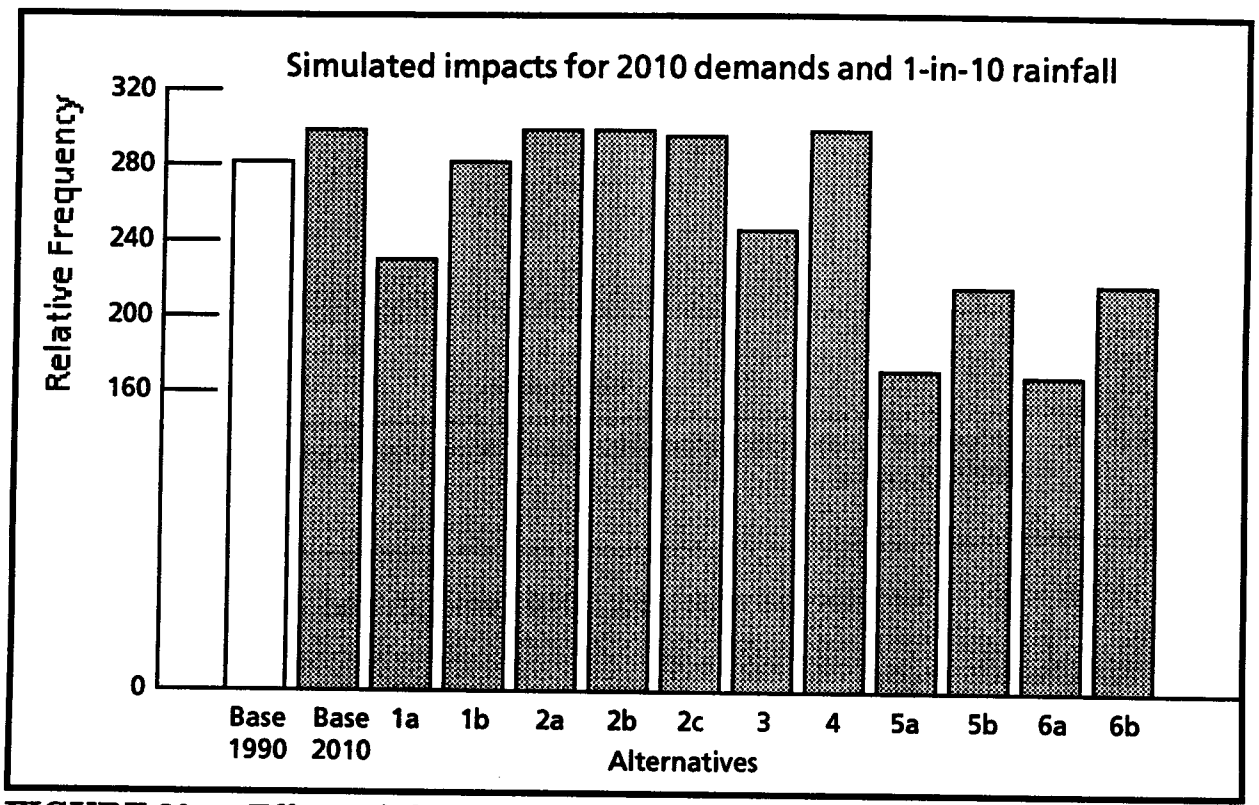

FIGURE 20. Effects of alternatives on simulated seawater intrusion in the LWC Planning Area.

The individual modeling scenarios involving agricultural efficiency were generally not effective in helping to meet the seawater intrusion protection criterion; however, scenarios 6a and 6b, both of which included scenario 2c (increased efficiency for both citrus and small vegetables) met the seawater intrusion protection criterion for the lower Tamiami aquifer better than scenarios 5a and 5b which did not include scenario 2c. Thus, it appears that increased agricultural efficiency would contribute to greater protection from seawater intrusion. Modeling scenario 4, which was applicable only to Collier County, did not help to meet the seawater intrusion protection criterion.

Effectiveness for the General Aquifer Protection Criterion

The general aquifer protection criterion had been completely met in the base case model simulations for Collier County, and so no simulations were not needed to achieve compliance with the general aquifer protection criterion in Collier County.

Only a few cells in the layer representing the Sandstone aquifer of eastern Lee County and western Hendry County had failed to meet the general aquifer protection criterion. Scenario 1a, 5a, 6a, and 6b caused small improvements in meeting the general aquifer protection criterion for the Sandstone aquifer layer in Lee County. Scenarios 2a, 2b, and 2c did not help to meet the general aquifer protection criterion for the Sandstone aquifer in Hendry County.

DISCUSSION OF MODELING RESULTS

None of the individual modeling scenarios (1a, 1b, 2a, 2b, 2c, 3, and 4) nor the combination modeling scenarios were successful in eliminating **all** problems in meeting the resource protection criteria in the modeled portion of the LWC Planning Area. However, the modeling results showed that all of the scenarios, either individually or in combination with other scenarios, did help to meet one or more of the resource protection criteria. The fact that some individual modeling scenarios, when evaluated in isolation from other scenarios, did not appear to help meet criteria should not be construed as evidence that the measures these scenarios represent are ineffective. Rather, the fact that these same individual scenarios did help to meet criteria when combined with other scenarios should be cited as evidence that the measures represented by all of the scenarios would be helpful in meeting the resource protection criteria.

The application of the regional models suggests that unless new approaches are taken, it may not be possible to support the projected growth to the year 2010 while maintaining the proposed level of resource protection. Furthermore, the problem areas identified do not necessarily begin in the year 2010. Many of the same areas failed to meet protection criteria for the 1990 permitted demand level, indicating existing problems or their onset by the time the permits issued through the year 1990 reach their full demand. Some of the problems occurred during both a 1-in-10 drought as well as during average rainfall conditions, indicating chronic problems. It should be noted, however, that all of the scenarios simulated were more effective during average rainfall conditions than a 1-in-10 drought condition. The following chapter of the plan identifies recommendations designed to address the issues identified by ground water modeling.

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III. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The following conclusions are based on all of the information and analyses that were considered as part of the process to create this plan, including the ground water modeling results and the projected growth in water demand in the LWC Planning Area.

(1) Analyses based on the application of resource protection criteria indicate that development of water resources to meet projected urban and agricultural demands has the potential to cause significant harm to water resources and associated natural systems.

(2) New sources of water will need to be developed to meet increasing demands for water. Existing sources of water will need to be used and managed more efficiently.

(3) There is insufficient information to evaluate the full capacity of some new water sources. This information needs to be developed as quickly as possible.

(4) Competition for water among water users within the LWC Planning Area is expected.

(5) Competition for water between water users and the environment and among water users will require the District to make decisions concerning which uses of water best serve the public interest. The regulatory framework for making these decisions needs to be put in place as quickly as possible in order to promote maximum reasonable-beneficial use of water resources.

ALLOCATING WATER RESOURCES

The goal of the SFWMD's water supply planning effort, as stated in the Water Supply Policy Document, is to attain maximum reasonable-beneficial use of water. This plan is designed to achieve this overall goal in the LWC Planning Area through a combined, integrated analysis which supports protection and enhancement of the environment while meeting the needs of the region through such methods as diversifying supply sources. Implementation of this plan's comprehensive recommendations will combine to better protect the environment, lessen competition among users, decrease the frequency, severity and duration of water shortages, and otherwise promote prudent management of the state's natural resources. The following is a discussion of the major policies and objectives which arise in formulating recommendations on the subject of allocating water.

The overall allocation scheme is designed to maximize the level of certainty for legal water users, consistent with other agency objectives. To accomplish this task, the plan recommendation "package" will propose change to the current allocation method in four general areas: (1) developing new sources, (2) increasing efficiencies, (3) altering water resource protection strategies, (4) performing additional studies of water resources and the environment. Associated with the development of new allocation methods is the proposed strategy for water resource/environmental protection. Since these environmental protection provisions actually serve to define

what water remains for allocation, the policy determinations for these matters are of primary importance. The following discussion presents an overall view of these policy decisions, in the context of resource allocation, in an attempt to explain the relationship between these factors.

The plan's recommended environmental protection objective is to protect the functions and values of the planning area's natural systems and their associated ecosystems. Water needs for these systems are defined as being dependent upon a number of factors including hydrology, soil type and wetland type. Resource protection criteria are then developed and directed toward defining levels of significance of impact in terms of severity, duration and frequency. A series of additional objectives and policies follow from this threshold determination to protect the function and values of natural systems. Specifically, the reservation from allocation of that supply required to maintain or enhance these protected natural systems must occur in coordination with the protection criteria. Establishment of the Outstanding Natural System and mitigation banking concepts work in conjunction to preserve the natural systems while allowing human uses to occur in harmony with the stated environmental objectives. Optimization of surface water management control elevations to achieve the primary purpose of protecting natural systems as well as flood protection and water conservation is another associated objective.

Recommendations concerning development of new supply sources raises policies which, although first conceived of in the Water Supply Policy Document, will be implemented for the first time as a result of the plan's initial determinations and subsequent agency actions in such areas as rulemaking and operations. New sources include such under-utilized supplies as the Floridan Aquifer System, reverse osmosis/desalinization and aquifer storage and recovery technology. A two step policy determination is necessary to effectuate this diversification. First, limits on existing supply sources must be established, then guidance on development of the new source must be provided. Included in this process as the first step is the associated concept of aquifer or supply source zoning. The designation, or "zoning," of water bodies where specific, priority use types are granted a preference in competition is a threshold policy concept recommended for further exploration and potential implementation by this plan as a means of requiring use of new sources. Another policy concept which the alternative recommendations address is requiring use of the lowest quality water appropriate for the intended purposes, specifically reuse of reclaimed water. Recommendations suggest staff explore criteria development to require reuse of reclaimed water to the maximum extent in the region through subsequent rulemaking efforts.

Another general area of recommendations concerning allocation schemes concerns efficiency and demand management. Two policy objectives that work in conjunction with each other in this are: prohibition of wasteful and unreasonable uses of the state's water supply while continuing to provide a "certain" or dependable supply for users. The task of the Governing Board is to provide staff with policy guidance on alternatives to balance these interests. The plan's recommendations attempt to achieve a balance between these sometimes divergent interests. Specifically, the plan recommends the Governing Board direct staff to further explore requiring increased efficiency measures for both urban and irrigation users through continuing to require water conservation plans for urban uses, exploring increased agricultural irrigation efficiency, improved drainage management and coordination with local governments, particularly in "water poor" regions. Implementation of these conservation measures must be accomplished through rulemaking proceedings. These efficiency measures will result in less water allocated to users, thereby

stretching supplies and preserving the resources for future users while simultaneously achieving environmental protection objectives. With less water allocated to users, less protection from drought events occurs. Thus, the corresponding subject of a user's physical certainty, or the risk of drought, arises. The need for definition of supplemental crop irrigation requirements (volume) or return frequency of droughts thus is addressed in plan recommendations and must be evaluated in rulemaking.

The recommendations presented in this chapter provide initial direction towards meeting the overall goal, guiding directives, and policies outlined in Chapter I. Moreover, the recommendations are intended to be guidance to staff, but are not intended to impose any requirements upon the regulated community, local governments or the citizens of the planning region. By accepting this plan, including the following recommendations, the Governing Board is making a preliminary determination to pursue the courses of action set forth in the recommendations. Each recommendation is accompanied with a set of implementing steps involving further Governing Board decisions and participation in such areas as budget preparation, rulemaking and local government coordination. These recommendations are not intended to be inflexible. For example, while acceptance of this plan will result in staff exploring the concepts stated in the recommendations, further analysis, input from interested citizens and other factors may influence the staff and/or Governing Board to alter the course set forth in this planning document; thus the characterization of this document as "dynamic." In sum the recommendations do not constitute final agency action on any of the subjects discussed.

Organizationally, there are four general recommendation areas, stated above. Each recommendation area contains a number of subtopics related to the general category. The following discussion presents a summary of issues and conclusions associated with each subtopic and, then the specific recommendations. Finally, since the recommendations guide staff and do not provide final determinations on any of the subjects, a list of anticipated, future Governing Board actions related to each recommendation is provided. This list of future Governing Board decisions related to each recommendation may change as additional matters are brought to staff's attention through further analysis, input from interested citizens, rule development, local government coordination and the like. This plan does not contend that these recommendations alone will satisfy the plan goal and all of the directives and policies. However, these recommendations, if implemented, will begin the process of altering the current trends.

RECOMMENDATIONS

Develop New Sources of Water

Opportunities exist for developing new sources of water in the LWC Planning Area. The development of these new sources probably offers the greatest opportunity to balance the increasing demands of urban and agricultural water users with the need to protect the environment.

Deeper Aquifers

Hydrogeologic information suggests that additional water can be supplied to the LWC Planning Area from deeper aquifers such as the Floridan Aquifer System. Water from this aquifer system will require desalination and treatment for potable

use. The SFWMD has embarked upon a major aquifer exploration program in the LWC Planning Area to evaluate the quality and productivity of the Floridan Aquifer System. The plan for the Floridan Aquifer testing program includes drilling and testing at four to six sites in the planning area during fiscal years 1993-94 through 1995-96. A final report is scheduled to be completed by October 1, 1996.

The Sandstone aquifer may be able to provide additional capacity in portions of Hendry County. The extent and thickness of the Sandstone aquifer in northeastern Hendry County needs to be mapped and evaluated.

Data contained in Chapter V of the Background Document and in "Water Supply Cost Estimates" (Post, Buckley, Schuh & Jernigan Inc., 1991) indicate that the capital and operating costs of the reverse osmosis (RO) systems which are required to utilize the brackish Floridan aquifers may be $.10 to $.24 per thousand gallons higher than the capital and operating costs of the lime or membrane softening processes used for the Surficial Aquifer System water. A higher cost differential would apply when treatment capacity has already been constructed. In that case, utilities required to switch to a brackish aquifer would save only the operating costs of the Surficial treatment process and would bear the capital and the operating cost of going to the deeper aquifer. The additional cost in this case may be $.73 to $.85 per thousand gallons. The programs of exploration, mapping and testing proposed below are expected to cost the District $1.2 million over the next five years.

Recommendations:

(1) The District should budget for and complete its planned drilling and testing of the Floridan Aquifer System in the LWC Planning Area by October 1, 1996.

(2) The District should make preliminary results of the Floridan Aquifer testing available in a timely fashion to public and private water suppliers and local governments.

(3) The District should conduct exploration, mapping, and testing of the Sandstone aquifer.

(4) The District should develop criteria for development of the Floridan Aquifer System using RO technology.

Future Governing Board Considerations:

- Budgetary process for research and potential District project (e.g., District ASR project).
- Presentation of Final Reports on Floridan Aquifer tests.
- Potential Local Government Coordination.
- Potential comments on local government comprehensive planning elements.
- Rule development/adoption regarding criteria for Floridan Aquifer development.

Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) is defined as the underground "storage" of injected water in an acceptable aquifer during times when water is available, and the subsequent "recovery" of this water when it is needed. Simply stated, the aquifer acts as a reservoir for the injected water. There are five ASR facilities in operation in Florida: (Manatee County, Peace River, Cocoa, Port Malabar, and Boynton Beach. In addition, there are another 23 systems in Florida in some stage of investigation, of which the following are in the development or testing phases: Lake Okeechobee/ Taylor Creek, Marathon, Stock Island, Tampa, and Collier, Lee, Dade, and Broward counties.

Operating ASR facilities in the U.S. generally store treated drinking water, though there is interest in using raw water or reclaimed water for ASR. Potential sources of water for ASR application in Florida include surplus surface water (treated or untreated), ground water, potable water, and reclaimed water (CH2M Hill, 1993). Potential uses of ASR in South Florida include enhancing potable and agricultural water supplies, improving water quality, preventing saltwater intrusion, increasing water storage capability, controlling contaminant plumes, and maintaining distribution system flows or pressure.

ASR projects may be able to provide a number of benefits for the LWC Planning Area, including: (1) decreasing the intensity of ground water pumping from the shallow aquifer system during the peak-use dry season and potentially mitigate drawdown impacts on wetlands, (2) allowing utilities to reduce treatment capacity and associated costs by using excess off-peak capacity to treat ASR water and then using the ASR water to meet peak demands, and (3) providing "new" water if increased recharge of the shallow aquifer system is induced by the operation of such a system.

Cooperative agreements with public and private water suppliers and local government appear to be a good way to evaluate the feasibility of ASR. There are two ongoing examples of local government cooperative agreements to test the feasibility of ASR in the LWC Planning Area. Collier County is currently working with the Big Cypress Basin Board to cooperatively fund an ASR project. In addition, the District has provided funding to the Lee County Regional Water Supply Authority for an ASR feasibility study in Lee County.

While there are several potential benefits to ASR projects, there are still some risks associated with uncertainty about the technical and institutional feasibility of ASR. For example, permitting of untreated surface water ASR is still a difficult and uncertain process. In view of the potential risks and benefits of ASR for the LWC Planning Area, this plan makes a number of recommendations to reduce the uncertainty involved in planning ASR projects.

Data in Chapter V of the Background Document indicate that the additional capital and operating costs per thousand gallons recovered for the ASR system operation would be $.23 to $.27 per thousand gallons when the water recovered in a year is 100 times the daily recovery capacity. These costs may not fully account for the surface facilities (piping, storage, chlorination, etc.) that utilities might incur. Other available data indicate that "typical unit costs for water utility ASR systems now in operation tend to range from $200,000 to $600,000 per MGD of recovery capacity" (CH2M Hill, 1993, p. 6-15). At the same annual recovery rate used above (100 times the daily recovery capacity) the costs per thousand gallons recovered

would be $.30 to $.70 per thousand gallons. Treatment system cost savings could more than offset the injection and recovery costs but are situation specific. The programs proposed below to further evaluate this option are expected to cost the District $3 million over the next five years.

Recommendations:

(5) The District should continue to work with public and private water suppliers and local governments in identifying additional sites for ASR projects. The District should continue to provide funding to support additional ASR facilities in the planning area.

(6) The District should actively work with the Florida Department of Environmental Protection (FDEP) regarding Florida Underground Injection Control (UIC) regulations to address the concepts of ASR in Florida laws.

(7) The District should determine areas within the region where canal flow into estuaries can be reduced and stored underground for eventual use.

(8) The District should prepare criteria for implementing ASR within the Floridan Aquifer System.

Future Governing Board Considerations:

- Local government cooperative agreement execution.
- Budgetary process for research funding and support for ASR facilities, either District operated or cooperatively developed, within the planning area.
- Rule development/adoption regarding criteria for ASR development of the Floridan Aquifer.
- Potential rule development/adoption concerning artificial injection/ recharge.
- Potential interagency agreements with the Department of Environmental Protection concerning matters such as the permitting and operation of ASR projects.

Reclaimed Water

Reclaimed water is a significant potential source of water for the LWC Planning Area. Discharges from wastewater treatment plants in the planning area are anticipated to rise from 43 MGD in 1990 to approximately 147 MGD in 2010. Potential uses of reclaimed water include landscape and agricultural irrigation, ground water recharge, industrial uses, environmental enhancement, and fire protection. Approximately 45 percent of the total wastewater discharge in 1990 was directed to reuse.

Although reclaimed water is a significant source of water for the LWC Planning Area, the model simulations showed a relatively small improvement in meeting resource protection criteria for wetlands and aquifer protection when the reclaimed water supply was fully utilized. Modeling results suggest that reclaimed water could probably be more effective in preventing seawater intrusion; however, the scale of the ground water models used for this plan could not provide detailed information about

the use of reclaimed water for mitigation of seawater intrusion. Nevertheless, increased use of reclaimed water appeared to be very effective in reducing seawater intrusion according to the modeling simulations.

Requiring 100 percent reuse as specified in the recommendation below would impact only those wastewater systems which would not be achieving this goal without the implementation of this plan. A review of the wastewater utility capsules presented in Appendix E and related data indicates that, with a few exceptions, the existing disposal plans of wastewater utilities in the LWC Planning Area include reuse sufficient to achieve the 100 percent reuse goal. Region-wide the use may fall short of the goal by approximately 25 MGD of the estimated target of 122 MGD. Adoption of a new rule for reclaimed water would help assure that the present plans are implemented.

The additional disposal costs to assure reuse of the 25 MGD apparently not included in present plans will depend on which options may be available to particular wastewater utilities. Options which may be expanded to accommodate the use of the remaining targeted wastewater may include transmission to other areas where there is a deficit of reclaimed water, the use of percolation ponds, especially in locations where well fields may benefit from the ground water recharge, and additional residential reuse. If a regional wastewater distribution system is needed, the lead could be taken by a regional water supply authority for the county. Based on a review of planning level cost studies (including Lee County Regional Water Supply Authority, 1993 and Boyle Engineering, 1992), the costs of implementing such systems may vary from around $1.15 to $1.60 per thousand gallons which would make the cost of the additional reuse on an annual basis about $10.5 to $14.5 million.

Recommendation:

(9) The District should initiate the rule development process for new water use rules that accelerate the use of reclaimed water in the LWC Planning Area.

Future Governing Board Considerations:

- Rule development/adoption concerning reuse criteria as detailed in the recommendation.

Surface Water Resources

Surface water bodies in the LWC Planning Area include lakes, rivers, and canals which provide storage and conveyance of surface water. Lake Trafford and Lake Hicpochee are the two largest lakes within the planning area, but neither lake is considered a good source of water supply.

The Caloosahatchee River is the most important source of surface water in the region. The river is supplied by inflows from Lake Okeechobee and runoff from within its own basin. The freshwater portion of the river (C-43) extends eastward from the Franklin Lock and Dam (S-79) towards Lake Okeechobee and the cities of La Belle and Moore Haven. West of S-79, the river mixes freely with estuarine water as it empties into the Gulf of Mexico. The Caloosahatchee River may be able to yield additional water to augment water supplies during the wet season by reducing wet season discharge to the ocean. The feasibility of developing a seasonal water supply from the Caloosahatchee River depends upon the nature and extent of potential

environmental impacts as well as the availability of a suitable storage facility. Aquifer storage and recovery technology appears to be the most likely storage option.

The remaining rivers and canals in the LWC Planning Area drain either into the Caloosahatchee River or the Gulf of Mexico. The majority of canals were constructed as surface water drainage systems rather than for water supply purposes. The C-43 Canal is the only major canal used for water supply and it is maintained by releases from Lake Okeechobee on a schedule operated by the U.S. Army Corps of Engineers.

The Lee County Department of Natural Resources completed work on the Lee County Surface Water Management Master Plan, but it has not yet been adopted by the Board of County Commissioners. This plan includes recommendations to help increase water supply of the 49 basins within Lee County. Lee County has created the Lee County Storm Water Utility to implement the recommendations in the master plan. There has also been a proposal to the county for retrofitting structures within the Lehigh Acres area to increase the water levels within this area during the dry season.

As of 1992 the costs of capital improvement for 30 of the Lee County basins had been estimated and totaled $67.5 million (Johnson Engineering, 1990-92; Johnson Engineering *et al.*, 1990-91). The programs proposed below to cooperatively further evaluate the feasibility of using the Caloosahatchee River as a seasonal source of supply are expected to cost the District $300,000 over the next five years.

Recommendations:

(10) The District should enter into a cooperative agreement with the Lee County Regional Water Supply Authority to explore the feasibility of using the Caloosahatchee River as a source of supply, perhaps in conjunction with ASR technology.

(11) The District should coordinate with the Lee County Department of Natural Resources to assist adoption of the current Lee County Surface Water Management Master Plan by the Lee County Board of Commissioners. The District should also continue to cooperate with Lee County in identifying other potentially beneficial improvements and water management strategies for Lee County in the future.

(12) Lee County should adopt a dedicated funding source for the Lee County Storm Water Utility.

Future Governing Board Considerations:

- Execution of cooperative agreements.

Use Water More Efficiently

Urban and Agricultural Water Conservation

There are opportunities to use water more efficiently, primarily by increased urban and agricultural conservation. Increases in water use efficiency due to conservation will not be sufficient to supply the increased demands for future growth, nor will they be sufficient to provide the level of environmental protection that is

advocated under this plan. Although conservation will only be one part of the solution to future water supply, its portion is important.

Results from alternative modeling scenario 2 as described in Chapter II of this document indicate that increasing agriculture irrigation efficiency would have a positive effect on wetland protection. When the irrigation efficiency of small vegetables alone was improved (scenario 2a) there was a 7 percent reduction in area of wetlands that had not met the wetland protection criterion compared to the 2010 base case. When the irrigation efficiency of citrus alone (scenario 2b) was increased there was only a 1 percent reduction in wetland problem areas. When irrigation efficiency for citrus and vegetables was increased (scenario 2c) the models indicated that an 8 percent reduction in wetland problem areas compared to the 2010 base case. While this reduction is not dramatic it does indicate that additional benefit can be realized by increasing the existing irrigation efficiency of agriculture, particularly vegetables.

Recommendations:

(13) The District should continue to require water conservation plans for public and private water suppliers, commercial and industrial water use, and irrigation of landscape and golf courses. These plans should at least contain the current (January 1993) mandatory water conservation elements.

(14) The District should explore the rule development process for new water use rules that promote increasing irrigation efficiency for vegetable fields in the Lower West Coast region.

Future Governing Board Considerations:

- Governing Board consideration of cooperative agreements
- District budgetary process for research programs including aquifer monitoring and the relationship between water use, vegetable production rates and economic impacts.
- Rule development/adoption for increased irrigation efficiencies.

Inefficient Water Use Practices

In several areas of the LWC Planning Area (particularly in the "Four Corners" area where Hendry, Lee, Glades, and Charlotte counties meet) there are a number of domestic wells which, due to their design, are occasionally impaired by large agricultural withdrawals which cause regional water level declines. Until these inefficient small domestic facilities are enhanced, it is not possible to maximize reasonable-beneficial use in the area. Historically, the District has required the large users in the area to mitigate these impacts by installing efficient withdrawal facilities for the domestic users in the impaired area. The District has also worked with local governments to require changes in well construction rules. Until all users have maximized their efficiency, development of water resources in these areas will effectively be "held hostage." This situation is in conflict with State water policy.

Recommendation:

(15) The District should explore rulemaking and funding options to address mitigation of impacts by large urban and agricultural users caused by regional water level declines on inefficient domestic withdrawal facilities.

Future Governing Board Considerations:

- Rule development/adoption concerning mitigation criteria for inefficient facilities addressing such issues as funding for domestic well replacement, minimum levels for aquifer development for all use types, linkage to water shortage restrictions, timing of well replacement and minimum facility type.

- Potential District budgetary process.

- Potential Local Government cooperative agreements.

A map of suggested depths for domestic wells tapping the Sandstone aquifer in the region is found in Appendix L.

Drainage Management

Changing drainage management practices may be an efficient way to mitigate impacts to wetlands. The modeling analysis indicates that modifying water levels in existing drainage canals and eliminating unnecessary canals can significantly elevate ground water levels beneath wetlands. Lee and Collier counties have undertaken extensive studies of their surface water systems, resulting in recommendations to alter the current management practices and structures.

The information used to simulate these water levels for Collier County was derived from one of the drainage management projects proposed by the Big Cypress Basin for the area around Golden Gates Estates South in west central Collier County. Additional specific drainage management projects for the Big Cypress Basin are outlined in their five-year capital improvements plan for fiscal years 1994 through 1998.

A conceptual need has been identified to place water control structures on the Lee and Collier county portions of the Corkscrew canal system. The purpose of these structures is to prevent excessive drainage of the Bird Rookery Swamp portion of the CREW project.

The most recent five year capital improvement plan for the Big Cypress Basin includes about $5.3 million to implement improved drainage management in the Basin. The program proposed below to further evaluate water control structures in the Corkscrew canal system is expected to cost the District $800,000 over the next five years.

Recommendation:

(16) The District should explore the drainage management plans proposed by the Big Cypress Basin for the Golden Gate Estates South area in west central Collier County and conduct preliminary studies and conceptual design for water control structures in the Corkscrew canal system.

Future Governing Board Considerations:

- District budgetary processes.
- District studies concerning design of water control structures.

Coordination with Public and Private Water Suppliers and Local Governments

The District can help accomplish water resource management objectives with a program of cooperative agreements and cost-sharing projects with public and private water suppliers and local governments.

The Lee County Regional Water Supply Authority (RWSA) was created in 1990 and charged with identifying future urban water demands and sources. The RWSA includes representatives of Lee County, Fort Myers, Sanibel and Cape Coral utility departments. The RWSA contracted with a consultant to produce a long-range water supply plan for urban water users and utilities. The plan is near completion and will include recommendations for future supply sources, interconnects, and delivery systems through the year 2030.

Lee County's long-range water supply plan is expected to provide an approach to regional urban water supply planning that is more integrated than could be accomplished by the individual plans of the separate water suppliers in the county. Greater efficiency and utilization of both existing and planned facilities is possible with regional planning. The RWSA may enable public and private water suppliers and local governments and water suppliers to attain greater economies of scale by pooling their resources for the exploration of new water sources or the enhancement of existing infrastructure. For example, the RWSA is analyzing the efficacy of potable water system interconnects. Interconnection of water delivery systems does not augment existing supplies, but it may enhance flexibility for utility operators. Some of the recommendations anticipated to be included in the RWSA plan would be difficult to implement without the existence of the RWSA. The potential benefits of integrated urban water supply planning are significant enough that Collier County may want to consider exploring the creation of a regional water supply authority as well.

The "Draft Water Supply Master Plan 1993 - 2030" (Lee County Regional Water Supply Authority, 1993, Vol. 1, Table 4.4-1) projects revenue needs for fiscal years 1994 to 1998 to total $61.2 million. This will cover administration, planning/testing, engineering/permitting, legal/land acquisition, construction and debt service. As is indicated below, specific projects in which the District may choose to financially participate have not been identified. Based on the cost of about $750,000 which the District has expended in support of the Lee County Regional Water Supply Authority, a similar amount could be required to encourage the consideration of a similar regional authority in Collier County over the next five years.

Recommendations:

(17) The District should identify specific projects and develop cost-sharing partnerships with public and private utilities and local governments to implement this plan during fiscal years 1994-95 through 1997-98.

(18) The District should encourage urban water suppliers in Collier County to explore the possibility of forming a regional water supply authority.

Future Governing Board Considerations:

- District budgetary processes, particularly for the purpose of cooperatively funding specific RWSA and local government projects.

Modify Planning and Regulatory Strategies to Protect Water Resources and the Environment

Outstanding Natural Systems

Environmental protection and enhancement are key elements of the District's mission and one of the most significant issues of the LWC Water Supply Plan. A special working group of the Advisory Committee designated certain lands within the LWC Planning Area as Outstanding Natural Systems (ONS). A map of the ONS lands in the LWC Planning Area is shown in Figure 21.

ONS lands include both publicly and privately owned lands. Most of the lands within the ONS areas are relatively pristine and undeveloped. Environmentally sensitive land management practices have been in place for many of the privately owned ONS lands. The ONS lands as a whole appear to offer the greatest opportunity for preserving ecological integrity and biological diversity because they contain a wide variety of plant and animal species and communities. Environmental scientists generally recognize that these communities do not exist in isolated habitats, but rather they operate as components of the larger natural ecosystem. Efforts to protect the ecosystem as a whole also serve to protect the individual species inhabiting the ecosystem. Such efforts might be characterized as an ecosystems approach to environmental protection. Development of the ONS lands concept is one of the most significant results of this plan.

Three strategies have been identified to implement the ONS lands concept. The ONS map will serve as a planning tool in guiding compatible land uses in and adjacent to ONS Lands. The ONS lands will also be used to target research on the relationship between ground water withdrawals and wetland impacts. Finally, the ONS map will be used to identify regional off-site mitigation areas. These implementation strategies form the basis of the recommendations related to ONS.

Recommendations:

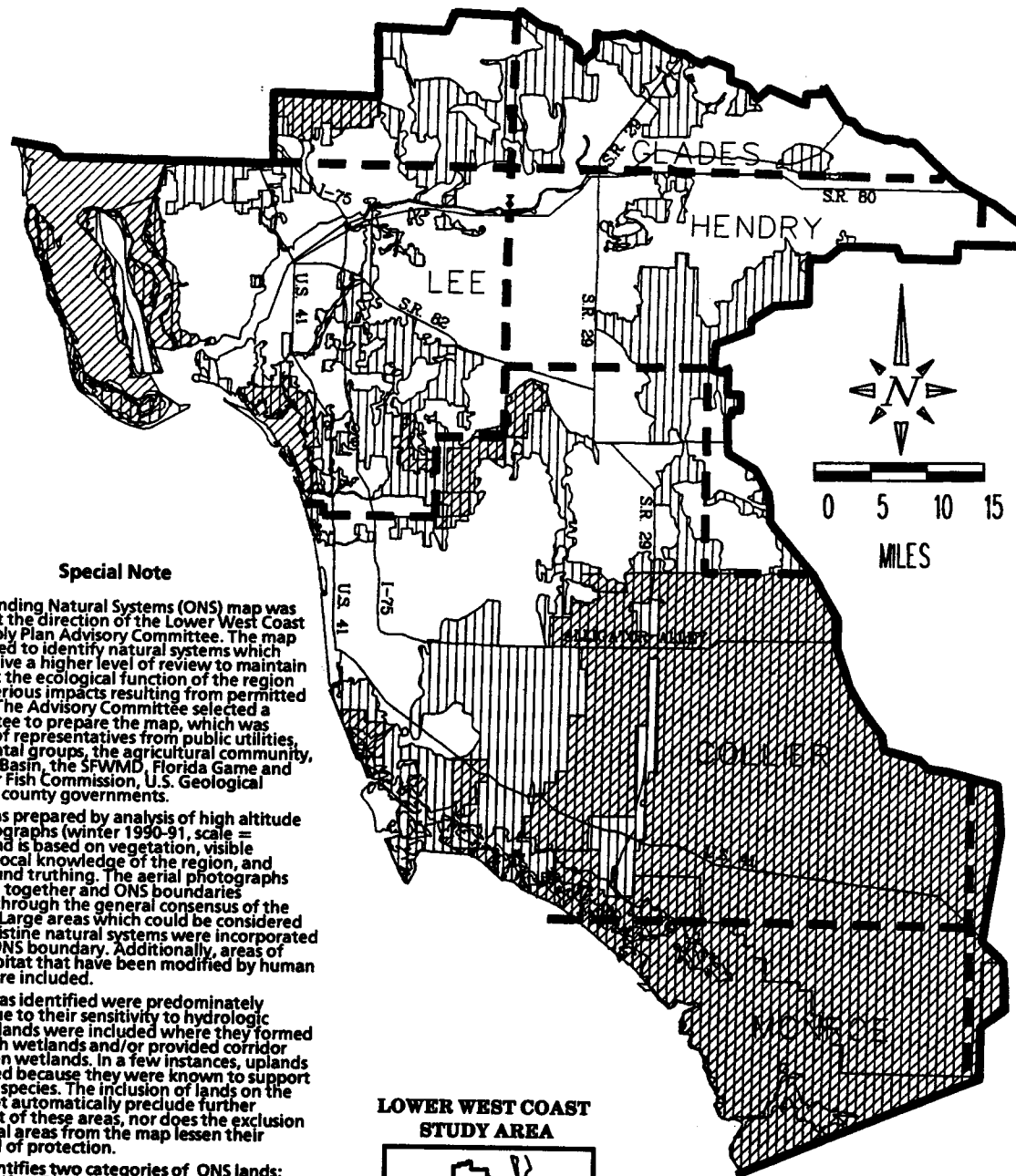
(19) The District should encourage the incorporation of the ONS lands concept into state, regional, and local planning efforts recognizing the distinctions between ONSe and ONSm as described in this plan.

(20) The ONS map should be used to target the District's research program on the impacts of consumptive uses on wetlands.

(21) The ONS map should be used to identify regional off-site mitigation areas.

Future Governing Board Considerations:

- Comments on Local Government Comprehensive Plans in addition to other state plans.



Special Note

The Outstanding Natural Systems (ONS) map was prepared at the direction of the Lower West Coast Water Supply Plan Advisory Committee. The map was prepared to identify natural systems which should receive a higher level of review to maintain and protect the ecological function of the region from deleterious impacts resulting from permitted water use. The Advisory Committee selected a subcommittee to prepare the map, which was composed of representatives from public utilities, environmental groups, the agricultural community, Big Cypress Basin, the SFWMD, Florida Game and Fresh Water Fish Commission, U.S. Geological Survey, and county governments.

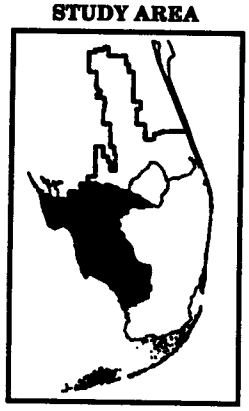
The map was prepared by analysis of high altitude aerial photographs (winter 1990-91, scale = 1:40,000) and is based on vegetation, visible hydrology, local knowledge of the region, and limited ground truthing. The aerial photographs were pieced together and ONS boundaries delineated through the general consensus of the committee. Large areas which could be considered relatively pristine natural systems were incorporated within the ONS boundary. Additionally, areas of valuable habitat that have been modified by human activities were included.

The ONS areas identified were predominately wetlands, due to their sensitivity to hydrologic changes. Uplands were included where they formed a mosaic with wetlands and/or provided corridor links between wetlands. In a few instances, uplands were included because they were known to support endangered species. The inclusion of lands on the map does not automatically preclude further development of these areas, nor does the exclusion of any natural areas from the map lessen their existing level of protection.

The map identifies two categories of ONS lands: ONSe and ONSm. The ONSe lands are areas that have been purchased for environmental preservation/conservation purposes. The ONSm lands are natural systems that are used for multiple purposes (i.e., agriculture, residential, water supply, surface water management, etc.). Many of the ONSm lands are native range or improved pasture and their designation is not intended to impact present uses and management practices.

Due to the scale of the map and inherent limitations of using aerial photographs, developed and agricultural lands exist within the ONS boundary. In addition, certain natural areas that have significant ecological value lie outside the ONS boundary. Consequently, the ONS boundary is very general and is intended only to be used to identify the regionally significant natural systems for water supply planning purposes.

LOWER WEST COAST STUDY AREA



LEGEND

ONSe-LANDS PURCHASED FOR ENVIRONMENTAL CONSERVATION/PRESERVATION PURPOSES

ONSm-NATURAL SYSTEMS CURRENTLY USED FOR MULTIPLE PURPOSES

composition name: ons.8x11.3.grn	
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Planning Dept.	Div. 905

FIGURE 21. Outstanding Natural Systems in the LWC Planning Area.

- District budgetary processes, particularly for funding research in stated areas.

- Rule development/adoption concerning mitigation banking areas and their usage in water use contexts.

Water Source Reservation

Ground water modeling results suggest that there is a potential for increased competition for water resources in the future. Most of the future competition for water in the LWC Planning Area will be for water in the shallow aquifers, because this water is the least costly to develop and generally has the highest quality. There will be less competition for new and alternative sources of water such as the Floridan Aquifer and reclaimed water.

The development of new and alternative sources of water will help to lessen future competition; however, not all water users will be able to use these sources, because of higher water costs or lower water quality. Other water users will be able to use the new and alternative sources, but will not use them while conventional sources remain available. The sharply increased potential for water use competition in the future suggests that it would be prudent for the District to explore modification of its rules for water use permitting to achieve the following objectives:

(1) Maximize reasonable-beneficial use of water resources.

(2) Lessen the amount of competition among water users.

(3) Provide water users with additional information to plan for resolution of potential problems caused by competition with other water users.

(4) Promote use of the lowest quality water available and suitable for an intended use.

(5) Resolution of competition situations.

The District currently has limited rules which guide decision-making for water use permits when there is competition among applicants. However, competing application situations are currently resolved on a case-by-case basis. The District could achieve the objectives set forth above and promote quicker, more orderly, and more efficient development of new and alternative water sources by modifying its water use permitting rules to provide for water source reservation. Water source reservation, or "zoning," is the preferential reservation of water from one or more sources for use by one or more classes of water users when there is competition for water from that source or sources.

The concept of supply source reservation is extremely complex from multiple standpoints. Technical, legal, economic, social, and policy questions surround the District's determination in this regard. As stated in the introduction, this document is not self-executing. The District intends to initiate rulemaking proceedings to adopt criteria for implementation of many of the recommended actions, including supply source reservation. It is impossible at this early juncture to forecast the outcome of this rulemaking effort. Thus, while the plan recommends, as a starting point, specific source reservation actions, a host of related considerations must be addressed in the rulemaking effort. The purpose of this plan is to provide general guidance to initiate the source reservation and rulemaking efforts rather than to specifically direct the outcome.

Statutory authority exists for reserving sources to protect the environment as well as to maximize reasonable-beneficial use or to resolve competition among human users. The State Water Use Plan (Section 373.036), the Reasonable-Beneficial test and Public Interest tests (sections 373.223 and 373.233) and the "Model Water Code" all provide insight into this concept.

It is important to note that it is the intent of the District to protect the public interest, particularly the existing infrastructure associated with public water supply sources. The source reservation concept is expected to be applied when future increases in demand trigger a competition between user classes. User classes are defined here as urban, agricultural, and environmental. Competition can also occur within a user class, such as potable water demands competing with landscape irrigation demands.

Prior to making a determination that competition between users will occur and that preference shall be granted to a user or class of users, several resource management steps must be exhausted. First, the efficiency of users should be maximized, unless overridden by other considerations. Secondly, the feasibility of using other sources must be explored, especially sources with the lowest quality of water available for the intended purpose. Examples of different sources include deeper aquifers, ASR technology, management of water levels through public works, interconnects, and the application of reclaimed water. If new sources are developed and the potential for competition still exists, especially between the environment and human uses, then opportunities for mitigation must be explored. If all of these actions fail to ameliorate the competition, resulting in potential harm to the resource or an existing legal user, then the allocation must be reduced or denied.

The source reservation concept is intended to be a mechanism to help avoid the reduction or denial of water allocations by providing prior notice to all users that certain users will have preferred access to certain sources within defined areas. This information would help other users to more successfully plan and implement long term water resource development strategies.

The current vision of the source reservation concept does not preclude non-preferred users from access to the reserved water source in question. However, it is expected that if a user does not have preference for that source, that user will encounter increased risk. This risk could occur in the form of shorter term permits, earlier cutbacks during water shortages, additional permit conditions and increased potential for denial of requests for expanding the allocation.

As part of the rulemaking process, District staff will develop an analysis of where competition is likely to occur in the future using hydrologic modeling and land use information. Once competition areas are identified, staff will analyze and propose, through rulemaking, resource related criteria to determine which use class is entitled to preference in each geographic area of expected competition. In this manner, uses which best serve the public interest may be identified. Possible criteria to be applied in this analysis include:

- applying resource protection criteria to identify potential problem areas,
- determining possible recharge benefits of use,
- enhancement of water resources in the area because of the nature of the activity or the amount of water required,

- benefits to fish and wildlife,
- protection of public investment,
- whether water is exported from the area,
- reasonableness of the purpose of the use in relation to other uses,
- economic values of use,
- social values of use (public interest test),
- extent and avoidance of harm, and
- local government planning decisions.

Upon application of the selected criteria, staff will develop maps, supporting documentation and rule proposals which identify the preferred user classes for different sources and in different locations throughout the region. Throughout this public rulemaking process, the Governing Board will have a significant level of involvement in setting policy in this area.

One type of source reservation the District may consider is reserving Surficial Aquifer water for agricultural users in preference to utilities. In such a case, the cost differentials of $.10 to $.24 per thousand gallons presented in the discussion of the costs of going to deeper aquifers would be a relevant cost comparison when utilities needing new capacity were zoned out of the surficial aquifer.

Recommendations

(22) The District should modify its rules for water use permits to provide for source reservation of the shallow aquifers for specific classes of water users in geographically specific areas where future competition among users occurs and when alternative management techniques are not appropriate.

(23) The District should begin more detailed evaluations to determine how, where, and when water source reservation can be implemented.

Future Governing Board Considerations:

- Rule development/adoption.

- Comments on Local Government Comprehensive Plans in addition to other state plans.

Mitigation Banking

The District's responsibilities for environmental protection must be continuously balanced against the agency's other responsibilities. This balancing is reflected in the District's Water Supply Policy Document which sets forth the goal of attaining maximum reasonable-beneficial use of water while simultaneously achieving environmental protection.

Inherent to the ONS concept is the recognition that not all wetlands or other natural systems have equal potential for preserving ecological integrity and biological diversity. Smaller tracts of undeveloped land, particularly those surrounded by developed lands, may have less value for long-term ecosystem preservation than larger tracts. It may not always be feasible to protect smaller

tracts of undeveloped land nestled among developed areas. Some smaller tracts may be altered under specific circumstances if other suitable lands off-site are restored and/or set aside for environmental mitigation. A regulatory program which provides for off-site environmental mitigation will accelerate the protection and enhancement of lands which have a greater value for ecosystem protection. The implementation of such a regulatory program would require: (1) a pool of lands suitable and available for off-site mitigation, and (2) specific criteria and rules governing off-site mitigation. A regulatory program incorporating these features is defined as an environmental mitigation banking program.

The District is currently working on guidelines and criteria to allow off-site mitigation of environmental impacts related to surface water management permits. However, there are currently no guidelines and criteria for allowing off-site mitigation of environmental impacts related to consumptive use permits.

Allowing mitigation of wetland impacts related to consumptive use permits could provide applicants with an economically attractive alternative when avoidance or on-site mitigation are not feasible. Mitigation costs are highly site specific and depend on the forms and amounts of mitigation required in each situation. Implementation of this recommendation will require rulemaking. A detailed economic analysis will be required in conjunction with the rulemaking.

Recommendations:

(24) The District should develop specific criteria and rules to allow withdrawals of water to cause adverse environmental impacts if suitable off-site mitigation is provided.

(25) Off-site mitigation should generally be allowed only when avoidance and minimization of adverse impacts is not feasible.

Future Governing Board Considerations:

- Rule development/adoption.
- Comments on Local Government Comprehensive Plans in addition to other state plans.
- District budgetary process to consider research, land acquisition and bank establishment.

Revisions to the District's Basis of Review for Water Use Permits

The District's current requirements for issuing water use permits are outlined in the Management of Water Use Permitting Information Manual, Volume III, which is also referred to as the "Basis of Review" (SFWMD, 1993). Current District requirements and guidelines provide different classes of water users with different levels of service for water use. Levels of service specify the amount of water allocated to a permittee, and, therefore, the frequency with which a permittee may expect to incur water shortages. Levels of service are usually, but not always, based on the calculated water needs of the permittee during a drought having some specified return frequency.

The environment is also a user of water. Wetlands "use" of water is currently protected by limiting the drawdowns caused by water use permittees during a drought in which there is no rainfall for 90 days. Thus, wetlands theoretically have a different level of service than water use permittees.

The modeling analyses for this plan were based on the assumption that all classes of water users, including wetlands, were assigned a uniform level of service based on a drought with a return frequency of one in ten years. This is reflected in the wetland protection criteria which includes limits on the severity and duration of ground water drawdowns based on a drought with a return frequency of one in ten years.

Each of the resource protection criteria used in this plan incorporates three components that characterize and limit the severity, duration, and frequency of ground water level declines. The resource protection criteria used in this plan provide a rational and consistent methodology for both water use allocations and water shortage planning. They also provide a sounder basis for protecting wetlands by explicitly limiting the three components of water level declines that potentially have adverse impacts on wetlands.

Insofar as the adoption of the resource protection criteria requires the complete elimination of violations of the criteria, there may be far-reaching economic impacts. This is indicated by the modeling results in Chapter II, which show the most successful combination of alternative modeling scenarios still was not able to eliminate all wetland problem areas. It appears that large scale changes in the sources and/or amount of use must take place in at least some areas before criteria violations would be eliminated. Implementation of this recommendation will require rulemaking. A detailed economic analysis will be required in conjunction with the rulemaking.

Recommendations:

(26) The resource protection criteria used in this plan (wetland protection, seawater intrusion protection, and general aquifer protection criteria) should be translated into rule form so that the criteria can be incorporated in the District's Basis of Review for water use permits.

(27) The District should incorporate a uniform level of service for all water use classes into its Basis of Review for water use permits.

Future Governing Board Considerations:

- Rule development/adoption.

Perform Additional Studies of Water Resources and the Environment

Impacts to Natural Systems

Much remains to be learned about the relationship between consumptive use withdrawals of water and impacts to natural systems. Both new and ongoing studies need to focus on this relationship. The recently initiated Everglades Research Plan represents a significant opportunity for understanding the effects of alterations in hydrology on natural systems. It involves field and laboratory experiments to determine the biogeochemical and hydrologic parameters that cause large-scale

ecologic change in the Everglades. It is anticipated that this effort will generate results that are relevant to the LWC Planning Area.

A major challenge is to sort out the effects of alterations in hydrology from the effects of other factors. Fire frequency and soil conditions are factors that have a major influence on the way vegetation is affected by consumptive use. Surface water drainage and changes in adjacent land uses must also be considered. This situation is further complicated by the fact that different types of wetland communities may be affected differently by changes in hydrology. All of these factors must be weighed to develop sound regulatory criteria that are tailored to specific wetland community types.

A major portion of the responsibility for the two programs proposed below, to (1) develop geographically specific regulatory criteria for drawdowns under wetlands and (2) to investigate the impacts that may have already occurred, will fall on the Research Appraisal Division. This division recently received six more positions to deal with these issues district-wide. A monitoring program similar to that proposed in the third recommendation below was recently instituted by the Southwest Florida Water Management District (SWFWMD). The SWFWMD expects their program to have a first year cost of about $450,000 and annual costs of about $90,000. This is considered to be a reasonable estimate of the commitment that the third recommendation below would require to implement the plan recommendation.

Recommendations:

(28) The District should initiate a comprehensive research and monitoring program designed to better understand the relationship between consumptive use withdrawals and impacts to natural systems. The ultimate goal of this program should be to develop geographically specific regulatory criteria for drawdowns under wetlands that are tailored to specific types of wetland communities.

(29) This research and monitoring program should include an investigation of whether impacts have already occurred as a result of consumptive uses in the LWC Planning Area. A review should be conducted to identify past permitted uses that seem to have had significant potential for wetland impacts. Remote sensing data, historical wetland survey information, and field data should be analyzed in an effort to evaluate whether impacts have actually occurred. Any impacts that are documented should be evaluated with respect to the amount of drawdown and the type of vegetative community.

(30) The program should include long-term vegetative and hydrologic monitoring in areas where there is potential for future impacts to natural systems. The District already requires monitoring as a condition of certain consumptive use permits. It may be necessary to augment permit compliance data with additional monitoring data collected by the District. All monitoring data should be periodically compiled and evaluated for impacts caused by withdrawals.

Future Governing Board Considerations:

- District budgetary processes.

- Governing Board consideration of research studies.
- Rule development/adoption.

Economic Analyses

Generic cost information for a variety of water supply options is included in the Background Document of this plan; however, detailed economic analysis of water supply options for specific areas was not conducted because of the regional nature of this plan. Additional economic analyses of water supply options which conform to the recommendations of this plan would be useful to water purveyors and users and to the District in rulemaking and preparing for the next update of the plan. The program proposed below to prepare economic cost-benefit analyses of specific water supply options would cost the District an estimated $350,000.

Recommendation:

(31) Detailed economic analyses should be performed for specific water supply options that appear to be particularly effective. Cost-benefit relationships should be prepared to evaluate regional options such as reuse, exploitation of deeper aquifer systems, and major surface water management projects.

Future Governing Board Considerations:

- District budgetary processes.
- Rulemaking.
- Future Water Supply Planning Documents.

Water Shortage Triggers

More efficient management of the water resources in the LWC Planning Area can be attained if water shortage management strategies were directly tied to the permitting and allocation process. The concept of "water shortage triggers" involves monitoring local and regional water levels and identifying key water levels that would initiate, or "trigger," management actions by the SFWMD and local landowners.

The target water levels could be identified for the Lower West Coast aquifer systems using the general aquifer protection criterion levels as a guide. The District could monitor water level trends in the region using water-level measurement and telemetry systems. The local landowners could monitor water levels in their wells. As water levels fall during an extended dry period, management actions, such as pumping cutbacks, could be initiated to protect the resource. Table 1 illustrates a hypothetical example of this concept. The local landowners could be familiar with these "trigger" water levels and would be able to operate their water management systems with greater flexibility. Land owners would have advance notice of actions that would be taken in the event of a water shortage because the target water levels and proposed water shortage management actions would be included as part of their water use permits.

The SFWMD is currently working on a proposal to develop these water shortage triggers for several planning areas in the District. Unfortunately, staff has not been

able to complete this effort in time to be included in the draft of the LWC Water Supply Plan.

TABLE 1. Hypothetical Water Shortage Triggers.

Water Level (NGVD)	Water Shortage Phase	Management Action (Pumpage Reductions)
20 feet	Warning	Voluntary 15%
10 feet	Phase I	15% mandatory
Sea level	Phase 2	30% mandatory
Minus 15 feet	Phase 3	45% mandatory
Minus 25 feet	Phase 4	60% mandatory

Recommendation:

(32) Staff should continue to develop the water shortage management scheme, and when it is complete the SFWMD should enter into rulemaking to implement this protocol in the LWC Planning Area.

Future Governing Board Considerations:

- Rule Development/Adoption.
- District Budgetary Processes.
- Water Shortage Declarations.

IMPLEMENTATION STRATEGIES

The recommendations stated above are intended to be guidance to staff. They are not intended to impose any requirements upon the regulated community, local governments or the citizens of the planning region. By accepting this plan, including the recommendations explained above, the Governing Board is making a preliminary determination to pursue the courses of action set forth in the recommendations. Governing Board determinations are necessary prior to application of any one of the recommendations to affected citizens. Each recommendation is accompanied with a set of implementing steps; this demonstrates continued Governing Board involvement, review, decisions and participation in such areas as budget preparation, rulemaking and local government coordination. Moreover, these recommendations are not intended to be inflexible. For example, while acceptance of this plan will result in staff exploring the concepts stated in the recommendations, further analysis, input from interested citizens and other factors may influence the staff and/or Governing Board to alter the course set forth in this planning document. In sum, the recommendations are not self-executing and do not constitute final agency action on any of the subjects discussed. Meaningful points of entry will be provided prior to implementation of any recommendation which substantially affects the interests of any party.

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IV. SUMMARY

State Water Policy mandates that water management districts plan for future water supplies. The South Florida Water Management District began to fulfill this mandate with the publication of the District's Water Supply Policy Document in December 1991. The Water Supply Policy Document interpreted state water planning policy for application within the District, and provided direction for three other key elements needed to meet the directives of state law: (1) regional water supply plans, and, where appropriate, more localized water supply plans; (2) water supply elements of Surface Water Improvement and Management plans (SWIM plans); and (3) revisions to the District's Basis of Review for Water Use Permitting.

The Lower West Coast (LWC) Water Supply Plan is a regional water supply plan that focuses on water supply demands and constraints in the LWC Planning Area. The principal constraints on water supply in the LWC Planning Area are environmental protection, seawater intrusion, and protection of the aquifers from other adverse impacts caused by excessive ground water drawdowns.

This plan provides long-range guidance for decisions affecting water supply in the LWC Planning Area. These decisions will involve the District, utilities, agriculture, environmental interests, land developers and local governments.

PLANNING PROCESS

The process developed for this plan included five major components: (1) development of goals, directives, and policies, (2) data collection and review, (3) analysis and modeling, (4) preparation of recommendations, and (5) public participation and comment.

Three principles influenced the plan's preparation and outcome:

- **The plan is regional and not site-specific.** The plan looks at demands and potential impacts in the region as a whole rather than distinguishing and addressing localized problem areas within the planning area. The plan does not make specific recommendations for individual permittees or localized problem areas, but rather provides regional recommendations.

- **The plan must be oriented towards the LWC Planning Area and its people.** The data and information are specific to the LWC Planning Area. Population, geologic, meteorologic, and demand information from the LWC Planning Area were used in this plan. The LWC Water Supply Plan Advisory Committee was comprised of 49 people from the LWC Planning Area representing environmental, agricultural, utility and local government interests. The committee influenced the direction and content of the plan.

- **The plan is dynamic and ongoing.** The plan is a "snapshot" representing the current understanding of what future water demands and resulting impacts might be between now and the year 2010. It must be recognized, however, that the planning process is iterative; the plan is scheduled to be reviewed and amended every five years. As our understanding of the resources and issues change, so will the plan.

IMPLEMENTATION OF RECOMMENDATIONS

This plan presents 32 recommendations in 4 categories: (1) develop new sources of water, (2) use water more efficiently, (3) modify strategies to protect water resources and the environment, and (4) perform additional studies of water resources and the environment. The recommendations are not self implementing; they will instead be implemented by actions of the District, local governments, water suppliers, and water users. Actions by the District include regulation; research and testing; operations and construction; and cooperative funding of water supply projects with local government and water suppliers. General time frames and the responsible parties involved in implementing each of the recommendations are listed below.

Develop New Sources of Water

Deeper Aquifers

(1) The District should budget for and complete its planned drilling and testing of the Floridan Aquifer System in the LWC Planning Area by October 1, 1996.

Responsible Party: SFWMD
Time Frame: 2-3 years

(2) The District should make preliminary results of the Floridan Aquifer testing available in a timely fashion to public and private water suppliers and local governments.

Responsible Party: SFWMD
Time Frame: 1-2 years

(3) The District should conduct exploration, mapping, and testing of the Sandstone aquifer.

Responsible Party: SFWMD
Time Frame: 3-4 years

(4) The District should prepare criteria for development of the Floridan Aquifer System using RO technology.

Responsible Party: SFWMD
Time Frame: 1 year

Aquifer Storage and Recovery

(5) The District should continue to work with public and private water suppliers and local governments in identifying additional sites for ASR projects. The District should continue to provide funding to support additional ASR facilities in the planning area.

Responsible Parties: Utilities & SFWMD
Time Frame: 4-5 years

(6) The District should actively work with the Florida Department of Environmental Protection (FDEP) regarding Florida Underground Injection Control (UIC) regulations to address the concepts of ASR in Florida laws.

Responsible Parties: FDEP & SFWMD
Time Frame: 2-3 years

(7) The District should determine areas within the region where canal flow into estuaries can be reduced and stored underground for eventual use.

Responsible Party: SFWMD
Time Frame: 3-5 years

(8) The District should prepare criteria for implementing ASR within the Floridan Aquifer System.

Responsible Party: SFWMD
Time Frame: 1 year

Reclaimed Water

(9) The District should initiate the rule development process for new water use rules that accelerate the use of reclaimed water in the LWC Planning Area.

Responsible Parties: Utilities & SFWMD
Time Frame: 20 years

Surface Water Resources

(10) The District should enter into a cooperative agreement with the Lee County Regional Water Supply Authority to explore the feasibility of using the Caloosahatchee River as a source of supply, perhaps in conjunction with ASR technology.

Responsible Party: SFWMD
Time Frame: 3-4 years

(11) The District should coordinate with the Lee County Department of Natural Resources to help assist adoption of the current Lee County Surface Water Management Master Plan by the Lee County Board of Commissioners. The District should also continue to cooperate with Lee County in identifying other potentially beneficial improvements and water management strategies for Lee County in the future.

Responsible Parties: Lee County & SFWMD
Time Frame: 1-2 years

(12) Lee County should adopt a dedicated funding source for the Lee County Storm Water Utility.

Responsible Party: Lee County
Time Frame: 1 year

Use Water More Efficiently

Urban and Agricultural Water Conservation

(13) The District should continue to require water conservation plans for public and private water suppliers, commercial and industrial water use, and irrigation of landscape and golf courses. These plans should at least contain the current (January 1993) mandatory water conservation elements.

Responsible Party: SFWMD
Time Frame: Ongoing

(14) The District should explore the rule development process for new water use rules that promote increasing irrigation efficiency for vegetable fields in the Lower West Coast region.

Responsible Parties: SFWMD
Time Frame: 1 year

Inefficient Water Use Practices

(15) The District should explore rulemaking and funding options to address mitigation of impacts by large urban and agricultural users caused by regional water level declines on inefficient domestic withdrawal facilities.

Responsible Party: SFWMD
Time Frame: 1 year

Drainage Management

(16) The District should explore the drainage management plans proposed by the Big Cypress Basin for the Golden Gate Estates South area in west central Collier County and conduct preliminary studies and conceptual design for water control structures in the Corkscrew canal system.

Responsible Parties: BCBB & SFWMD
Time Frame: 5 years

Coordination with Public and Private Water Suppliers and Local Governments

(17) The District should identify specific projects and develop cost-sharing partnerships with public and private utilities and local governments to implement this plan during fiscal years 1994-95 through 1997-98.

Responsible Parties: Utilities & SFWMD
Time Frame: 3 years

(18) The District should encourage urban water suppliers in Collier County to explore the possibility of forming a regional water supply authority.

Responsible Parties: Collier County, Collier County Utilities, City of Naples, and SFWMD
Time Frame: 1-2 years

Modify Planning and Regulatory Strategies to Protect Water Resources and the Environment

Outstanding Natural Systems

(19) The District should encourage the incorporation of the ONS lands concept into state, regional, and local planning efforts recognizing the distinctions between ONSe and ONSm as described in this plan.

Responsible Party: SFWMD
Time Frame: 1 year

(20) The ONS map should be used to target the District's research program on the impacts of consumptive uses on wetlands.

Responsible Party: SFWMD
Time Frame: 5 years

(21) The ONS map should be used to identify regional off-site mitigation areas.

Responsible Party: SFWMD
Time Frame: 1 year

Water Source Reservation

(22) The District should modify its rules for water use permits to provide for source reservation of the shallow aquifers for specific classes of water users in geographically specific areas where future competition among users occurs and when alternative management techniques are not appropriate.

Responsible Party: SFWMD
Time Frame: 1 year

(23) The District should begin more detailed evaluations to determine how, where, and when water source reservation can be implemented.

Responsible Party: SFWMD
Time Frame: 1 year

Mitigation Banking

(24) The District should develop specific criteria and rules to allow withdrawals of water to cause adverse environmental impacts if suitable off-site mitigation is provided.

Responsible Party: SFWMD
Time Frame: 1 year

(25) Off-site mitigation should generally be allowed only when avoidance and minimization of adverse impacts is not feasible.

Responsible Party: SFWMD
Time Frame: 2 years

Revisions to the District's Basis of Review for Water Use Permits

(26) The resource protection criteria used in this plan (wetland protection, seawater intrusion protection, and general aquifer protection criteria) should be translated into rule form so that the criteria can be incorporated in the District's Basis of Review for water use permits.

Responsible Party: SFWMD
Time Frame: 1 year

(27) The District should incorporate a uniform level of service for all water use classes into its Basis of Review for water use permits.

Responsible Party: SFWMD
Time Frame: 1 year

Perform Additional Studies of Water Resources and the Environment

Impacts to Natural Systems

(28) The District should initiate a comprehensive research and monitoring program designed to better understand the relationship between consumptive use withdrawals and impacts to natural systems. The ultimate goal of this program should be to develop geographically specific regulatory criteria for drawdowns under wetlands that are tailored to specific types of wetland communities.

Responsible Party: SFWMD
Time Frame: 10 years

(29) This research and monitoring program should include an investigation of whether impacts have already occurred as a result of consumptive uses in the LWC Planning Area. A review should be conducted to identify past permitted uses that seem to have had significant potential for wetland impacts. Remote sensing data, historical wetland survey information, and field data should be analyzed in an effort to evaluate whether impacts have actually occurred. Any impacts that are documented should be evaluated with respect to the amount of drawdown and the type of vegetative community.

Responsible Party: SFWMD
Time Frame: 10 years

(30) The program should include long-term vegetative and hydrologic monitoring in areas where there is potential for future impacts to natural systems. The District already requires monitoring as a condition of certain

consumptive use permits. It may be necessary to augment permit compliance data with additional monitoring data collected by the District. All monitoring data should be periodically compiled and evaluated for impacts caused by withdrawals.

Responsible Party: SFWMD
Time Frame 10 years

Economic Analyses

(31) Detailed economic analyses should be performed for specific water supply options that appear to be particularly effective. Cost-benefit relationships should be prepared to evaluate regional options such as reuse, exploitation of deeper aquifer systems, and major surface water management projects.

Responsible Party: SFWMD
Time Frame: 1-2 years

Water Shortage Triggers

(32) Staff should continue to develop the water shortage management scheme, and when it is complete, the SFWMD should enter into rulemaking to implement this protocol in the LWC Planning Area.

Responsible Party: SFWMD
Time Frame: 1 year