TECHNICAL MEMORANDUM

AN ATLAS OF SURFACE WATER MANAGEMENT BASINS IN THE EVERGLADES: THE WATER CONSERVATION AREAS AND EVERGLADES NATIONAL PARK

by

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EXECUTIVE SUMMARY

This atlas discusses the water management facilities of the surface water management basins of the Everglades of southeastern Florida. The Everglades, as defined in this Atlas, comprises the Water Conservation Areas (WCAs) and Everglades National Park (ENP) and occupies parts of four south Florida counties: Palm Beach, Broward, Dade, and Monroe.

The primary system of levees, canals, and water control structures in the Everglades was designed and built by the U.S. Army Corps of Engineers (COE) under the Central and Southern Florida Project for Flood Control and Other Purposes (Project). The Project provides flood protection, water control, agricultural and municipal water supply and support for allied purposes to south Florida. As local sponsor, the South Florida Water Management District (District) manages the day to day operation and maintenance of most Project structures. The COE has final authority over the operation of the structures in the Project. The Project is dynamic with new structures being constructed and old structures and old water management practices being modified to meet the changing needs of southern Florida.

By text, maps, and tables of information, the Project canals and water control structures of six surface water management basins are described. The six basins considered are the WCA 1, WCA 2A, WCA 2B, WCA 3A, WCA 3B, and ENP basins. The basins have a combined area of 3,060 square miles and are served by 18 Project levees, five major Project canals, and 60 Project water control structures.

The WCAs were designed to receive excess water from the Everglades Agricultural area, to receive regulatory releases from Lake Okeechobee, to prevent waters accumulating in the Everglades from overflowing into urban and agricultural lands in coastal areas, to recharge regional groundwater, and to store water for dry season water releases to eastern Dade, Broward, and Palm Beach counties for agricultural and municipal water supply and for control of saltwater intrusion to groundwater. The WCAs are impounded by levees, with inflows and outflows regulated by water control structures. The levees were designed to contain the Standard Project Flood.

The Everglades National Park basin is a natural basin set aside to preserve a portion of the original Everglades. The ENP basin does not include significant Project works, but surface water inflows to the basin are made by way of Project water control structures and canals.

Project canals in the Everglades provide the means by which water is conveyed from one place to another for purposes of flood control, drainage, agricultural and municipal water supply, and regulatory releases from Lake Okeechobee. The Project water control structures in the Everglades regulate the flow of water into and out of the WCAs and Project canals. In general, they are used to discharge excess water from the WCAs during flooding and to maintain minimum water levels in the WCAs during periods of low natural flow. Some structures are used to supply water from

one WCA to another, or to neighboring basins in Palm Beach, Broward, and Dade counties.

A bibliography is included with the atlas. It lists publications concerning hydrology and hydraulics, water use, water quality, and land use in the EAA. For the reader unfamiliar with some of the concepts and words used in these descriptions, the Appendices contain a discussion of basic hydrologic and hydraulic concepts, and a glossary of terms.

SUMMARY INFORMATION

BASIN	PROJECT CANALS	PROJECT WATER CONTROL STRUCTURES	DESIGN LEVEL OF FLOOD PROTECTION	PRIMARY FUNCTIONS OF CANALS AND STRUCTURES
WCA 1	• L-10/L-12 BORROW CANAL (I.E., WEST PALM BEACH CANAL) • L-8 BORROW CANAL • HILLSBORO CANAL	S-5A, S-5AE, S-5AW, S-5AS, S-6, S-10A, S-10C, S-10D, S-10E, S-39, G-94A, G-94B, G-94C, G-94D	SPF[1]	•PROVIDE VIABLE WETLAND HABITAT •TO DETAIN AND STORE FLOOD AND DRAINAGE WATER DURING THE WET SEASON •TO PREVENT WATER ACCUMULATING IN THE EVERGLADES FROM OVERFLOWING INTO URBAN AND AGRICULTURAL LANDS IN EASTERN PALM BEACH COUNTY •TO SUPPLY WATER TO EASTERN PALM BEACH AND BROWARD COUNTIES •TO RECEIVE AND STORE REGULATORY RELEASES FROM LAKE OKEECHOBEE •TO PASS WATER SUPPLY RELEASES FROM LAKE OKEECHOBEE TO THE HILLSBORO CANAL BASIN
WCA 2A	•NORTH NEW RIVER CANAL	S-7, S-10A, S-10C, S-10D, S-10E, S-11A, S-11B, S-11C, S-38, S-38A, S-38B, S-39A, S-143, S-144, S-145, S-146	SPF[1]	•PROVIDE VIABLE WETLAND HABITAT •TO DETAIN AND STORE FLOOD AND DRAINAGE WATER DURING THE WET SEASON •TO PREVENT WATER ACCUMULATING IN THE EVERGLADES FROM OVERFLOWING INTO URBAN AND AGRICULTURAL LANDS IN EASTERN BROWARD COUNTY •TO SUPPLY WATER TO EASTERN BROWARD COUNTY AND WCA 2B •TO RECEIVE AND STORE REGULATORY RELEASES FROM LAKE OKEECHOBEE AND WCA 1 •TO PASS WATER SUPPLY RELEASES FROM LAKE OKEECHOBEE TO THE NORTH NEW RIVER CANAL BASIN
WCA 2B		S-124, S-141, S-144, S-145, S-146	SPF[1]	•TO PROVIDE VIABLE WETLAND HABITAT •TO RECHARGE REGIONAL GROUNDWATER (I.E., THE BISCAYNE AQUIFER) •TO SUPPLY WATER TO EASTERN BROWARD COUNTY •TO RECEIVE AND STORE REGULATORY RELEASES FROM WCA 2A •TO PREVENT WATER ACCUMULATING IN THE EVERGLADES FROM OVERFLOWING INTO URBAN AND AGRICULTURAL LANDS IN EASTERN BROWARD COUNTY
WCA 3A	•MIAMI CANAL •NORTH NEW RIVER CANAL •L-67A BORROW CANAL	S-8, S-9, S-11A, S-11B, S-11C, S-12A, S-12B, S-12C, S-12D, S-140, S-142, S-150, S-151, S-190, S-333, S-339, S-340, S-343A, S-343B, S-344, G-64, G-123, G-155, G-204, G-205, G-206	SPF[1]	•PROVIDE VIABLE WETLAND HABITAT •TO DETAIN AND STORE FLOOD AND DRAINAGE WATER DURING THE WET SEASON •TO PREVENT WATER ACCUMULATING IN THE EVERGLADES FROM OVERFLOWING INTO URBAN AND AGRICULTURAL LANDS IN EASTERN DADE CONTY •TO SUPPLY WATER TO EASTERN DADE COUNTY AND ENP •TO RECEIVE AND STORE REGULATORY RELEASES FROM LAKE OKEECHOBEE AND WCA 2A •TO PASS WATER SUPPLY RELEASES FROM LAKE OKEECHOBEE TO EASTERN DADE COUNTY AND ENP
WCA 3B	•MIAMI CANAL	S-9XS, S-30, S-31, S-32, S-32A, S-151, S-335, S-337, L-29-1	SPF[1]	•TO PROVIDE VIABLE WETLAND HABITAT •TO RECHARGE REGIONAL GROUNDWATER (I.E., THE BISCAYNE AQUIFER) •TO SUPPLY WATER TO EASTERN DADE COUNTY AND ENP •TO PASS WATER SUPPLY RELEASES FROM LAKE OKEECHOBEE AND WCA 3A TO EASTERN DADE COUNTY AND ENP •TO RECEIVE AND STORE REGULATORY RELEASES FROM WCA 3A •TO PREVENT WATER ACCUMULATING IN THE EVERGLADES FROM OVERFLOWING INTO URBAN AND AGRICULTURAL LANDS IN EASTERN DADE COUNTY
ENP	•L-67 EXTENSION BORROW CANAL	S-12A, S-12B, S-12C, S-12D, S-12E, S-12F, S18C, S-24A, S-175, S-197, S-333, S-332, S-334, PLUG IN BUTTON-WOOD CANAL, S-346, S-347	NONE	•TO SUPPLY WATER TO ENP

[1]STANDARD PROJECT FLOOD

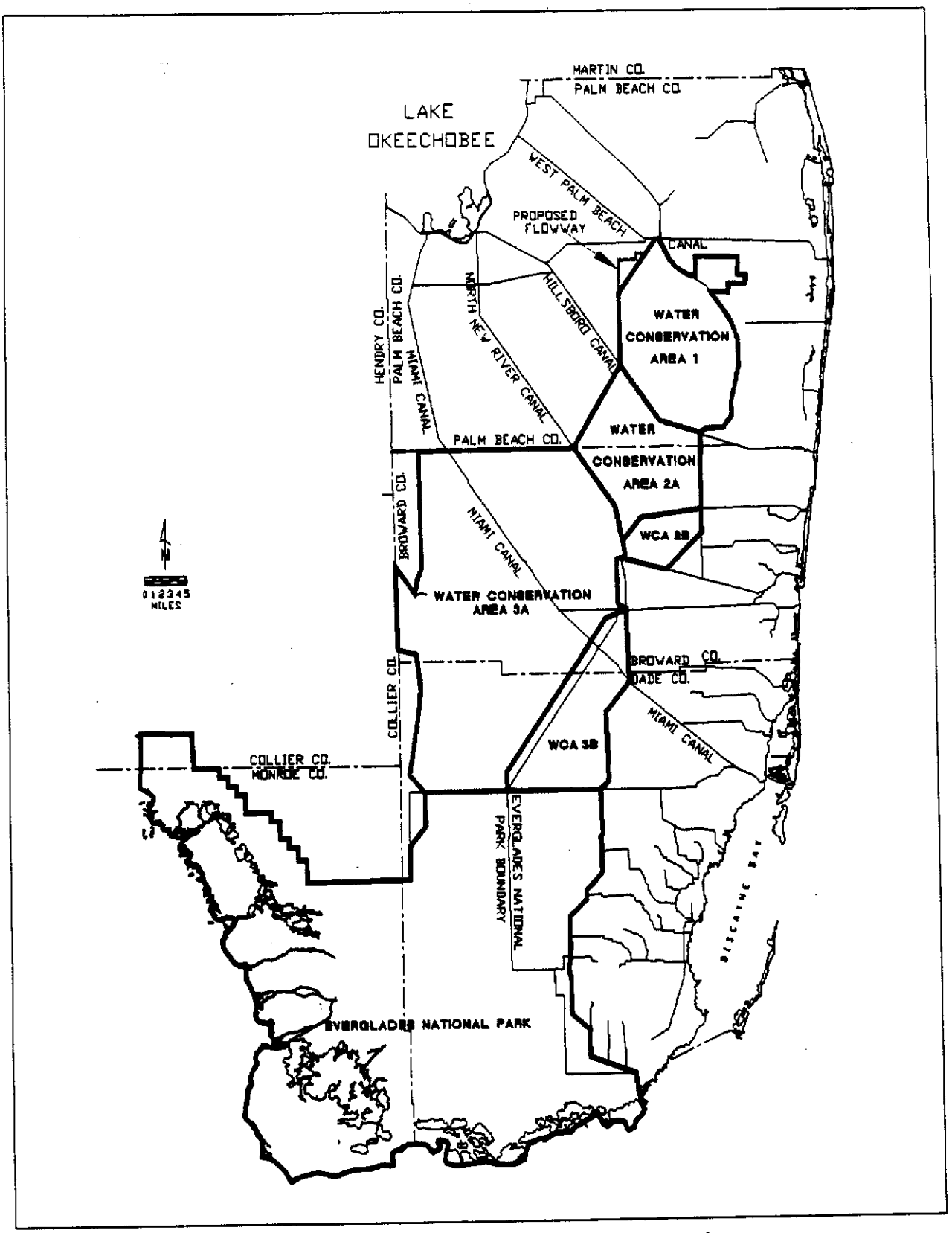

FIGURE 1. The Everglades Drainage Basins

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ABSTRACT

An atlas of the surface water management basins of the Everglades of southeastern Florida is presented. The Everglades comprise six basins: five Water Conservation Areas (WCAs), WCA 1, WCA 2A, WCA 2B, WCA 3A, WCA 3B, and the Everglades National Park basin. The canals and water control structures of the Central and Southern Florida Project for Flood Control and Other Purposes (Project) located in each basin are described and are discussed with regard to their operation and management. The basins have a combined area of 3,060 square miles and are served by 18 Project levees, five major Project canals, and 60 Project water control structures. The WCAs were designed to provide viable wetland habitat, to receive excess water from the Everglades Agricultural area, to receive regulatory releases from Lake Okeechobee, to prevent flood water accumulating in the Everglades from flooding urban and agricultural lands in eastern coastal areas, to recharge regional groundwater, and to store water for dry season water deliveries to eastern Dade, Broward, and Palm Beach counties for agricultural and municipal water supply and control of saltwater intrusion to groundwater. The WCAs are impounded by levees, with inflows and outflows regulated by water control structures. The levees were designed to contain the Standard Project Flood. Everglades National Park basin is a natural basin set aside strictly to preserve a portion of the Everglades in its natural state. Everglades National Park basin does not include significant Project works, but surface water inflows to the basin are made by way of Project water control structures and canals.

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INTRODUCTION

This atlas discusses the water management facilities of the surface water management basins of the Everglades of southeastern Florida. The Everglades, as defined in this Atlas, comprises the Water Conservation Areas (WCAs) and Everglades National Park (ENP) and occupies parts of four south Florida counties: Palm Beach, Broward, Dade, and Monroe.

The word basin usually refers to all the land area contributing runoff to a stream or canal upstream of a given point. In a highly managed and interconnected system of streams and canals, such as the Central and Southern Florida Project, a somewhat different definition is useful. For purposes of this Atlas, a basin is considered to be an area bounded by levees and roadways, and less frequently by natural ridges and high ground, where all surface water inflows and outflows from the area are managed in some way (i.e., controlled by a weir, spillway, culvert, or pump station); hence, the term "surface water management basin".

The South Florida Water Management District (District) and the U.S. Army Corps of Engineers (COE) have primary authority over water management in these basins. The primary system of levees, canals, and water control structures in the Everglades was designed and built by the COE under the Central and Southern Florida Project for Flood Control and Other Purposes (Project). The District now manages the day to day operation and maintenance of most structures in the Project and is the agency primarily responsible for permitting surface water drainage and water use in the Everglades. The COE, however, has final authority over the operation of the structures in the Project.

The surface water management basins of the Everglades and the associated Project structures were first delineated in 1951 by the COE in their Partial Definite Report, Central and Southern Florida Project for Flood Control and Other Purposes, Part 1, Agricultural and Conservation Areas (with Preliminary Information on Lake Okeechobee and Principal Outlets). Further refinements in design parameters and basin boundaries were made in subsequent general design memorandums (GDMs).

The Project is dynamic. As the population of South Florida has grown, and as land use and water demands have changed, the Project has evolved in response to these changes. Some parts of the original Project were never built and other parts have been rebuilt or modified. As the need has arisen, new water control structures, canals, and levees have been designed and constructed and new water management practices implemented. In some cases, the basins themselves have been redefined. As the COE cannot always participate in construction of new works, the District has occasionally designed and constructed additions or modifications to the Project subject to COE approval. Although many of these structures are not, strictly speaking, part of the Central and Southern Florida Project since they were not constructed by the COE, where they are owned, operated, and maintained by the District, they are included in this Atlas as Project structures. These structures will

usually be explicitly identified in the text or implicitly identified by their designations.

The District has sponsored publication of this atlas so that up to date non-technical descriptions of the surface water management basins in the Everglades are available to District personnel, to local governments or drainage districts affected by the Everglades, and to other interested persons. Text, maps, and tables of information are used to define and locate basins within the Everglades. The Project canals, levees, and control structures within each basin are described and are discussed with regard to their operation and management.

The Project canals and water control structures of six surface water management basins are described in this atlas. The six basins considered are the WCA 1, WCA 2A, WCA 2B, WCA 3A, WCA 3B, and ENP basins.

Following the basin descriptions is a bibliography of publications related to the surface water management basins in the Everglades. A variety of subjects are included: hydrology, hydraulics of canals and structures, water use, water quality, and land use. Included under hydrology and hydraulics are publications describing various statistical and mathematical models used by the District to predict rainfall, runoff, and canal flow.

Although the basin descriptions are not technical, the reader unfamiliar with the hydrology of lands within the Everglades, and with basic water resources engineering, may find some words and concepts unfamiliar. Where this is the case, the reader is referred to the Appendices. Appendix 1 is a discussion of the important concepts with which the reader should be familiar to understand the basin descriptions. Appendix 2 is a glossary of terms, abbreviations, and acronyms used in these descriptions. Also defined in the glossary are the District's designations for the various Project and District works: canals, levees, and water control structures.

Using the Basin Descriptions

The surface water management basins (hereafter, drainage basins) of the Everglades are identified in Figure 1. Map A (folded and placed in pocket of the flyleaf) is a large map showing the basin boundaries, relative to local roads and landmarks. These maps should be referenced to precisely locate basin boundaries and District and Project works within the Everglades. To reduce the size of the map required, that protion of the Everglades National Park Basin in Monroe County is not included on Map A. The plug in the Buttonwood Canal at Flamingo in ENP is the only Project structure within this area.

Each description contains three parts. The first part is a written discussion of the basin and is divided into two sections. The first section, Description of the Basin, provides a general description of the basin and its Project and District works: the drainage area; the general location of the basin within the Everglades; the purpose of and general operation of canals in the basin; the alignment of and direction of water flow in these canals; the location of inlets and outlets to the canals; and the location, purpose, and operation of structures controlling flow in the canals. The second section, **Comments on Design and Historic Operation**, provides commentary on a variety of topics related to the basin: the design storm (see **Design Storm** under **BASIC CONCEPTS**, Appendix 1); significant changes to the basin and its works (e.g., urban development or enlargement of a canal) since the GDM was written,

particularly with regard to any changes in flood protection for the basin, and proposals under consideration to redefine the basin or to modify any canals or control structures.

The second part of each basin description is a set of two maps. The first map locates the basin relative to other basins in the Everglades. The second map is a schematic drawing of the basin and its canals and control structures. It is intended that these maps should be used in conjunction with the written descriptions to understand the layout and operation of canals and structures in the basin. Major roads and landmarks are included on the schematic maps to help the reader locate the basin within the Everglades.

The third part of each basin description is a table presenting information about Project and District control structures (see **Control Structures** under **BASIC CONCEPTS**) located in the basin. The tables provide a physical description of each structure: type of structure, method of controlling water flow, and pertinent dimensions or elevations. Where a structure has been designed to pass a certain discharge under specified conditions of upstream and downstream water levels, this information is included as the design discharge, design headwater stage, and design tailwater stage, respectively. The specified discharge is generally the flood discharge expected to pass the structure for the design storm (see Design Storm under **BASIC CONCEPTS**). In some cases, however, the design discharge may refer to water passed through the structure to supply downstream users or to maintain a specified water level in a canal downstream. If a structure was designed to be used to maintain a specified upstream water level under normal non-flooding conditions, this information is included as the optimum headwater stage. Peak water levels upstream and downstream of the structures, and peak discharges through the structures, are also given for those structures where this information has been recorded. Other information about the structures may be cited as relevant.

WATER CONSERVATION AREA 1 BASIN

Description of the Basin

The Water Conservation Area 1 (WCA 1) basin has an area of 242.7 square miles and is located in south-central Palm Beach County (Figure 3). Most of the basin (i.e., that part within WCA 1) is part of Arthur R. Marshall Loxahatchee National Wildlife Refuge. The boundary of the WCA 1 basin relative to local roads and landmarks is shown on Map A. A schematic map showing the WCA 1 basin boundary, canals, and control structures is given in Figure 4.

General Function and Operation of Project Structures

WCA 1 and its associated Project structures have six primary functions: (1) to provide viable wetland habitat (i.e, the WCA is managed insofar as practicable as a natural Everglades system), (2) to detain and store flood and drainage water during the wet season for water supply during the dry season, (3) to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in Eastern Palm Beach County, (4) to receive and store releases from Lake Okeechobee, (5) to provide conveyance for water supply releases from Lake Okeechobee to the Hillsboro Canal basin, and (6) to supply water to eastern Palm Beach and Broward counties. Inflows to the WCA are from local rainfall, from the S-5A, L-8, and C-51 basins by way of S-5A and S-5AS, from the S-2 and S-6 basins by way of S-6, and from Lake Okeechobee by way of the L-10/L-12 borrow (i.e., the West Palm Beach Canal), the L-8 borrow, and the Hillsboro canals. When required by the WCA 1 regulation schedule (Figure 2 and Table 1) excess water is discharged to WCA 2A by way of the four S-10 structures, to the Hillsboro Canal by way of S-39, and to C-51 by way of S-5AS and S-5AE. The S-10 structures provide the principal means of discharging water from WCA 1. The discharges at S-39 and at S-5AS are relatively minor. Water supply to eastern Palm Beach County is by way of four sets of culverts in L-40 (G-94A, G-94B, G-94C, and G-94D) and by way of S-39.

TABLE 1. Water Conservation Area 1 Regulation Schedule

Zone	Water Management Practice
A	Regulatory releases up to the maximum discharge at the S-10 structures (and S-39 if downstream conditions permit). If the WCA water level is in Zone A on March 1, the dashed line becomes the regulation schedule. No attempt is made to draw the WCA down to 14.0 ft NGVD in these years.
B	Regulatory releases up to the maximum discharge at the S-10 structures (and S-39 if downstream conditions permit). Amount of releases to be based on a 30-day forecast and inflows to the WCA.
C	Stages in the WCA are allowed to rise into this zone if water levels have previously been drawn down to elevation 14.0 ft NGVD or below for at least 30 days.
D	Releases from the WCA for water supply only.

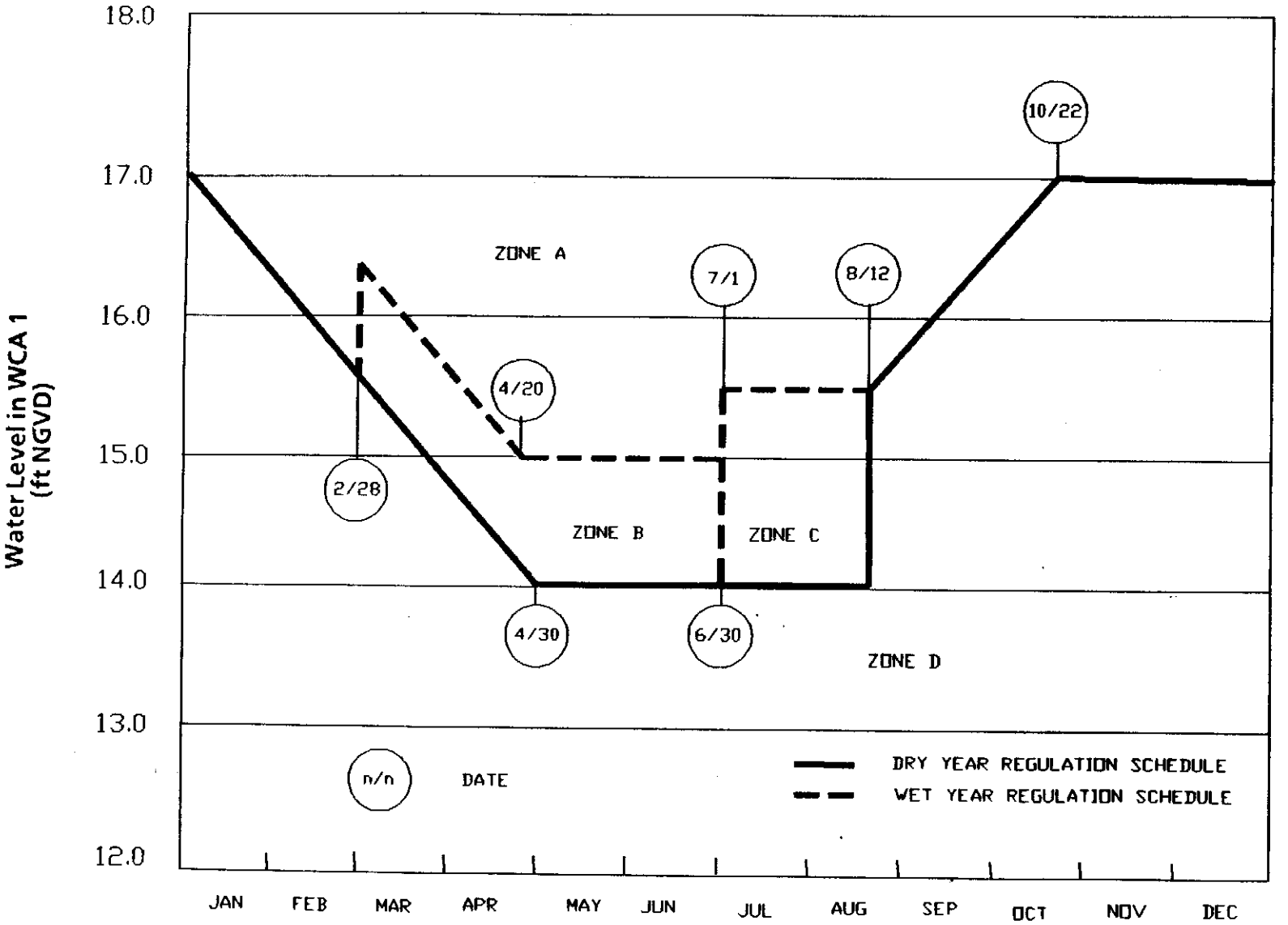

FIGURE 2. **Regulation Schedule for Water Conservation Area 1**

WCA 1 is connected to Lake Okeechobee by way of the Hillsboro Canal, the L-10/L-12 borrow canal, and the L-8 borrow canal. Releases from the lake to WCA 1 are possible by way of the L-10/L-12 borrow canal and the Hillsboro Canal, but are rare events and are only a small part of the water discharged to the WCA by way of S-6 and S-5A. Releases from the lake are made to the Hillsboro Canal by way of S-351, are passed through the S-2 and S-6 basins in the Everglades Agricultural Area (EAA), and are pumped from the canal into the WCA by way of S-6. Releases from the lake to the L-10/L-12 borrow canal are made by way of S-352, are passed through the S-5A basin in the EAA, and are pumped to WCA 1 by way of S-5A. See An Atlas of The Everglades Agricultural Area Surface Water Management Basins (Cooper, 1989) for further information on releases from Lake Okeechobee to WCA 1.

The Hillsboro Canal may be used to supply water from Lake Okeechobee to the Hillsboro Canal basin for irrigation and municipal water supply. These water supply releases are passed through WCA 1 enroute to the Hillsboro Canal basin. See An Atlas of Eastern Palm Beach County Surface Water Management Basins (Cooper and Lane, 1988) for further information concerning the Hillsboro Canal basin.

The L-8 borrow canal has been used occasionally to transfer water from WCA 1 to Lake Okeechobee. In this case, water is released to the L-8 borrow canal by way of S-5AS and is discharged to the lake by way of Culvert #10A. Since this operation depends solely on gravity discharge, the WCA water level must be higher than the lake water level.

Project Canals

The three Project canals primarily affecting water management in WCA 1 are the Hillsboro Canal, the L-10/L-12 borrow canal, and the L-8 borrow canal. All three canals connect WCA 1 to Lake Okeechobee. The L-10/L-12 borrow canal is the Project name given to the West Palm Beach Canal west of L-8. East of L-8, the West Palm Beach Canal is known by its Project name, C-51. Although the Project names for the West Palm Beach Canal are not as widely used as West Palm Beach Canal, they will be the names used here to avoid confusion as to the part of the West Palm Beach Canal being referenced.

The Hillsboro Canal connects to Lake Okeechobee by way of S-2 at the north end of the canal at South Bay west of Belle Glade. The connection to WCA 1 is by way of S-6 at the intersection of L-6 and L-7 on the west side of the WCA. From S-6, the Hillsboro Canal passes on through the WCA and provides a means of conveying water from Lake Okeechobee to the Hillsboro Canal basin in eastern Palm Beach and Broward Counties.

The L-10/L-12 borrow canal connects to Lake Okeechobee by way of S-352 at the north end of the canal at the town of Canal Point. The connection of the canal to WCA 1 is by way of S-5A at the south end of the canal at the northern most tip of the WCA. The canal also connects, at its southern end, to the L-8 borrow canal by way of S-5AW. The junction of the L-10/L-12 borrow canal to the L-8 borrow canal is about two miles east of the intersection of U.S. Highway 441 with U.S. Highway 98. The canal may be connected to the WCA by way of the L-8 borrow canal and S-5AS when S-5AW is open.

The L-8 borrow canal connects to Lake Okeechobee by way of Culvert #10A at the north end of the canal, four miles south of Port Mayaca. The connection to WCA

1 is by way of S-5AS at the south end of the borrow canal at the northern most tip of the WCA. The canal may be connected to the WCA by way of the West Palm Beach Canal and S-5A when S-5AW is opened.

Project Water Control Structures

There are 14 Project water control structures affecting water flow into and out of WCA 1. S-5A, S-5AE, S-5AS, S-5AW, and S-6 control inflows to the WCA. S-5AS, S-10A, S-10C, S-10D, S-10E, S-39, G-94A, G-94B, G-94C, and G-94D control outflows from the WCA. Design criteria for the structures in WCA 1 are given in Table 2. There are two non-Project pump stations affecting inflows and outflows to WCA 1; both are under the operation and management of the Acme Improvement District. One of the pump stations is used in conjunction with G-94D to provide both flood protection and water supply to the Acme Improvement District. The other pump station provides flood protection and discharges to WCA 1 through a non-Project culvert in L-40.

S-5A, S-5AE, S-5AS, and S-5AW are located at the northern tip of the WCA near the junction of the L10/L-12 borrow canal with the L-8 borrow canal and C-51. They are operated in conjunction with one another to control flood runoff from the S-5A, L-8, and C-51 basins and to make water supply releases for irrigation from WCA 1 to the S-5A, L-8, and C-51 basins.

S-5A is a pump station located on the south side of the L-10/L-12 borrow canal just west of S-5AW and the L-8 borrow canal. It discharges to WCA 1. The pump station has three functions: (1) to mitigate agricultural flooding by removing excess water from the S-5A basin at a maximum design rate of three-quarters of an inch of runoff per day; (2) to convey water supply from Lake Okeechobee through the L-10/L-12 borrow canal to WCA 1; and (3) to discharge, when capacity is available, flood flows from the L-8 basin and western portion of the C-51 basin to WCA 1. As a general rule, pumping is initiated whenever the stage in the West Palm Beach Canal exceeds 12.5 ft. Pumping may begin at a lower stage if flooding occurs or is imminent in the S-5A basin.

S-5AE is a gated culvert located in the L-8 Tieback Levee at the west end of C-51. The gates are closed whenever flood conditions exist downstream in C-51 (i.e., the headwater stage at G-124 in C-51 is greater than 13.0 ft NGVD, or the tailwater stage at S-5AE is greater than 13.0 ft NGVD and the headwater stage is greater than the tailwater stage). The gates are occasionally opened to discharge water from the C-51 basin to the S-5A basin if the tailwater (i.e., C-51 side) stage is greater than the headwater stage and if S-5A has capacity available in excess of the water being removed from the S-5A basin. During periods of low natural flow (i.e., when the headwater stage at S-155 in C-51 is below 8.0 ft NGVD), S-5AE is opened to supply water to the C-51 basin from Lake Okeechobee by way of Culvert #10A and the L-8 borrow canal and by way of S-352 and the L-10/L-12 borrow canal, and from WCA 1 by way of S-5AS. Depending on stages in the L-8 borrow, S-5A and S-5AW are opened to pump water out of the western end of C-51. Water supply releases are not possible under some drought conditions.

S-5AS is a gated spillway located at the junction of L-7 and L-40 at the southern end of the L-8 borrow canal. It controls flows between WCA 1 and the L-8, S-5A, and C-51 basins. Subject to availability of water in WCA 1, the gates can be opened to supply water to C-51, to the L-10/L-12 borrow canal, and to the L-8 borrow canal as necessary to meet agricultural requirements for irrigation, for municipal water

supply, and to maintain the optimum stages in the canals. The gates are occasionally opened to pass flows from the L-8 borrow canal to WCA 1 when the canal stage exceeds the stage in WCA 1; however, this is a rare occurrence. Occasionally, S-5AS has been opened to transfer water from WCA 1 to Lake Okeechobee. Water discharged by gravity flow to the L-8 borrow canal, subsequently is discharged to the lake by way of Culvert #10A.

S-5AW is a gated culvert in the west levee of L-8 at the east end of the L10/L12 borrow canal. The gates are closed whenever a flood condition exists in the S-5A basin (i.e., S-5A cannot lower the stage in the L-10 borrow canal at Canal Point below 12.5 ft NGVD). The gates can be opened, in the absence of flooding in the S-5A basin, whenever a flood condition exists in the L-8 basin or in the western portion of the C-51 basin (see S-5AE, above). The excess flow is then pumped to WCA 1 by S-5A. During periods of low natural flow, the gates can be opened to supply water, depending on the availability in the S-5A basin, to the L-8 and C-51 basins or from the L-8 basin to the S-5A basin.

S-6 is a pump station located at the point where the Hillsboro Canal enters WCA 1. As a general rule, pumping from the Hillsboro Canal to WCA 1 is initiated when the stage at any point in the Hillsboro Canal exceeds 12.5 ft NGVD. Pumping may be initiated at a lower stage if flooding occurs or is imminent in the S-6 or S-2 basins. The stage in the canal is not to be drawn down below 10.0 ft NGVD. Pumping also may be initiated upon request by the U. S. Army Corps of Engineers to water supply from Lake Okeechobee to WCA 1 by way of S-351 and the Hillsboro Canal, when the entire capacity of S-6 is not needed for removal of water from the S-2 and S-6 basins.

S-10A, S-10C, and S-10D are gated spillways located in L-39 on the southwest boundary of WCA 1 about 15 miles west of Boca Raton. The principal function of these structures is to maintain the stage in WCA 1 at its regulation schedule. These structures were designed to discharge the entire Standard Project Flood from WCA 1. Regulatory discharges through S-39 supplement the discharge through the S-10 structures and are not normally required. The three structures are maintained by the U.S. Army Corps of Engineers, but are operated by the District.

S-10E is a gated culvert located through L-39 about one-half mile southeast of S-6. This structure permits discharge of water from WCA 1 into the northern portion of WCA 2A. It is used in conjunction with S-10A, S-10C, and S-10D to maintain the stage in WCA 1 at its regulation schedule. It is normally opened before the other three S-10 structures. When S-10E cannot hold the stage in WCA 1 at its regulation schedule, the other S-10 structures are opened. This structure was built by the District and is operated by the District at the request of the U.S. Army Corps of Engineers.

S-39 is a gated spillway located in the Hillsboro Canal at the point it crosses L-40. During normal operation, the gate on S-39 is opened as required to maintain the optimum stage in the Hillsboro Canal at Deerfield Lock of 7.7 ft NGVD. When the stage in WCA 1 is over its regulation schedule the gate may be opened to discharge excess water in the WCA to tide water, by way of the Hillsboro Canal and Deerfield Lock, if two conditions are met: (1) the water is not needed in WCAs 2A or 3A and (2) there is sufficient capacity in the Hillsboro Canal (i.e., the tailwater stage does not exceed 9.0 ft NGVD).

Acme Improvement District (AID) owns and operates the two pumping stations, Pumping Station #1 (AID PS #1) and Pumping Station #2 (AID PS #2). They are located on the northeast perimeter of the WCA on L-40. AID PS #1 is used for drainage of 9.3 square miles of the AID. It has a capacity of about 230 cfs (100,000 GPM). AID PS # 2 is used for drainage of 10.3 square miles of the AID and for water supply to the AID for irrigation. For drainage, the capacity of the pumping station is about 275 cfs (120,000 GPM), and for water supply, the capacity is about 135 cfs (60,000 GPM). AID PS #1 discharges to WCA 1 through a non-Project gated culvert in L-40 and PS #2 makes its connection to WCA 1 through G-94D.

G-94A, G-94B, G-94C, and G-94D are identical gated culverts located in L-40. They are 8.3, 11.6, 15.8, and 20.1 miles, respectively, from S-39 along L-40. Structure G-94A and G-94B are used for water supply to the Lake Worth Drainage District (LWDD). G-94D is used in conjunction with an Acme Improvement District pump station (AID PS #2) to provide both water supply and flood control to the Acme Improvement District. Water may be withdrawn from WCA 1 as needed if the water level in the WCA is above 11.0 ft. When the water level is below 11.0 ft, water may be withdrawn only if releases are being made to the WCA from Lake Okeechobee.

Those culverts were constructed by the U. S. Army Corps of Engineers and are maintained by the District. AID operates G-94D under a permit from the District. G-94A and G-94B are operated by LWDD under a permit from the District. G-94A, G-94B, G-94C, and G-94D are also known as S-4, S-3, S-2, and S-1, respectively.

Comments on Design and Historic Operation

Project Design

WCA 1 is impounded by three levees: L-7, L-39, and L-40 (Figure 4). These levees were designed to hold water in WCA 1 at stages estimated to occur during the Standard Project Flood. The design was formulated assuming that the regulation schedule for the WCA would allow for continued growth of emergent vegetation. The emergent vegetation significantly reduces the wind tide and wave run-up to be expected during a major hurricane. Without the vegetation, the levees would have to be much larger than they are to provide the same flood protection.

WCA 1 Regulation Schedule

The current regulation schedule for WCA 1 is the third schedule used since completion of the WCA in 1960. The original schedule had a maximum pool elevation of 17.0 ft NGVD and a minimum pool elevation of 14.0 ft NGVD. Over the nine years that this schedule was in effect, water levels in the dry season dropped to less than 11.0 ft NGVD in most years.

To augment storage of water for water supply in the dry season, a new schedule was effected in 1969. Under the new schedule, the minimum pool elevation was increased to 15.0 ft NGVD. Over the seven years that this schedule was in effect, water levels in the dry season were held higher than 14.0 ft NGVD in most years. Under this schedule, however, large areas of marsh that had previously dried out during most dry seasons, now remained inundated most years.

It is important to the maintenance of existing plant and animal communities that the marsh dry out periodically (i.e., 30 days or more, at least once in two or three years). For this reason, in 1972, the U. S. Fish and Wildlife Service

recommended returning to a schedule that had a minimum pool elevation of 14.0 ft NGVD.

The current regulation schedule (see Figure 2), a modified version of the schedule proposed in 1972, was implemented in July 1975. The wet year regulation schedule (dashed line) is followed if the water level in the WCA exceeds the wet year regulation schedule any time between March 1 and July 1; otherwise the dry season regulation schedule (solid line) is followed. Releases from WCA 1 to the EAA may be made for irrigation purposes when water levels are above 14.0 ft. No releases are made from WCA 1 if the pool elevation falls below 11.0 ft NGVD, unless water is being passed through the WCA from another source (e.g., Lake Okeechobee).

Inflows from the EAA

The original drainage design for the Everglades Agricultural Area (EAA) called for removing excess water from the EAA to both Lake Okeechobee and the WCAs. Because of environmental problems in the lake resulting from inflows of nutrient rich water, the current District water management plan for the EAA discourages discharge of water to Lake Okeechobee. Consequently, almost all water pumped from the EAA is discharged to the WCAs. The additional water in WCA 1 allows more frequent releases to the EAA during dry periods.

The water management plan is known as the Interim Action Plan (IAP) and was originally implemented under the Lake Okeechobee Temporary Operating Permit from the Florida Department of Environmental Regulation (FDER). FDER has since granted the District permission to continue the plan under the Lake Okeechobee Operating Permit (LOOP). See An Atlas of Everglades Agricultural Area Surface Water Management Basins (Cooper, 1989) for specific information concerning the operation of structures in the EAA under the IAP.

S-10E

S-10E has only recently been added to the Project. It was built by the District at District expense. It is intended to provide environmental benefit to WCA 2A by increasing the hydroperiod of the northern part of the WCA (i.e., north of S-10D) and by providing a more natural flow path through the WCA. Previous to construction of S-10E, the northern part of the WCA dried out earlier in the dry season and stayed dry longer into the wet season than the rest of the WCA. S-10E provides the means of discharging water from WCA 1 directly into the northern part of WCA 2A. When regulatory releases are required from WCA 1 to WCA 2A, S-10E is the preferred outlet and is opened first. The other S-10 structures are opened when S-10 E is not able to pass the regulatory discharge at the required rate. It should be noted that the discharge capacity of S-10E is small compared to the other S-10 structures. It's function is strictly environmental enhancement, and it is not intended to supply significant regulatory discharge from WCA 1.

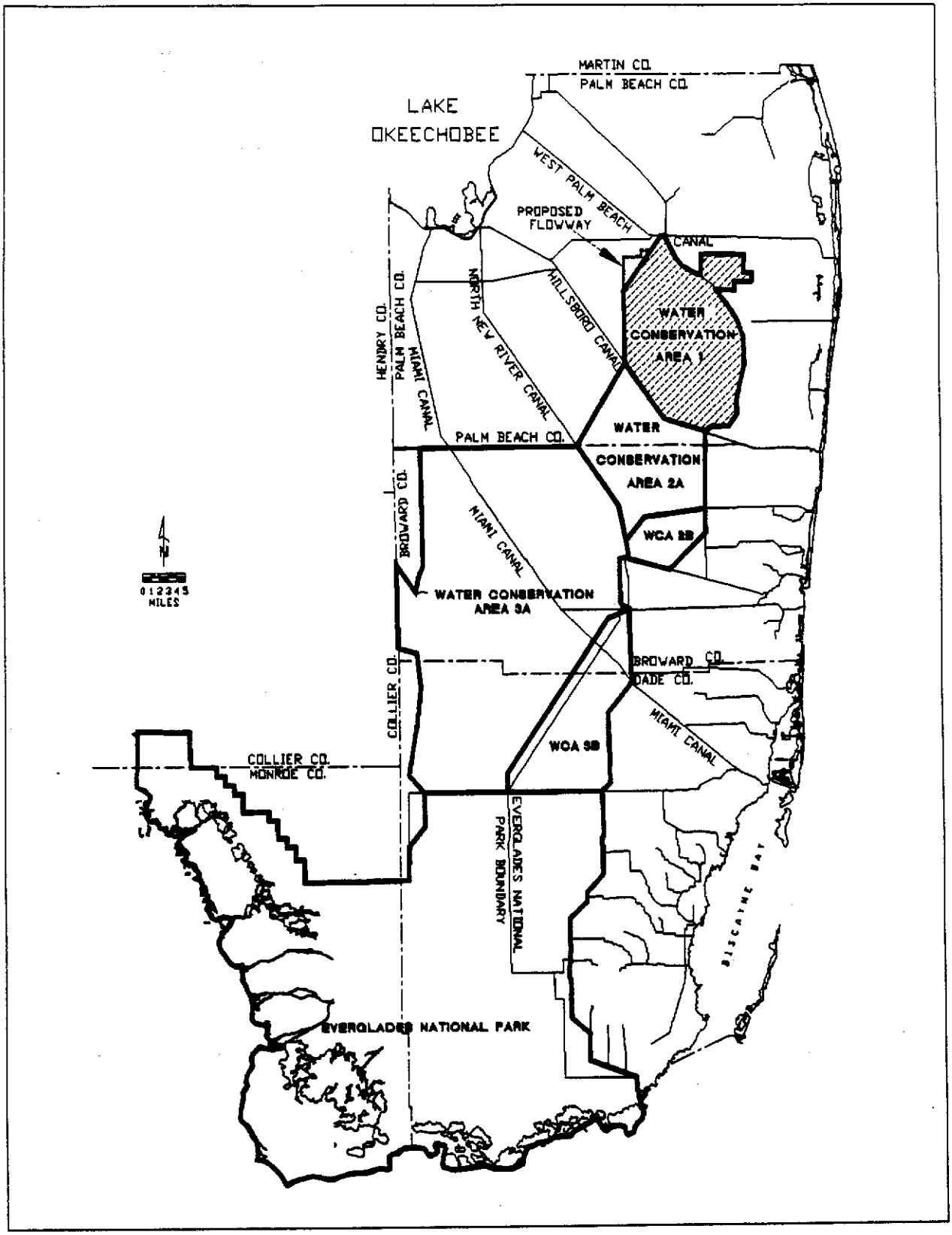

FIGURE 3. Water Conservation Area 1 Basin Location Map

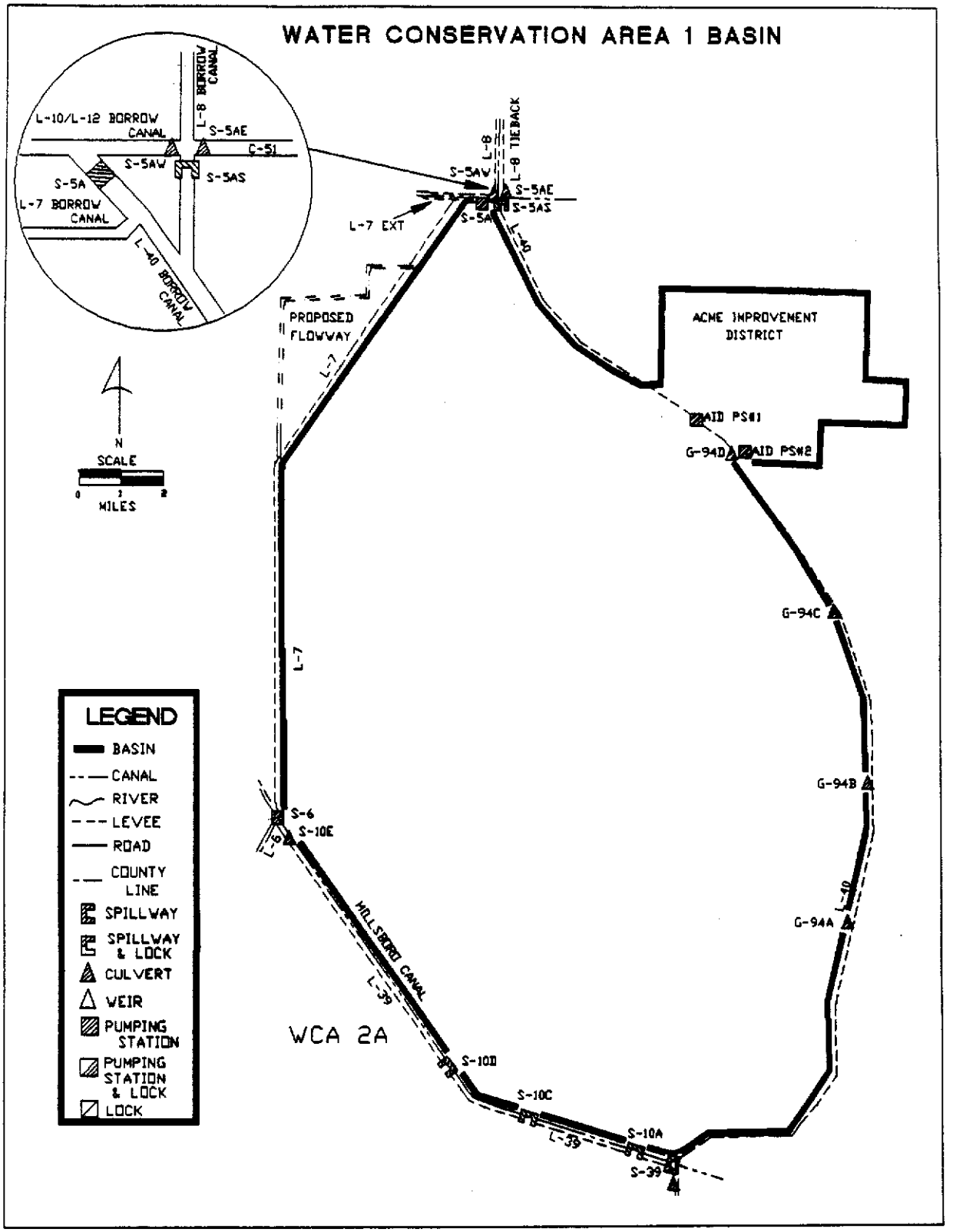

FIGURE 4. **Water Conservation Area 1 Basin Map**

TABLE 2. Water Conservation Area 1 Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Dsicharge (cfs)	Date of Peak
S-5A	Pump Station 6 units-800 cfs each	13.0 (canal side)	24.1 (WCA 1 side)	11.5-12.0 in L-10/L-12 Borrow Canal	4800	HW = 14.26 TW = 18.54 Q(south) = 5235	10/3/57 9/26/60 10/24/83
S-5AE	Gated Box Culvert 2-7ftx7ftx65ft Reinforced concrete box Invert elev = 1.0ft NGVD	11.5 (west side)	10.0 (east side)	Not used to control stage	700	HW = 19.34 TW = 16.38	9/27/60 10/23/83
S-5AS	Gated Spillway 2-Gates 19.3ft highx22.8ft wide Net crest lgth = 44.0ft Crest elev = 1.0ft NGVD	18.0 (canal side)	17.9 (WCA 1 side)	Not used to control stage	2000	HW = 19.34 TW = 16.3	9/27/60 10/3/85
S-5AW	Gated Box Culvert 2-7ftx7ftx80ft Reinforced concrete box Invert elev = -1.75 to 0.3ft NGVD	13.0 (west side)	11.5 (east side)	Not used to control stage	700		
S-6	Pump Station 3 units - 975 cfs each	12.5 (EAA side)	20.8 (WCA 1 side)	10.0 - 12.5 on EAA side	2925	HW = 14.74 TW = 17.90 Q = 2920	12/25/57 10/20/60 6/9/66
S-10A	Gated Spillway 4 Gates 8.0 ft highx25.7 ft wide net crest lgth = 100.0 ft crest elev = 10.0 ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	4680	HW = 18.1 Q = 3158	10/18/60 9/24/77
S-10C	Gated Spillway 4 Gates 8.0 ft highx25.7 ft wide net crest lgth = 100.0 ft crest elev = 10.0 ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	4680	HW = 18.1 Q = 2661	10/18/60 2/15/85
S-10D	Gated Spillway 4 Gates 8.0 ft highx25 7 ft wide net crest lgth = 100.0 ft crest elev = 10.0 ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	4680	HW = 18.1 Q = 2508	10/18/60 2/15/83
S-10E	Gated Culvert 3-72 in x 40 ft CMP invert elev = 9.0 ft	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	438	HW = 17.5 TW = 16.2 Q = 430	11/10/87 1/15/88 9/10/85
S-39	Gated Spillway 1-Taintor Gate 16.0 ft wide x 9.2 ft high net crest lgth = 15.0 ft crest elev = 2.5 ft NGVD	11.0 (WCA 1 side)	9.0 (east side)	HW = Regulation Schedule in WCA 1 TW = 9.0 Max	800	HW = 18.10 TW = 12.39 Q = 800	10/18/60 10/15/65 8/15/89
G-94A	Gated Culvert 2-72x70ft CMP invert elev = 7.0ft NGVD					Not gaged	

In = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

TABLE 2. Water Conservation Area 1 Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Dsicharge (cfs)	Date of Peak
G-94B	Gated Culvert 2-72x70ft CMP invert elev = 7.0ft NGVD					Not gaged	
G-94C	Gated Culvert 2-72x70ft CMP invert elev = 7.0ft NGVD					Not gaged	
G-94D	Gated Culvert 2-72x70ft CMP invert elev = 7.0ft NGVD					Not gaged	

In = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

WATER CONSERVATION AREA 2A

Description of the Basin

The Water Conservation Area 2A (WCA 2A) basin has an area of 164.7 square miles and is located (Figure 6) in south-central Palm Beach County (65.5 square miles) and in north-central Broward County (99.2 square miles). The boundary of the WCA 2A basin relative to local roads and landmarks is shown on Map A. A schematic map showing the WCA 2A basin boundary, canals, and control structures is given in Figure 7.

General Function and Operation of Project Structures

WCA 2A and its associated Project structures have six primary functions: (1) to provide viable wetland habitat (i.e., the WCA is managed insofar as is practicable as a natural Everglades system), (2) to detain and store flood and drainage water during the wet season for water supply during the dry season, (3) to prevent water accumulating in the Everglades from overflowing into urban and North New River and Miami lands in eastern Broward County (4) to receive and store regulatory releases from Lake Okeechobee and WCA 1, (5) to provide conveyance for water supply releases from Lake Okeechobee to eastern Broward County, and (6) to supply water to eastern Broward County and WCA 2B. Inflows to the WCA are from local rainfall, from WCA 1 by way of the S-10 structures, and from the S-7 basin by way of S-7. When required by the WCA 2A regulation schedule (Figure 5, also see discussion in **Comments on Design and Historic Operation**), excess water is discharged to WCA 3A by way of the three S-11 structures, to WCA 2B by way of S-144, S-145, and S-146, to the North New River Canal basin by way of S-143, and to the C-13 and C-14 basins by way of S-38. The S-11 structures provide the principal means of discharging water from WCA 2A. The discharge at all other structures is relatively minor. During periods of low natural flow, water stored in the WCA can be released for water supply by way of the S-11 structures to basins in eastern Dade County and to Everglades National Park, by way of S-143 to the North New River Canal basin, and by way of S-38 to the C-13 and C-14 basins. Additional outflows from the WCA are to the C-14 basin and to the Hillsboro Canal basin by seepage through L-36 to the L-36 borrow canal.

WCA 2A is connected to Lake Okeechobee by way of the North New River Canal. Regulatory releases from the lake, made to the canal by way of S-351, are passed through the S-2 and S-7 basins in the Everglades North New River and Miami Area, and are discharged by gravity flow or pumping from the canal into the WCA by way of S-7. Regulatory releases from the lake to WCA 2A are rare events and are only a small part of the water discharged to the WCA by way of S-7. See An Atlas of The Everglades North New River and Miami Area Surface Water Management Basins (Cooper, 1989) for further information on regulatory releases from Lake Okeechobee to WCA 2A.

In addition to regulatory releases from the lake, the North New River Canal may be used to supply water from Lake Okeechobee to the C-13, C-14 and North New River Canal basins for irrigation and municipal water supply. These water supply releases are passed through WCA 2A by way of the North New River Canal and the L-35B borrow canal. See An Atlas of Eastern Broward County Surface Water Management Basins (Cooper and Lane, 1987) for further information concerning the C-13, C-14, and North New River Canal basin.

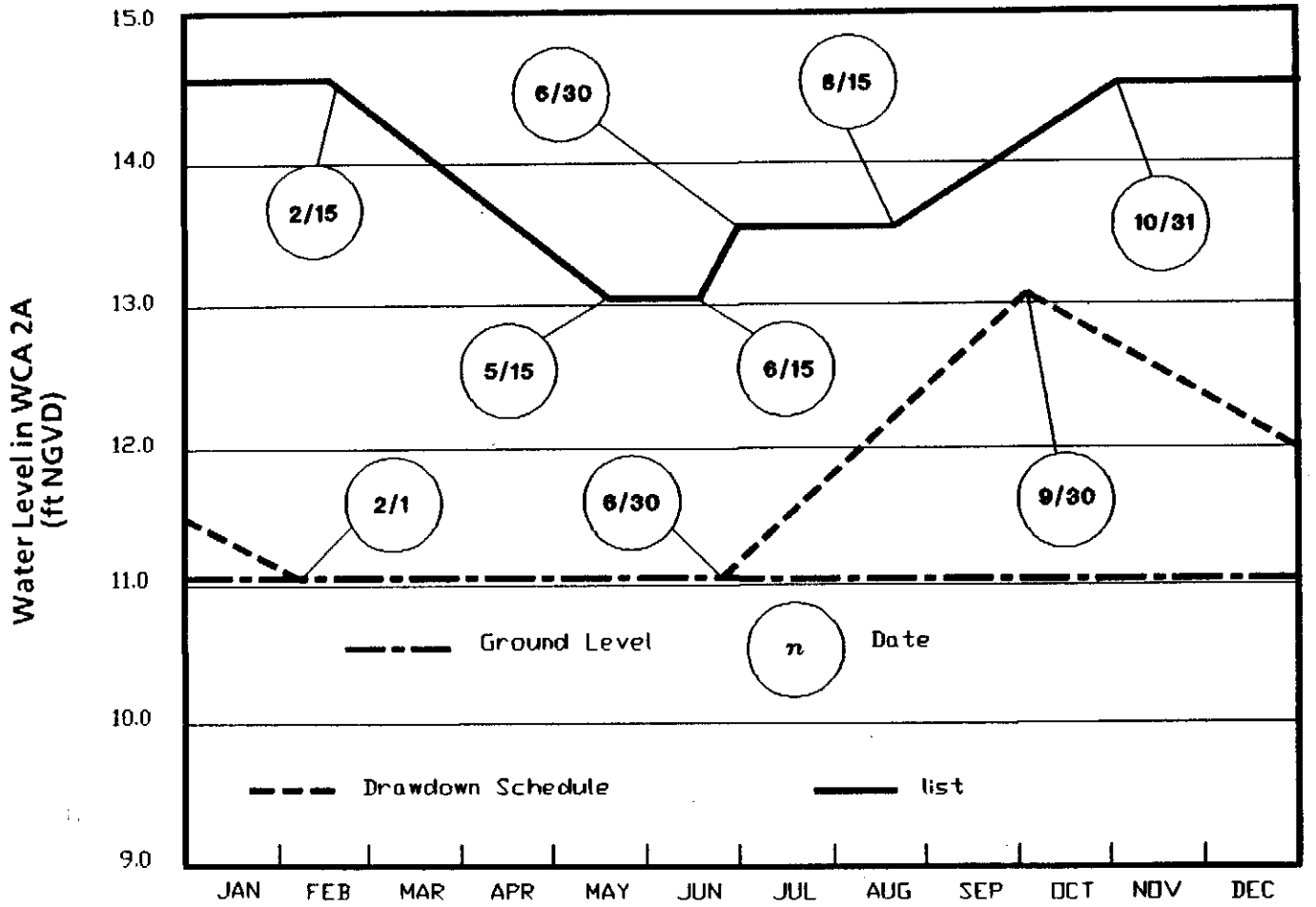

FIGURE 5. Regulation Schedule for Water Conservation Area 2A

Project Canals

There are two Project canals affecting water management in WCA 2A: the North New River Canal and the L-35B borrow canal. The North New River Canal connects Lake Okeechobee to WCAs 2A and 3A. The connection to Lake Okeechobee is by way of S-2 and S-351 at the north end of the canal at South Bay west of Belle Glade. The connection with WCA 2A is by way of S-7 at the intersection of L-5 and L-6, just east of U.S. Highway 27 on the Palm Beach-Broward County line. The connection with WCA 3A is by way of S-150 just west of S-7. From S-7, the North New River Canal passes on through the WCA and provides a means of conveying water from Lake Okeechobee to eastern Broward County.

The L-35B borrow canal connects the North New River Canal to C-13 and C-14. The canal runs west to east just north of L-35B making an open channel connection to the North New River Canal at its west end and connecting to C-14 at its east end by way of S-38.

Project Control Structures

There are sixteen Project structures controlling inflows to and outflows from WCA 2A. S-7, S-10A, S-10C, S-10D, and S-10E control inflows to the WCA. S-11A, S-11B, S-11C, S-38, S-38A, S-38B, S-39A, S-143, S-144, S-145, and S-146 control outflows from the WCA. Design criteria for the structures in WCA 2A are given in Table 4. There is one non-Project pump station discharging to WCA 2A. It is owned and operated by the North Springs Improvement District. The structure is located adjacent to S-38B on the L-36 borrow canal.

S-7 is a pump station and gated spillway located at the point where the North New River Canal enters WCA 2A just east of U.S. Highway 27 at the Palm Beach-Broward County line. As a general rule, water is discharged from the North New River Canal to WCA 2A when the stage at any point in the canal exceeds 12.5 ft NGVD. Pumping may be initiated at a lower stage if flooding occurs or is imminent in the S-7 or S-2 basins. Discharge is by gravity flow through the gated spillway if the stage in WCA 2A is low enough to permit a discharge adequate to maintain the optimum stage in the North New River Canal and by pumping otherwise. Normally the headwater stage (i.e., canal side) at S-7 is drawn down to and held at 10.0 ft NGVD. It is not to be drawn down below 8.7 ft NGVD. Pumping also may be initiated upon request by the U. S. Army Corp of Engineers to provide regulatory discharge from Lake Okeechobee to WCA 2A by way of S-351 and the North New River Canal when the entire capacity of S-7 is not needed for removal of water from the S-2 and S-7 basins.

S-10A, S-10C, and S-10D are gated spillways located in L-39 on the northwest boundary of WCA 2A about 15 miles west of Boca Raton. The principal function of the S-10 structures is to maintain the stage in WCA 1 at its regulation schedule. These structures were designed to discharge the entire Standard Project Flood from WCA 1. The S-10 structures are maintained by the U. S. Army Corps of Engineers and are operated by the District under a contract with the Corps.

S-10E is a gated culvert located through L-39 about one-half mile southeast of S-6. This structure permits discharge of water from WCA 1 into the northern portion of WCA 2A. It is used in conjunction with S-10A, S-10C, and S-10D to maintain the stage in WCA 1 at its regulation schedule. It is normally opened before the other three S-10 structures. When S-10E can no longer hold the stage in WCA 1 at its

regulation schedule, the other S-10 structures are opened. This structure was built by the District and is operated by the District at the request of the U. S. Army Corps of Engineers.

S-11A, S-11 B, and S-11C are gated spillways located in L-38W on the south west boundary of WCA 2A about 29 miles west of Ft. Lauderdale. The principal function of the S-11 structures is to maintain the stage in WCA 2A at its regulation schedule. These structures were designed to discharge the entire Standard Project Flood from WCA 2A. Regulatory discharges through S-38, S-143, S-144, S-145, and S-146 only supplement the discharge through the S-11 structures and are not normally required. The three structures are maintained by the U.S. Army Corps of Engineers and are operated by the District under contract with the Corps.

S-38 is a gated culvert, through L-36, at the west end of C-14. It has two functions: (1) to supply water to the C-14 and C-13 basins during periods of low natural flow and (2) when the stage in WCA 2A is above the regulation schedule, to discharge water from the WCA to tidewater by way of C-13 and C-14. Water releases are made as necessary to maintain the optimum stages in C-13 and C-14. Regulatory discharges through S-38 are made only if the water is not needed in WCA 3A, and C-13 and C-14 can accept additional water without flooding occurring in either basin. No discharges are made at S-38 if the tailwater stage exceeds 8.2 ft NGVD.

S-38A is a culvert located in the L-36 borrow canal just north of C-14. Control of water flow is effected by a riser and stoplogs. Together with S-38B, this structure controls seepage from WCA 2A to the L-36 borrow canal in the C-14 basin by regulating the water level in the borrow canal. Normally a stage of 7.65 ft NGVD is maintained in this section of the canal. Runoff, pumped drainage, and intercepted seepage are discharged from the borrow canal to C-14 by way of S-38A.

S-38B is a gated culvert located in the alignment of the L-36 borrow canal just north of Wiles Road. The structure is normally closed and acts as a divide between the Hillsboro Canal basin and the C-14 basin. S-38B is occasionally opened to transfer water from the Hillsboro Canal basin to the C-14 basin.

The North Springs Improvement District is permitted to discharge into WCA 2A by way of a pump station located at S-38B on the east side of the WCA. The pump station has a capacity of 440 cfs (200,000 GPM). It has four discharge tubes each capable of passing 110 cfs. The southernmost tube may discharge either to the L-36 borrow south of S-38B in the C-14 basin or into WCA 2A. The northernmost tube may discharge either to the L-36 borrow canal north of S-38B into the Hillsboro Canal basin or into WCA 2A. The middle two tubes can discharge only to WCA 2A. Usual operation of the structure (Table 3) is to discharge to the L-36 borrow canal dividing flow north and south of S-38B. Discharge is made to WCA 2A only when pumping to the L-36 borrow canal would cause flooding in the Hillsboro Canal or C-14 basins (i.e., a water level in the L-36 borrow canal on either side of S-38B greater than 9.5 ft NGVD).

S-39A is a culvert located in the L-36 borrow canal at its intersection with the Hillsboro Canal. Control of water flow is effected by a riser and stop logs. Together with S-38B, this structure controls seepage from WCA 2A to the L-36 borrow canal in the Hillsboro Canal basin by regulating the water level in the borrow canal. Under present operation, all of the stop logs have been removed from S-39A and the water level in the borrow is maintained by operation of Deerfield Lock. Runoff, pumped

TABLE 3. Operation of the North Springs Improvement District Pump Station at S-38B

Indicator Water Levels Permitted Discharge	Water Level in[1] L-36 Borrow Canal North of Pump Station	Water Level in[1] L-36 Borrow Canal South of Pump Station	Water Level[1] at the Pump Intake
Discharge to Hillsboro Basin at 10,000 GPM	Less than 9.5	NA[2]	Less than 7.8
Discharge to C-14 basin at 10,000 GPM	NA[2]	Less than 9.5	Less than 7.8
Discharge to Hillsboro basin at 50,000 GPM	Less than 9.5	NA[2]	Greater than 7.8
Discharge to C-14 basin at 50,000 GPM	NA[2]	Less than 9.5	Greater than 7.8
Discharge to WCA at 100,000 GPM	Greater than 9.5	Greater than 9.5	Greater than 7.8 Less than 10.0
Discharge to WCA at 200,000 GPM	Greater than 9.5	Greater than 9.5	Greater than 10.0

[1]All water levels in ft NGVD
[2]NA = Not Applicable

drainage, and intercepted seepage are discharged from the borrow canal to the Hillsboro Canal by way of S-39A.

S-143 is a gated culvert through L-35B and in the alignment of the North New River Canal. It has two functions: (1) to supply water to the North New River Canal basin during periods of low natural flow and (2) when the stage in WCA 2A is above the regulation schedule and when requested by the U. S. Army Corps of Engineers, to discharge water from the WCA to tidewater by way of the North New River Canal. S-143 is one of two structures that can be used to supply water to the North New River Canal basin. The other is S-141 which can pass water, if available, from WCA 2B to the North New River Canal . Water releases are made at these structures as necessary for water control and salinity control to maintain a stage in the North New River Canal at Sewell Lock of between 3.5 and 4.5 ft NGVD. Regulatory discharges through S-143 are made only if the water is not needed in WCA 3A and the stage at the tailwater of S-34 in the North New River Canal is less than 6.0 NGVD. No discharges are made at S-143 if the tailwater stage exceeds 10.0 ft NGVD.

S-144, S-145, and S-146 are identical gated culverts through L-35B, connecting WCA 2A to WCA 2B. These culverts and the S-11 structures maintain the stage in WCA 2A at the regulation schedule for the WCA, discharging excess water to WCA 2B and WCA 3A respectively. The S-11 structures are primarily responsible for discharging excess water from WCA 2A. In terms of time, the S-144, S-145, and S-146 culverts are open more often than the S-11 structures. Because of the culverts' limited discharge capacity, however, large regulatory releases must be passed through the S-11 structures. S-144, S-145, and S-146 make relatively minor

discharges in comparison; S-144, S-145, and S-146 are used primarily to supply water to WCA 2B from WCA 2A as necessary to maintain it as a wetland.

Comments on Design and Historic Operation

Project Design

WCA 2A is impounded by six levees: L-6, L-35B, L-36, L-38E, L-38W, and L-39 (Figure 7). These levees were designed to hold water in WCA 2A at stages estimated to occur during the Standard Project Flood. The design was formulated assuming that the regulation schedule for the WCA would allow for continued growth of emergent vegetation. The emergent vegetation significantly reduces the wind tide and wave run-up to be expected during a major hurricane. Without the vegetation, the levees would have to be much larger than they are to provide the same flood protection.

Lake Okeechobee Regulatory Discharge

WCA 2A is the receiving body for regulatory releases from Lake Okeechobee by way of the North New River Canal. However, during a major storm event, water is discharged primarily through the Caloosahatchee River (C-43) and the St. Lucie Canal (C-44). This is a result of localized drainage entering the North New River Canal and reducing its ability to receive regulatory discharges from the lake.

Although the St. Lucie Canal and the Caloosahatchee River can and do pass the largest discharges from the lake, they are not the preferred outlets from the lake since water released in this way is lost to the ocean and, in some cases, damages the estuaries of the St. Lucie and Caloosahatchee Rivers. To the extent practicable, regulatory releases are made to the North New River and Miami canals. Water released to these canals is stored in the WCAs, if possible, to keep it in the system. This affords additional opportunity for using the water, and it limits the amount of freshwater that enters the estuaries of the Caloosahatchee and St. Lucie Rivers.

Although first priority is given to regulatory releases by the North New River and Miami canals, such releases are not common and little of the regulatory discharge from Lake Okeechobee is handled in this way. There are two reasons that regulatory releases to the North New River and Miami canals are rare.

1. Most significantly, regulatory releases to the North New River and Miami canals cannot be made if doing so would compromise North New River and Miami water control in any of the basins the canals pass through. In general, it is required that weather conditions in the affected EAA basins be dry and that water levels in the canals be low enough not to restrict local inflows. As a rule of thumb, the canal water levels must be below 11.0 ft NGVD. With no local inflows, however, the tailwater at the outlet structure (i.e., S-351 for the North New River Canal) can be allowed to rise as high as 13.5 ft NGVD during regulatory discharge.

2. Although the COE and District policy does not explicitly restrict regulatory releases to the WCAs when they are over schedule, such releases usually are not made when other options are available. Releases are also not made if it is perceived that they would be harmful to the environment in the receiving WCA; e.g., by drowning deer in WCA 3A.

The wet weather conditions that cause Lake Okeechobee to go over schedule also are likely to create wet conditions in the EAA basins, with water levels over 11.0 ft NGVD, and to cause the WCAs to go over schedule. These factors combine to make regulatory releases by way of the North New River and Miami canals rare events.

S-10E

S-10E has only recently been added to the Project by permit from the Department of the Army. It was built by the District at District expense. It is intended to provide environmental benefit to WCA 2A by increasing the hydroperiod of the northern part of the WCA (i.e., north of S-10D) and by providing a more natural flow path through the WCA. Previous to construction of S-10E, the northern part of the WCA dried out earlier in the dry season and stayed dry longer into the wet season than the rest of the WCA. S-10E provides the means of discharging water from WCA 1 directly into the northern part of WCA 2A. When regulatory releases are required from WCA 1 to WCA 2A, S-10E is the preferred outlet and is opened first. The other S-10 structures are opened when S-10E is not able to pass the regulatory discharge at the required rate. It should be noted that the discharge capacity of S-10E is small compared to the other S-10 structures. Its function is strictly environmental enhancement, and it is not intended to supply significant regulatory discharge from WCA 1.

WCA 2A Regulation Schedule

Prior to completion of WCA 2A in 1961, much of the Everglades that are now impounded in the WCA dried out periodically (usually annually). The composition and distribution of plant and animal species in the area were in part determined by this periodic drying. After completion of the WCA and under the regulation schedule in effect at that time, the majority of the land surface within the WCA remained flooded throughout the year. As a result, there was substantial change in the composition and distribution of plant and animal species in the WCA. In 1980 in an effort to restore WCA 2A to a condition more like its natural state, the District proposed and began testing a modified regulation schedule that dried out the WCA annually. The results of these tests showed positive trends in restoring the WCA to its natural condition. Based on these results, a new regulation schedule (i.e., the "'Drawdown Schedule" shown in Figure 5) has been proposed. The District has recommended to the COE that this new schedule permanently replace the schedule in effect prior to 1980 (i.e.,the"Normal Operating Schedule" shown in Figure 5). At the time of publication, the COE was reviewing the proposal. See District Technical Publication 88-2 Environmental Response of WCA 2A to Reduction in Regulation Schedule and Marsh Drawdown (Worth, 1988) for more information on the WCA 2A regulation schedule.

Inflows from the EAA

The original drainage design for the Everglades North New River and Miami Area (EAA) called for removing excess water from the EAA to both Lake Okeechobee and the WCAs. Because of environmental problems in the lake resulting from inflows of nutrient- rich water, the current District water management plan for the EAA discourages discharge of water to Lake Okeechobee. Consequently, almost all water pumped from the EAA is discharged to the WCAs.

This water management plan is known as the Interim Action Plan (IAP) and was originally implemented under the Lake Okeechobee Temporary Operating Permit from the Florida Department of Environmental Regulation (FDER). FDER has since granted the District permission to continue the plan under the Lake Okeechobee Operating Permit (LOOP). See An Atlas of Everglades North New River and Miami Area Surface Water Management Basins (Cooper, 1989) for specific information concerning the operation of structures in the EAA under the IAP.

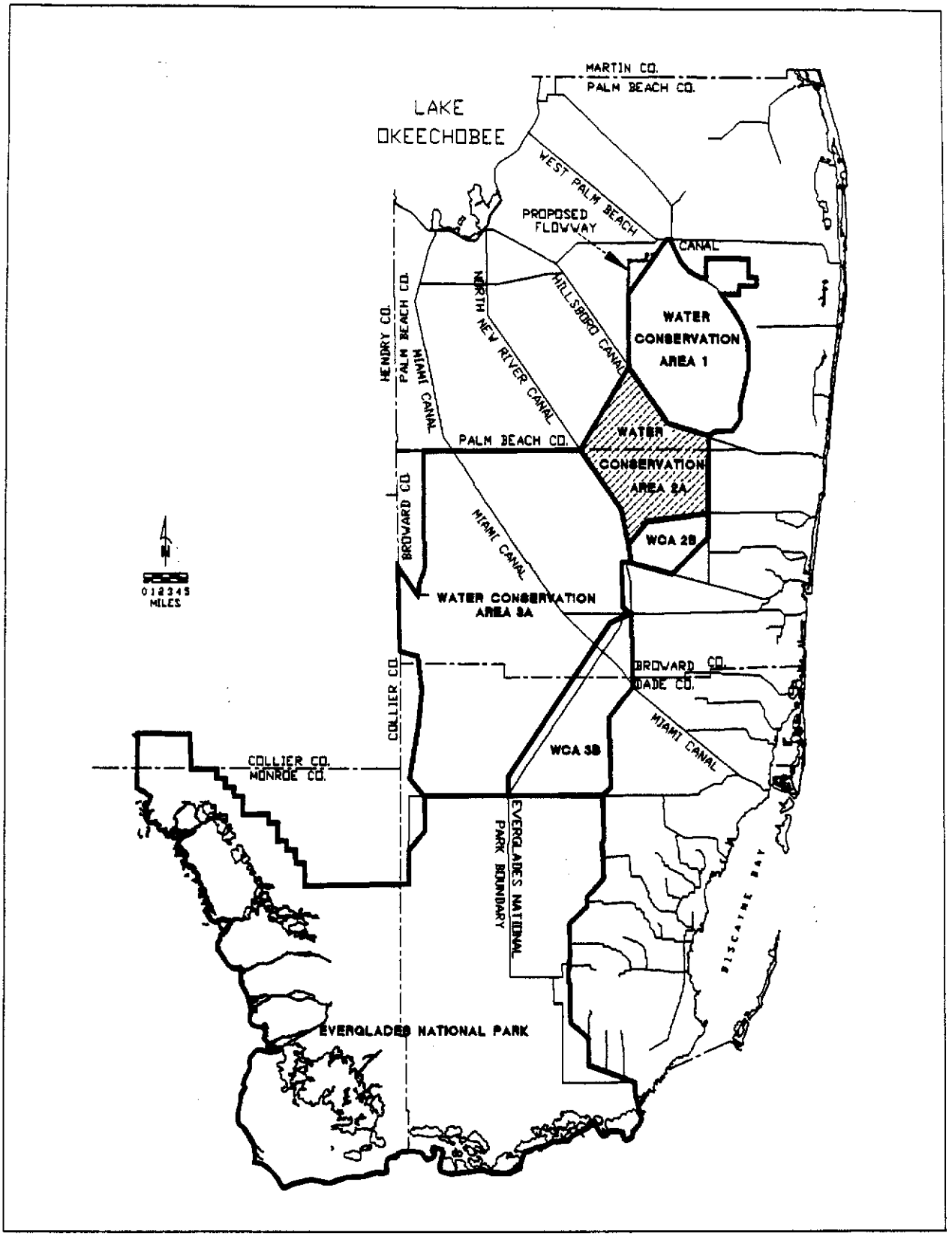

FIGURE 6. Water Conservation Area 2A Basin Location Map

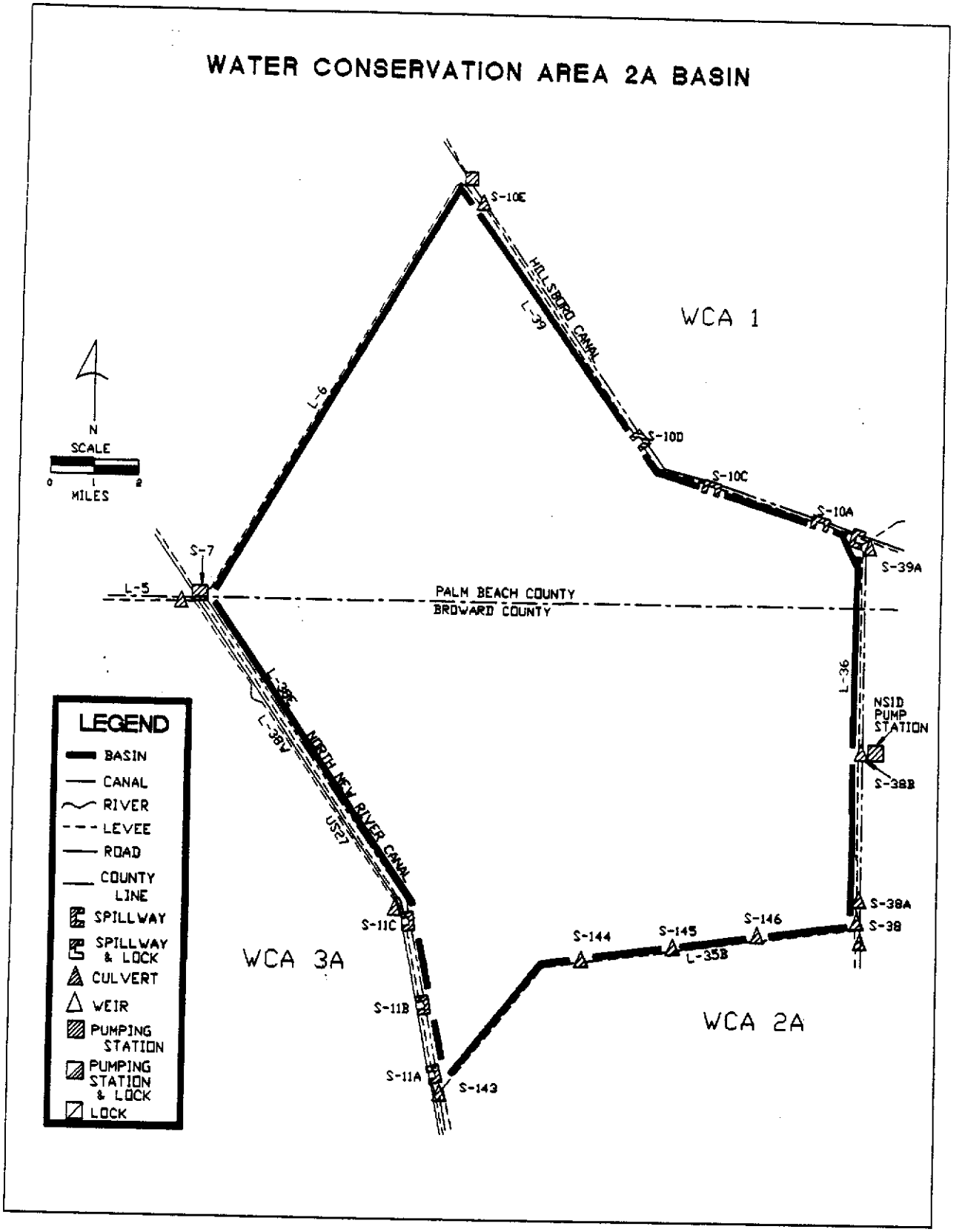

FIGURE 7 **Water Conservation Area 2A Basin Map**

TABLE 4. Water Conservation Area 2A Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-7	Pump Station 3 units - 830 cfs each Gated box culvert 1-14.7 ftx13.3 ftx43 ft Invert elev = 1.75ft NGVD	13.0 (Pumped Discharged) (EAA side)	18.3 (Pumped Discharged) (WCA 2A side)	10.0-12.5 in North New River Canal	2490	HW = 14.09 TW = 15.5 Q = 2790 (pump)	10/31/61 11/15/69 8/20/81
S-10A	Gated Spillway 4 gates 8.0 ft highx25.7 ft wide net crest lgth = 100.0 ft crest elev = 10.0 ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	4680	HW = 18.1 Q = 3158	10/18/60 9/24/77
S-10C	Gated Spillway 4 gates 8.0 ft highx25.7 ft wide net crest lgth = 100.0 ft crest elev = 10.0 ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	4680	HW = 18.1 Q = 2661	10/18/60 2/15/85
S-10D	Gated Spillway 4 gates 8.0 ft highx25.7 ft wide net crest lgth = 100.0 ft crest elev = 9.0 ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	4680	HW = 18.1 Q = 2508	10/18/60 2/15/83
S-10E	Gated Spillway 3-72 in x40 ft CMP Invert elev = 9.0ft NGVD	17.3 (WCA 1 side)	16.4 (WCA 2A side)	Regulation schedule in WCA 1	438	HW = 17.5 TW = 16.2 Q = 430	11/10/87 1/15/88 9/10/85
S-11A	Gated Spillway 4 gates 9.0 ft high x 25.8 ft wide net crest lgth = 100.0 ft crest elev = 7.5 ft NGVD	15.6 (WCA 2A side)	14.6 (WCA 3A side)	Regulation schedule in WCA 2A	5570	HW = 15.5 Q = 2685	11/15/69 2/31/80
S-11B	Gated Spillway 4 gates 9.0 ft high x 25.8 ft wide net crest lgth = 100.0 ft crest elev = 7.5 ft NGVD	15.6 (WCA 2A side)	14.6 (WCA 3A side)	Regulation schedule in WCA 2A	5570	HW = 15.5 Q = 2194	11/15/69 9/24/77
S-11C	Gated Spillway 4 gates 9.0 ft high x 25.8 ft wide net crest lgth = 100.0 ft crest elev = 7.5 ft NGVD	15.6 (WCA 2A side)	14.6 (WCA 3A side)	Regulation schedule in WCA 2A	5570	HW = 15.5 Q = 3408	11/15/69 8/15/78
S-38	Gated Culvert 2-72 in x 52 ft CMP Invert elev = 3.0ft to 2.0 ft NGVD	9.8 (WCA 2A side)	7.0 (C-14 side)	Regulation schedule in WCA 2A TW<8.2	500	HW = 15.47 TW = 10.47 Q = 586	11/15/69 4/25/79 9/22/66
S-38A	Culvert with riser and stoplogs 2-60 in x 70 ft CMP Invert elev = 2.0 ft NGVD	9.0 (north side)	8.0 (south side)	HW = 7.65	190		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

TABLE 4. Water Conservation Area 2A Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-38B	Culvert with riser and stoplogs 2-60 in x 70 ft CMP Invert elev = 0.0 ft NGVD	9.0 (south side)	7.65 (north side)				
S-39A	Culvert with riser and stoplogs 3-72 in x 54 ft CMP	(south side)	(north side)	HW = 7.0-7.5			
S-143	Gated Culvert 2-72 in x 70 ft CMP Invert elev = 2.0ft	13.0 (WCA 2A side)	10.0 (North New River Canal side)	Regulation schedule in WCA 2A	500		
S-144	Gated Culvert 2-72 in x 98ft CMP Invert elev = 4.0ft	12.0 (WCA 2A side)	10.0 (WCA 2B side)	Regulation schedule in WCA 2A	210		
S-145	Gated Culvert 2-72 in x 98 ft CMP Invert elev = 4.00ft	12.0 (WCA 2A side)	10.0 (WCA 2B side)	Regulation schedule in WCA 2A	210		
S-146	Gated Culvert 2-72 in x 98 ft CMP Invert elev = 4.0ft	12.0 (WCA 2A side)	10.0 (WCA 2B side)	Regulation schedule in WCA 2A	210		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

WATER CONSERVATION AREA 2B

Description of the Basin

Water Conservation Area 2B (WCA 2B) basin, located in central Broward County (Figure 8), has an area of 43.8 square miles. The boundary of WCA 2B basin relative to local roads and landmarks is shown on Map A. A schematic map showing the WCA 2B basin boundary, canals, and control structures is given in Figure 9.

General Function and Operation of Project Structures

WCA 2B and its associated Project structures have five primary functions: (1) to provide viable wetland habitat (i.e., the WCA is managed insofar as is practicable as a natural Everglades system, (2) to recharge regional groundwater (i.e., the Biscayne Aquifer), (3) to supply water to adjacent basins in Broward County, (4) to receive and store regulatory discharges from WCA 2A, and (5) to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in eastern Broward County. Although the District attempts to operate WCA 2B as a natural Everglades system, this is not always possible due to the porous geological characteristics of the basin. Rainfall is the primary source of water to WCA 2B, but water can be supplied from WCA 2A as necessary to maintain WCA 2B as a wetland. The regulation schedule for WCA 2B is used only in part. When the water level in the WCA exceeds 11.0 ft NGVD, excess water is discharged to the North New River Canal by way of S-141. During periods of low natural flow and if the water is available in WCA 2B, water can be supplied to the North New River Canal by way of S-141 as needed to maintain the optimum stage in the canal.

WCA 2B occupies an area of significant recharge to the Biscayne Aquifer. Water supplied to the aquifer by way WCA 2B is important to maintaining groundwater levels in coastal areas to the east. Adequate groundwater levels are essential to proper management of municipal wellfields and to restrict saltwater intrusion to groundwater. The borrow canals of the levees impounding the WCA on the east cut into the Biscayne Aquifer and intercept some of the groundwater flow to the east. The intercepted groundwater and seepage through the levees are an important source of water to adjacent basins in Broward County: to the C-13 and C-14 basins by seepage to the L-35A and L-36 borrow canals and to the North New River Canal basin by seepage through L-35 to the North New River Canal. The rates of seepage through L-35, L-35A, and L-36 are not regulated by specific operation of Project structures, although the rates are probably affected by the stages held in the North New River Canal and the L-35A and L-36 borrow canals.

Project Canals

The various borrow canals of the levees impounding WCA 2B on the east (i.e., L-35, L-35A, and L-36) intercept seepage from the WCA and convey this water to adjacent basins for maintenance of groundwater levels and for municipal water supply.

Project Water Control Structures

There are four Project structures controlling inflows to and outflows from WCA 2B. S-144, S-145, and S-146 control inflows to WCA 2B. S-141 controls outflows from the WCA. Design criteria for the structures in WCA 2B are given in Table 5.

S-141 is a sheet pile overflow section or weir in L-38E at the southwest corner of WCA 2B. Control of water flow is effected by stop logs. It is used to make releases of water from WCA 2B to the North New River Canal to regulate the stage in the WCA and for water supply to the North New River Canal basin when water is available in the WCA. Water supply releases to the North New River Canal are normally made by way of S-143 from WCA 2A. Releases from these two structures are used to maintain an optimum stage in the North New River Canal at Sewell Lock of between 3.5 and 4.5 ft NGVD. Water is discharged from the WCA by way of S-141 if the stage in the WCA is above 10.0 ft NGVD and if the tailwater at S-34 is below 6.0 ft NGVD.

S-144, S-145, and S-146 are identical gated culverts through L-35B, connecting WCA 2A to WCA 2B. These culverts and the S-11 structures maintain the stage in WCA 2A at the regulation schedule for the WCA, discharging excess water to WCA 2B and WCA 3A respectively. The S-11 structures are primarily responsible for discharging excess water from WCA 2A. In terms of time, the S-144, S-145, and S-146 culverts are open more often than the S-11 structures. Because of the culverts limited discharge capacity, however, large regulatory releases must be passed through the S-11 structures. In comparison, S-144, S-145, and S-146 make relatively minor discharges. S-144, S-145, and S-146 are used also to supply water to WCA 2B from WCA 2A as necessary to maintain it as a wetland.

Comments on Design and Historic Operation

Project Design

WCA 2B is impounded by five levees: L-35, L-35A, L-35B, L-36, and L-38E (Figure 9). These levees were designed to hold water in WCA 2B at stages estimated to occur during the Standard Project Flood. The design was formulated assuming that the regulation schedule for the WCA would allow for continued growth of emergent vegetation. The emergent vegetation significantly reduces the wind tide and wave run-up to be expected during a major hurricane. Without the vegetation, the levees would have to be much larger than they are to provide the same flood protection.

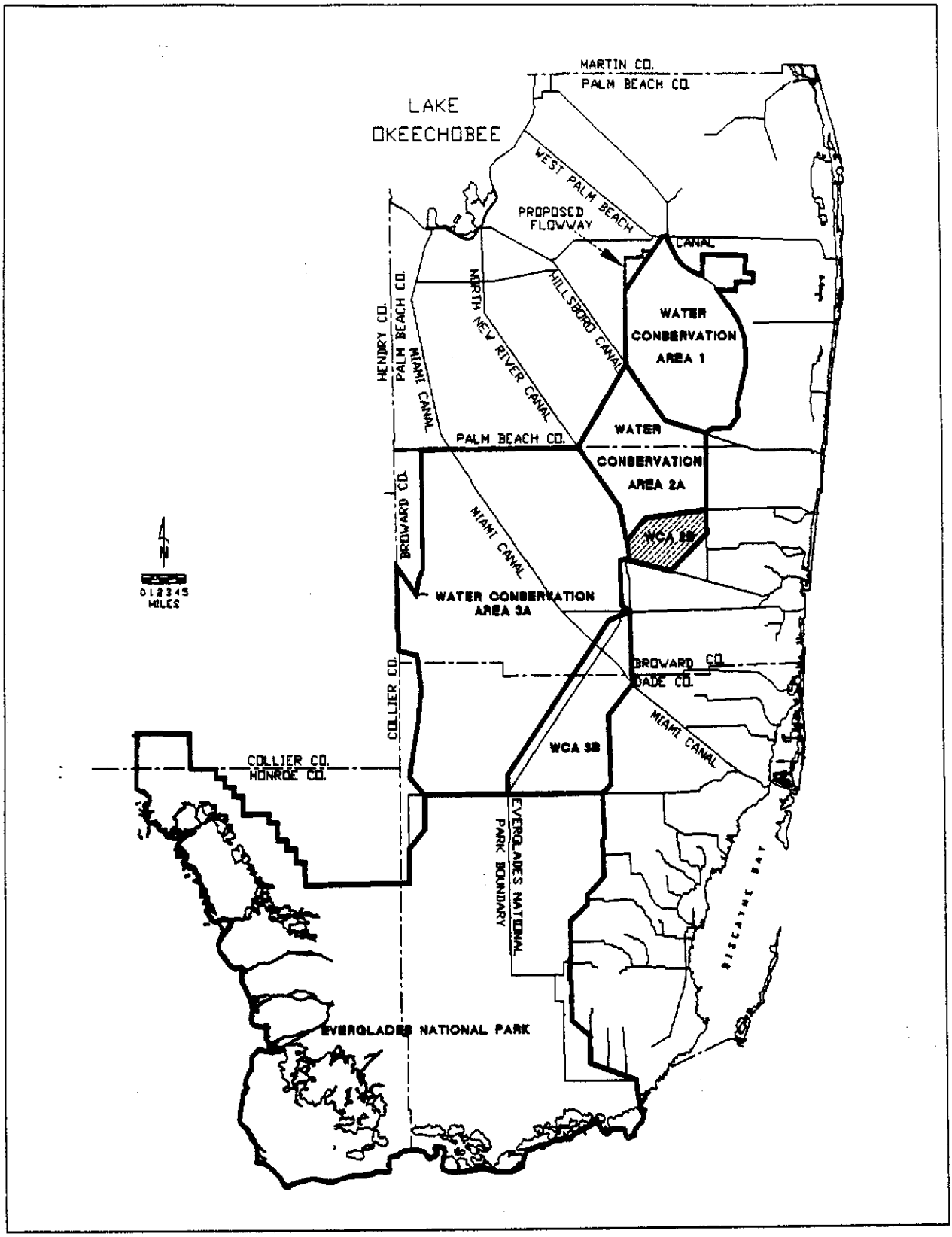

FIGURE 8. Water Conservation Area 2B Basin Location Map

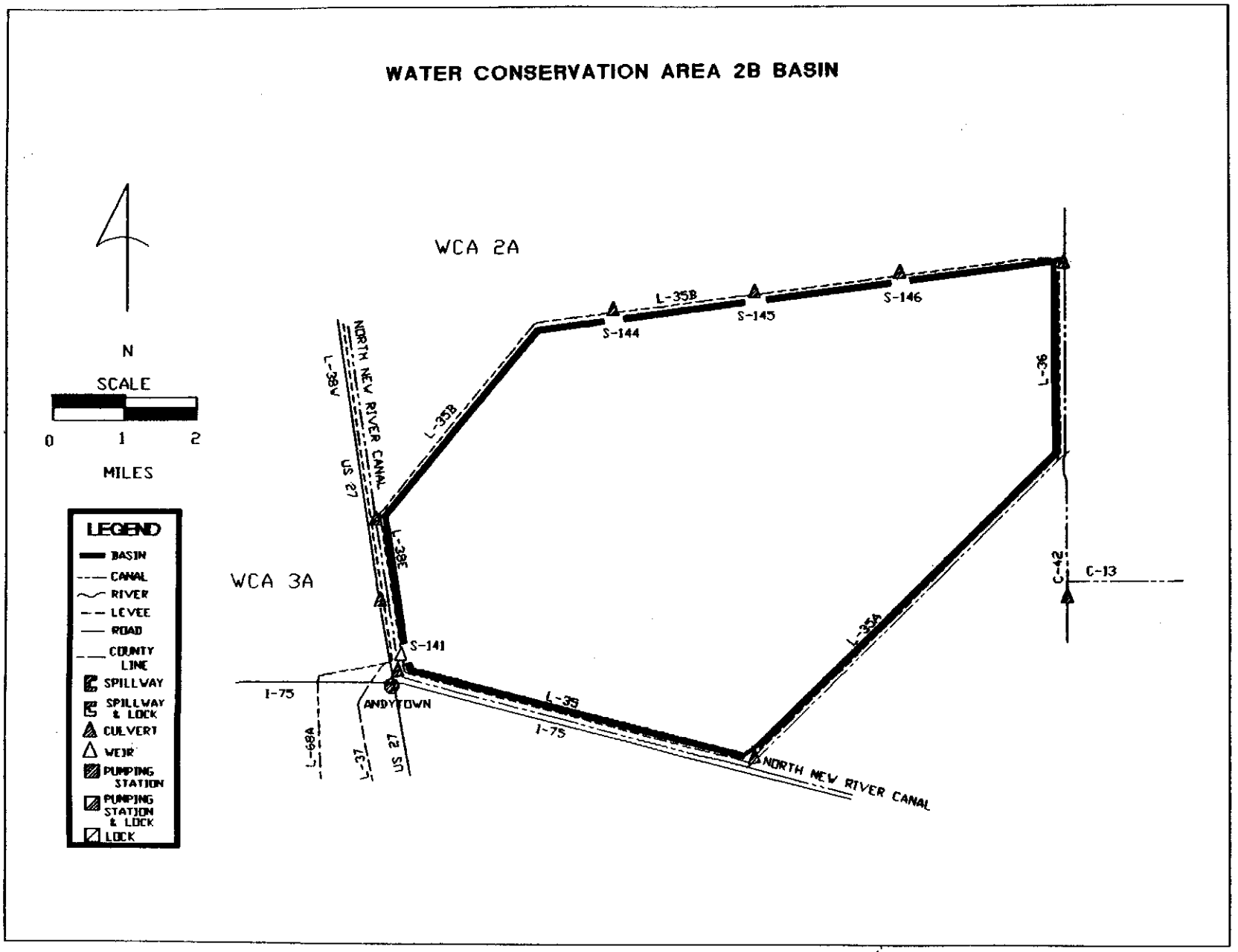

FIGURE 9. Water Conservation Area 2B Basin Map

TABLE 5. Water Conservation Area 2B Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-124	Gated Culvert 5-72 inx48 ft CMP invert elev = 1.0 ft NGVD	7.02	6.57	HW = 5.0-5.5	490	*HW = 7.8 + TW = 6.86 *HW may have been above 8.0	4/25/79 4/25/70
S-141	Sheetpile overflow weir in L-38E flash board control net crest lgth = 30.0 ft crest elev = 7.0 ft NGVD	10.0 (WCA 2B side)	8.0 (North New River Canal side)		435		
S-144	Gated Culvert 2-72 inx98 ft CMP invert elev = 4.0 ft NGVD	12.0 (WCA 2A side)	10.0 (WCA 2B side)	Regulation Schedule in WCA 2A	210		
S-145	Gated Culvert 2-72 inx98 ft CMP invert elev = 4.0 ft NGVD	12.0 (WCA 2A side)	10.0 (WCA 2B side)	Regulation Schedule in WCA 2A	210		
S-146	Gated Culvert 2-72 inx98 ft CMP invert elev = 4.0 ft NGVD	12.0 (WCA 2A side)	10.0 (WCA 2B side)	Regulation Schedule in WCA 2A	210		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

WATER CONSERVATION AREA 3A

Description of the Basin

The Water Conservation Area 3A (WCA 3A) basin has an area of 767.3 square miles and is located (Figure 11) in western Broward County (568.4 square miles) and in north-western Dade County (198.9 square miles). The boundary of the WCA 3A basin relative to local roads and landmarks is shown on Map A. A schematic map showing the WCA 3A basin boundary, canals, and control structures is given in Figure 12.

General Function and Operation of Project Structures

WCA 3A and its associated structures have six primary functions: (1) to provide viable wetland habitat (i.e., the WCA is managed insofar as practicable as a natural Everglades system), (2) to detain and store flood and drainage water during the wet season for water supply during the dry season, (3) to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in eastern Dade and Broward counties, (4) to receive and store regulatory releases from Lake Okeechobee and WCA 2A, (5) to provide conveyance for water supply releases from Lake Okeechobee to eastern Dade County and Everglades National Park (ENP), and (6) to supply water to eastern Dade County and ENP. Inflows to the WCA are from local rainfall, from WCA 2A by way of the S-11 structures, from the S-8 basin by way of S-8, G-204, G-205, and G-206, from the S-7 basin by way of S-150, from the L-28 borrow canal by way of S-140, from the L-3 borrow canal by way of G-155, from the Feeder Canal basin by way of the S-190 in the L-28 Interceptor borrow canal, from the L-28 Gap basin by way of sheet flow through the L-28 gap and by way of the L-28 Tieback Levee borrow canal, from the North New River Canal by way of G-123 and S-142, from the C-11 basin by way of S-9, and from the area between L-38E and L-38W by way of G-64. When required by the WCA 3A regulation schedule (Figure 10 and Table 6, also see the discussion in **Comments on Design and Historic Operations**), excess water can be discharged to ENP by way of the S-12 structures and S-333, to the Tamiami Canal by way of S-343A, S-343B and the S-344 to WCA 3B by way of S-151, and to the Big Cypress National Preserve by way of S-344. The S-12 structures, S-333, and S-151 provide the principal means of discharging water from WCA 3A. Discharges at the other structures are minor in comparison. During periods of low natural flow, water stored in the WCA can be released for water supply to ENP by way of the S-12 structures and S-333, to basins in southeast Dade County by way of S-333 and S-151, and to the Big Cypress National Preserve by way of S-344. Additional outflows of water from the WCA are to the C-11 basin by way of seepage through L-37 to the L-37 borrow canal.

WCA 3A is connected to Lake Okeechobee by way of the North New River and Miami canals. Regulatory releases from the lake are made to the North New River Canal by way of S-351, are passed through the S-2 and S-7 basins in the Everglades Agricultural Area (EAA), and are discharged into the WCA by way of S-150. Regulatory releases from the lake to the Miami Canal are made by way of S-354, are passed through the S-3 and S-8 basins in the EAA, and are pumped to WCA 3A by way of S-8. Regulatory releases from the lake to WCA 3A are rare events and are only a small part of the water discharged to the WCA by way of S-8 and S-150. See An Atlas of The Everglades Agricultural Area Surface Water Management Basins (Cooper, 1989) for further information on regulatory releases from Lake Okeechobee to WCA 3A.

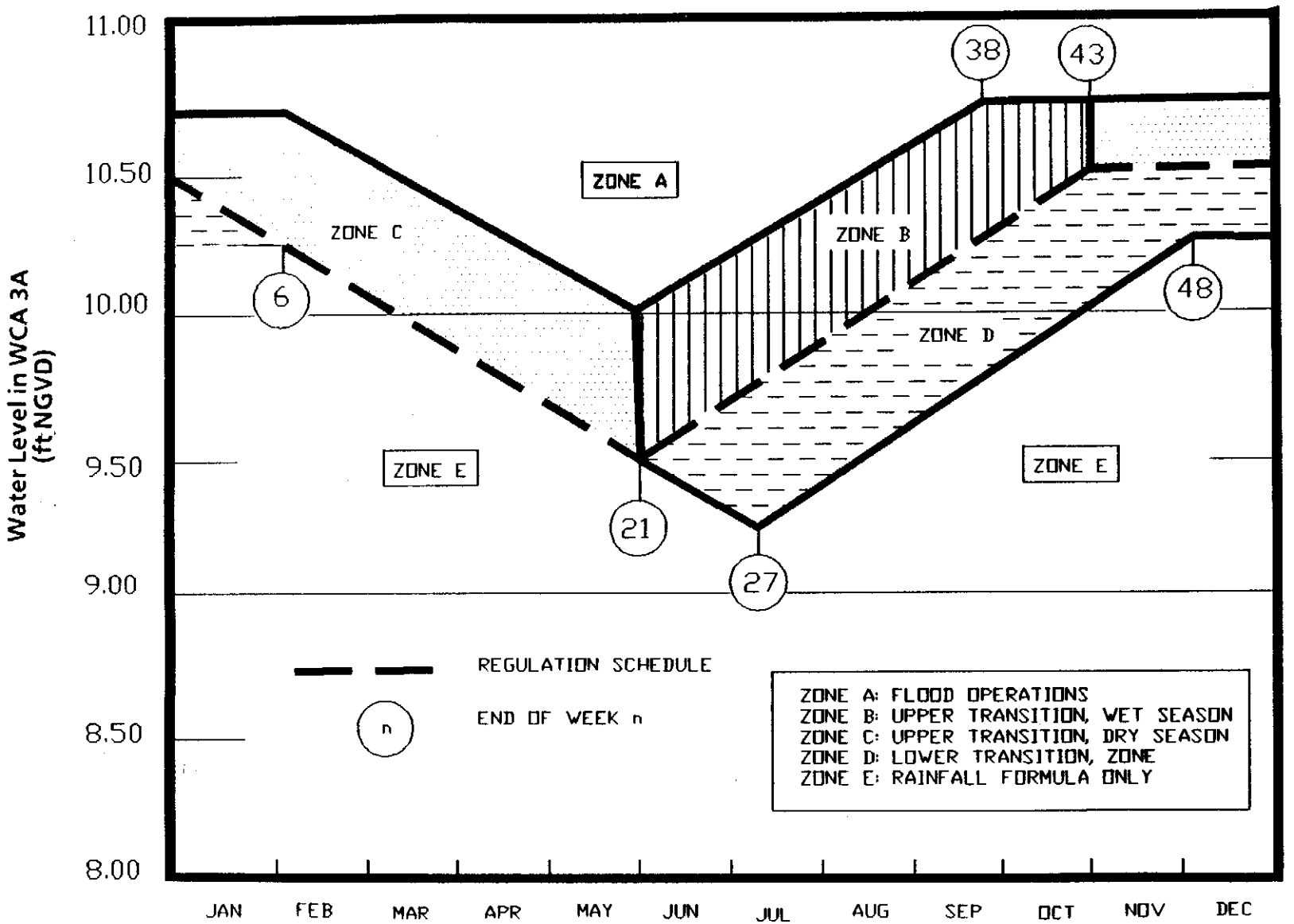

FIGURE 10. Regulation Schedule for Water Conservation Area 3A

TABLE 6. Water Conservation Area 3A Regulation Schedule

	S - 12 s	S-333	S-151	L-28 Culverts
Zone A	Open full	Maximum allowable discharge	Maximum diversionto 3B when 3B stageis less than 8.5 feet	S-343A & B and S-344 open full if no problems downstream
Zone B	S-333 Open; Discharge 45% of target flow S-333 Closed; Discharge at least 73% of target flow.(up to 100% if desired by ENP)	Discharge up to 55% of target flow when permitted by the Rainfall Plan	Same as Zone A whether S-333 is open or closed.	Same as Zone A whether S-333 is open or closed.
Zone C	S-333 Open; Discharge 45% of target flow S-333 Closed; Discharge 45% of target flow plus all or part of S-333's amount if desired by ENP.	Same as Zone B	May be used to divert water from WCA-3A whether S-333 is open or closed	May be used to divert water from WCA-3A whether S-333 is open or closed
Zone D	S-333 Open; Discharge 45% of target flow S-333 Closed; Discharge 45% of target flow plus all or part of S-333's amount if desired by ENP.	Same as Zone B	Used only for water supply deliveries to Dade County	Closed
Zone E	Discharge 45% of target flow whether S-333 is open or closed.	Same as Zone B	Used only for water supply deliveries to Dade County	Closed

In addition to regulatory releases from the lake, the Miami Canal may be used to supply water from Lake Okeechobee to eastern Dade County for irrigation and municipal water supply and to Everglades National Park. These water supply releases are passed through WCA 3A by way of the Miami Canal and the L-67A borrow canal. The water is passed to eastern Dade County and the southeastern parts of Everglades National Park by way of S-151 and S-333 to the South Dade Conveyance System. Water is passed to the northern parts of Everglades National Park (i.e., Shark River Slough) by way of the S-12 structures and S-333. See An Atlas of Eastern Dade County Surface Water Management Basins (Cooper and Lane, 1988) for further information on the South Dade Conveyance System and water supply to eastern Dade County.

Under the current experimental water management plan, water deliveries to Shark River Slough are determined as a function of rainfall, evaporation, and the water level in WCA 3A and the previous week's discharge. Discharge rates are calculated on a week to week basis. Insofar as possible, fifty-five percent of the calculated discharge, or target, is released to Northeast Shark River Slough by way of S-333 and the L-29 borrow canal. The actual discharge is subject to restrictions based on the S-333 tailwater level and groundwater and canal levels in the East Everglades area. Flow passes from the L-29 borrow canal to the slough by way of uncontrolled culverts under U. S. Highway 41 between L-67 Extension and L-30. The remaining forty-five percent of the target is discharged to ENP on the west side of L-67 Extension by way of the S-12 structures.

Project Canals

The four Project canals primarily affecting water management in WCA 3A are the Miami Canal, the L-67A borrow canal, the North New River Canal, and C-60. The Miami and the North New River canals connect WCA 3A to Lake Okeechobee.

The Miami Canal connects to Lake Okeechobee by way of S-3 at the north end of the canal at the town of Lake Harbor. The connection to WCA 3A is by way of S-8, 15 miles west of U.S. Highway 27 on the Broward-Palm Beach County line. The Miami Canal crosses WCA 3A from northwest to southeast leaving WCA 3A and entering WCA 3B at S-151. The canal continues to the southeast entering tidewater at Biscayne Bay. Most of the Miami Canal within WCA 3A has been re-dug parallel to its original channel and is known by its Project name C-123.

The L-67A borrow canal is on the WCA 3A side of L-67A and connects the Miami Canal to S-333 and the S-12 structures. There are no structures directly controlling flow into or out of this canal. Flow in the canal is indirectly affected by the operation of the S-12 structures, S-333, and S-151.

The North New River Canal connects to Lake Okeechobee by way of S-2 at the north end of the canal at South Bay west of Belle Glade. The connection with WCA 3A is by way of S-150 just west of S-7. It also makes a connection with WCA 2A by way of S-7 at the intersection of L-5 and L-6, just east of U.S. Highway 27 on the Palm Beach-Broward County line.

C-60 conveys discharge from S-140 to a bridge on I-75 about 4.3 miles east of L-28. It was constructed to facilitate the movement of water away from S-140 so that the tailwater level at the pump remains within design conditions. The canal is aligned from S-140 due east for 2.7 miles. It then extends to the southeast connecting to the north borrow of I-75. A bridge on I-75 at that point allows

conveyance to the south. This alignment was chosen to make use of an existing bridge on what was then the Everglades Parkway (State Road 838), and to form an impoundment for research studies between the canal levee and the Everglades Parkway (now I-75). The impoundment area was to be used for studies in wildlife management and evaporation and seepage control experiments. Water levels in the impoundment are controlled by two 48 inch culverts.

Project Water Control Structures

There are twenty-four Project structures controlling flows into and out of WCA 3A. Inflows are controlled by S-8, S-9, S-11A, S-11B, S-11C, S-140, S-142, S-150, S-190, G-64, G-123, G-155, G-204, G-205, and G-206. Outflows are controlled by S-12A, S-12B, S-12C, S-12D, S-151, S-333, S-343A, S-343B, and S-344. There are two structures controlling flow internal to the WCA: S-339 and S-340. Design criteria for the control structures in WCA 3A are given in Table 7.

S-8 is a pump station and gated spillway located at the point where the Miami Canal enters WCA 3A, 15 miles west of U.S. Highway 27 at the Palm Beach-Broward County line. As a general rule, water is discharged from the Miami Canal to WCA 3A when the stage at any point in the canal exceeds 12.5 ft NGVD. Pumping may be initiated at a lower stage if flooding occurs or is imminent in the S-3 or S-8 basins. Discharge is by gravity flow through the gated spillway if the stage in WCA 3A is low enough to permit a discharge adequate to maintain the optimum stage in the Miami Canal and by pumping otherwise. The headwater (i.e., canal side) stage is not to be drawn down below 9.5 ft NGVD. Pumping also may be initiated upon request by the U. S. Army Corp of Engineers, to provide regulatory discharge from Lake Okeechobee to WCA 3A by way of S-354 and the Miami Canal when the entire capacity of S-8 is not needed for removal of excess water from the S-8 basin.

S-9 is a pump station located at the west end of C-11, one-half mile west of U.S. Highway 27. Its function is to remove excess water from the western portion of the C-11 basin. Excess water in the basin results from storm runoff and from seepage to the L-37 and L-33 borrow canals from WCAs 3A and 3B respectively. The pumps are put into operation whenever the headwater stage at S-13A exceeds 4.0 ft NGVD and at other times if flooding occurs or is likely to occur in the western C-11 basin. The stage in the canal at the pump station is not to be pumped down below 0.0 ft NGVD.

S-11A, S-11 B, and S-11C are gated spillways located in L-38W on the southwest boundary of WCA 2A about 20 miles west of Ft. Lauderdale. They connect WCA 2A to WCA 3A. The principal function of the S-11 structures is to maintain the stage in WCA 2A at its regulation schedule. These structures were designed to discharge the entire Standard Project Flood from WCA 2A. The three structures are maintained by the U. S. Army Corps of Engineers and are operated by the District under a contract with the Corps.

S-12A, S-12B, S-12C, and S-12D are identical gated spillways located in L-29 between L-28 and L-67. They connect WCA 3A to ENP. These structures have two functions: (1) to maintain the stage in WCA 3A at its regulation schedule, and (2) to supply water to Everglades National Park. Operation of the structures depends on the stage in WCA 3A and on the amount of water to be delivered to ENP. These structures are designed to discharge the entire Standard Project Flood from WCA 3A. The four structures are maintained by the U.S. Army Corps of Engineers and are operated by the District under a contract with the Corps.

S-140 is a pump station and gated culvert located in L-28 just north of Interstate Highway 75. It removes excess water from the L-28 borrow canal and discharges the water to C-60 in WCA 3A. The structure is operated to maintain a stage of 10.5 ft NGVD in the L-28 borrow canal. Discharge to WCA 3A is made by the gated spillway if the stage in the WCA is low enough to permit an adequate discharge, otherwise the pumps are used.

S-142 is a gated culvert through L-35W, connecting WCA 3A to the North New River Canal. It is used in conjunction with G-123 to discharge excess water from the North New River Canal to WCA 3A. When G-123 is pumping excess water in the North New River Canal upstream of S-34, S-142 is opened to pass the discharge on to WCA 3A. Regulatory discharges through S-142 are made only if the water is not needed in WCA 3A, and the stage at S-34 in the North New River Canal is less than 6.0 NGVD. No regulatory discharges are made at S-142 if the tailwater stage exceeds 10.0 ft NGVD.

S-150 is a gated culvert located in L-5 just west of S-7. It can be used to pass water by gravity flow from the North New River Canal (i.e., from the S-7 and S-6 basins) to WCA 3A unless this interferes with the supply of water to WCA 2A by way of S-7. Discharge through S-150 is also initiated upon request by the U. S. Army Corp of Engineers, to provide regulatory discharge from Lake Okeechobee to WCA 3A by way of S-351 and the North New River Canal when the capacity of S-150 is not needed for removal of excess water from the S-7 basin.

S-151 is a gated culvert located in the alignment of the Miami Canal at the point where L-67A crosses the canal. It connects WCA 3A to WCA 3B. The structure has two functions: (1) to discharge excess water from WCA 3A and (2) to supply water to WCA 3B and to basins in eastern Dade County. Regulatory releases from WCA 3A by way of S-151 are made according to the regulation schedule for the WCA (Figure 10 and Table 6). During periods of low natural flow, water is discharged through S-151 as necessary to maintain the optimum stages in canals in eastern Dade County.

S-190 is a gated spillway located in the L-28 Interceptor borrow canal about 32 miles south of Clewiston. (The structure is not shown on Figure 12). S-190 prevents overdrainage of the lands drained by the tributaries of the L-28 Interceptor borrow canal (i.e., the East and West Feeder Canals) by maintaining optimum upstream water levels. Water discharged through the structure is passed to WCA 3A by way of the L-28 Interceptor borrow canal. During the wet season (May 15 to October 15), the upstream stage is maintained insofar as is possible between 14.2 and 14.8 ft NGVD. During the dry season (October 15 to May 15), the upstream stage is maintained insofar as is possible between 15.2 and 15.8 ft NGVD.

S-333 is a gated spillway located in L-67 at the intersection of L-67 and L-29 at the southeast corner of WCA 3A. It connects WCA 3A to the L-29 borrow canal and subsequently to ENP and to the South Dade Conveyance System (SDCS). The structure currently has three functions: (1) to supply water to the basins in southeastern Dade County by way of the SDCS, (2) to supply water to ENP by way of Northeast Shark River Slough, and (3) when required by the WCA 3A regulation schedule, to discharge excess water to the L-29 borrow canal. Functions two and three are a result of the current experimental water management plan for water deliveries to Shark River Slough in ENP and were not part of the original design for S-333. (See Comments on Design and Operation.) Regulatory discharges to the L-29 borrow canal can be routed to Northeast Shark River Slough, or to canals of the SDCS

with subsequent discharge to Taylor Slough and the Eastern Panhandle of ENP and to tidewater in Biscayne Bay. Water supply releases to the SDCS through S-333 are made in conjunction with S-337. S-337 releases water from WCA 3B or from WCA 3A by way of C-304 to the SDCS by way of the L-30 borrow canal. The total amount of water released at S-337 and S-333 is the amount necessary to maintain minimum water deliveries to ENP (i.e., to the Eastern Panhandle and Taylor Slough) and to maintain the optimum stages at coastal structures in Project canals in south Dade County. When S-333 is used for water supply to the SDCS, the headwater stage at S-334 is maintained between 5.0 and 7.0 ft NGVD. When S-333 is used to make regulatory releases from WCA 3A, the stage in L-29 at the L-29-1 culvert must be maintained below 7.5 ft NGVD to prevent flooding of the Indian village located on the berm. Water releases at S-333 are curtailed if the water table elevation at groundwater well G-3273 exceeds 6.8 ft NGVD. G-3273 is located approximately in the center of the East Everglades area bounded by ENP, WCA 3A, and L-31N.

S-339 is a gated sheetpile barrier dam located in the alignment of C-123 (the Miami Canal) about six miles north of Interstate Highway 75. The gates on the structure are usually closed to prevent excess drainage of the northern portion of WCA 3A and to force water out of C-123 and into the surrounding wetlands. The gates are opened to facilitate water movement down C-123 for regulatory releases or for water supply. The openings are governed by the stage in the WCA, the amount of water being pumped at S-8, the amount of water deliveries being made to the SDCS and to ENP, and the gate opening at S-340. The optimum headwater stage at S-339 is 11.0 ft NGVD.

S-340 is a gated sheetpile barrier dam located in the alignment of C-123 (the Miami Canal) about 2.7 miles south of Interstate Highway 75. The gates on the structure are usually closed to prevent excess drainage of the central portion of WCA 3A and to force water out of C-123 and into the surrounding wetlands. The gates are opened to facilitate water movement down C-123 for regulatory releases or for water supply. The openings are governed by the stage in the WCA, the amount of water being pumped at S-8, and the amount of water deliveries being made to the SDCS and to ENP. The optimum headwater stage at S-340 is 9.3 ft NGVD.

S-343A and S-343B are gated culverts through L-29 between L-28 and S-12A. They connect WCA 3A to the Tamiami Canal and to the area between U.S. Highway 41 and the Loop Road by way of numerous culverts and bridges under U.S. Highway 41. Flow from this area to the south to ENP is restricted by the Loop Road which has few culverts under it. Water may build up in the area and eventually discharge to the south to the ENP basin over the top of the Loop Road. S-343A and S-343B are normally closed. They are opened to discharge water from WCA 3A according to the WCA's regulation schedule (Figure 10 and Table 6).

S-344 is a gated culvert through L-28 about nine miles north of U.S. Highway 41. The L-28 borrow canal crosses the levee from east to west at this structure. Its principal function is to make regulatory discharge from WCA 3A (Figure 10 and Table 6). Flow through S-344 is diverted to the south in the L-28 borrow canal to the Tamiami Canal. It joins flow from the S-343 structures in passing to the southwest under U.S. Highway 41 by way of various culverts and bridges. S-344 may also make discharges to the Big Cypress Preserve to extend the hydroperiod during day periods.

G-64 is a gated culvert through L-38W at Twenty-Six Mile Bend. The structure drains the area between L-38E and L-38W to WCA 3A. The structure is normally open.

G-123 is a pumping station located on the North New River Canal adjacent to S-34. It pumps excess water from the reach of the North New River Canal downstream of S-34 to the reach of the canal upstream of S-34. This water is subsequently discharged to WCA 3A by way of S-142. Pumping is initiated if the headwater stage (i.e., east side) at G-123 exceeds 3.7 ft NGVD. Pumping is terminated if the headwater stage drops below 3.5 ft NGVD or if the tailwater stage rises above 1 1.5 ft NGVD. S-34 is closed during pumping at G-123.

G-155 is a sheetpile weir located in the gap between L-4 and L-4 Extension at the northwest corner of WCA 3A. Control of waterflow is effected by risers and stoplogs. The structure permits water from the L-3 borrow canal to flow into WCA 3A, but it prevents overdrainage of the area drained by the canal by maintaining optimum upstream (i.e., in the L-3 borrow canal) water levels. Upstream water levels are changed by adding or removing stoplogs. During the dry season, the optimum upstream water level is 14.5 ft NGVD, and during the wet season, it is 12.5 ft NGVD.

G-204, G-205, and G-206 are sets of culverts located in L-5 at the north end of WCA 3A. G-204 is 0.6 miles east of S-8; G-205 is 3.7 miles east; and G-206 is 7.7 miles east. Water flow through the culverts is controlled by risers and stoplogs. The culverts are used to regulate the water level in the Holey Land tract located north of L-5. Operational criteria for these culverts are determined by an agreement between the South Florida Water Management District and the Florida Game and Fresh Water Fish Commission. Discharge will be from the Holey Land into WCA 3A. See **Comments on Design and Historic Operation**.

Comments on Design and Historic Operation

Project Design

WCA 3A is impounded by seven levees: L-4, L-5, L-28, L-29, L-38W, L-67A, and L-68A (Figure 12). These levees were designed to hold water in WCA 3A at stages estimated to occur during the Standard Project Flood. The design was formulated assuming that the regulation schedule for the WCA would allow for continued growth of emergent vegetation. The emergent vegetation significantly reduces the wind tide and wave run-up to be expected during a major hurricane. Without the vegetation, the levees would have to be much larger than they are to provide the same flood protection.

Modified Water Deliveries to Everglades National Park General Design Memorandum

The U.S. Army Corps of Engineers (COE) is currently considering a General Design Memorandum (GDM) that, if implemented, would change the way water deliveries are made to ENP. Until recently water delivered to the Park originated in WCA 3A and was passed to the Park west of L-67 Extension by way of the S-12 structures. The deliveries were made according to a fixed delivery schedule and by the need to maintain WCA 3A at its regulation schedule. The majority of water released from WCA 3A for regulatory purposes was through the S-12 structures. It has become apparent, however, that the temporal and spatial distribution of these deliveries is having adverse effects on the natural environment in the Park. The COE's GDM is in response to these concerns about the distribution of water deliveries to the Park.

The GDM proposes changes to the physical system of canals and structures and proposes methods of operation for the structures that if implemented would, as nearly as possible, return the hydrology of Shark River Slough to a natural condition. The physical system would be changed to allow more water to be delivered to ENP by way of Northeast Shark River Slough east of L-67 Extension. There are five modifications being considered: (1) construction of structures in L-67A to allow water to be passed from WCA 3A to WCA 3B, (2) construction of structures in L-29 to allow water to be passed from WCA 3B to Northeast Shark River Slough, (3) removal of L-67 Extention and filling of the borrow canal, (4) construction of a levee around a residential area in the East Everglades west of L-31N (to protect the area from flooding), and (5) construction of two pumping stations to control seepage and discharge from the protected area and L-31N. Operation of the new and existing structures would be changed to allow water deliveries to be more "naturally" based, that is, correlated to upstream weather conditions. The COE is currently testing a water management plan, the Rainfall Plan developed by the District in consultation with the COE and ENP, for determining amounts of water deliveries to the Park based on upstream weather conditions.

As part of the Rainfall Plan the regulation schedule for WCA 3A has been modified to moderate the abrupt changes in discharge to Everglades National Park that occurred under the unmodified schedule whenever the water level in WCA 3A exceeded the regulation schedule. Under the Rainfall Plan, transition zones have been added to the regulation schedule. The effect of these transition zones is to gradually change the discharge to the Park as the water level in WCA 3A approaches the regulation schedule.

Inflows from the EAA

The original drainage design for the Everglades Agricultural Area (EAA) called for removing excess water from the EAA to both Lake Okeechobee and the WCAs. Because of environmental problems in the lake resulting from inflows of nutrient rich water, the current District water management plan for the EAA discourages discharge of water to Lake Okeechobee. Consequently, almost all water pumped from the EAA is discharged to the WCAs.

This water management plan is known as the Interim Action Plan (IAP) and was originally implemented under the Lake Okeechobee Temporary Operating Permit from the Florida Department of Environmental Regulation (FDER). FDER has since granted the District permission to continue the plan under the Lake Okeechobee Operating Permit (LOOP). See An Atlas of Everglades Agricultural Area Surface Water Management Basins (Cooper, 1989) for specific information concerning the operation of structures in the EAA under the IAP.

Lake Okeechobee Regulatory Discharge

WCA 3A is the receiving body for regulatory releases from Lake Okeechobee by way of the North New River and Miami Canals. However, during a major storm event, water is discharged primarily through the Caloosahatchee River (C-43) and the St. Lucie Canal (C-44). This is a result of localized drainage entering the North New River and Miami canals reducing their ability to receive regulatory discharges from the lake.

Although the St. Lucie Canal and the Caloosahatchee River can pass the largest discharges from the lake, they are not the preferred outlets from the lake since

water released in this way is lost to the ocean and, in some cases, damages the estuaries of the St. Lucie and Caloosahatchee Rivers. To the extent practicable, regulatory releases are made to the North New River and Miami canals. Water released to these canals is stored in the WCAs, if possible, to keep it in the system. This affords additional opportunity for using the water, and it limits the amount of freshwater that enters the estuaries of the Caloosahatchee and St. Lucie Rivers.

Although first priority is given to regulatory releases by the North New River and Miami canals, such releases are not common, and little of the regulatory discharge from Lake Okeechobee is handled in this way. There are two reasons that regulatory releases to the agricultural canals are rare.

1. Most significantly, regulatory releases to the North New River and Miami canals cannot be made if to do so would compromise agricultural water control in any of the basins the canals pass through. In general, it is required that weather conditions in the affected EAA basins be dry and that water levels in the canals be low enough not to restrict local inflows. As a rule of thumb, the canal water levels must be below 11.0 ft NGVD. With no local inflows, however, the tailwater level at the outlet structure (i.e., S-351 for the North New River Canal and S-354 for the Miami Canal) can be allowed to rise as high as 13.5 ft NGVD during regulatory discharge.

2. Although COE and District policy does not explicitly restrict regulatory releases to the WCAs when the WCAs are over schedule, such releases usually are not made if it is perceived the releases would be harmful to the environment in the receiving WCA, e.g., by drowning deer in WCA 3A.

The wet weather conditions that cause Lake Okeechobee to go over schedule also are likely to create wet conditions in the EAA basins, with water levels over 11.0 ft NGVD, and to cause the WCAs to go over schedule. These factors combine to make regulatory releases by way of the North New River and Miami canals rare events.

C-123 (The Miami Canal)

As originally excavated, the Miami Canal in the reach that crosses WCA 3A had only a limited conveyance. In 1966, the COE issued a Letter Report recommending that the conveyance of the Miami Canal in this reach be increased to 1,000 cfs in order to better supply water to eastern Dade County and ENP. The spoil piles from the original excavation had created high ground where trees and other dry site vegetation had become established. Since these sites were considered valuable wildlife habitat, it was further recommended that a new canal, C-123, be excavated parallel to the original channel. North of Alligator Alley, C-123 was dug 900 feet west of the Miami Canal and south of Alligator Alley; C-123 was dug 200 feet west of the Miami Canal. C-123 was completed in 1972.

G-204, G-205, and G-206

These sets of culverts provide an outlet for the Holey Land tract to WCA 3A. The Holey Land is a large tract of state property east of the Miami Canal and north of WCA 3A. Under a District plan, the area would be restored as a functional wetland. This would require reintroduction of overland flow into the area. Water would be pumped into the north end of the tract from the Miami Canal, and would be discharged from the tract to the WCA by way of G-204, G-205, and G-206. The pump

stations, levees, and outlet culverts necessary for the restoration are in place, but disagreement among the various state agencies with jurisdiction over the acres as to the operational plan has prevented implementation of the restoration up to the time of this writing. See An Atlas of the Surface Water Management Basins of the Everglades Agricultural Area (Cooper, 1989) for more information on the Holey Land.

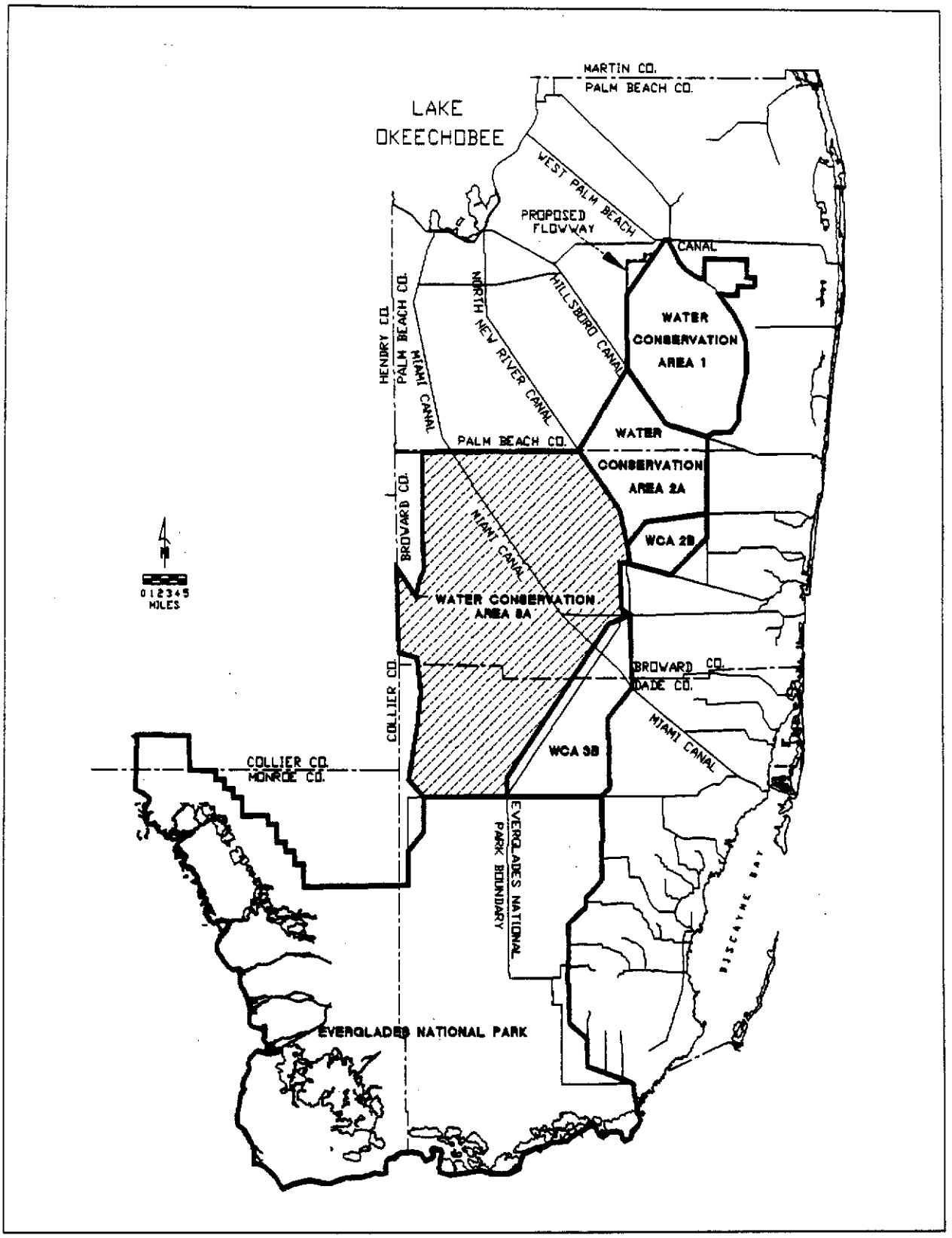

FIGURE 11. Water Conservation Area 3A Location Map

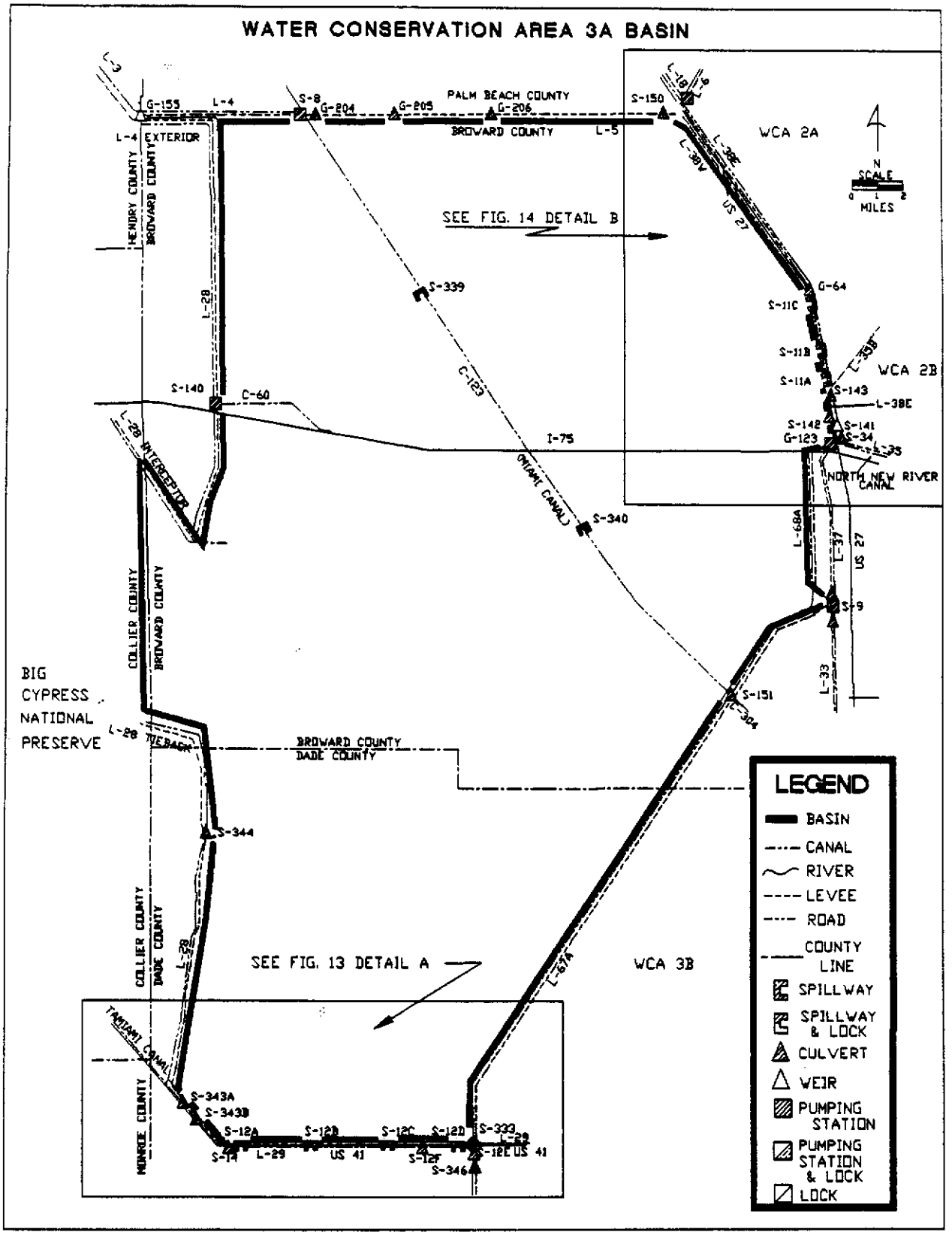

FIGURE 12. Water Conservation Area 3A Basin Map

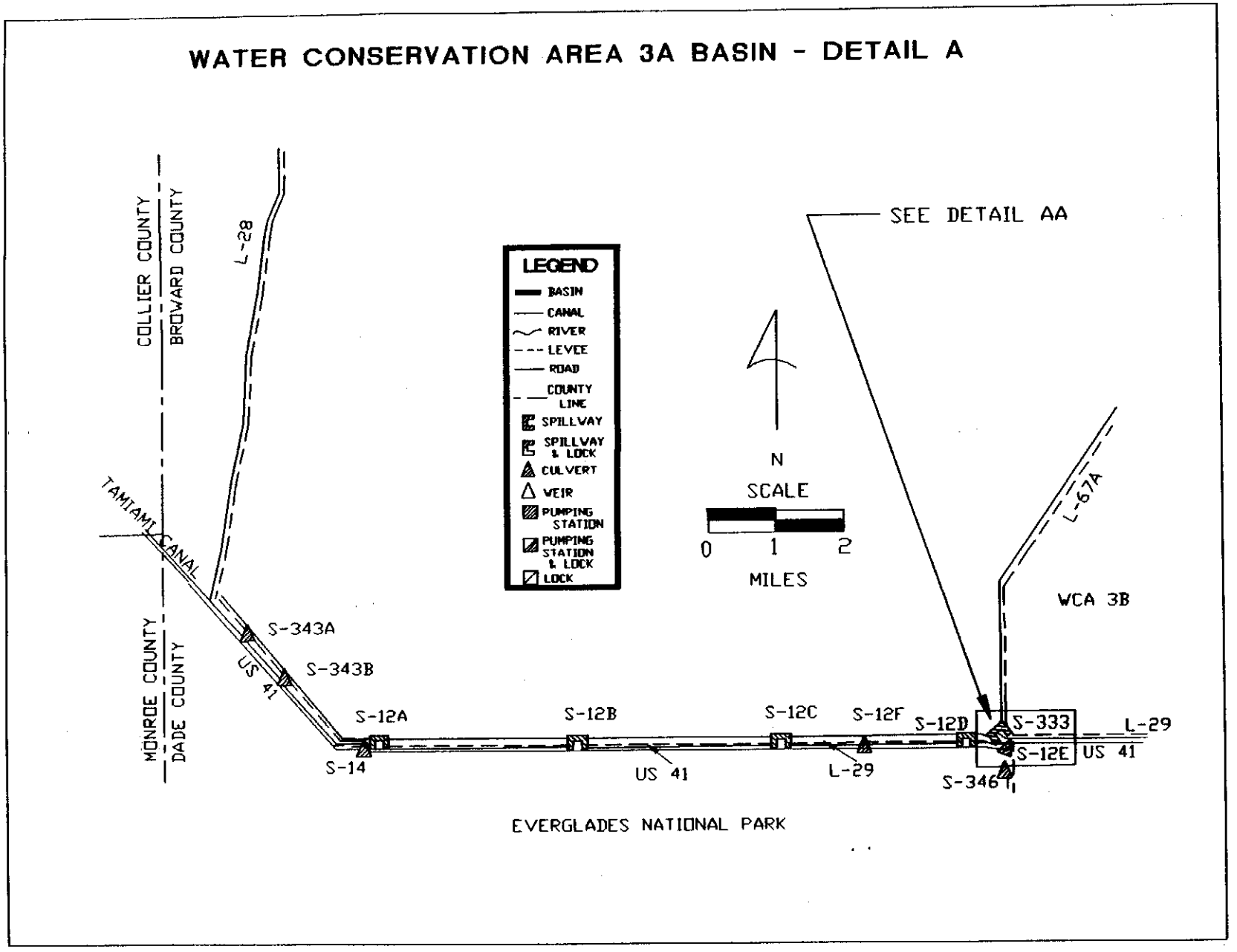

FIGURE 13. Water Conservation Area 3 Basin (Detail A)

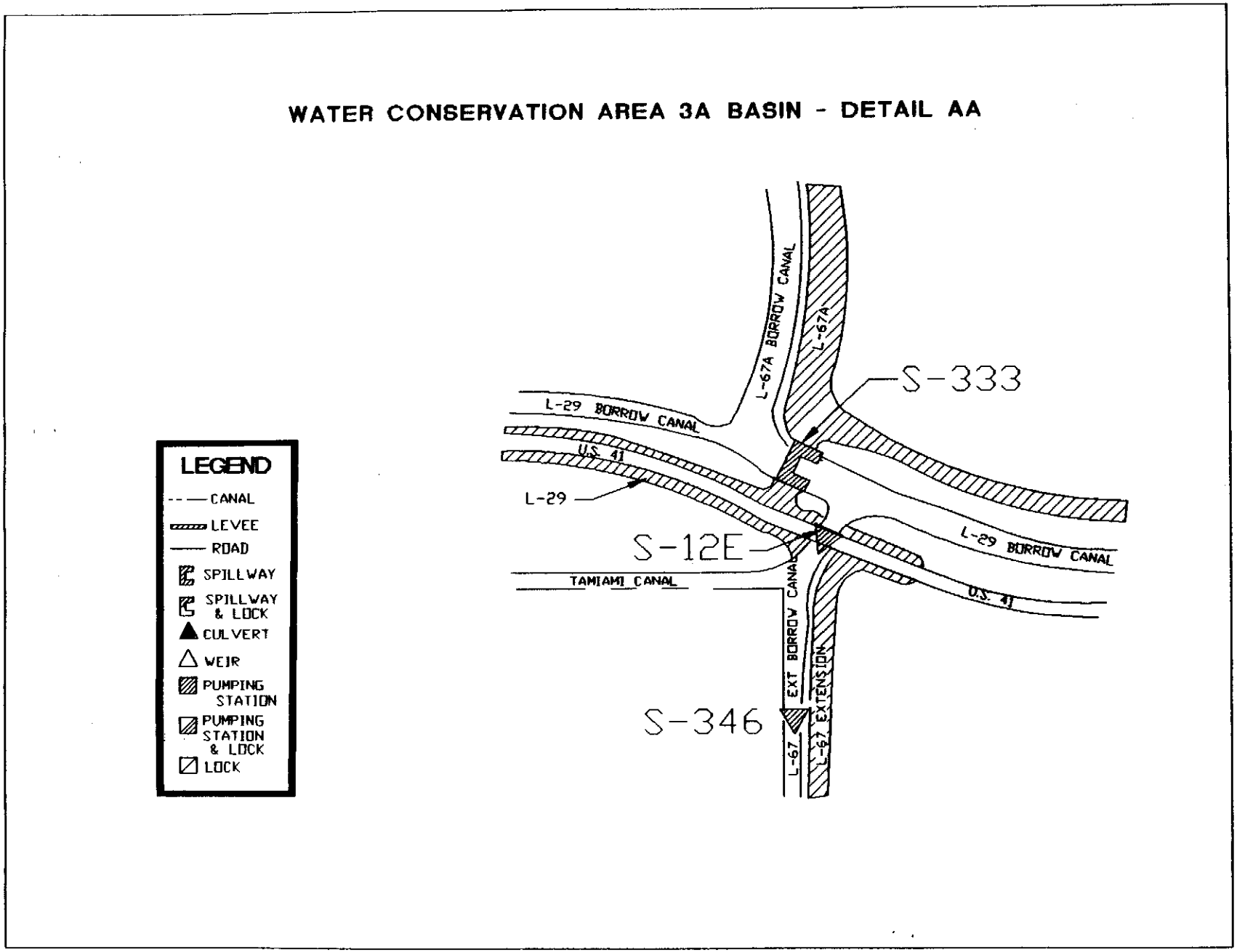

FIGURE 13A. Water Conservation Area 3 Basin (Detail AA)

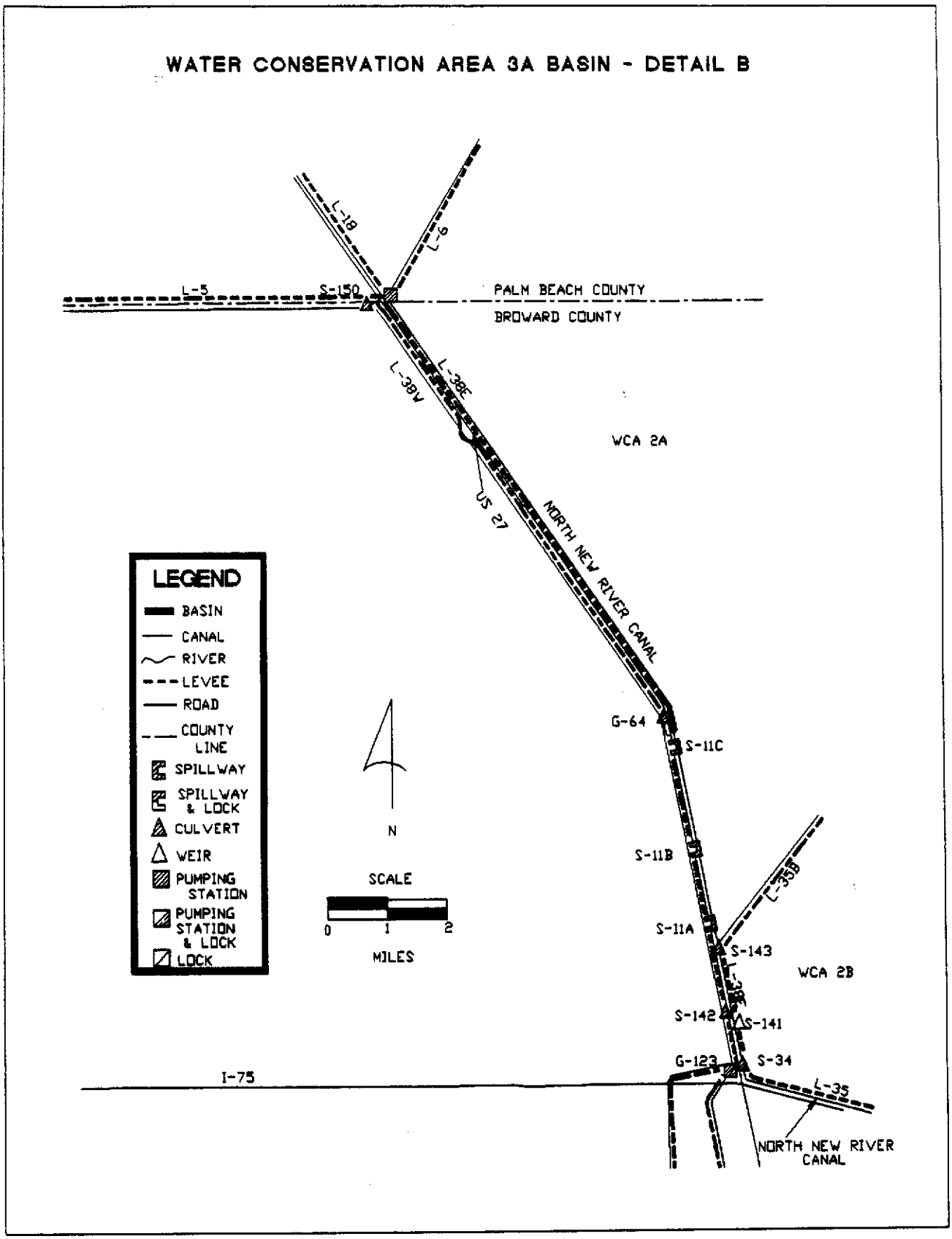

FIGURE 14. Water Conservation Area 3A Basin Map (Detail B)

TABLE 7. Water Conservation Area 3A Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-8	Pump Station 4 units-1040 cfs each Gated Box Culvert 1-16.5 ftx14.4 ftx78.5 ft Reinforced concrete box invert elev = 1.0 ft NGVD	12.0 (Pumped Discharge) 12.0 (Gravity Discharge) (EAA side)	16.5 11.9 (Gravity Discharge) (WCA 3A side)	10.0-12.5 in Miami Canal	4170 (Pumped Discharge) 500 (Gravity Discharge)	HW = 13.05 TW = 14.69 Q = 4240 (pump) Q = 1250 (SPW)	2/15/66 7/11/66 10/22/69 1/18/77
S-9	Pump Station 3 units-960 cfs each	4.0 (C-11 side)	14.4 (WCA 3A side)	3.0-3.5	2880	Intake = 6.1 Q = 2060	4/25/79 8/18/81
S-11A	Gated Spillway 4 gates 9.0 ft highx25.8 ft wide net crest lgth = 100.0 ft crest elev = 7.5 ft NGVD	15.6 (WCA 2A side)	14.6 (WCA 3A side)	Regulation Schedule in WCA 2A	5570	HW = 15.5 Q = 2685	11/18/69 2/31/80
S-11B	Gated Spillway 4 gates 9.0 ft highx25.8 ft wide net crest lgth = 100.0 ft crest elev = 7.5 ft NGVD	15.6 (WCA 2A side)	14.6 (WCA 3A side)	Regulation Schedule in WCA 2A	5570	HW = 15.5 Q = 2194	11/18/69 9/24/77
S-11C	Gated Spillway 4 gates 9.0 ft highx25.8 ft wide net crest lgth = 100.0 ft crest elev = 7.5 ft NGVD	15.6 (WCA 2A side)	14.6 (WCA 3A side)	Regulation Schedule in WCA 2A	5570	HW = 15.5 Q = 3408	11/18/69 8/15/78
S-12A	Gated Spillway 6-gates 10.2 ft highx25.8 ft wide Net crest lgth = 150 ft Crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation Schedule in WCA 3A	8000	HW = 10.5 TW = 10.2 Q(south) = 783	10/26/68 7/17/82 11/6/82
S-12B	Gated Spillway 6-gates each 10.2 ft highx25.8 ft wide Net crest lgth = 150 ft Crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation Schedule in WCA 3A	8000	HW = 10.5 TW = 10.3 Q(North) = 22 Q(South) = 819	10/26/68 11/6/69 3/27/76 9/23/76
S-12C	Gated Spillway 6-gates 10.2 ft highx25.8 ft wide Net crest lgth = 150 ft Crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation Schedule in WCA 3A	8000	HW = 10.5 TW = 10.4 Q(North) = 13 Q(South) = 1340	10/26/68 11/7/69 2/27/85 10/17/78

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

TABLE 7. Water Conservation Area 3A Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-12D	Gated Spillway 6-gates 10.2 ft highx25.8 ft wide Net crest lgth = 150 ft Crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation Schedule in WCA 3A	8000	HW = 10.5 TW = 10.2 Q(North) = 16 Q(South) = 1640	10/26/68 10/6/82 3/28/85 11/5/82
S-140	Pump Station 3 units: 435 cfs each Gated box culvert 1-16 ftx16 ftx56.6 ft Reinforced concrete box invert elev = 3.0 ft	10.5 (Pumped Discharge) 10.5 (Gravity Discharge) (L-28 Borrow Canal side)	14.6 (Pumped Discharge) 10.3 (Gravity Discharge) (WCA 3A side)	10.5 (Pumped Discharge) 10.5 (Gravity Discharge)	1300 (Pumped Discharge) 300 (Gravity Discharge)	HW = 11.4 TW = 13.0 Q = 1504 Q = 303	6/24/86 6/30/86 6/20/82 7/1/85
S-142	Gated culvert 2-72 in x 42ft CMP Invert elev = 2.0 ft NGVD	11.0 (WCA 3A side)	9.0 (North New River Canal side)		500	TW = 11.3	6/27/85
S-150	Gated culvert 5-84in x 92ft CMP Invert elev = 3.0ft NGVD	11.0 (EAA side)	10.0 (WCA 3A side)	Not used to control stage	1000	HW = 14.09 TW = 12.28 Q = 1575	10/31/61 7/16/68 3/30/82
S-151	Gated culvert 6-84 in x 98 ft CMP Invert elev = -15.0 ft NGVD	7.5 (WCA 3A side)	6.4 WCA 3B side)	Regulation Schedule in WCA 3A	1105	HW = 11.80 TW = 9.80 Q = 1959	11/7/69 8/12/88 2/17/83
S-333	Gated Spillway 1-gate 14.6ft highx29ft wide net crest lgth = 29ft crest elev = -3.1ft NGVD	7.5 (WCA 3A side)	7.0 (L-29 Borrow Canal side)	Regulation Schedule in WCA 3A	1350	HW = 10.50 TW = 7.80 Q = 1610	7/18/82 8/18/82 5/14/85
S-339	Gated Sheetpile barrier dam 3 gates 12 ft high x 12 ft wide net crest lgth = 36 ft crest elev = -2.8 ft NGVD	11.0 (north side)	10.8 (south side)	HW = 11.0	1100	HW = 12.25 TW = 11.82 Q = 1362	11/12/87 9/11/88 5/7/85
S-340	Gated Sheetpile barrier dam 3-gates 12ft highx12ft wide net crest length = 36ft crest elev = -4.3ft NGVD	9.3 (north side)	9.1 (south side)	HW = 9.3	1100	HW = 11.45 TW = 11.50 Q = 2630	7/14/82 9/1/88 7/2/85
S-343A S-343B	Gated Culverts 3-72 in x 82 ft CMP invert elev = 0.0 ft NGVD	9.5 (WCA 3A side)	9.3 (south side)	Regulation Schedule in WCA 3A	195		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

TABLE 7. Water Conservation Area 3A Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-344	Gated Culvert 3-72 in x 78 ft CMP invert elev = 1.0 ft NGVD	9.9 (WCA 3A side)	9.7 (west side)	Regulation Schedule in WCA 3A	135		
G-64	Gated Culvert 1-72 in x 72 ft CMP invert elev = 2.5 ft NGVD	(north side)	(south side)				
G-123	Pump Station 4 units; 100 cfs each	20.0 (south side of S-34)	12.0 (north side of S-34)		400		
G-155	Sheet-pile weir with stoplogs 14 bays each 5.9 ft wide Net crest length = 73 ft crest elevation = 10.0 ft	14.5	14.0		890		
G-204	Culvert with riser and stoplogs 4-72inx72 ft CMP invert elev = 5.39ft NGVD			Holey Land Operational Schedule			
G-205	Culvert with riser and stoplogs 6-72 in x72 ft CMP invert elev = 4.44ft NGVD			Holey Land Operational Schedule			
G-206	Culvert with riser and stoplogs 5-66 inx66ft CMP invert elev = 3.75ft NGVD			Holey Land Operational Schedule			

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

WATER CONSERVATION AREA 3B

Description of the Basin

The Water Conservation Area 3B (WCA 3B) basin has an area of 153.6 square miles and is located (Figure 15) in south-central Broward County (30.5 square miles) and in north-central Dade County (123.1 square miles). The boundary of the WCA 3B basin relative to local roads and landmarks is shown on Map A. A schematic map showing the WCA 3B basin boundary, canals, and control structures is given in Figure 16.

General Function and Operation of Project Structures

WCA 3B and its associated Project structures have seven primary functions: (1) to provide viable wetlands habitat (i.e., the WCA is managed insofar as is practicable as a natural Everglades system), (2) to recharge regional groundwater (i.e., the Biscayne Aquifer), (3) to supply water to adjacent basins in Dade County, (4) to provide conveyance for water supply releases from Lake Okeechobee and WCA 3A to eastern Dade County and southeastern Everglades National Park, (5) to receive and store regulatory discharges from WCA 3A, (6) to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in eastern Dade County, and (7) when WCA 3B can not store the regulatory discharges from WCA 3A, to provide conveyance for the discharges through the WCA for subsequent discharge to tidewater. Rainfall is the primary source of water to WCA 3B. Water supply releases from WCA 3A or Lake Okeechobee to eastern Dade County and southeastern ENP are passed through WCA 3B by way of C-304 (i.e., the Project name for the Maimi Canal in WCA 3B). Regulatory releases from WCA 3A are made to WCA 3B by way of S-151. These releases are stored in WCA 3B when capacity is available; otherwise, they are routed through WCA 3B to C-6 (i.e., the Project name for the Miami Canal east of WCA 3B) by way of C-304 and S-31. There is not a regulation schedule for WCA 3B, but as a rule of thumb, if the water level in the WCA exceeds about 9.5 ft NGVD, the excess water is discharged to C-6.

WCA 3B occupies an area of significant recharge to the Biscayne Aquifer. Water supplied to the aquifer by way of WCA 3B is important to maintaining groundwater levels in coastal areas to the east. Adequate groundwater levels are essential to proper management of municipal well fields and to restrict saltwater intrusion to groundwater. The borrow canals of the levees impounding WCA 3B cut into the Biscayne Aquifer and intercept some of the groundwater flow to the east. The intercepted ground water and seepage through the levees is an important source of water supply to adjacent basins in Dade County: to the C-9 and C-11 basins by seepage to the L-33 and L-37 borrow canals, to the C-4 basin by seepage to the L-30 borrow canal, and to Northeast Shark River Slough by seepage to the L-29 borrow canal.

The rate of seepage to the L-33 borrow canal is regulated by the water level held in the canal by S-9XS, S-30, and S-32. Seepage from the L-33 borrow canal to C-9 is a major source of water supply to the C-9 basin. Water can also be supplied to the C-9 basin from WCA 3B or WCA 3A by way of S-31, S-32, and S-30. Excess water in the L-33 borrow canal is discharged through S-9XS which acts as a weir to maintain the desired water level.

The rate of seepage to the L-30 borrow canal is regulated by the water level held in the canal by S-335. Excess water in the L-30 borrow canal is discharged to the south to the L-31N borrow canal by way of S-335. S-32A is a divide structure at the north end of the L-30 borrow canal. It prevents water in the borrow canal from flowing north into C-6.

The rate of seepage to the L-29 borrow canal is not specifically regulated by operation of Project structures, although the water level in the L-29 borrow canal probably effects the rate of seepage. The water level in the borrow canal can not be effectively maintained at an optimum level since there are open culverts under U.S. Highway 41 connecting the L-29 borrow canal to Northeast Shark River Slough to the south. Excess water in the L-29 borrow canal passes to the south through these culverts. Raising the water level in the canal to reduce seepage increases the discharge of water to Northeast Shark River Slough.

Project Canals

The Miami Canal is the Project canal primarily affecting water management in WCA 3B. C-304 is that section of the Miami Canal from S-151 to S-31. It crosses the upper quarter of the WCA from northwest to southeast. It is used primarily to convey water across the WCA from either Lake Okeechobee or WCA 3A to eastern Dade County and southeastern ENP. The reaches of the Miami Canal west of WCA 3B (i.e., C-123 and the L-23/L-24 borrow canal) convey water to WCA 3B from Lake Okeechobee and WCA 3A.

The various borrow canals of the levees impounding the WCA on the east (i.e., L-29, L-30, and L-33) intercept seepage from the WCA and convey this water to adjacent basins for maintenance of groundwater levels and municipal water supply.

Project Water Control Structures

There are nine Project water control structures affecting flow into and out of WCA 3B. Inflows are controlled by S-151. Outflows are controlled by S-9XS, S-30, S-31, S-32, S-32A S-335, S-337, and G-69. Design criteria for the control structures in WCA 3B are given in Table 8.

S-9XS is a culvert located in the L-33 borrow canal just south of C-11. Control of water flow is effected by risers and stoplogs. In conjunction with S-30 and S-32, S-9XS regulates the amount of seepage through L-33 to the L-33 borrow canal by controlling the stage held in the L-33 borrow canal. S-30 and S-32 are not generally opened and S-9XS is used as a weir to maintain the optimum stage in the borrow canal of 6.0 ft NGVD. Excess water is discharged to C-11 by way of S-9XS.

S-30 is a gated culvert located in C-9 on the west side of U.S. Highway 27. In conjunction with S-32 and S-9XS, S-30 regulates the amount of seepage through L-33 to the L-33 borrow canal by controlling the stage held in the L-33 borrow canal. S-30 and S-32 are not generally opened and S-9XS is used as a weir to maintain the optimum stage in the borrow canal of 6.0 ft NGVD. Excess water in the borrow canal is discharged to C-11 by way of S-9XS. Subject to availability, water can be supplied to the C-9 basin from WCA 3B or WCA 3A by way of S-31, S-32 and S-30 to maintain the optimum stage in C-9. Seepage around S-30 from the L-33 borrow canal to C-9 is also an important source of water supply to the C-9 basin.

S-31 is a gated culvert located in the Miami Canal (between C-304 and C-6) and through L-30. This structure permits releases of excess water from WCA 3B, and when used in conjunction with S-151, it permits releases of excess water from WCA 3A. Water release can be made at S-31 if the stage in WCA 3A is over its regulation schedule, or if the stage in WCA 3B exceeds 9.5 ft NGVD. During periods of low natural flow, sufficient water is released to C-6 by way of S-31 to maintain a headwater stages of 2.5 ft NGVD at S-26 in C-6 and 1.85 ft NGVD at S-27 in C-7.

S-32 is a gated culvert located in the L-33 borrow canal just north of C-6. In conjunction with S-30 and S-9XS, S-32 regulates the amount of seepage through L-33 to the L-33 borrow canal by controlling the stage held in the L-33 borrow canal. S-30 and S-32 are not generally opened and S-9XS is used as a weir to maintain the optimum stage in the borrow canal of 6.0 ft NGVD. Excess water in the borrow canal is discharged to C-11 by way of S-9XS. Subject to availability, water can be supplied to the C-9 basin from WCA 3A or WCA 3B by way of S-31, S-32, and S-30 to maintain the optimum stage in C-9.

S-32A is a gated culvert located in the L-30 borrow canal at its north end. It is always closed and acts as a divide between C-6 and the L-30 borrow canal.

S-151 is a gated culvert located in the alignment of the Miami Canal at the point L-67A crosses the canal. It connects WCA 3A to WCA 3B. The structure has two functions: (1) to discharge excess water from WCA 3A and (2) to supply water to WCA 3B and to basins in eastern Dade County. Regulatory releases from WCA 3A by way of S-151 are made according to the regulation schedule for the WCA (Figure 10 and Table 6). During periods of low natural flow, water is discharged through S-151 as necessary to maintain the optimum stages in canals in eastern Dade County.

S-335 is a gated spillway located in the alignment of the L-30 borrow canal just north of C-4. It is part of the SDCS, and it connects the L-30 borrow canal to the L-31N borrow canal. The structure has two functions: (1) to make water deliveries to basins in south Dade County, and (2) to maintain an optimum headwater stage (in the L-30 borrow canal) for control of seepage from WCA 3B. Water supply releases are made in conjunction with S-334. S-334 releases water from the L-29 borrow canal to the L-31N borrow canal. The total amount of water released at S-335 and S-334 is the amount necessary to maintain the optimum stages at coastal structures in Project canals in south Dade County and to maintain upper canal reaches within 1.5 feet of the optimum during a 1 in 10 year drought. During operation of the SDCS for water supply, the headwater stage at S-335 is maintained between 5.0 and 6.0 ft NGVD and the stage in the L-31N borrow canal at S-331 is maintained between 3.0 and 3.5 ft NGVD. At other times S-335 is operated to maintain a stage of 6.0 ft NGVD in the L-30 borrow canal to reduce seepage from WCA 3B through L-30.

S-337 is a gated spillway located in the alignment of L-30 near the levee's north end and just south of C-6. The structure connects C-304 (the Miami Canal) in WCA 3B to the L-30 borrow canal and the SDCS. It has three functions: (1) to supply water to the SDCS from WCA 3B, (2) to discharge excess water from WCA 3B as capacity is available in downstream canals, and (3) to discharge sufficient water to the L-30 borrow canal to maintain the optimum stage in the canal for control of seepage from WCA 3B. Water supply releases to SDCS are made in conjunction with S-333. S-333 releases water from WCA 3A to the L-29 borrow canal and to the SDCS by way of S-334. The total amount of water released at S-337 and S-333 is the amount necessary to maintain the optimum stages at coastal structures in Project canals in south Dade County. During operation of the SDCS for water supply, the headwater

stage at S-335 is maintained between 5.0 and 6.0 ft NGVD and the stage in the L-30 borrow canal at S-32A is maintained below 6.0 ft NGVD. At other times S-337 is operated to maintain a stage of 6.0 ft NGVD in the L-30 borrow canal to reduce seepage from WCA 3B through L-30.

G-69 is a gated culvert located in L-29 about four miles west of L-30. It connects WCA 3B with the L-29 borrow canal. This culvert is also known as L-29-1 and was put in place by the COE at the time L-29 was constructed. The purpose of the culvert is to release water from WCA 3B as necessary for flood control. The culvert has very rarely been opened.

Comments on Design and Historic Operation

Project Design

WCA 3B is impounded by four levees: L-29, L-30, L-33, and L-67A (Figure 14). These levees were designed to hold water in WCA 3B during the Standard Project Flood (SPF). The design was formulated assuming that the regulation schedule for the WCA would allow for continued growth of emergent vegetation. The emergent vegetation significantly reduces the wind tide and wave run-up to be expected during a major hurricane. Without the vegetation, the levees would have to be much larger than they are to provide the same flood protection.

Modified Water Deliveries to Everglades National Park General Design Memorandum

The U.S. Army Corps of Engineers is currently considering a General Design Memorandum (GDM) that, if implemented, would change the way water deliveries are made to ENP. Until recently, water delivered to the Park originated in WCA 3A and was passed to the Park west of L-67 Extension by way of the S-12 structures. The deliveries were made according to a fixed delivery schedule and by the need to maintain WCA 3A at its regulation schedule. The majority of water released from WCA 3A for regulatory purposes was through the S-12 structures. It has become apparent, however, that the temporal and spatial distribution of these deliveries are having adverse effects on the natural environment in the Park. The COE's GDM is in response to these concerns about the distribution of water deliveries to the Park.

The GDM proposes changes to the physical system of canals and structures and proposes methods of operation for the structures that if implemented would, as nearly as possible, return the hydrology of Shark River Slough to a natural condition. The physical system would be changed to allow more water to be delivered to ENP by way of Northeast Shark River Slough east of L-67 Extension. There are four modifications being considered: (1) construction of structures in L-67A to allow water to be passed from WCA 3A to WCA 3B, (2) construction of structures in L-29 to allow water to be passed from WCA 3B to Northeast Shark River Slough, (3) removal of L-67 Extension and filling of the borrow canal, (4) construction of a levee around a residential area in the East Everglades west of L-31N (to protect the area from flooding), and (5) construction of two pumping stations to control seepage and discharge from the protected area and L-31N. Operation of the new and existing structures would be changed to allow water deliveries to be more "naturally" based, that is, correlated to upstream weather conditions. The Corps is currently testing a water management plan, the Rainfall Plan developed by the District in consultation with the COE and ENP, for determining amounts of water deliveries to the Park based on upstream weather conditions.

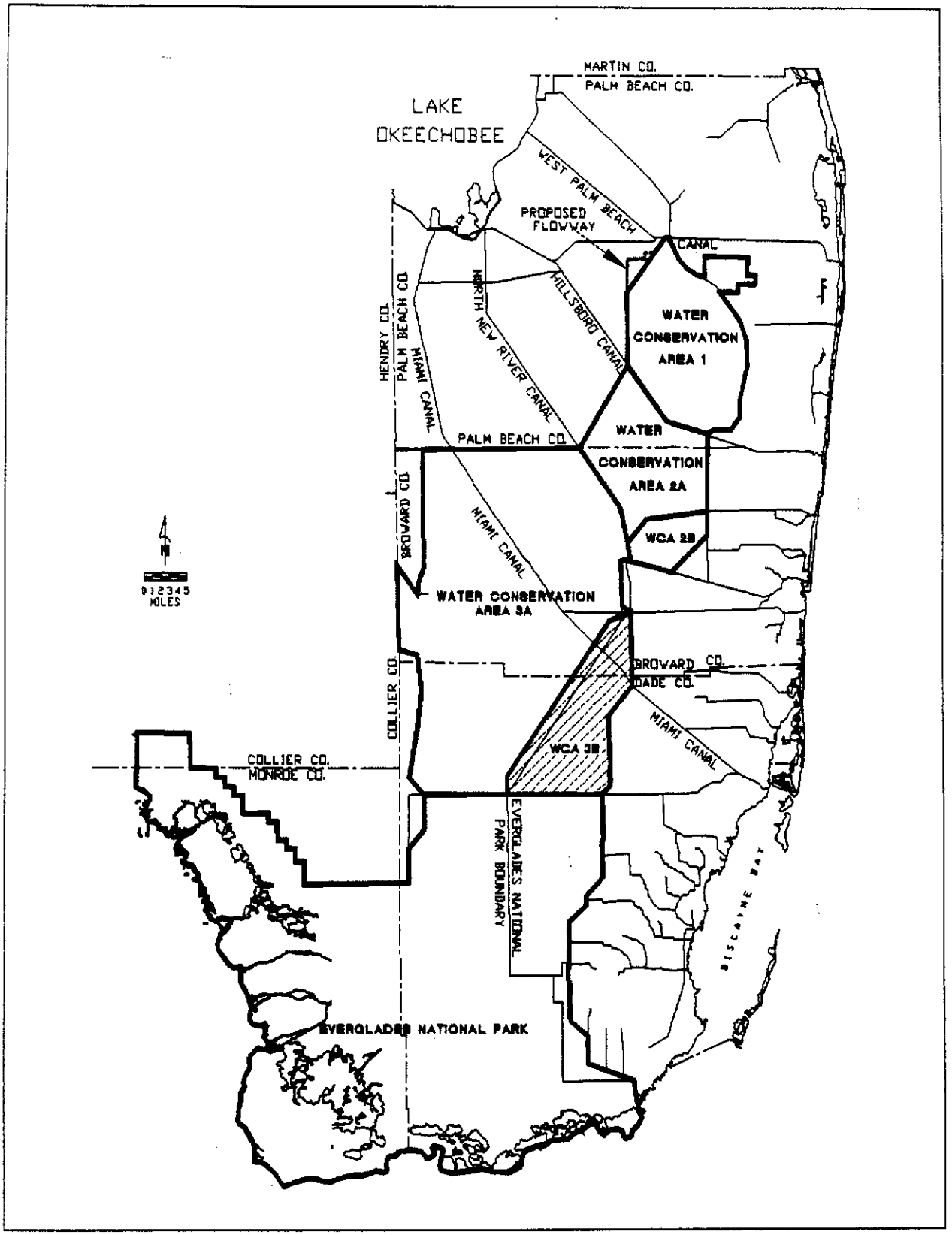

FIGURE 15. Water Conservation Area 3B Basin Location Map

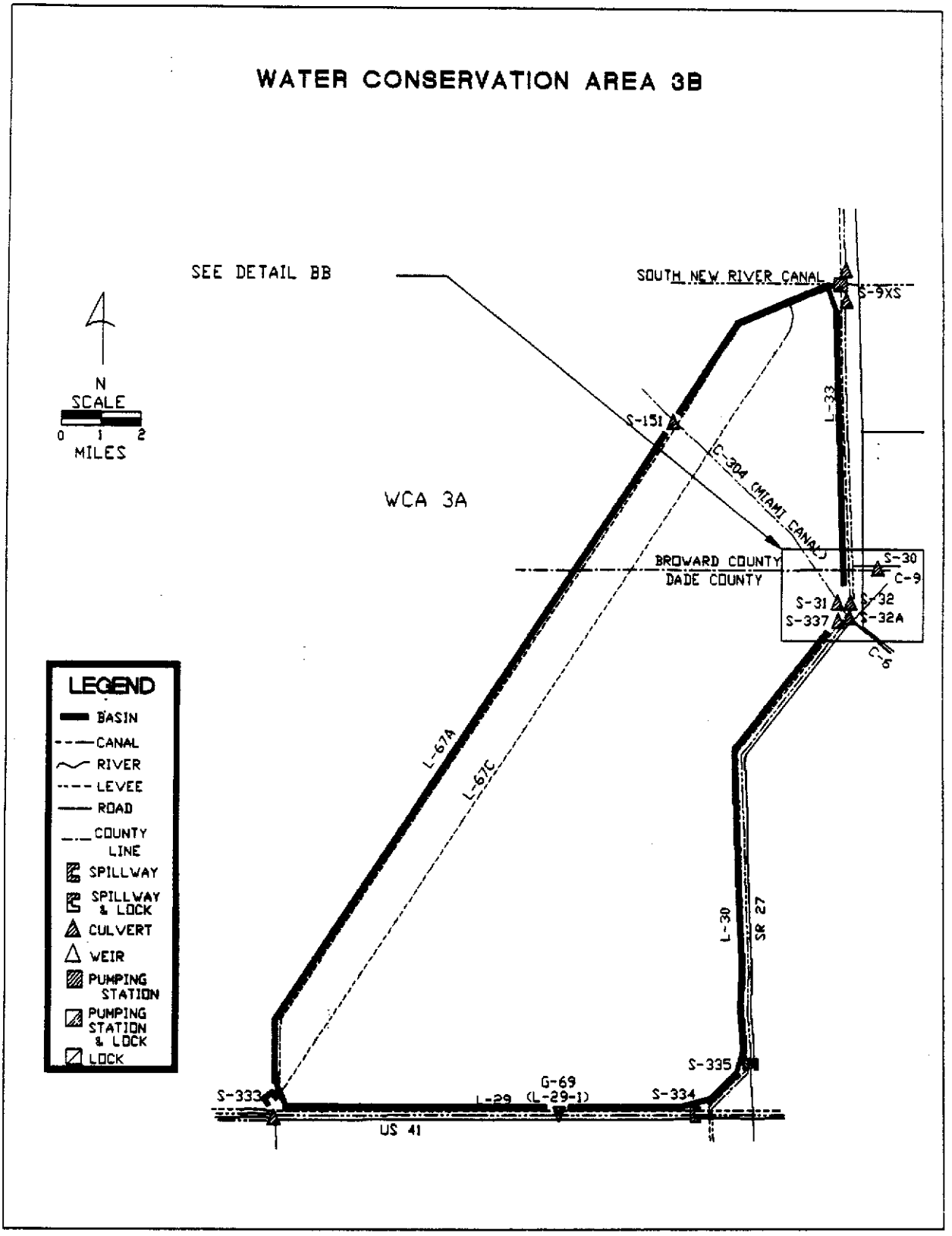

FIGURE 16. Water Conservation Area 3B Basin Map

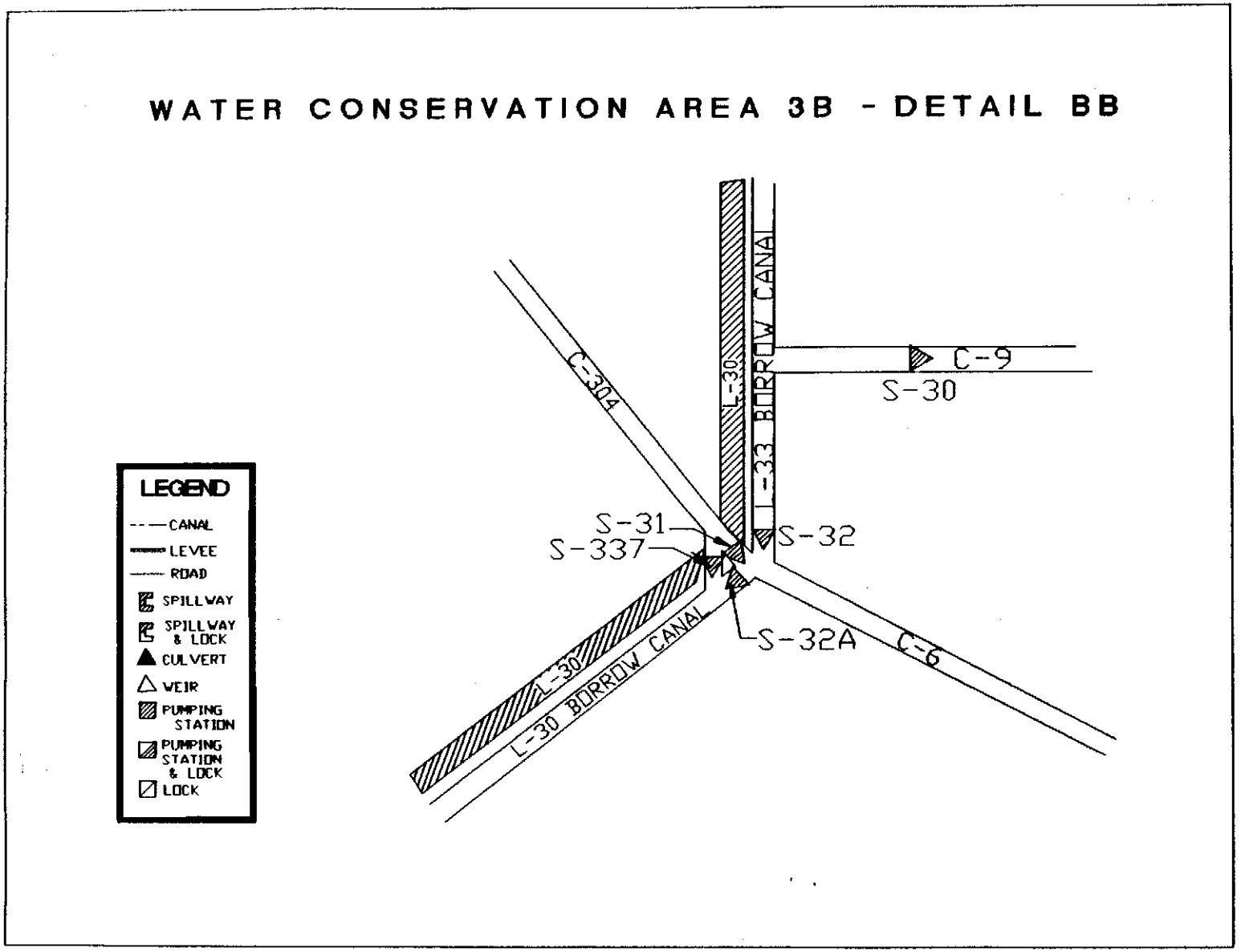

FIGURE 16A. Water Conservation Area 3B Basin (Detail BB)

TABLE 8. Water Conservation Area 3B Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-9XS	Culvert with riser and stoplogs 2-71 in x 42 ft CMP Invert elev = -1.0ft NGVD	(north side)	(south side)	HW = 6.0			
S-30	Gated Culvert 3-84 in x 288 ft CMP invert elev = -5.0 ft NGVD	(west side)	(east side)		560	HW = 7.3 TW = 3.1 Q = 818	8/20/88 8/18/88 8/13/66
S-31	Gated Culvert 3-84 in x 172 ft CMP invert elev = -3.0 ft NGVD	6.0 (WCA 3B side)	4.0 (C-6 side)	Regulation Schedule in WCA 3B	700	HW = 9.45 TW = 6.59 Q = 1090	10/14/85 7/1/82 3/20/70
S-32	Gated Culvert 1-54 in x 102 ft CMP invert elev = -2.0 ft NGVD	2.5 (north side)	1.6 (south side)	HW = 2.0		HW = 6.59 TW = 5.4 Q = 65	7/1/82 7/14/86 4/11/87
S-32A	Gated Culvert 1-54 in x 102 ft CMP invert elev = -2.0 ft NGVD	(south side)	(north side)				
S-151	Gated Culvert 6-84 in x 98 ft CMP invert elev = -2.0 ft NGVD	7.5 (WCA 3A side)	6.4 (WCA 3B side)	Regulation Schedule in WCA 3A	1105	HW = 11.30 TW = 9.80 Q = 1959	7/4/69 8/12/88 2/17/83
S-335	Gated Spillway 1 gate 11.2ft highx20.0ft wide Net crest lgth = 20 ft crest elev = -4.2ft NGVD	5.0 (north side)	4.8 (south side)		525	HW = 7.6 TW = 7.15	8/20/88 8/16/88
S-337	Gated Culvert 6-84 in x164 ft CMP invert elev = -3.0to-4.0ft NGVD	5.5 (WCA 3B side)	5.2 (L-30 borrow canal side)		605	HW = 9.18 TW = 7.8	4/3/87 7/3/86
G-69 (L-29-1)	Gated Culvert 2-72 in x80ft CMP invert elev = -1.0 ft NGVD				Very rarely opened		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

EVERGLADES NATIONAL PARK BASIN

Description of the Basin

The Everglades National Park (ENP) basin has an area of 1684.5 square miles and is located (Figure 17) in western Dade County (886.5 square miles), in northwestern Monroe County (773.9 square miles), and southwestern Collier County (24.1 square miles). The boundary of the ENP basin relative to local roads and landmarks is shown on Map A. A schematic map showing the ENP basin boundary, canals, and control structures is given in Figures 18 and 19.

The ENP basin includes all of Everglades National Park, the East Everglades Area, and a portion of the South Unit of the East Everglades Wildlife Management Area. The East Everglades Area is in north-central Dade County and is bounded by L-29, L-31N and Everglades National Park. The portion of the South Unit of the East Everglades Wildlife Management Area included in the ENP basin is in south-central Dade County and is bounded by ENP and C-111. This land was formerly owned by Aerojet Corporation. Almost the entire basin is undeveloped and in public ownership. There is some private development in the East Everglades Area, but this is limited to a residential area near L-31N and a few orchards and farms. Aerojet still has holdings within the South Unit of the Everglades Wildlife Management Unit. The basin is managed insofar as is possible as a natural Everglades system.

General Function and Operation of Project Structures

Project structures are largely peripheral to the basin and have as their primary function supply of water to the basin. There are six Project structures within the basin: L-67 Extension, the plug in the Buttonwood Canal, S-175, S-332, S-346 and S-347. The L-67 Extension borrow canal serves as a "get away channel" for discharges from the S-12 structures. A get away channel allows water to move away from the outlet structure so that the tailwater stage at the structure does not rise high enough to prevent effective discharge of water through the structure. The plug in the Buttonwood Canal (at the boat basin in Flamingo) serves as a barrier to prevent very saline water in Florida Bay from moving up the Buttonwood Canal to Coot Bay. S-175 and S-332 are used to deliver water to Taylor Slough in ENP. S-346 and S-347 control flow in the L-67 Extension borrow canal.

Inflows to the ENP basin are from local rainfall, from WCA 3A to Shark River Slough in ENP by way of the S-12 structures and S-333, from the L-31W borrow canal to Taylor Slough by way of S-332 and S-175, and from C-111 to the South Unit of the East Everglades Wildlife Management Area and to the Panhandle of the Park by way of gaps in the south berm of C-111 between S-18C and S-197.

Under the current experimental water management plan, water deliveries to Shark River Slough are determined as a function of rainfall, evaporation, and the water level in WCA 3A and the previous week's discharge. Discharge amounts are calculated on a week to week basis. Insofar as possible, 55 percent of the calculated discharge, or target, is released to Northeast Shark River Slough by way of S-333 and the L-29 borrow canal. The actual discharge is subject to restrictions based on the S-333 tailwater level and groundwater and canal levels in the East Everglades area. Flow passes from the L-29 borrow canal to the slough by way of uncontrolled culverts under U. S. Highway 41 between L-67 Extension and L-30. The remaining 45 percent of the target is discharged to ENP on the west side of L-67

Extension by way of the S-12 structures. Water supply to Taylor Slough and to the panhandle of the Park is required by law to be at least 55,000 acre-feet per year (37,000 acre-feet to Taylor Slough and 18,000 acre-feet to the Panhandle).

Project Water Control Structures

There are ten Project structures controlling flows into the ENP basin: S-12A, S-12B, S-12C, S-12D, S-18C, S-175, S-197, S-332, S-333, and S-334. There are two structures controlling flow internal to the basin: S-346, S-347, and the plug in the Buttonwood Canal. S-24A is the only Project structure controlling flow out of the basin. There are three other Project structures, S-12E, S-12F, and S-14 in the basin that are not currently operated. They are always closed. Design criteria for the control structures in the ENP basin are given in Table 11.

S-12A, S-12B, S-12C, and S-12D are identical gated spillways located in L-29 between L-28 and L-67. They connect WCA 3A to the ENP basin. These structures have two functions: (1) to maintain the stage in WCA 3A at its regulation schedule, and (2) to supply water to Everglades National Park. Operation of the structures depends on the stage in WCA 3A and on the amount of water to be delivered to ENP. These structures are designed to discharge the entire Standard Project Flood from WCA 3A. The four structures are maintained by the U. S. Army Corps of Engineers and are operated by the District under contract with the Corps.

S-12E is a gated culvert under U. S. Highway 41 at the junction of L-29 with L-67. It connects the L-29 borrow canal to L-67 Extension borrow canal. Before the installation of S-333, S-12E connected WCA 3B to the ENP basin and could have been used to discharge water from WCA 3B. Since the structure is no longer an outlet for WCA 3B, it is always closed, although it could be used to make discharges from the L-29 borrow canal to the ENP basin.

S-12F is a culvert in the old Tamiami Canal (on the south side of US 41) between S-12C and S-12D. Water flow through the structure is controlled by stoplogs placed in a riser. The structure is always closed, preventing water from flowing to the east in the Tamiami Canal.

S-14 is a gated culvert located in the south berm of the Tamiami Canal just west of S-12A. This structure is always closed forcing water in the Tamiami Canal west of the structure through culverts under U. S. Highway 41. The Tamiami Canal west of the structure receives water from the Big Cypress area and from WCA 3A by way of S-343 and S-344 and the L-28 borrow canal. The water passing under U. S. Highway 41 is impounded in the area between U. S. Highway 41 and Loop Road as this area has restricted outflow. The water may eventually enter the ENP basin by way of culverts under the Loop Road or, since outflow is restricted, by overtopping the road.

S-18C is a gated spillway located in C-111 about six and one-half miles upstream of U. S. Highway 1. It is used to control the stage in C-111 upstream to S-177 and in C-111E, and to regulate discharges downstream in C-111. Discharges through S-18C are of two types: (1) to pass flood flows from the C-111 basin and (2) to supply water to the Panhandle of ENP by way of gaps in the south berm of C-111 downstream of S-18C. The structure is operated to maintain a headwater stage of 2.3 ft NGVD when water is available. The minimum allowable water supply deliveries to ENP are given in Table 9.

TABLE 9. Minimum Water Deliveries to ENP by way of S-18C

Month	Minimum Delivery (acre-feet)	Month	Minimum Delivery (acre-feet)
January	1540	July	510
February	630	August	860
March	290	September	2690
April	110	October	4630
May	110	November	4060
June	340	December	2230

S-24A is a gated culvert through L-31N about three and one-half miles south of L-29. This structure provides some drainage for the East Everglades Area. It has been opened occasionally to pass flows from the L-31N borrow canal into the East Everglades area. It is usually closed.

S-175 is a gated culvert located in the L-31W borrow canal about one and one-half miles north of State Road 27. It is used to control the stage upstream in the L-31W borrow canal to S-174 and to regulate discharge downstream to the borrow canal and to ENP. During normal operation, the structure maintains a headwater stage of 4.5 ft NGVD.

S-197 is a gated culvert and earthen plug located in C-111 just east of U.S. Highway 1. It prevents movement of saltwater up C-111, it prevents discharge of freshwater into Manatee Bay except under extreme flood conditions, and it provides an outlet for the C-111 basin during extreme flood events. The culverts are not operated except under extreme flood conditions upstream. For large flood flows, the earthen plug is removed to allow the large discharges to pass to Manatee Bay. The operation of S-197 and the removal of the plug depend on the operation of and the conditions at S-18C and S-177. When S-18C and S-177 have been opened to their maximum capacity for six hours or more, and the headwater stage at S-177 exceeds 4.3 ft NGVD, the gates at S-197 are opened full and the plug is removed within twenty-four hours, if practicable and as necessary, to prevent the headwater stage at S-177 from rising further. The District has responsibility for operation of the gated culverts at S-197. The U.S. Army Corps of Engineers is responsible for removing the plug. In practice, the District has always done the actual plug removal at the Corps' request.

S-332 is a pumping station located on the west berm of the L-31W borrow canal at the head of Taylor Slough. The structure makes scheduled releases to ENP by way of Taylor Slough. Discharges to Taylor Slough are by gravity flow through the gated culverts, if possible, and by pumping othewise. The pumps are designed to operate when the headwater stage is between 2.0 ft NGVD and 5.0 ft NGVD. The pumps automatically shut off if the headwater stage drops below 2.0 ft NGVD. The tailwater stage must be below 5.8 ft NGVD for pumping to take place. The minimum allowable water supply deliveries to Taylor Slough are given in Table 10.

TABLE 10. Minimum Water Deliveries to ENP by way of S-332

Month	Minimum Delivery (acre-feet)	Month	Minimum Delivery (acre-feet)
January	740	July	7400
February	370	August	2960
March	185	September	5920
April	185	October	7770
May	370	November	3700
June	6660	December	740

S-333 is a gated spillway located in L-67 at the intersection of L-67 and L-29 at the southeast corner of WCA 3A. It connects WCA 3A to the L-29 borrow canal and subsequently to ENP and to the South Dade Conveyance System (SDCS). The structure currently has three functions: (1) to supply water to basins in southeastern Dade County by way of the SDCS, (2) to supply water to ENP by way of Northeast Shark River Slough, and (3) when required by the WCA 3A regulation schedule to discharge excess water to the L-29 borrow canal. Functions two and three are a result of the current experimental water management plan for water deliveries to Shark River Slough in ENP, and were not part of the original design for S-333 (see **Comments on Design and Operation**). Regulatory discharges to the L-29 borrow canal can be routed to Northeast Shark River Slough, or to canals of the SDCS with subsequent discharge to Taylor Slough, the eastern Panhandle of ENP, or to tidewater in Biscayne Bay. Water supply releases to the SDCS through S-333 are made in conjunction with S-337. S-337 releases water from WCA 3B by way of the L-30 borrow canal. The total amount of water released at S-337 and S-333 is the amount necessary to maintain the optimum stages at coastal structures in south Dade County. When S-333 is used for water supply to the SDCS, the headwater stage at S-334 is maintained between 5.0 and 7.0 ft NGVD. When S-333 is used to make regulatory releases from WCA 3A, the stage in L-29 at G-69 must be maintained below 7.5 ft NGVD to prevent flooding of the Indian village located on the berm. Water releases at S-333 are curtailed if the water table elevation at groundwater well G-3273 exceeds 6.8 ft NGVD. G-3273 is located approximately in the center of the East Everglades Area.

S-334 is a gated spillway located in the L-29 borrow canal at the canal's east end. The structure is used to control the stage in the L-29 borrow canal upstream to S-333, and to regulate discharge to the L-31N borrow canal. When S-333 is making releases from WCA 3A for water supply to the South Dade Conveyance System, S-334 is operated to maintain a headwater stage in the L-29 borrow canal of between 5.0 and 7.0 ft NGVD. When regulatory releases are being made from WCA 3A by way of S-333, S-334 is operated to maintain a headwater stage below 7.5 ft NGVD at G-69. This is to prevent flooding of the Indian village on the adjacent berm. At other times, S-334 is closed. The water level in the L-29 borrow canal, with S-334 closed, is

a function of seepage from WCA 3B and outflow to Northeast Shark River Slough by way of the culverts under U. S. Highway 41.

S-346 and S-347 are culverts located in the L-67 Extended borrow canal just south of U.S. Highway 41 and about five mile south of U.S. Highway 1, respectively. Control of water flow is effected by risers and stoplogs. The structures are normally closed to force water out of the borrow canal to increase sheet flow of water into ENP and to minimize canal flow into ENP. They are to be opened only during unusually dry conditions to facilitate minimum deliveries of water to Shark River Slough. They have not be opened to date.

The plug in the Buttonwood Canal is located at the connection of the canal to Florida Bay at the boat basin in Flamingo, ENP. The plug prevents very saline water in Florida Bay from moving up the Buttonwood Canal to Coot Bay. A small boat hoist allows small craft to be moved from the Bay side to the canal side and back. A small culvert allows for circulation between the canal and the bay when desirable. Water flow through the culvert is controlled by a riser and stoplogs.

Comments on Design and Historic Operation

Project Design

Project works associated with the basin are largely on the periphery of the basin. Their primary function is to supply water to the basin. They also pass flood flows from adjacent basins into the ENP basin.

Modified Water Deliveres to Everglades National Park General Design Memorandum

The U. S. Army Corps of Engineers is currently considering a General Design Memorandum (GDM) that, if implemented, would change the way water deliveries are made to ENP. Until recently, water delivered to the Park originated in WCA 3A and was passed to the Park west of L-67 Extension by way of the S-12 structures. The deliveries were made according to a fixed delivery schedule and by the need to maintain WCA 3A at its regulation schedule. The majority of water released from WCA 3A for regulatory purposes was through the S-12 structures. It has become apparent, however, that the temporal and spatial distribution of these deliveries is having adverse effects on the natural environment in the Park. The Corps' GDM is in response to these concerns about the distribution of water deliveries to the ENP.

The GDM proposes changes to the physical system of canals and structures and proposes methods of operation for the structures that if implemented would, as nearly as possible, return the hydrology of Shark River Slough to a natural condition. The physical system would be changed to allow more water to be delivered to ENP by way of Northeast Shark River Slough east of L-67 Extension. There are four modifications being considered: (1) construction of structures in L-67A to allow water to be passed from WCA 3A to WCA 3B, (2) construction of structures in L-29 to allow water to be passed from WCA 3B to Northeast Shark River Slough, (3) removal of L-67 Extension and filling of the borrow canal, (4) construction of a levee around a residential area in the East Everglades west of L-31N (to protect the area from flooding), and (5) construction of two pumping stations to control seepage and discharge from the protected area and L-31N. Operation of the new and existing structures would be changed to allow water deliveries to be more "naturally" based, that is, correlated to upstream weather conditions. The Rainfall Plan, a

statistical model developed by the District in cooperation with the Corps and ENP has been implemented to determine the amount, timing, and distribution of flows to the ENP. Currently, the Rainfall Plan is being refined in order to improve computed target flows to Shark River Slough. See A Two-Year Field Test of the Rainfall Plan: A Management Plan for Water Deliveries to Everglades National Park (Neidrauer, 1989) for more information regarding the Rainfall Plan.

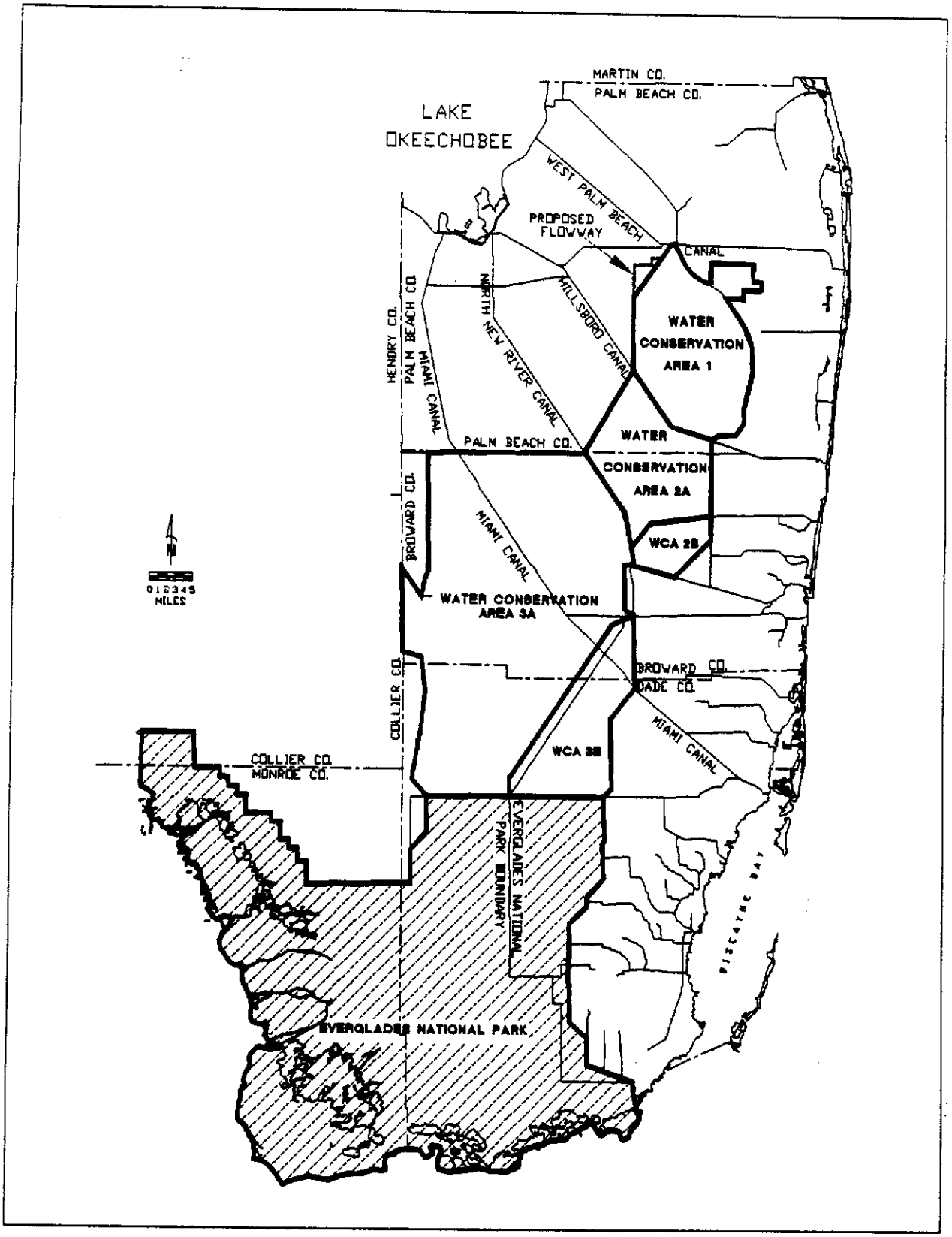

FIGURE 17. Everglades National Park Basin Location Map

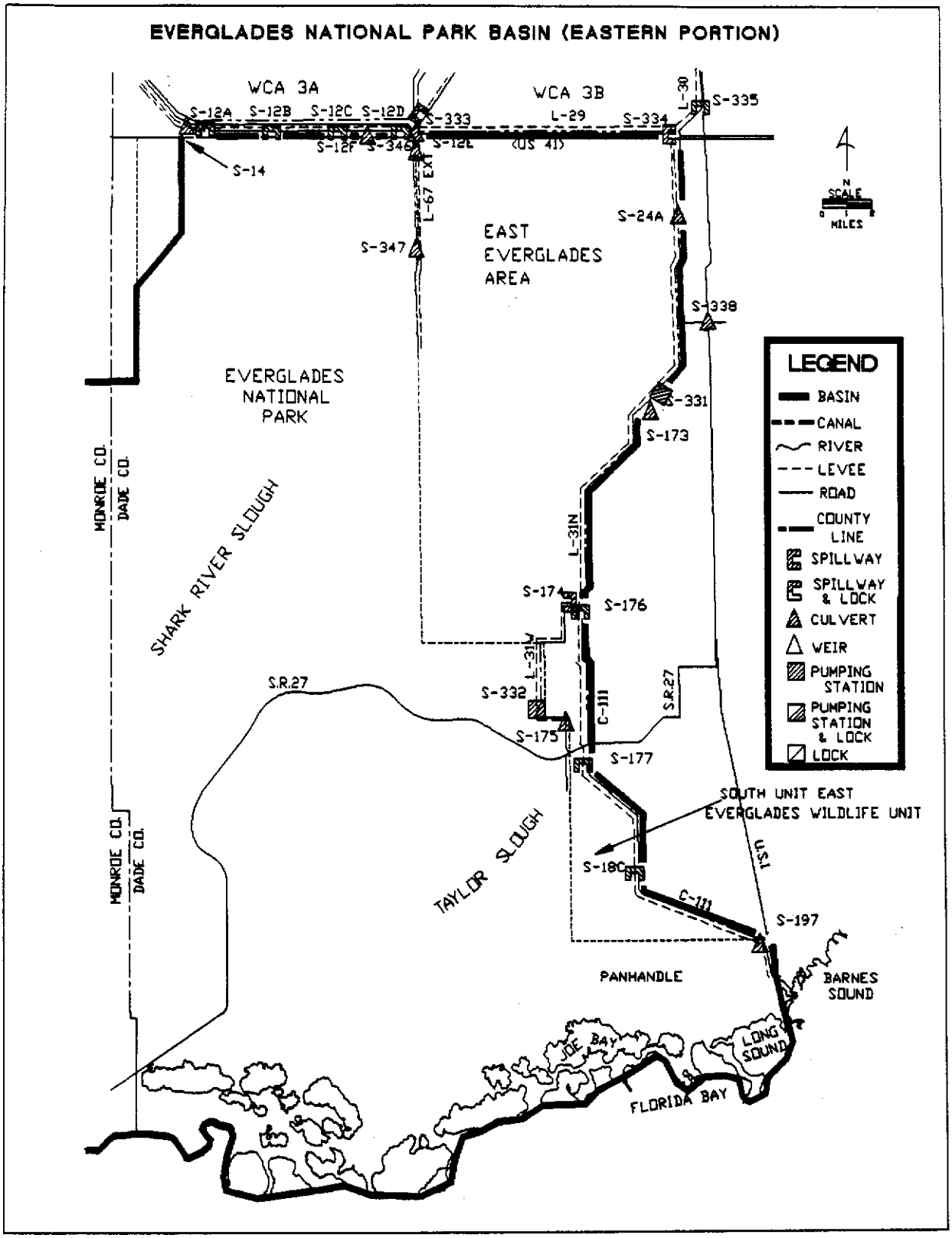

FIGURE 18. Everglades National Park Basin (Eastern Portion)

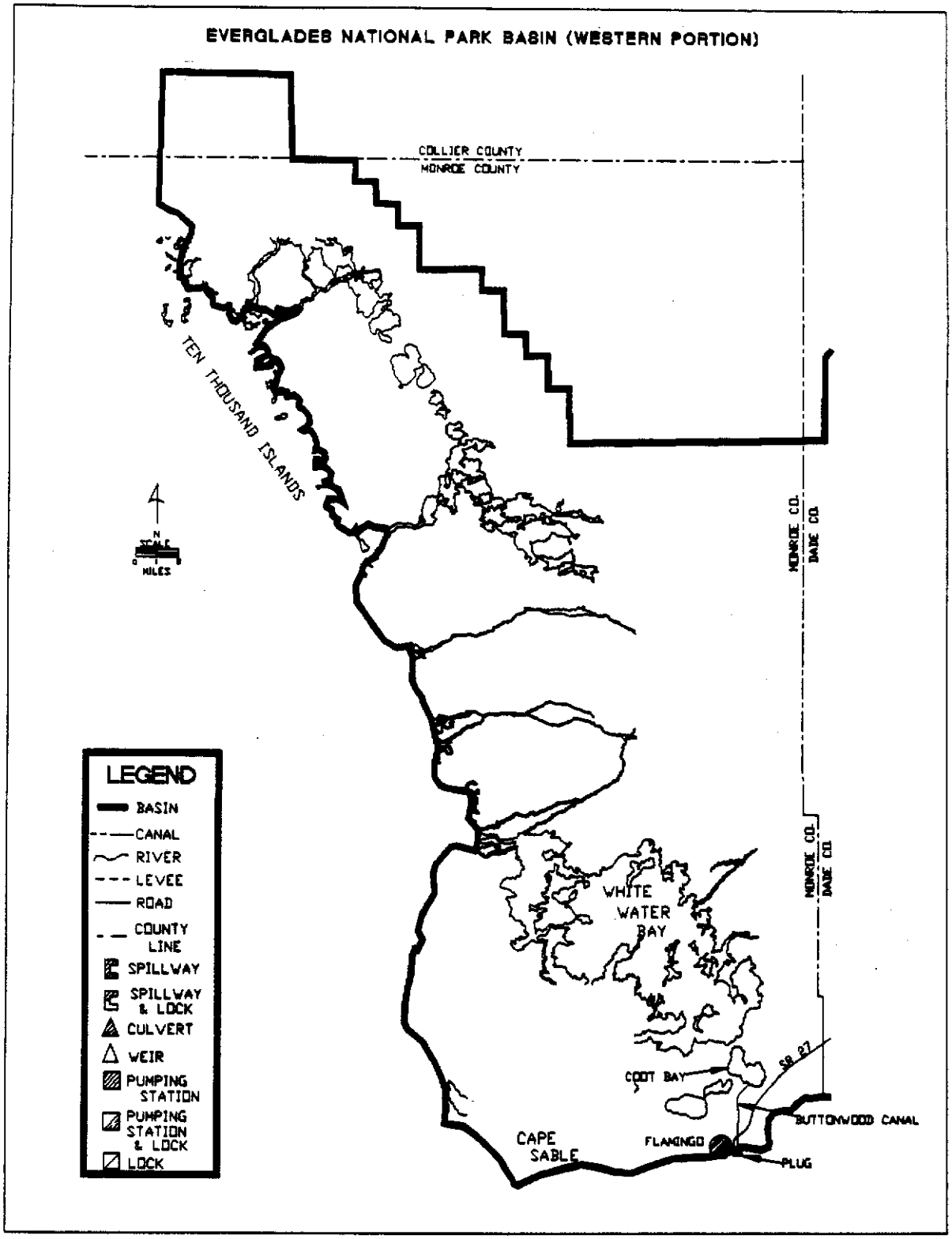

FIGURE 19. Everglades National Park Basin Map (Western Portion)

TABLE 11. The Everglades National Park Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-12A	Gated Spillways 6 gates each 10.2ft highx25.8ft wide net crest lgth = 150ft crest crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation schedule in WCA 3A	8000	HW = 10.5 TW = 10.2 Q(south) = 783	10/26/60 7/17/82 11/6/82
S-12B	Gated Spillways 6 gates each 10.2ft highx25.8ft wide net crest lgth = 150ft crest crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation schedule in WCA 3A	8000	HW = 10.5 TW = 10.3 Q(North) = 22 Q(South) = 819	10/26/60 11/6/69 3/27/76 9/23/76
S-12C	Gated Spillways 6 gates each 10.2ft highx25.8ft wide net crest lgth = 150ft crest crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation schedule in WCA 3A	8000	HW = 10.5 TW = 10.4 Q(North) = 13 Q(South) = 1340	10/26/60 11/7/69 2/27/85 10/17/78
S-12D	Gated Spillways 6 gates each 10.2ft highx25.8ft wide net crest lgth = 150ft crest crest elev = 0.8ft NGVD	12.4 (WCA 3A side)	11.9 (south side)	Regulation schedule in WCA 3A	8000	HW = 10.5 TW = 10.2 Q(North) = 16 Q(South) = 1640	10/26/60 10/6/82 3/28/85
S-12E	Gated Box Culvert 4-7ftx7ftx61.5ft Reinforced Concrete Box invert elev = 1.0ft NGVD	8.5 (north side)	8.0 (south side)		700 (never used)		
S-12F	Culverts with riser and stoplogs 3-72 inx100ft CMP invert elevs = 1.93,1.74, and 2.98ft NGVD 1-48inx100 ft CMP invert elev = 2.50ft nGVD				always closed		
S-14	Gated Culvert 2-7ftx7ftx65ft Reinforced Concrete Box invert elev = 0.0ft NGVD	7.0 (north side)	6.0 (south side)		500 (never used)	HW = 9.25	6/26/29
S-18C	Gated Culvert 2 gates 11.0 ft high x 22.8 ft wide net crest lgth = 44.0 ft crest elev = -7.0 ft NGVD	3.3 (north side)	2.8 (south side)	HW = 2.0to2.4	2100	HW = 3.30 TW = 2.90 Q = 2270	4/27/79 10/13/87 8/21/81
S-24A	Gated Culvert 2-54 in CMP	(west side)	(east side)		Open to pass flood flows only		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

TABLE 11. The Everglades National Park Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Discharge (cfs)	Peak Stage (ft NGVD) Peak Discharge (cfs)	Date of Peak
S-175	Gated Culvert 3-84 in x56ft RCP invert = - 5.0ft NGVD	5.0 (north side)	4.5 (south side)	HW = 4.5	500	HW = 5.85 TW = 5.16 Q = 534	8/18/81 8/20/81 8/19/81
S-197	Gated Culvert 3-84 in x66ft RCP invert = -8.0ft NGVD	1.4 (north side)	0.6 (south side)		550 (Normally closed)	HW = 2.74 TW = 2.2 Q = 3430 (with plug removed)	10/6/88 8/19/81
S-332	Pump Station 6 units; Variable Discharge	2.0 (L-31W borrow canal side)	<5.8 (Taylor Slough)		165	HW = 6.0 TW = 5.5 Q = 166	8/20/81 10/14/88 11/9/83
S-333	Gated Spillway 1 gate 14.6ft highx29ft wide net crest lgth = 29ft crest elev = -3.1ft NGVD	7.5 (WCA 3A side)	7.0 (L-29 borrow canal)	Regulation schedule in WCA 3A	1350	HW = 10.5 TW = 7.8 Q = 1610	7/18/82 8/8/88 5/14/85
S-334	Gated Spillway 1 gate 14.6ft highx29ft wide net crest lgth = 29.0ft crest elev = -7.0ft	5.0 (west side)	4.7 (east side)		1230	HW = 8.2 TW = 7.8 Q = 1246	8/18/81 8/20/81 5/1/85
S-346	Culverts with risers and stoplogs 2-72 in CMP invert elev = 0.0ft NGVD	6.2 (north side)	6.0 (south side)		165 (Normally closed)		
S-347	Culverts with risers and stoplogs 2-72 in CMP invert elev = 0.0ft NGVD	6.0 (north side)	5.8 (south side)		165 (Normally closed)		
Buttonwood Canal Plug	Earthen Plug and Culvert with riser and stoplogs 1-4 ft x8ft concrete box culvert Invert Elev = -5.0ft NGVD				60		

in = inches
ft = feet
elev = elevation
lgth = length
TW = tailwater
Q = discharge in cfs
CMP = corrugated metal pipe
RCP = reinforced concrete pipe
ft NGVD = feet relative to National Geodetic Vertical Datum
HW = headwater
CFS = cubic per second
ds = downstream
ups = upstream

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APPENDIX 1 - BASIC CONCEPTS

Runoff and Drainage - Several things can happen to rain after it falls to earth. At the beginning of a rain event, the rain will most likely seep into, or "infiltrate", the soil. As soil becomes saturated, however, the rain will tend to pool on the surface of the ground in puddles or ponds. These detention areas have only a limited storage volume, and when their capacity is exceeded, the excess water will flow downhill to the nearest stream or canal. That part of the rainfall that "runs off" of the soil surface to enter local streams is termed "surface runoff". Of the water that is detained on the surface, some will evaporate and the balance will eventually seep into the ground.

Water seeping into the ground enters a reservoir of subsurface water known as groundwater. Since, in south Florida, many soils are very sandy and underlying rock strata tend to be very porous, water flows easily between surface water and groundwater. The surface of the groundwater is known as the "water table". When the water table level is higher than local surface water levels (in canals, streams and lakes), water will enter the surface water from groundwater. When the water table is lower than the local surface water level, flow is from surface water to groundwater. In general, groundwater supplements stream flow during periods of low rainfall, and surface water recharges groundwater storage during periods of high rainfall. Although subsurface flow from groundwater to surface water is important to the long term supply of water to a canal or stream (it is sometimes referred to as "base flow"), it does not make significant contributions, if at all, to streamflow during storm events with high rainfall.

In the context of these basin descriptions, the term drainage is used to refer to the total surface and subsurface flows entering a canal from its drainage basin. It may be useful to keep in mind, however, that during a rain event (especially one severe enough to cause flooding), it is surface runoff that is the important contributor to this flow, and at times between rain events, subsurface flow from groundwater to surface water is most important.

Runoff from an area is influenced by several factors: how much rain has fallen recently, the depth to the water table, and how the land in the area is used. The amount of recent rain, and the depth to the water table dictate how much water is in the soil. The degree to which the soil is saturated, in turn, determines how much of the falling rain may infiltrate the soil, and thus, how much of the rain will run off to local streams.

Land use has a large impact on the amount of surface runoff entering local streams and canals. For example, much of the surface area in an urban area (e.g., roofs, roads, and parking lots) is impervious to water. Almost all the rain impacting impervious areas becomes surface runoff. Some water may be detained and will evaporate, but the percentage of rainfall that enters local canals or streams by surface flow in an urban area can be quite high. As a result, urban areas may be subject to high stream flows (flooding) during rain events.

A vegetated area can intercept and retain a large part of the rainfall, and subsequent surface runoff from a rain event. This intercepted water has an additional opportunity to evaporate or seep into the ground. In general, a smaller percentage of the rain falling on a vegetated area will enter local streams and canals

as surface runoff than a comparable urban area. As a result, stream flows in vegetated areas are moderated compared to urban areas.

Drainage Basin - If rains falls over a large enough area, some of the runoff from that storm will likely enter one stream, and some of it will enter another stream. It is said that those streams "drain" different basins, that they are in different "drainage basins". The drainage basin of a stream is all the land that contributes runoff to the stream or its tributaries. It is usually specified as that land which drains to the stream upstream of a given point, such as the mouth of the stream. The boundary between drainage basins is termed a "divide". Runoff is divided along the boundary, with runoff on one side of the boundary flowing to one stream and runoff on the other side of the boundary flowing to another stream. In a highly managed system such as the Central and Southern Florida Project, a somewhat different definition is useful. For purposes of this Atlas, a basin is considered to be an area bounded by levees and roadways, and less frequently by natural ridges and high ground, where all surface water inflows to and outflows from the area are managed in some way (i.e, controlled by a weir, spillway, culvert, or pump station); hence, the term "Surface water management basin".

Water Surface Elevations - A water surface elevation in a canal is the distance from the water's surface to some reference elevation or "datum". In the District, all elevations are relative to the National Geodetic Vertical Datum (NGVD). Water surface elevations are measured in feet (ft). Water surface elevations may also be referred to as "stages".

Important water surface elevations are the headwater and the tailwater stages at the control structures (see **Control Structures**). The difference between these stages will affect the flow through or over the structure. Gravity flow is always from the highest to lowest water surface elevation and, in general, flow increases as the difference in water surface elevation increases. In some basins, pumps are used to move water from lower to higher water surface elevations. Note that because of the flat topography in much of south Florida, water surface elevations may be independent of ground surface elevations. In these cases, it is possible for water to flow uphill relative to the ground surface.

The headwater side of a gravity flow structure is the side on which the stage is usually higher. The caveat is necessary since it is possible at some structures for the tailwater to occasionally be higher than the headwater stage. The headwater stage at a pumping station is usually defined as the side from which water is pumped and usually refers to the side with the lower stage. This convention allows the direction of water flow to be defined as from the headwater to the tailwater side in both cases.

Water surface elevations elsewhere in the canal are also important. Obviously, if the stage exceeds the elevation of the top of the canal, flooding will result. Not as obvious is the fact that the stage in the canal largely determines the water table elevation of the local groundwater (see **Runoff and Drainage**). The stage in the lower reaches (near the ocean) of some canals is maintained at levels high enough to prevent intrusions of saltwater into the local groundwater. In other areas, stages are maintained that keep water table elevations low enough to prevent drainage problems in low lying areas.

Water Control Structures - Water control structures are devices (e.g., weirs, spillways, and culverts) placed in or between canals to regulate water levels (stage

divide), amount of flow (water supply structure), or direction of flow (divide structure) in the canals. A structure may have more than one function. A divide structure is usually located at or near a basin boundary. When it is closed, it prevents water in one basin from entering the other basin. A water supply structure is also usually located near a basin boundary. It is used to pass water from one canal to another (i.e., from one basin to another). A divide structure also often serves as a water supply structure.

Hydraulic Analysis - A set of water surface elevations taken along the length of a canal is known as the hydraulic profile of the canal. In general, water surface elevations increase upstream. The water surface elevations are a function of the size and shape of the canal, the amount and location of inflow to the canal, the roughness and slope of the canal, and the downstream water surface elevation of the canal (often determined by some control structure). Canals are designed to pass a certain amount of flow without over-topping their banks. Designing a canal and its structures consists of selecting values for the factors listed above for which none of the water surface elevations of the resulting hydraulic profile exceed the elevation of the banks of the canal for the design discharge. Since the design discharge is given, and to a large extent the slope of the canal is determined by the topography of the basin, it is the size and shape of the canal, and the downstream water surface elevation (to be maintained by some structure), that are varied to achieve a successful design. (The downstream structure must also be large enough to pass the design discharge.) Because the factors that determine the water surface elevations are either known or can be reasonably estimated, it is possible to calculate the hydraulic profile of a proposed canal design. In this way an appropriate design can be selected. Similarly, calculation of the hydraulic profile, can be used to determine the flood protection provided by a canal constructed without regard to a specific design storm, or for a canal that has been modified with regard to its design specifications. For example, increasing the cross-sectional area of a canal will, in general, allow the canal to pass a given flow at stages lower than before enlargement (i.e., the hydraulic profile is lowered). Hydraulic analysis may determine for this canal that the flood protection has increased, that is, the canal can now pass the runoff from a storm more severe than the design storm.

Design Storm - The design storm for a basin is the most severe storm for which the canals and water control structures in the basin will accommodate that storm's runoff without an unacceptable level of flooding occurring in the basin. Sometimes a basin is described as having "flood protection" up to a certain design storm. The level of protection is the flood level at which flood damages <u>not</u> eliminated by the Project are considered relatively minor and are economically acceptable.

A severe storm is described by the frequency with which it may occur. On a long term average, a storm of given intensity may occur, for example, once in every 25 years (i.e., the storm has a four percent chance of being equalled or exceeded in any given year). This is written as 1-25 years and is read as one in 25 years. It must be emphasized, however, that a storm of a given intensity can occur at any time regardless of the frequency assigned to it. For example, two severe storms, of an intensity that occurs on average only once in every one hundred years (1-100 year storm), occurred in northern Palm Beach County within three months of each other in the early 1980s.

The U. S. Army Corps of Engineers specifies a Standard Project Storm (SPS) for south Florida. The rainfall amounts for the SPS are those for a 1-100 year storm increased by 25 percent. The storm is assumed to occur during the hurricane, or wet

season, when water tables are high and soils are wet. These conditions will maximize the runoff from the storm. The SPS is intended to be reasonably characteristic of large storms that have or could occur in the Project area. The runoff from the SPS is designated the Standard Project Flood (SPF). The capacity of a canal and its structures may be given as a percentage of the SPF (e.g., 40 percent SPF). The storm that would generate this amount of runoff is given by its frequency (e.g., 1-10 years). Note that it is implicitly assumed that these storms occur for antecedent weather conditions that will maximize the runoff from the storm in the basin of interest.

A severe storm of a certain frequency may not generate the same amount of runoff in different basins of the same size even when antecedent weather conditions or water table elevations for the basins are similar. Land use in the basins will affect the relative amounts of surface runoff to be expected from the basins (see **Runoff and Drainage**). Urban areas will often have more surface runoff than will more vegetated areas.

The amount of runoff to be expected per unit area for design storms at various recurrence intervals, antecedent conditions, and land use can be found in the Army Corps of Engineers' General Design Memorandums for the Project. The runoff calculated to occur for a given set of storm frequency, antecedent conditions, and land use is the design discharge.

APPENDIX 2 - GLOSSARY

Designations Given to Project Works

C-XXX
The letter C followed by a number, designates a Central and Southern Florida Project canal. For example, C-111 reads as "Canal 111".

Culvert #XXX
The word culvert followed by a number designates a Central and Southern Florida Project culvert through one of the levees on the perimeter of Lake Okeechobee. Each culvert connects the lake to an adjacent basin. All are under the operation and maintenance of the COE.

G-XXX
The letter G followed by a number, usually designates a South Florida Water Management District control structure (see **Water Control Structures**, under **Basic Concepts**). For example, G-72 reads as "water control structure 72". G structures were built by the District.

HGS-X
The letters HGS followed by a number refer to a Hurricane Gate Structure. These structures were in the levee around Lake Okeechobee and connected the lake to various canals and basins. All of the structures have been replaced by gated spillways.

L-XXX
The letter L followed by a number, designates a Central and Southern Florida Project levee. For example, L-38E reads as "Levee 38 east".

L-DX
The letter L followed by the letter D and a number refers to a Central and Southern Florida Project levee on the perimeter of Lake Okeechobee. For example, L-D9 refers to Levee 9 on the perimeter of the lake.

S-XXX
The letter S followed by a number, usually designates a Central and South Florida Project water control structure (see **Water Control Structures**, under **Basic Concepts**). For example, S-26 reads as "water control structure 26". The S structures were built by the Army Corps of Engineers.

Terms

1-XXX year

This designates the frequency for a design storm (see **Design Storm**, under **BASIC CONCEPTS**). For example, "1-100 year storm" reads as one in one-hundred year storm.

Borrow Canal

In most cases the material for construction of a levee is obtained by excavation immediately adjacent to the levee. The excavation is termed a "borrow". When the borrow paralleling the levee is continuous and allows for conveyance of water, it is referred to as a "borrow canal". For example, the canal adjacent to L-8 and is called the L-8 borrow canal. Many borrow canals, such as the L-8 borrow canal, are important features of the Project.

Crest Elevation

The crest elevation of a structure is the level below which water cannot pass the structure. Where the crest elevation of a structure is used to control water flow, the crest elevation is set to maintain the desired upstream water level.

Culvert

A culvert is a closed conduit for the conveyance of water. Within the District, culverts may be made of corrugated metal pipe or reinforced concrete. The concrete culvert may be either circular or rectangular in cross section. When it is rectangular, the culvert is usually referred to as a box culvert. The cross-sectional area and length of the culvert determine, and in some cases limit, the amount of flow possible through the culvert for given headwater and tailwater conditions. Further control of flow through the culvert may be affected by placing a gate or a riser and stoplogs at the headwater end.

District

District is an abbreviation for the South Florida Water Management District (formerly the Central and Southern Florida Flood Control District), the agency which operates and maintains the Project.

Drainage

Drainage is the removal of groundwater from a basin to maintain optimum groundwater levels. Overdrainage is the lowering of groundwater levels below desired levels. See water control.

Excess water

Excess water in a basin is water that must be removed from the basin for flood protection or to maintain optimum water levels for agriculture. The excess water may derive from rainfall, seepage through levees, or from surface water inflows from adjacent basins.

Flood Control

Flood control is the removal of surface water from a basin to prevent or minimize flood damages. (see **Design Storm**, under **Basic Concepts**)

Gated Spillway or Culvert

A spillway or culvert is "gated" when water flow through the structure is controlled by a gate. Within the Project almost all gates open upward to allow flow beneath the gate.

General Design Memorandum

A General Design Memorandum is a document written by the U.S. Army Corps of Engineers that reports all work done prior to preparation of the final design of a project. In the General Design Memorandums for the Central and Southern Florida Project four important aspects of the Project are developed: (1) each of the surface water management basins is delineated, (2) a set of design storms is determined for each basin and the resulting basin discharges are estimated (3) the flood protection to be afforded each basin is specified, (4) the size, number and general location of canals and structures needed to achieve the desired level of flood protection are determined. The final designs of the canals and structures are given in the Detailed Design Memorandums.

Project

Project is an abbreviation for the Central and Southern Florida Project for Flood Control and Other Purposes. The Project was responsible for the construction of most of the major canals and structures in south Florida.

Regulation Schedule

A regulation schedule specifies the outlet operational strategy for a reservoir (e.g., Lake Okeechobee) as a function of the water level in the reservoir and the time of year. In general, a regulation schedule optimizes the reservoir's ability to receive excess water in the wet season and to provide water supply in the dry season.

Regulatory Release

A regulatory release is water discharged from a reservoir (e.g., Lake Okeechobee) in accordance with its regulation schedule.

Riser and Stoplogs

Riser and stoplogs refers to a means of regulating the water level upstream of a culvert or weir. Stoplogs are individual beams, of fixed dimension, set one upon the other to form a bulkhead supported by channels or grooves (i.e., the riser) at either end of the span. The stoplogs slide in or out of the riser, the number of stoplogs determining the crest elevation of the bulkhead. The structure may be effectively closed by addition of enough stoplogs. The riser is located at the headwater end of the culvert or on top of the weir.

Saltwater Intrusion

In coastal areas of South Florida, fresh and salt groundwaters meet. The fresh groundwater is less dense than the salt groundwater. It floats on, but does not mix with the salt water. As a general rule, the boundary between fresh and salt water occurs about 40 feet below sea level for each foot the fresh groundwater table is above sea level. It is necessary to maintain the water table in coastal areas high enough to prevent salt water from entering the local groundwater and contaminating any nearby well fields.

Spillway

A spillway is a means of passing water from one location to another (e.g., from a lake to a canal or from one part of a canal to another). The purpose of the spillway is to control the flow of water. Control may be affected by gates or by the crest elevation of the spillway or both. Control by gate operation allows variable control of water flow and may control either the amount of flow or the upstream water level. Control by the crest elevation is usually not variable and controls only the upstream water level. When water control is strictly by the crest elevation of the spillway, the spillway is usually referred to as a weir.

Water Control

Water control is the regulation of groundwater levels (i.e., by the regulation of canal water levels) at all seasons and the conservation of water during the dry season. During wet periods, water must be removed from basins to maintain desired groundwater levels. This is sometimes referred to as drainage and is differentiated from flood control which generally refers to removal of surface water from a basin. During dry periods, outflows from the basin are restricted to retain water in the basins to prevent "overdrainage" (i.e., lowering of groundwater levels). In agricultural areas, overdrainage can lead to crop yield reduction or failure, and in coastal areas, to saltwater intrusion to groundwater. In some cases, water must be supplied to the basin to maintain groundwater levels.

Water Conservation Areas

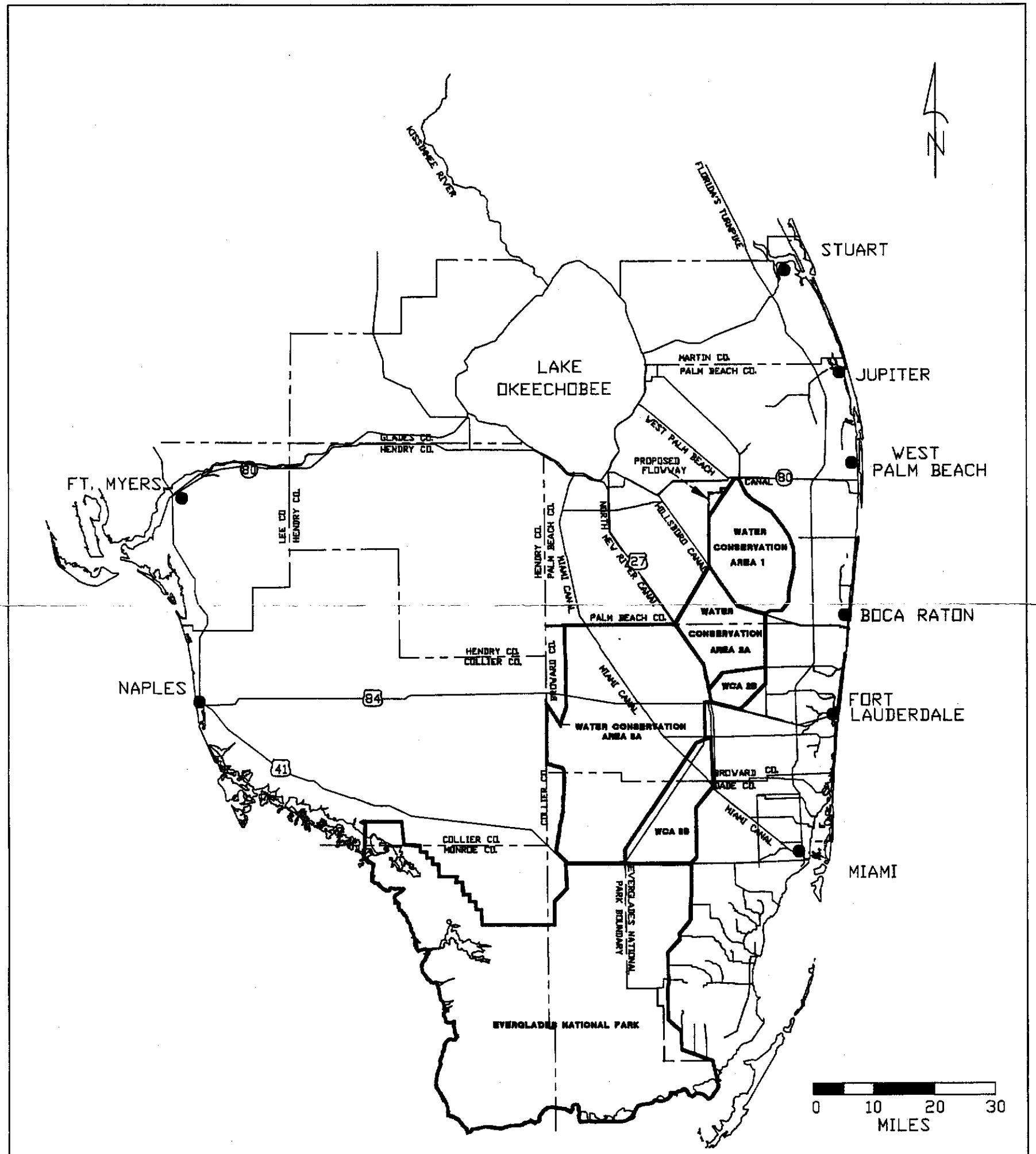
The five Water Conservation Areas (WCAs 1, 2A, 2B, 3A, and 3B) are located in western Dade and Broward Counties and in central Palm Beach County. WCAs 1, 2A, and 3A border on basins described in this publication (Figure 1). The WCAs are remnants of the original Everglades in South Florida. Water is impounded in the WCAs by Project levees, and water flow into and out of the WCAs is regulated by various Project water control structures. The WCAs are reservoirs managed to store excess water in the wet season, to provide water supply in the dry season, and to provide viable wetlands habitat. Water is stored in each WCA according to its regulation schedule. Outflows from a WCA are determined by the water level in the WCA relative to its regulation schedule and by the water requirements of basins downstream.

Weir

See Spillway.

ABBREVIATIONS

cfs:	Cubic feet per second
COE; Corps:	U. S. Army Corps of Engineers
ft:	Feet
EAA:	Everglades Agricultural Area
ENP:	Everglades National Park
FDER:	Florida Department of Environmental Regulation
GDM:	General Design Memorandum
IAP:	Interim Action Plan
LOOP:	Lake Okeechobee Operating Permit
LOTOP:	Lake Okeechobee Temporary Operating Permit
NGVD:	National Geodetic Datum (see **Control Structures**, under **Basic Concepts**)
SCDS:	South Dade Conveyance System
SPF:	Standard Project Flood (see **Design Storm**, under **Basic Concepts**)
SPS:	Standard Project Storm (see **Design Storm**, under **Basic Concepts**)
WCA:	Water Conservation Area



MAP A . SURFACE WATER MANAGEMENT BASIN IN THE EVERGLADES: WATER CONSERVATION AREAS AND EVERGLADES NATIONAL PARK