TECHNICAL MEMORANDUM

AN ATLAS OF MARTIN COUNTY SURFACE WATER MANAGEMENT BASINS

By

Richard M. Cooper
and
Ray Santee

November 1988

Water Resources Division
Resource Planning Department
South Florida Water Management District

AN ATLAS OF MARTIN COUNTY
SURFACE WATER MANAGEMENT BASINS

EXECUTIVE SUMMARY

This atlas contains information about the surface water management basins in Martin County, Florida. 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 District has sponsored publication of this atlas to make available up-to-date non-technical descriptions of the surface water management basins in Martin County to District personnel, to local governments in Martin County and to other interested persons. Text, maps, and tables of information are used to define and locate basins within the county. Canals, levees, and control structures within each basin and under the management of the District or the COE are located and are described and discussed with regard to their operation and management.

The surface water management basins of Martin County were first delineated in the 1950's by the COE in their General Design Memorandum (GDM) for the Central and Southern Florida Flood Control Project (Project). Based on the hydrology of the basins, the COE designed and constructed a system of canals, levees, and control structures to provide flood protection for southern and central Florida. The Project is dynamic, with new works being constructed and old ones being modified to meet the changing needs of southern Florida. Most of the works constructed under the Project are now under the management of the District.

Seven basins are described: the C-23, C-59, S-153, S-135, C-44, the Tidal St. Lucie River, and the North Fork St. Lucie River basins.

The Project canals in Martin County serve a variety of functions. The primary function of all the canals is to provide flood protection for the basins in which they are located. Secondary uses of the canals include land drainage for agriculture and urban or residential development and regulation of groundwater table elevations to prevent intrusion of saltwater into local groundwater. Most of the canals supply water for irrigation during periods of low natural flow.

The Project control structures in Martin County regulate the flow of water in the canals. In general they are used to discharge excess water from the basins during flooding and to maintain minimum water levels in the canals during drought periods. Some structures are usually closed to prevent water from passing from one basin to another as necessary. The coastal structures have the additional function of preventing saltwater from a tidal or storm surge from entering those canals discharging to tidewater.

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

SUMMARY INFORMATION

Basin	CSFFCP[1] Canals	CSFFCP[1] Control Structures	Design Level of Flood Protection	Primary Uses
C-23	•C-23	S-48 S-97 G-78	30% SPF[2] (1-10 Year)	•Flood protection • Drainage • Water supply • Control saltwater intrusion into local groundwater
C-59 Taylor Creek- Nubbin Slough	•C-59 •L-63S/L-64 Borrow Canal •L-63N Borrow Canal	S-191 S192 G-106	30% SPF[2] (1-10 Year)	•Flood protection • Drainage • Water supply
C-153	•L-65 Borrow Canal	S-153	>30% SPF[2] (>1-10 Year)	•Flood protection • Drainage
S-135	•L-47 Borrow Canal	S-135	3/4 inch of runoff per day	•Flood protection • Drainage •Water Supply •Intercept seepage through L-47
C-44	•C-44	S-80 S-153 S-308	100% SPF[2] (1-200 Year)	•Flood protection • Drainage • Water supply •Regulatory releases from Lake Okeechobee •Navigation
Tidal St. Lucie	•C-44A	S-80	None	•Flood protection •Navigation •Outlet for C-44 to tidewater

[1]Central and Southern Florida Flood Control Project
[2]Standard Project Flood

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This atlas was compiled under the supervision of Richard Tomasello, Supervising-Professional Engineer, Water Resources Division, Department of Resource Planning. The authors wish to extend their thanks to the many people who contributed to the completion of this atlas: to Alan Hall whose suggestion it was to publish the atlas as a Technical Memorandum, to Jim Lane for his many suggestions and comments, to Joel Van Arman for producing the tables and for supplying most of the citations in the bibliography, to Nettie Winograd for preparing the manuscript for review and for publication, and to the many people who reviewed the manuscript and offered their comments and suggestions. Our special thanks go to Dawn Reid and Barbara Brown for creating the excellent maps used in the atlas. Without Dawn's and Barbara's patient and painstaking efforts, this atlas could not have come into being.

ABSTRACT

An atlas of the surface water management basins in Martin County, Florida, is presented. Nine basins are described by text, maps, and tables of information. For each basin the canals and control structures of the Central and Southern Florida Flood Control Project located within that basin are described and are discussed with regard to their operation and management. The 8 canals and 12 control structures discussed provide flood protection to 400 square miles of Martin County. The design level of flood protection for all of the basins is at least 30 percent of the Standard Project Flood (SPF) with the largest basin in the county, the C-44 basin, protected from flooding to 100 percent of the SPF. In addition to flood protection, the canals and control structures provide drainage, contribute to agricultural water supply, provide navigable waterways, and in the case of the coastal structures, provide protection from saltwater intrusion into groundwater.

AN ATLAS OF MARTIN COUNTY
SURFACE WATER MANAGEMENT BASINS

INTRODUCTION

This atlas contains information about the surface water management basins in Martin County, Florida. 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 District has sponsored publication of this atlas to make available up-to-date non-technical descriptions of the surface water management basins in Martin County to District personnel, to local governments in Martin County, and to other interested persons. Text, maps, and tables of information are used to define and locate basins within the county. Canals, levees, and control structures within each basin and under the management of the District or the COE are located and are described and discussed with regard to their operation and management.

The surface water management basins of Martin County were first delineated in the 1950's by the COE in their General Design Memorandum (GDM) for the Central and Southern Florida Flood Control Project (Project). Presented in the GDM were the COE's analysis of the hydrology of each basin and an assessment of the flood risk for a storm of specified intensity and duration. Based on the hydrology of the basins, the COE designed a system of canals, levees, and control structures to provide some desired level of flood protection for each basin. Designs of these works were presented in the GDM and in the Detailed Design Memorandum for the Project. Most of the works constructed under the Project are now under the management of the District.

The Project is dynamic. As the population in 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, other parts have been rebuilt or modified, and as the need has arisen, new structures have been designed and constructed. In some cases, the basins themselves have been redefined. As the COE cannot always participate in construction of new works, the District has occasionally assumed responsibility for the design and construction of additions or modifications to the Project.

This atlas describes the seven surface water management basins in Martin County, Florida, and the Project works associated with each.

Following the basin descriptions is a bibliography of publications related to the surface water management basins in Martin County. 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 county and with basic water resources engineering may need some words and concepts defined. 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 control structures.

Using the Basin Descriptions

Surface water management basins (hereafter drainage basins) in Martin County are identified by the same designation as the major Project canal or structure located in that basin. For example, C-44 is a canal draining most of central Martin County. The drainage basin is named the C-44 basin. The S-153 basin on the other hand is named for the control structure S-153. In some cases, the canal also has a common name by which it is known. For example, C-44 is known as the St. Lucie Canal. The common name is given parenthetically in the chapter titles following the Project designation for the canal. Two drainage basins in Martin County are not identified by the major Project canal or structure located in the basin. These two basins are the North Fork of the St. Lucie River basin and the Tidal St. Lucie basin.

All of the drainage basins in Martin County are shown in Figure 1. Map A (folded and placed in the pocket of the flyleaf) is a large map showing the basin boundary, canals, levees, and control structures relative to local roads and landmarks. This map should be referenced to precisely locate basin boundaries and District and Project works within the county. Drainage basins that do not have Project works located within their boundaries are not described in this atlas.

Each basin 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 county; the purpose 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**); 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 Martin County. 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 county. Precise location of canals or structures within the basin can be obtained by reference to Map A.

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 given if relevant.

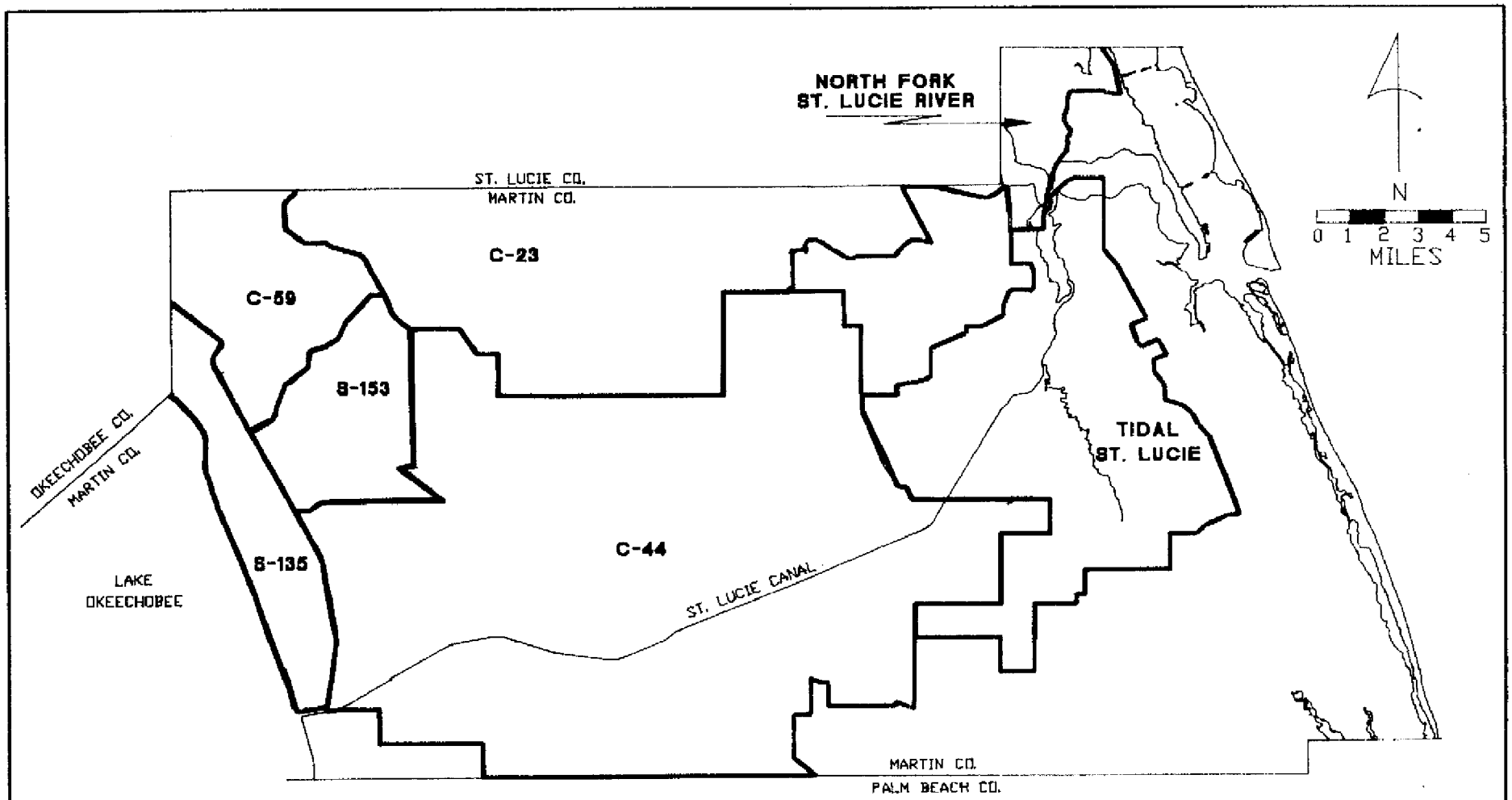

FIGURE 1. MARTIN COUNTY DRAINAGE BASINS

C-23 (COUNTY LINE CANAL) BASIN

Description of the Basin

The C-23 basin is approximately 167.7 square miles in area and is located in southwest St. Lucie County (82.7 square miles), eastern Okeechobee County (14.0 square miles), and northern Martin County (71.0 square miles,Figure 2). The basin boundary in Martin County relative to local roads and landmarks is shown on Map A. A schematic map showing the basin boundary, canals, and control structures is given in Figure 3.

The Project canal and control structures in the C-23 basin have three functions: (1) to remove excess water from the C-23 basin, (2) to supply water to the C-23 basin and occasionally to the C-24 basin during periods of low natural flow, and (3) to maintain a groundwater table elevation west of S-48 adequate to prevent intrusion of saltwater into local groundwater. Excess water in the basin may be discharged to tidewater by way of S-97 and S-48, or occasionally to the C-24 basin by way of G-78. Water surface elevations in C-23 are regulated by S-48 and S-97. In general the only water supply to the C-23 basin is from local rainfall and from pumping of groundwater from the Floridan Aquifer.

C-23 is the only Project canal in the basin. Its northern most end is in the C-24 basin and connects to C-24 at State Road 613 (Carlton Road) two miles south of State Road 70. From State Road 613, C-23 extends to the west two miles and then to the south to the Martin-St. Lucie County line. C-23 enters the C-23 basin on this north-south leg at Germany Canal Road six miles north of the county line. Flow in C-23 is divided between the C-23 and C-24 basins at Germany Canal Road by the divide structure G-78. At the Martin-St. Lucie County line, the canal turns to the east to follow the county line to a point one mile east of Florida's Turnpike. The canal extends another 1.5 miles to the southeast and discharges to tidewater in the North Fork of the St. Lucie River west of the City of Stuart. Normal flow of water in the north-south leg of C-23 south of G-78 is to the south, and flow of water in the east-west leg of C-23 is to the east. If water is being discharged to the C-24 basin for water supply or for flood control, flow of water in the north-south leg may be to the north.

There are three Project structures controlling flow in the C-23 basin: S-48, S-97 and G-78. Design criteria for the structures in this basin are given in Table 3.

S-48 is a fixed crest weir located at the outlet of C-23 to the North Fork of the St. Lucie River. If flow in the canal is adequate, the weir maintains a stage greater than 8.0 ft NGVD in the lower reach of C-23, adequate to prevent saltwater intrusion to local groundwater.

S-97 is a gated spillway located at the Florida's Turnpike crossing of C-23. It controls water surface elevations in the upper reach of C-23, and it regulates discharge to the lower reach of C-23. When flow in the canal is adequate, the structure is operated to maintain a headwater stage of between 20.5 and 22.2 ft NGVD during the wet season (i.e., May 15 to October 15) and between 22.2 and 23.2 ft NGVD during the dry season (i.e., October 15 to May 15).

G-78 is a culvert located in the alignment of C-23 at the end of Germany Canal Road, 3.6 miles southwest of where C-23 joins C-24. Control of water flow is by riser and flashboards. All flashboards are normally in place and the structure functions

as a divide between the C-23 and C-24 basins. G-78 can be opened for two reasons: (1) to discharge excess water from C-23 to C-24 during a storm event if C-24 has sufficient capacity to accept additional flows; and (2) during periods of low flow, to supply water from the C-23 basin to the C-24 basin when C-24 is below optimum and there is sufficient water in C-23. Although G-78 may occasionally be used to pass excess water from the C-23 to the C-24 basin, it was not designed to pass flood flows and is not considered to provide flood protection to the C-23 basin.

Comments on Design and Historic Operation

C-23 and S-97 were designed to pass thirty percent of the Standard Project Flood, and to meet irrigation delivery requirements for the basin.

There are a large number of citrus growers in the basin, and the demand for water is high. At the present time, the only source of water is local rainfall and artesian-well water from the Floridan Aquifer. This well water has a high mineral content and is generally mixed with surface water before it is used as irrigation water. In order to have an equitable distribution of the available surface water supply, the inverts of irrigation supply culverts and irrigation pump intakes have been limited to a minimum elevation of 14.0 ft NGVD.

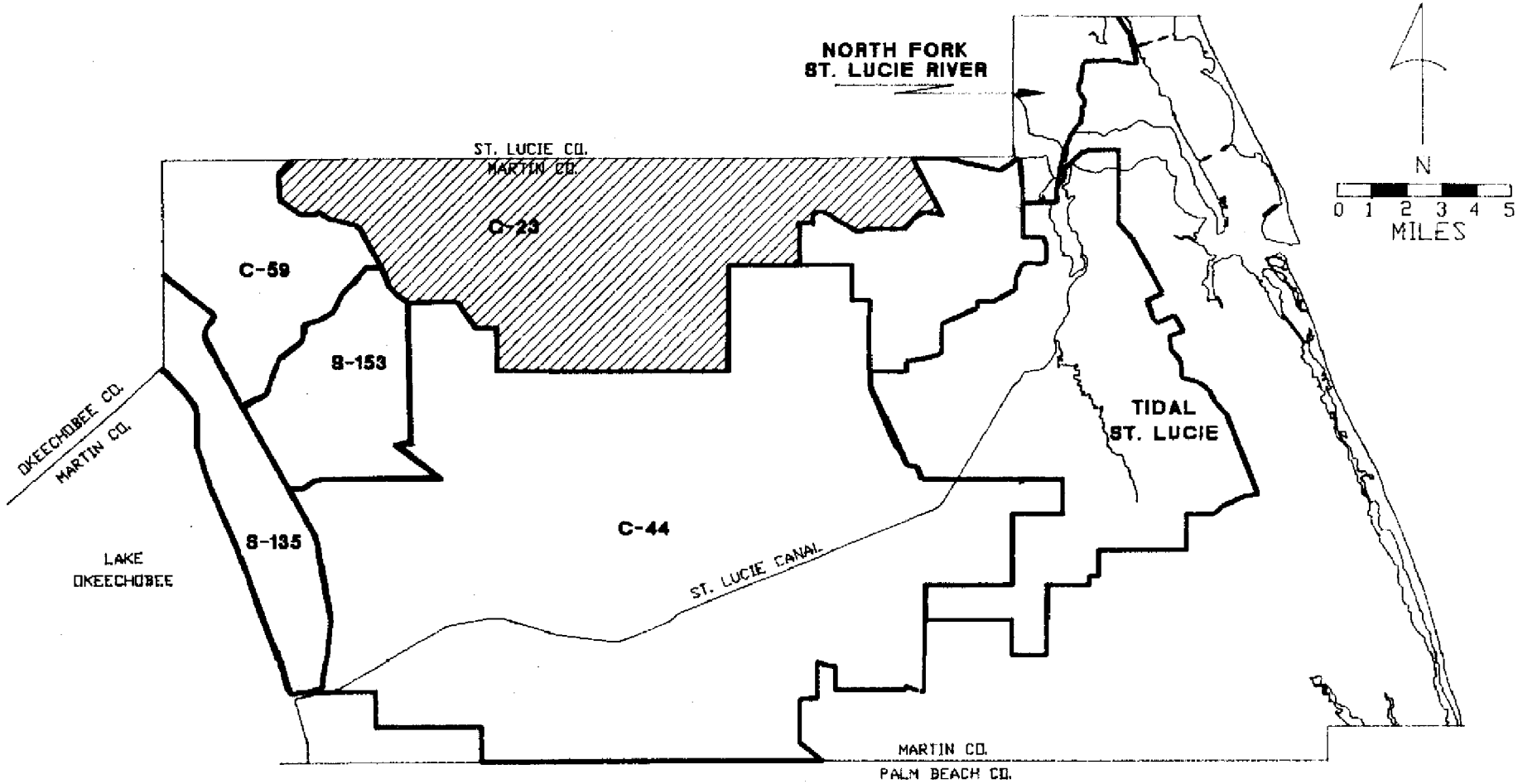

FIGURE 2. C-23 BASIN LOCATION MAP

C-23 BASIN

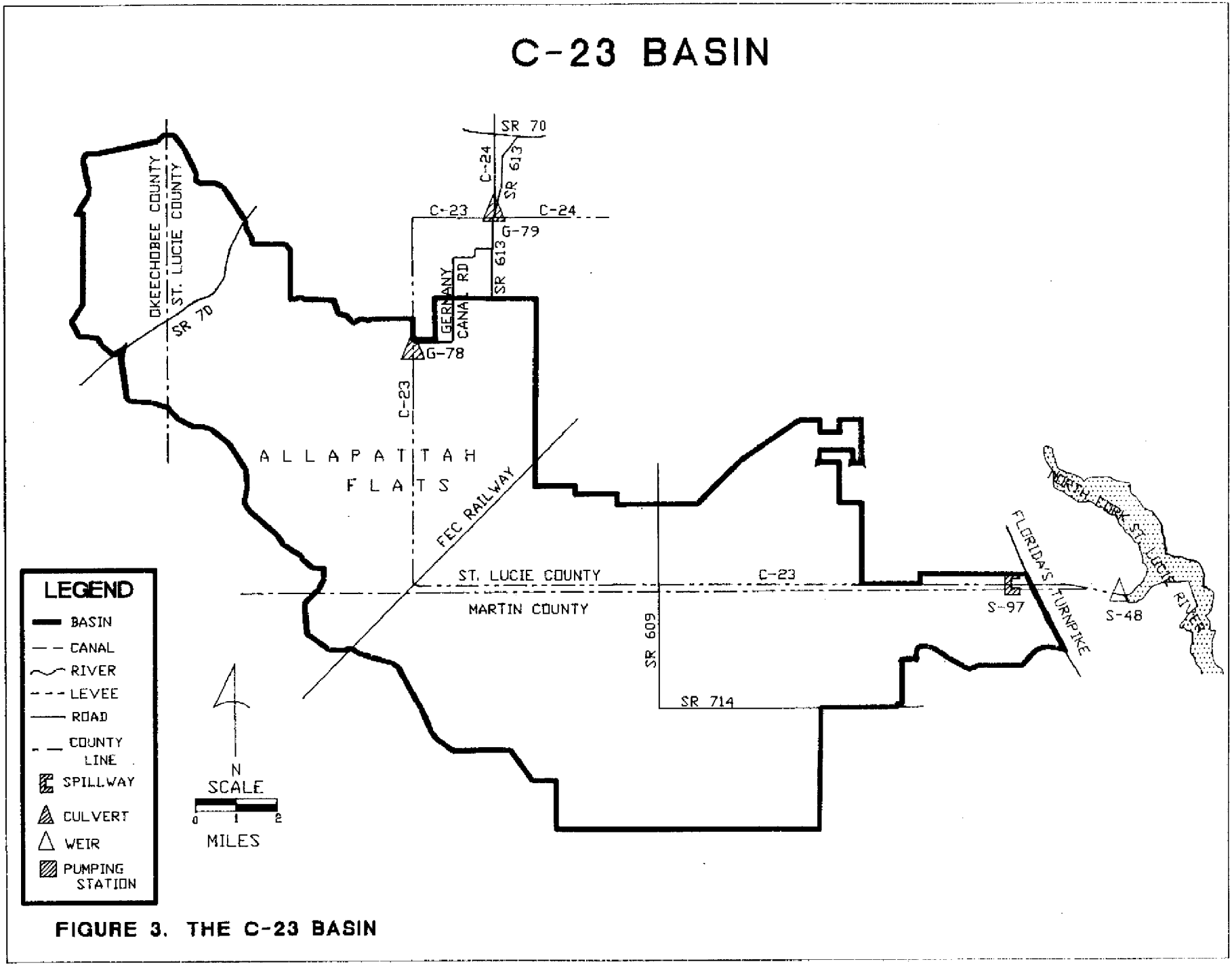

FIGURE 3. THE C-23 BASIN

TABLE 1. C-23 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-48 Stage divide	Fixed crest weir Crest lgth = 113.0ft Crest elev = 8.0ft NGVD	13.0	0.7	Passes flow when HW>8.0	5035	Q = 3859	9/19/85
S-97 Stage Divide	Gated Spillway, 2-gates 14.2ft high x 22.8ft wide Net crest lgth = 44ft Crest elev = 7.8 ft NGVD	18.5	14.0	May15 to Oct15 $20.5 \leq HW \leq 22.2$ Oct15 to May 15 $22.2 \leq HW \leq 23.2$	5035	HW = 23.82 Q = 3859	10/02/67 9/19/85
G-78 Divide Structre, C-23 and C-24 basins	Culvert with riser and flashboards 1-72in x 58ft CMP						

in = inches
ft = feet
elev = elevation
lgth = Length
TW = Tail water
Q = discharge in cfs
CMP = Corrugated metal pipe
RCP = Reinforced concrete pipe
ft NGVD = Feet relative to National Geodetic Vertical Datum
HW = Head water
CFS = Cubic feet per second
ds = downstream
ups = upstream

C-59 (TAYLOR CREEK-NUBBIN SLOUGH) BASIN

Description of the Basin

The C-59 drainage basin is approximately 187.9 square miles in area and is located in eastern Okeechobee County (159.8 square miles), southwestern St. Lucie County (9.4 square miles) and northwestern Martin County (18.7 square miles, Figure 4). The basin boundary in Martin County relative to local roads and landmarks is shown on Map A. A schematic map showing the basin boundary, canals and control structures is given in Figure 5.

The Project canals and control structures in the C-59 basin have two functions: (1) to remove excess water from the C-59 basin, and (2) to supply water to the S-133 basin during periods of low natural flow. Excess water is discharged from the basin to Lake Okeechobee by way of C-59 and S-191. Water surface elevations in the canals in the basin are regulated by S-191. Water supply to the S-133 basin is made by way of G-106. Water supply to the C-59 basin is from local rainfall.

There are three Project canals in the C-59 basin: C-59, the L-63S/L-64 borrow canal, and the L-63N borrow canal. The L-63N and the L-63S/L-64 borrow canals are tributary to C-59.

C-59 begins at the confluence of the L-63N and the L-63S borrow canals about five miles southeast of the town of Okeechobee. C-59 extends to the southwest approximately 1.2 miles and is connected to Lake Okeechobee via S-191. Flow in the canal is to the southwest to Lake Okeechobee.

The L-63S and the L-64 borrow canals drain the southeast portion of the basin. These canals are continuous along the southwest boundary of the basin. The L-63S borrow canal is aligned parallel to and south of State Road 710 from the Florida East Coast Railway crossing of State Road 710 to the confluence of the borrow canal with C-59. The L-64 borrow canal is parallel to and west of the Florida East Coast Railway from the railway's crossing of State Road 710 to a point about eight miles north of C-44. A plug in the canal at that point separates the L-64 borrow canal from the L-65 borrow canal that continues to the south. This plug acts as a divide between the S-153 basin and the C-59 basin. Flow south of the plug in the L-65 borrow canal is to C-44. Flow north of the plug in the L-64 and L-63S borrow canals is to the northwest to C-59. Four streams are tributary to the L-64 and L-63S borrow canals. Myrtle Slough drains the portion of the basin in Martin County. Henry Creek and Lettuce Creek drain the area near where Okeechobee, Martin, and St. Lucie Counties meet. Nubbin Slough drains the eastern part of the basin in Okeechobee County.

The L-63N borrow canal drains the northwest portion of the basin. The canal intercepts Taylor Creek at S-192, 1.3 miles north of the City of Okeechobee. Upper Taylor Creek (i.e., north of the L-63N borrow canal) drains to C-59 by way of the L-63N borrow canal. Lower Taylor Creek (i.e., south of the L-63N borrow canal) drains to S-193 directly or to S-133 by way of the L-D4 borrow canal. Mosquito Creek, draining the central part of the basin, is tributary to the L-63N borrow canal. In addition to its primary function as drainage canal, the L-63N borrow canal is also used to supply water to the S-133 basin by way of structure G-106.

There are three Project control structures regulating flow in the C-59 basin: S-191, S-192, and G-106. Design criteria for the structures in this basin are given in Table 2.

S-191 is a gated spillway located in the alignment of C-59 at the outlet of the canal to Lake Okeechobee. The structure has two functions: (1) to maintain optimum stages upstream in C-59 and in the L-63N and L-63S borrow canals, and (2) to prevent a hurricane tide on Lake Okeechobee from entering the C-59 basin. The gates are operated in so far as is possible to maintain a headwater stage in the C-59 canal of 19.0 ft NGVD. The gates are closed if the tailwater (i.e., lake side) stage reaches or exceeds the headwater stage.

S-192 is a gated culvert and pump station located in L-63N at the point the levee crosses Taylor Creek (see insert, Figure 5). The gates on the culvert are ordinarily closed so that the structure functions as a divide between the C-59 basin and the S-133 basin. The gates may be opened for two reasons: (1) to divert flows from upper Taylor Creek and the L-63N borrow canal to lower Taylor Creek to facilitate maintenance on the borrow canal; or (2) to augment flows in lower Taylor Creek to mitigate (by dilution) the effects of the poor quality water that occurs periodically in the lower portion of the creek. The diversions to mitigate the poor quality water are made only when Lake Okeechobee is below 14.0 ft NGVD (i.e., when gravity discharge to the lake can occur through S-193). When the lake stage is higher than 14.0 ft NGVD, S-193 is opened to discharge enough water from the lake to the S-133 basin for dilution of the poor quality water in the creek. The same quantity of water that is discharged to lower Taylor Creek by S-193 is removed from the S-133 basin by the pump station at S-192 and is discharged to the L-63N borrow canal.

G-106 is a gated culvert located in L-63N at the point where the levee crosses Mosquito Creek. This is about two and one-half mile east of the town of Okeechobee. G-106 discharges to Mosquito Creek south of the levee. The gates are occasionally open for water supply to the S-133 basin, but are closed most of the time.

Comments on Design and Historic Operation

S-191, C-59, and the L-63N and the L-63S borrow canals were designed to pass 30 percent of the Standard Project Flood from the C-59 basin without flooding occurring in the basin.

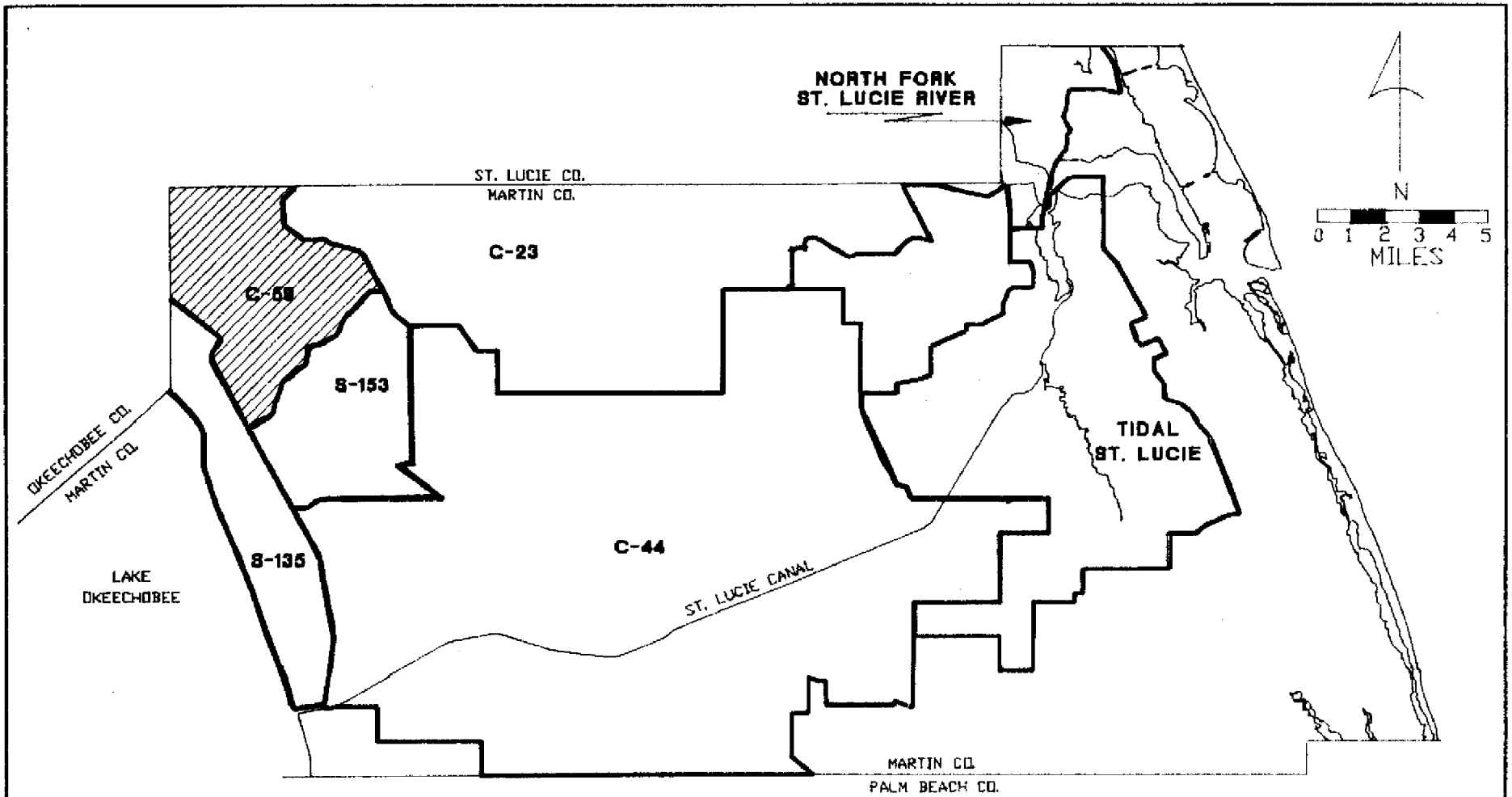

FIGURE 4. C-59 (NUBBIN SLOUGH) BASIN LOCATION MAP C-59 BASIN

C-59 BASIN

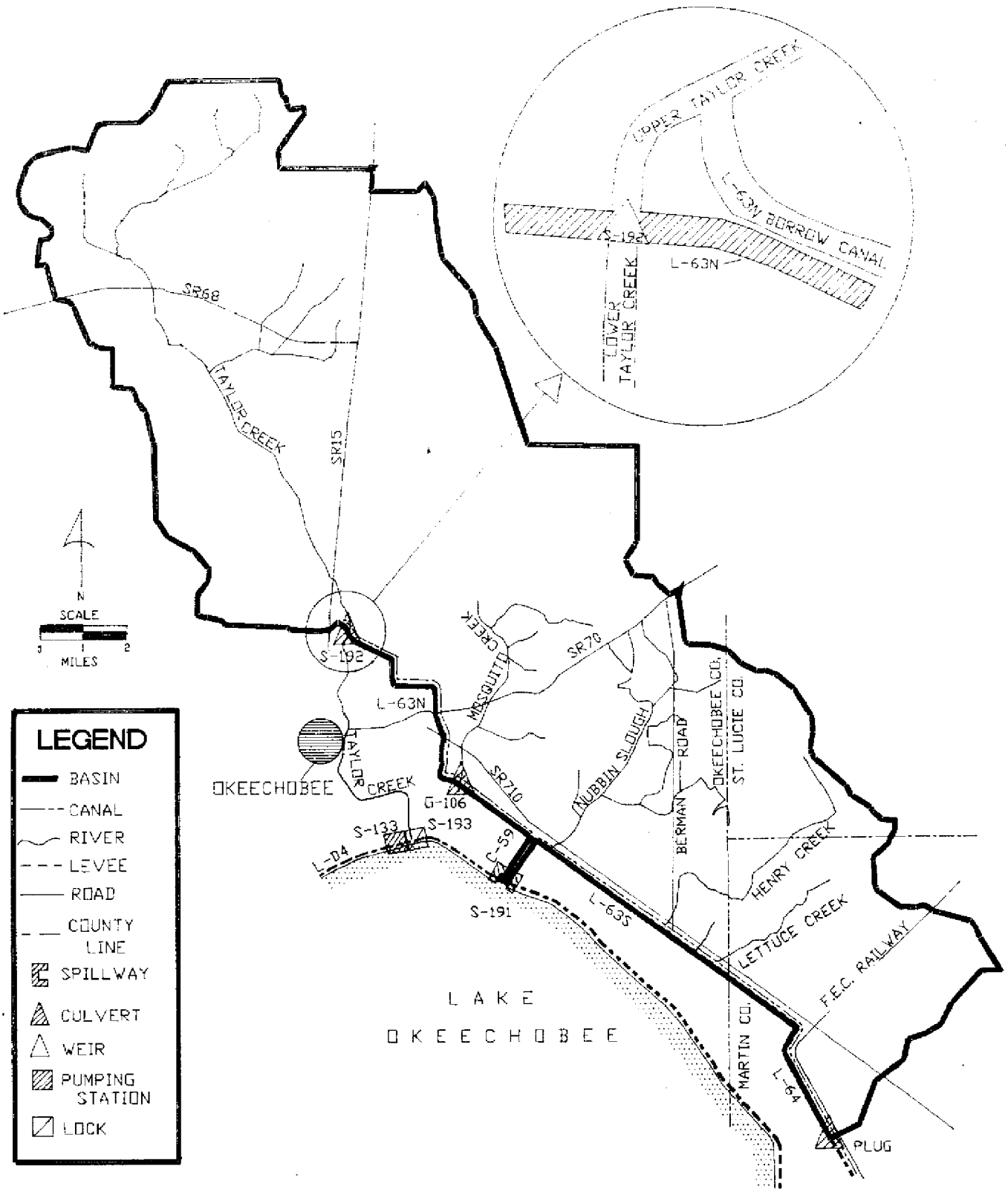

FIGURE 5. THE C-59 BASIN

TABLE 2. C-59 (Nubbin Slough) 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-191 Stage divide	Gated Spillway, 3-gates 17.6ft high x 27.8 ft wide NetCrest lgth = 81.0ft Crest elev = 7.4 ft NGVD	19.2	18.6	19.0 19.2 ≥ HW ≥ 18.8 (Gate closed if TW > HW)	7440	HW = 23.08 Q = 3236	7/18/74 6/25/87
S-192 Divide structure and pump station, Water supply from L-63N borrow canal to Taylor Creek	Gated Culvert 1-48in x 112ft CMP Invert elev = 8.0ft NGVD Pump Station, 1 unit: 13500 GPM	21.6 (water supply)	13.0 (water supply)	HW = 19.0 TW = 14.0 (water supply)	Normally Closed, open only for water supply		
G-106 Divide Structure and water supply from L-63N borrow canal to S-133 basin	Gated Culvert 1-36in x 90ft CMP Invert elev = 15.0ft NGVD				Ocassionally open for water supply		

in = inches
ft = feet
elev = elevation
lgth = Length
TW = Tail water
Q = discharge in cfs
CMP = Corrugated metal pipe
RCP = Reinforced concrete pipe
ft NGVD = Feet relative to National Geodetic Vertical Datum
HW = Head water
CFS = Cubic feet per second
ds = downstream
ups = upstream

S-153 BASIN

Description of the Basin

The S-153 drainage basin is approximately 19.9 square miles in area and is located (Figure 6) in western Martin County. The basin boundary relative to local roads and landmarks is shown on Map A. A schematic map showing the basin boundary, canal, and control structure is given in Figure 7.

The Project canal and control structure in the S-153 basin provide flood protection and drainage for the S-153 basin. Excess water in the S-153 basin is discharged to C-44 by way of the L-65 borrow canal and S-153. Water surface elevations in the borrow canal are regulated by S-153. Water supply to the basin is from local rainfall.

The L-65 borrow canal is the only Project canal in the S-153 basin. It is part of a continuous borrow canal along the east side of L-64 and L-65. The L-64/L65 borrow canal parallels the Florida East Coast Railway from C-44 to the railway's crossing of State Road 710. The L-64 and L-65 borrow canals are separated by a plug about eight miles north of C-44. This plug acts as a divide between the S-153 basin and the C-59 basin. Flow north of the plug in the L-64 borrow canal is to C-59, and flow south of the plug in the L-65 borrow canal is to C-44. Secondary drainage in the basin is provided by natural streams.

S-153 is the only Project control structure in the S-153 basin. It is a gated spillway located in the alignment of the L-65 borrow canal at the canal's outlet to C-44, just north of the town of Port Mayaca. S-153 regulates the stage in the L-65 borrow canal and controls discharges from the borrow canal to C-44. It also prevents water from C-44 from entering the borrow canal. The structure is operated to maintain an optimum stage in the L-65 borrow canal of 18.8 ft NGVD. If the tailwater (i.e., in the C-44 side) stage rises to within 0.2 ft of the headwater stage, the gates are closed to prevent water flow into the L-65 borrow canal. Design criteria for S-153 are given in Table 3.

Comments on Design and Historic Operation

S-153 was designed to pass thirty percent of the Standard Project Flood from the S-153 basin without causing flooding in the basin. However, S-153 was designed to serve a basin much larger than the current basin. 6,600 acres between the S-153 basin and C-44 originally drained to the L-65 borrow canal and to S-153. This land is now the cooling reservoir for a Florida Power and Light power plant. Since the reservoir is hydraulically connected to C-44, the land it occupies is now considered part of the C-44 basin. Because the drainage area of the S-153 basin has been significantly decreased, the flood protection the L-65 borrow canal and S-153 provide the basin has been significantly increased.

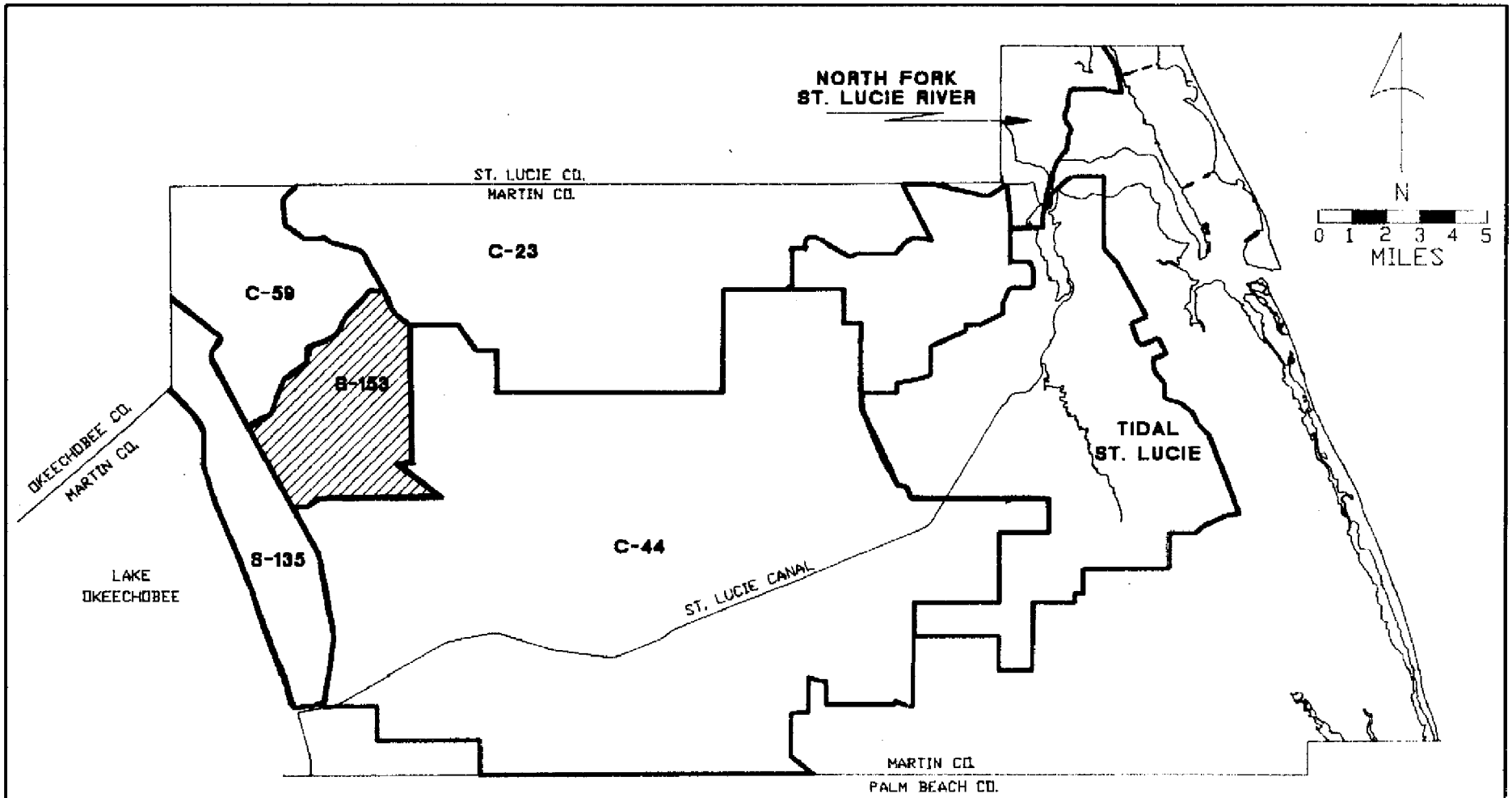

FIGURE 6. S-153 BASIN LOCATION MAP

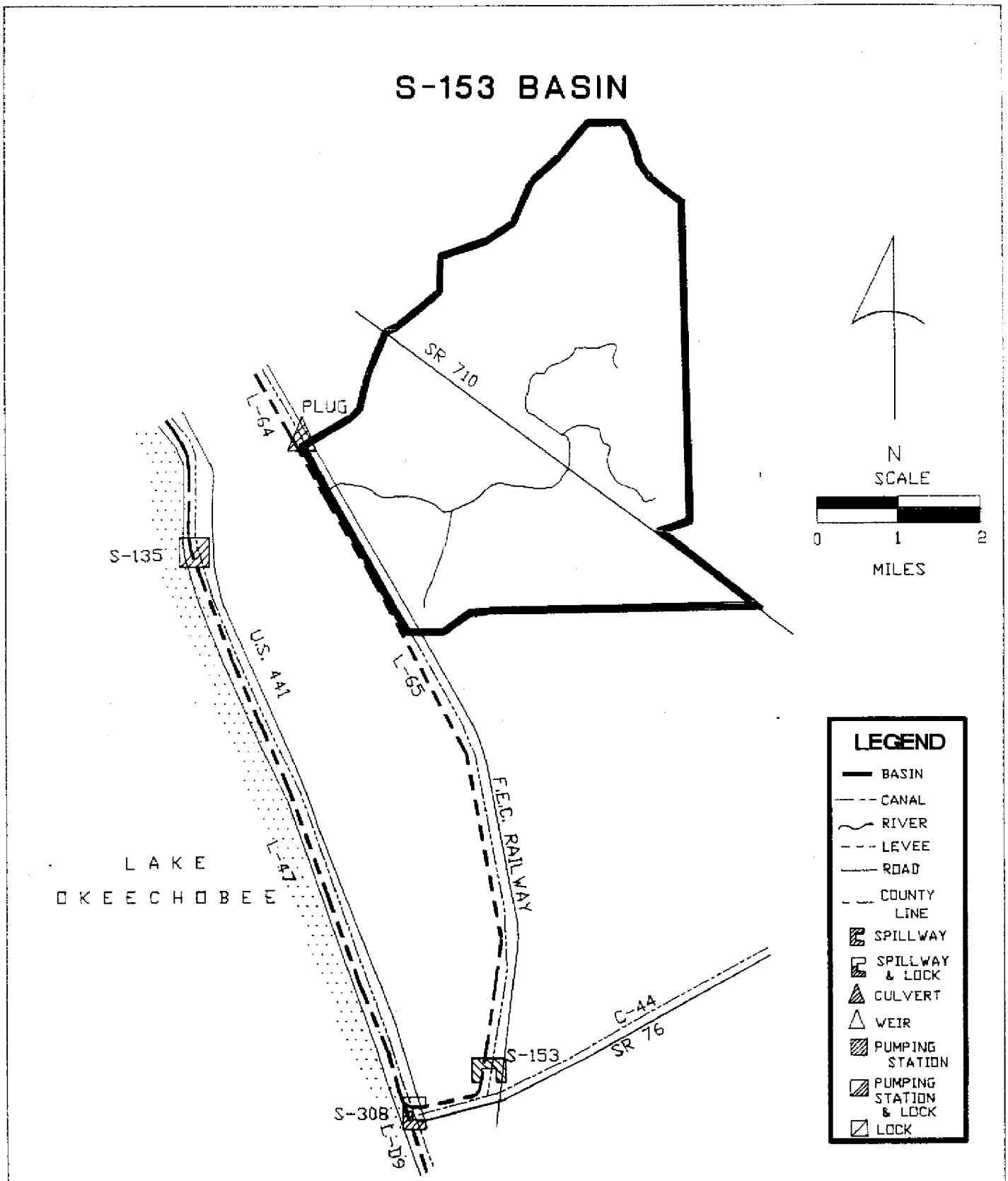

FIGURE 7. THE S-153 BASIN

TABLE 3. S-153 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-153 Stage divide	Gated Spillway, 2-split gates lower half 4 ft high x 18 ft wide upper half 4.8 ft high x 18 ft wide Net crest lgth = 140 ft crest elev = 12.2 ft NGVD	19.5	18.5	18.8 19.1 ≥ HW ≥ 18.6	2100	HW = 26.36 TW = 20.27 Q = 3900 (FPL Dike Failure) HW = 19.76 Q = 2526 (Storm Runoff)	10/31/79 10/31/79 10/31/79 6/26/84 9/25/83

in = inches
ft = feet
elev = elevation
lgth = Length
TW = Tail water
Q = discharge in cfs
CMP = Corrugated metal pipe
RCP = Reinforced concrete pipe
HW = Head water
CFS = Cubic feet per second
ds = downstream
ups = upstream
ft NGVD = Feet relative to National Geodetic Vertical Datum

S-135 BASIN

Description of the Basin

The S-135 basin is approximately 28.3 square miles in area and is located in northwestern Martin County (20.0 square miles, Figure 8) and in western Okeechobee County (8.3 square miles). The basin is impounded by levees: on the west by L-47, on the north by L-63S, on the south by L-65, and on the east by L-63S, L-64, and L-65. The basin boundary relative to local roads and landmarks is shown on Map A. A schematic map showing the basin boundary, canals, and control structures is given in Figure 9.

The Project canal and control structures in the S-135 basin have three functions: (1) to remove excess water from the basin to storage in Lake Okeechobee, (2) to intercept seepage through L-47, and (3) during periods of low natural flow, to supply water to the basin from Lake Okeechobee. Excess water is discharged from the basin by way of S-135. Water surface elevations in the L-47 borrow canal are regulated by S-135. Water supply to the basin is made from Lake Okeechobee by way of S-135. Boats may pass from the L-47 borrow canal to Lake Okeechobee by way of S-135 or by way of Henry Creek Lock.

The L-47 borrow canal is the only Project canal in the S-153 basin. It is aligned parallel to L-47 and the northeast shore of Lake Okeechobee from C-59 on the north to C-44 on the south. The L-47 borrow canal does not connect to either C-59 or C-44.

There are two Project control structures in the basin: S-135 and Henry Creek Lock (G-36). Design criteria for the structures in this basin are given in Table 4.

S-135 consists of a gated spillway, a navigation lock, and a pump station. It is located at Chancy Bay on the northeastern shore of Lake Okeechobee. Operation of the structure depends on the stage in Lake Okeechobee. The spillway can discharge to Lake Okeechobee by gravity flow when the tailwater (i.e., lake side) stage is below 13.0 ft NGVD, and the headwater (i.e., canal side) stage is greater than 13.0 ft NGVD. The gates on the spillway are ordinarily closed when the tailwater stage is greater than the headwater stage, but can be opened to supply water to the basin from the lake. Pumping is initiated when the headwater stage rises to 14.0 ft NGVD and is terminated when the headwater stage is less than 13.5 ft NGVD. If a storm is expected to raise the headwater stage above 14.0 ft NGVD, the canal is pumped down to 13.0 ft NGVD and held there, if possible, until the storm passes. The lock remains fully open when the stage in Lake Okeechobee is 14.0 ft NGVD or less. When the lake stage is greater than 14.0 ft NGVD, the lock is operated as needed between 5:30 AM and 8:00 PM daily, and is closed between 8:00 PM and 5:30 AM.

Henry Creek Lock is a navigation lock between Lake Okeechobee and the L-47 borrow canal. It is located on the northwest shore of Lake Okeechobee at Henry Creek, about nine miles south of the City of Okeechobee. The lock gates are opened full whenever the Lake Okeechobee stage is below 14.0 ft NGVD. When the lake exceeds 14.0 ft NGVD, the lock is operated as needed between 5:30 AM and 8:00 PM daily and is closed between 8:00 PM and 5:30 AM.

Comments on Design and Historic Operation

S-135 can remove water from the S-135 basin at the rate of three-quarters of an inch of runoff per day. The structure was designed to pump against the Standard Project Flood on Lake Okeechobee.

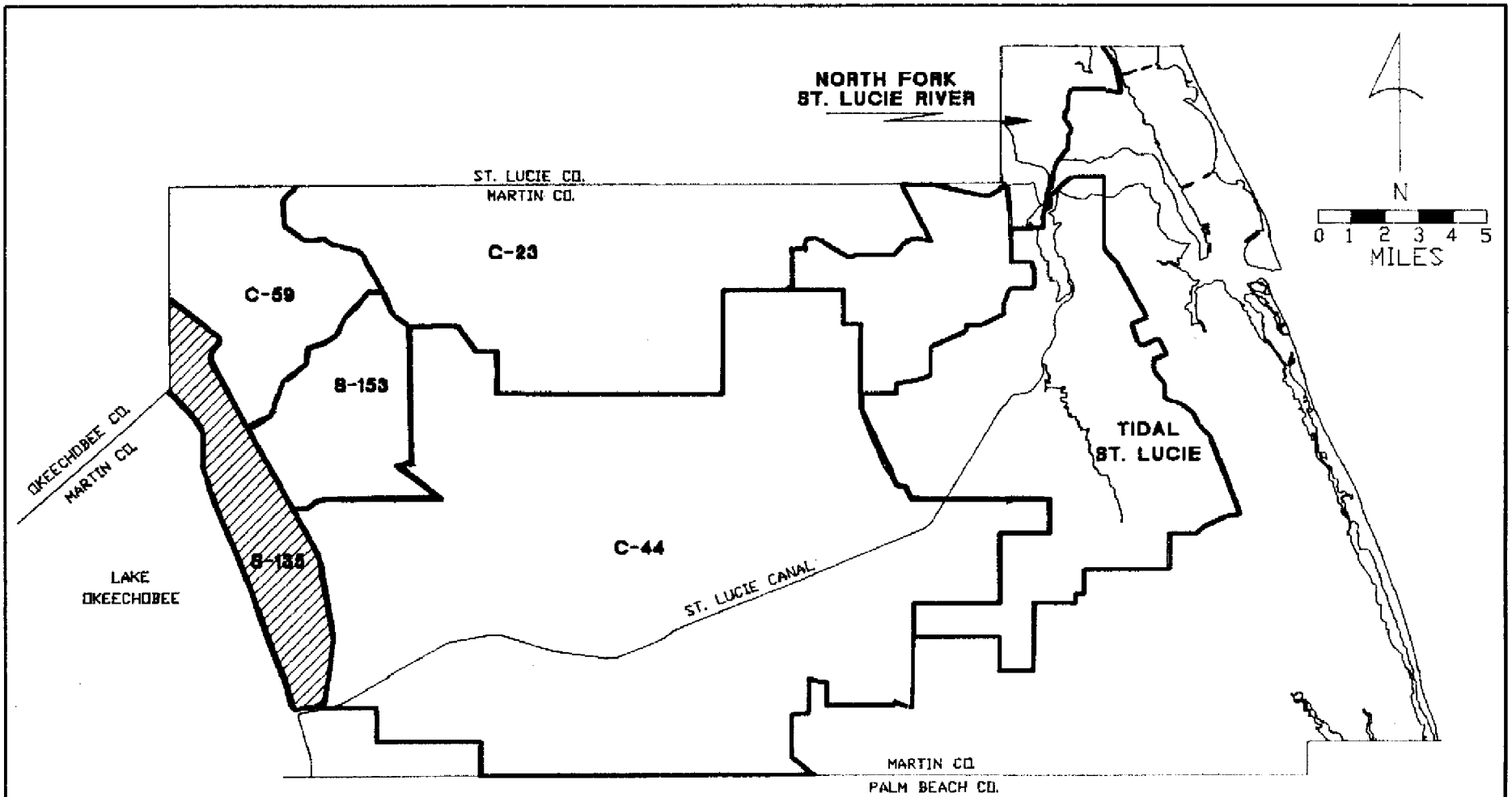

FIGURE 8. S-135 BASIN LOCATION MAP

S-135 BASIN

S-135 BASIN

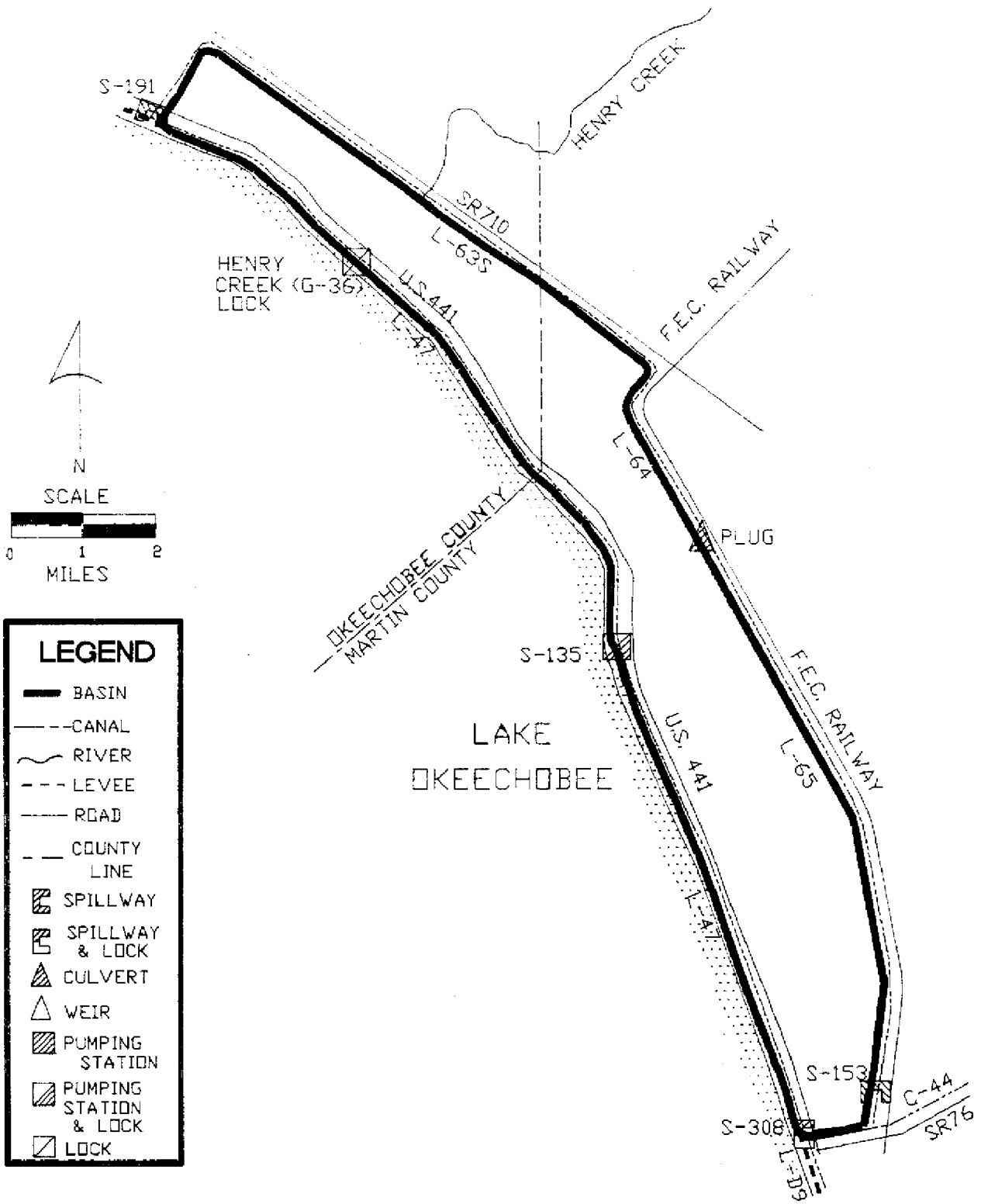

FIGURE 9. THE S-135 BASIN

TABLE 4. S-135 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-135 Drainage of, or water supply to, area bounded by L-47, L-63S, L-64 and L-65	Pump Station, 4-units : 125 CFS each Gated culvert spillway 2-96in x 161ft CMP Invert elev = 5.0ft NGVD Navigation lock 15ft wide x 50ft long	13.0 (pump)	23.5 (pump)	14.0 or below (lock open)	500	HW = 14.13 (storm runoff) HW = 21.15 (FPL dike failure)	9/10/86 10/31/79
Henry Creek Lock G-36	Navigation Lock 15ft wide x 50ft Long						

in = inches
ft = feet
elev = elevation
lgth = Length
TW = Tail water
Q = discharge in cfs
CMP = Corrugated metal pipe
RCP = Reinforced concrete pipe
HW = Head water
CFS = Cubic feet per second
ft NGVD = Feet relative to National Geodetic Vertical Datum
ds = downstream
ups = upstream

C-44 (ST. LUCIE CANAL) BASIN

Description of the Basin

The C-44 basin is approximately 189.8 square miles in area and is located (Figure 10) in west-central Martin County. The basin boundary relative to local roads and landmarks is shown on Map A. A schematic map showing the basin boundary, canal, and control structures is given in Figure 11.

The Project canal and control structures in the C-44 basin have five functions: (1) to provide drainage and flood protection for the C-44 basin, (2) to accept runoff from the S-153 basin and to discharge this runoff to tidewater, (3) to discharge water from Lake Okeechobee to tidewater when the lake is over schedule, (4) to supply water to the C-44 basin during periods of low natural flow, and (5) to provide a navigable waterway from Lake Okeechobee to the Intracoastal Waterway. Excess water in the C-44 basin is discharged to tidewater (i.e., to C-44A) by way of C-44 and S-80. Water surface elevations in C-44 are regulated by S-80. Regulatory releases from Lake Okeechobee are made to C-44 by way of S-308. Water supply to the basin is made from Lake Okeechobee by way of S-308 and from local rainfall. Both S-80 and S-308 have navigation locks to pass boat traffic around the structures.

C-44 is the only Project canal in the C-44 basin. It is aligned from west to east, north of, and approximately parallel to State Road 76 from Port Mayaca on Lake Okeechobee to S-80, eight-tenth of a mile southwest of Florida's Turnpike. The canal discharges to tidewater in C-44A downstream of S-80.

There are three Project structures controlling flow in the C-44 basin: S-80, S-153, and S-308. Design criteria for the structures in the basin are given in Table 5.

S-80 is a gated spillway which is operated to restrict upstream and downstream stages and channel velocities to non-damaging levels. Typically headwater stages are maintained between 14.0 and 14.5 ft NGVD. The lock at S-80 is operated between 6:00 AM and 10:00 PM daily. It is closed at other times.

S-153 is a gated spillway located in the alignment of the L-65 borrow canal at the canal's outlet to C-44 just north of Port Mayaca. It controls the stage in the L-65 borrow canal and controls discharges from the borrow canal to C-44. S-153 also prevents water from C-44 from entering the borrow canal. The structure is operated to maintain an optimum stage in the L-65 borrow canal of 18.8 ft NGVD. If the tailwater (i.e., in the C-44 side) stage rises to within 0.2 ft of the headwater stage, the gates are closed to prevent water flow into the L-65 borrow canal.

S-308 is a gated spillway and navigation lock located near Port Mayaca at the outlet of Lake Okeechobee to C-44. Operation of the structure depends on the stage in Lake Okeechobee relative to the lake's regulation schedule. If the lake stage is at or below schedule, the structure is operated to maintain the tailwater (i.e., canal side) stage at 14.5 ft NGVD. If the lake schedule is exceeded by less than one foot, moderate (i.e., as required to bring the lake back to schedule) discharges are made through S-308. If the lake stage exceeds the lake schedule by more than one foot, up to the maximum discharge (see Table 5) is made through the structure. The lock is opened whenever the stage in Lake Okeechobee is below 14.5 ft NGVD. When the stage in the lake is above 14.5 ft NGVD, the lock is operated as needed

between 6:00 AM and 10:00 PM daily. The lock remains closed between 10:00 PM and 6:00 AM.

Currently, on an experimental basis, the St. Lucie Estuary Management Plan (SLEMP) is being used to regulate flows in C-44. The objective of this plan is to provide environmental benefit to the St. Lucie Estuary by controlling salinity levels in the estuary. Control of salinity levels in the estuary is affected by regulating inflows of freshwater to the estuary by way of C-44. This operational strategy moderates regulatory discharges from Lake Okeechobee during wet periods and provides for supplemental discharges to the estuary during dry periods. Regulatory releases from Lake Okeechobee are moderated by making a series of relatively small discharges (i.e., pulses) rather than one large release. These pulses are timed to mimic the natural runoff that might have occurred from rainfall events. It is hoped that eventually the amount and timing of freshwater releases to the estuary can be correlated to rainfall.

Comments on Design and Historic Operation

C-44 and S-80 were designed to pass the Standard Project Flood (SPF) from the C-44 basin and the S-153 basin and to pass regulatory discharges from Lake Okeechobee to tidewater. Together with the Caloosahatchee River, the St. Lucie Canal can pass the Standard Project Flood from Lake Okeechobee.

C-44 is operated and maintained by the U.S. Army Corps of Engineers (COE). Permission to cross the right of way of the canal or to discharge water to the canal must be obtained from the COE. Permits for water use and for surface water management systems in the basin are the responsibility of the District however.

C-44 is a reach of the St. Lucie Canal and of the Okeechobee Waterway. The St. Lucie Canal comprises C-44 and C-44A. The Okeechobee Waterway comprises the St. Lucie Canal, Lake Okeechobee and the Caloosahatchee River (C-43).

It was realized early in the settlement of South Florida that the water level in Lake Okeechobee would have to be substantially reduced if drainage and flood control in the Everglades were to be accomplished. The easiest way to drain and subsequently control water levels in the lake was by way of canals connecting the lake to the St. Lucie and the Caloosahatchee Rivers. Work on the St. Lucie Canal began in 1915. The primary purpose of the canal was to divert the entire flow from Lake Okeechobee to the ocean. Secondarily, it was expected to provide a navigable waterway from Lake Okeechobee to the ocean and to provide hydroelectric power at the eastern end of the canal. It was envisioned that after the completion of the canal, the then existing Caloosahatchee waterway would be enlarged to provide a cross-state canal. Because of difficulties in financing the project, completion of the canal was delayed until 1917, and then, the completed canal was only half as large as the original design (i.e., 200 feet wide and 12 feet deep). Control of water flow was provided by a dam and lock at the eastern end (at the present site of S-80). Although a hydroelectric plant was installed at the control structure, it later proved to be impractical.

Lack of money prevented further work on the St. Lucie Canal until the 1930's when the Corps constructed Hoover Dike. As part of the legislation authorizing the dike, money was also authorized for deepening the St. Lucie Canal and constructing a new lock structure. In 1948, the St. Lucie Canal was deepened again.

When the Central and Southern Florida Flood Control Project was authorized in 1949, the St. Lucie Canal was placed under its management. As part of the Project, a spillway and lock (S-308) were completed in 1977 at the outlet of Lake Okeechobee to the St. Lucie Canal to better regulate lake stage and control discharges to the canal.

The District and the COE are currently (1988) investigating plans to reduce deposition of sediments in the St. Lucie Estuary. There are two significant problems:

1. Deposition of coarse, sandy sediments at the outlet of C-44A to the South Fork of the St. Lucie River creates shoals that restrict flow and are a hazard to navigation.

2. Deposition of fine clays and organic materials elsewhere in the estuary may create environmental problems. In some cases, the fine materials promote anaerobic conditions on the estuary bottom, an unsuitable environment for the organisms typically inhabiting the estuary. Additionally, these fine materials may contain high concentrations of toxic materials (e.g., heavy metals and pesticides).

The sediments involved in these depositions result in part from scouring of canal banks upstream along C-44. Continuous scour in some areas has widened the canal to the extent that purchase of additional right-of-way has been required. It is believed that C-44A, the tributaries to both C-44 and C-44A, and Lake Okeechobee are also sources of sediments, but the relative contributions of these sources has not yet been determined.

Several alternative plans have been suggested: (1) installation of rip-rap and other structural materials along the banks of the canal, (2) stabilization of the canal banks through sloping and revegetation, (3) construction of a large settlement basin, and (4) continuation of the current practice of periodic dredging of the estuary. The COE is preparing a draft General Design Memorandum which will describe the various options and make recommendations for future work.

The District, the COE, the U. S. Department of Agriculture, the Martin County Soil and Water Conservation District have sponsored a demonstration project to evaluate the use of various structural materials and vegetation to stabilize the canal banks. Three sites were chosen for study: Site 1 is located just upstream of S-80 and is subjected to lowered water levels and high water velocities during regulatory discharges. This site was stabilized with large rocks placed at or below the waterline and various types of plants placed above the waterline. Site 2 is located midway between S-80 and S-308 near Indiantown. Little fluctuation in water levels occurs at this site during regulatory releases. It was stabilized with vegetation. Site 3 is located just downstream of S-308 in an area subjected to higher water levels and high water velocities during regulatory releases. This site was stabilized with various types of structural materials placed at and above the waterline.

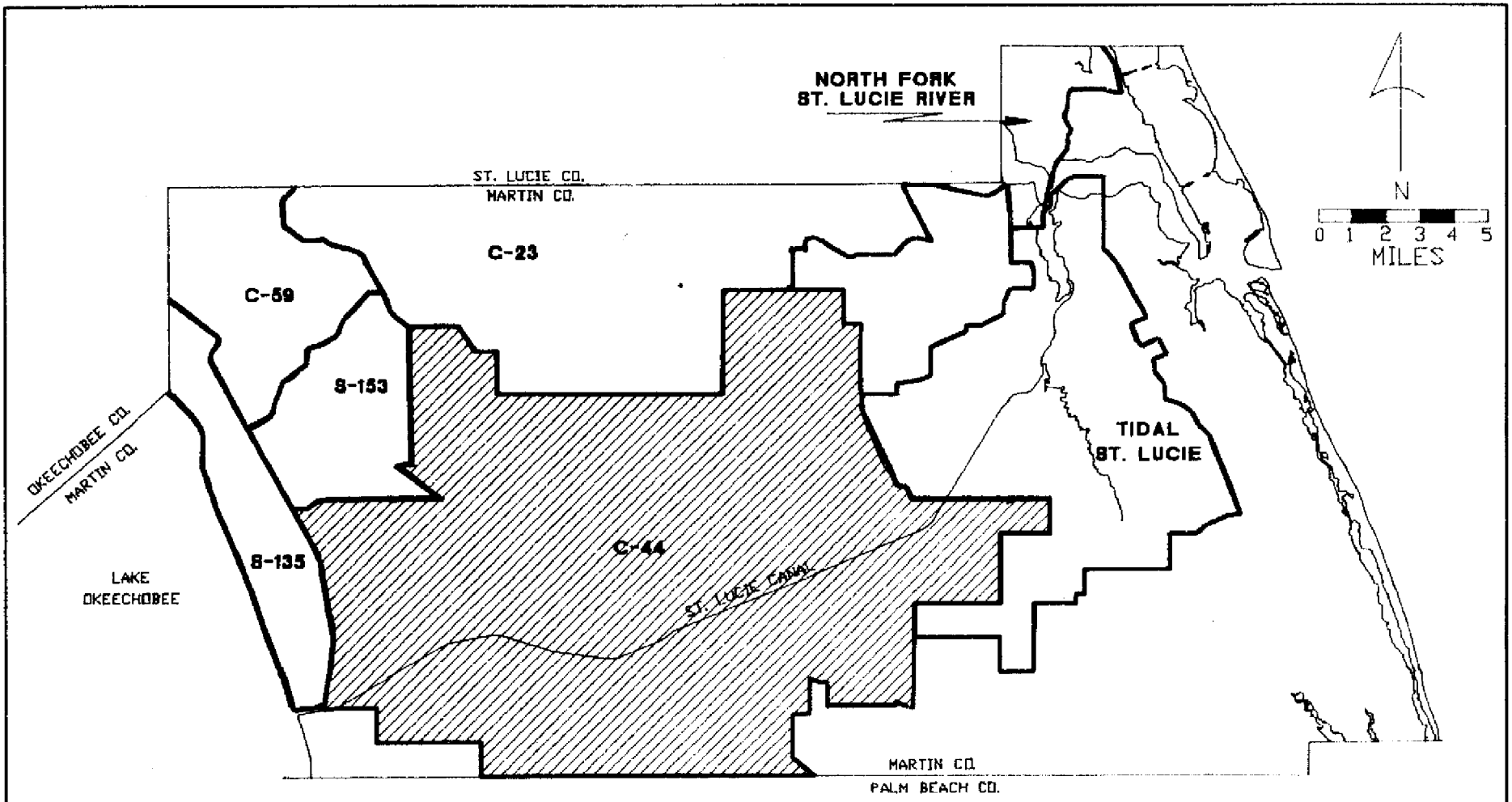

FIGURE 10. C-44 BASIN LOCATION MAP

C-44 BASIN

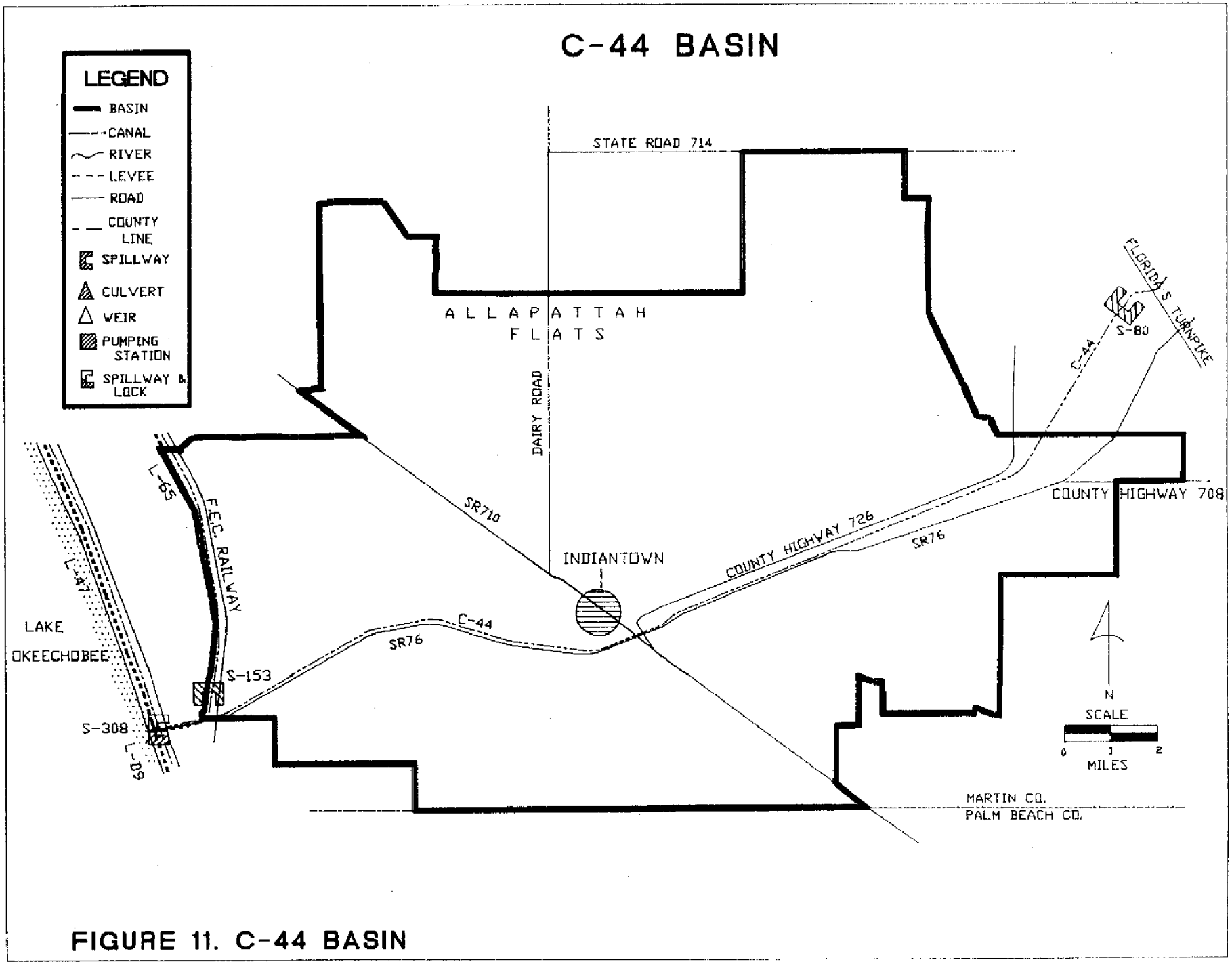

FIGURE 11. C-44 BASIN

TABLE 5. C-44 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-308 Outlet for Lake Okeechobee and Navigation lock	Gated Spillway, 4-gates 16.9ft high x 29 ft wide Net Crest lgth = 116ft Crest elev = 9.1ft NGVD Navigation Lock 56ft wide x 400ft long	24.9	23.2	Lake Okeechobee Regulation Schedule	14800	Q = 8150 (average daily) HW = 18.8	2/26/83 3/24/83
S-80 Stage divide and Navigation lock	Gated Spillway, 7-gates 10.5ft high x 20.0 ft wide Net crest lgth = 140 ft Crest elev = 0.56 ft Navigation Lock 50ft wide x 250ft long	12.0	6.8	14.5 ≥ HW ≥ 14.0	16900	Q = 11500 HW = 16.89 (Storm Runoff) Q = 15,000 HW = 15.8 (FPL Dike Failure	3/26/70 3/26/70 10/31/79 10/31/79

in = inches
ft = feet
elev = elevation

lgth = Length
TW = Tail water
Q = discharge in cfs

CMP = Corrugated metal pipe
RCP = Reinforced concrete pipe
ft NGVD = Feet relative to National Geodetic Vertical Datum

HW = Head water
CFS = Cubic feet per second

ds = downstream
ups = upstream

TIDAL ST. LUCIE BASIN

Description of the Basin

The Tidal St. Lucie basin is approximately 69.8 square miles in area and is located (Figure 12) in eastern Martin County. The basin boundary relative to local roads and landmarks is shown on Map A. A schematic map of the basin boundary, canals, and control structure is given in Figure 13.

The Project canal and control structure in the Tidal St. Lucie Basin have three functions: (1) to accept flows from C-44 and to discharge those flows to tidewater in the St. Lucie River, (2) to provide a navigable waterway from S-80 to the Intracoastal Waterway, and (3) to provide drainage for portions of the Tidal St. Lucie basin. Water from the C-44 basin is discharged to the C-44A basin by way of S-80. Discharge from the C-44A basin and water surface elevations in C-44A are uncontrolled. A lock at S-80 allows boat traffic to bypass the structure.

C-44A is the only Project canal in the Tidal St. Lucie basin. C-44A is a continuation of C-44 and is the lower reach of the St. Lucie Canal (part of the Okeechobee Waterway). C-44A begins at S-80 eight-tenths of a mile upstream of the Florida's Turnpike crossing of C-44A. About two miles downstream of S-80 the canal intercepts the South Fork of the St. Lucie River. The canal follows approximately the old channel of the river to the northeast, discharging to the estuary of the South Fork of the St. Lucie River southeast of the City of Stuart. There are four streams tributary to C-44A: the South Fork of the St. Lucie River, Hog Creek, Mapps Creek, and the Hanson Grant Outlet. These streams discharge to tidewater in C-44A downstream of S-80. No lands in the basin drain to C-44 upstream of S-80.

S-80 is the only Project structure controlling flow in the C-44A basin. S-80 is a gated spillway operated to restrict upstream and downstream stages and channel velocities to non-damaging levels. Typically headwater stages are maintained between 14.0 and 14.5 ft NGVD. The lock at S-80 is operated between 6:00 AM and 10:00 PM daily. It is closed otherwise. Design criteria for S-80 are given in Table 6.

Comments on Design and Historic Operation

C-44A is maintained as a navigable channel of the Okeechobee Waterway between S-80 and the Intracoastal Waterway.

The District and the COE are currently (1988) investigating plans to reduce deposition of sediments in the St. Lucie Estuary. There are two significant problems:

1. Deposition of coarse, sandy sediments at the outlet of C-44A to the South Fork of the St. Lucie River creates shoals that restrict flow and are a hazard to navigation.

2. Deposition of fine clays and organic materials elsewhere in the estuary may create environmental problems. In some cases, the fine materials promote anaerobic conditions on the estuary bottom, an unsuitable environment for the organisms typically inhabiting the estuary. Additionally, these fine

materials may contain high concentrations of toxic materials (e.g., heavy metals and pesticides).

The sediments involved in these depositions result in part from scouring of canal banks upstream along C-44. Continuous scour in some areas has widened the canal to the extent that purchase of additional right-of-way has been required. It is believed that C-44A, the tributaries to both C-44 and C-44A, and Lake Okeechobee are also sources of sediments, but the relative contributions of these sources has not yet been determined.

Several alternative plans have been suggested: (1) installation of rip-rap and other structural materials along the banks of the canal, (2) stabilization of the canal banks through sloping and revegetation, (3) construction of a large settlement basin, and (4) continuation of the current practice of periodic dredging of the estuary. The COE is preparing a draft General Design Memorandum which will describe the various options and make recommendations for future work.

The District, the COE, the U. S. Department of Agriculture, the Martin County Soil and Water Conservation District have sponsored a demonstration project to evaluate the use of various structural materials and vegetation to stabilize the canal banks. Three sites were chosen for study: Site 1 is located just upstream of S-80 and is subjected to lowered water levels and high water velocities during regulatory discharges. This site was stabilized with large rocks placed at or below the waterline and various types of plants placed above the waterline. Site 2 is located midway between S-80 and S-308 near Indiantown. Little fluctuation in water levels occurs at this site during regulatory releases. It was stabilized with vegetation. Site 3 is located just downstream of S-308 in an area subjected to higher water levels and high water velocities during regulatory releases. This site was stabilized with various types of structural materials placed at and above the waterline.

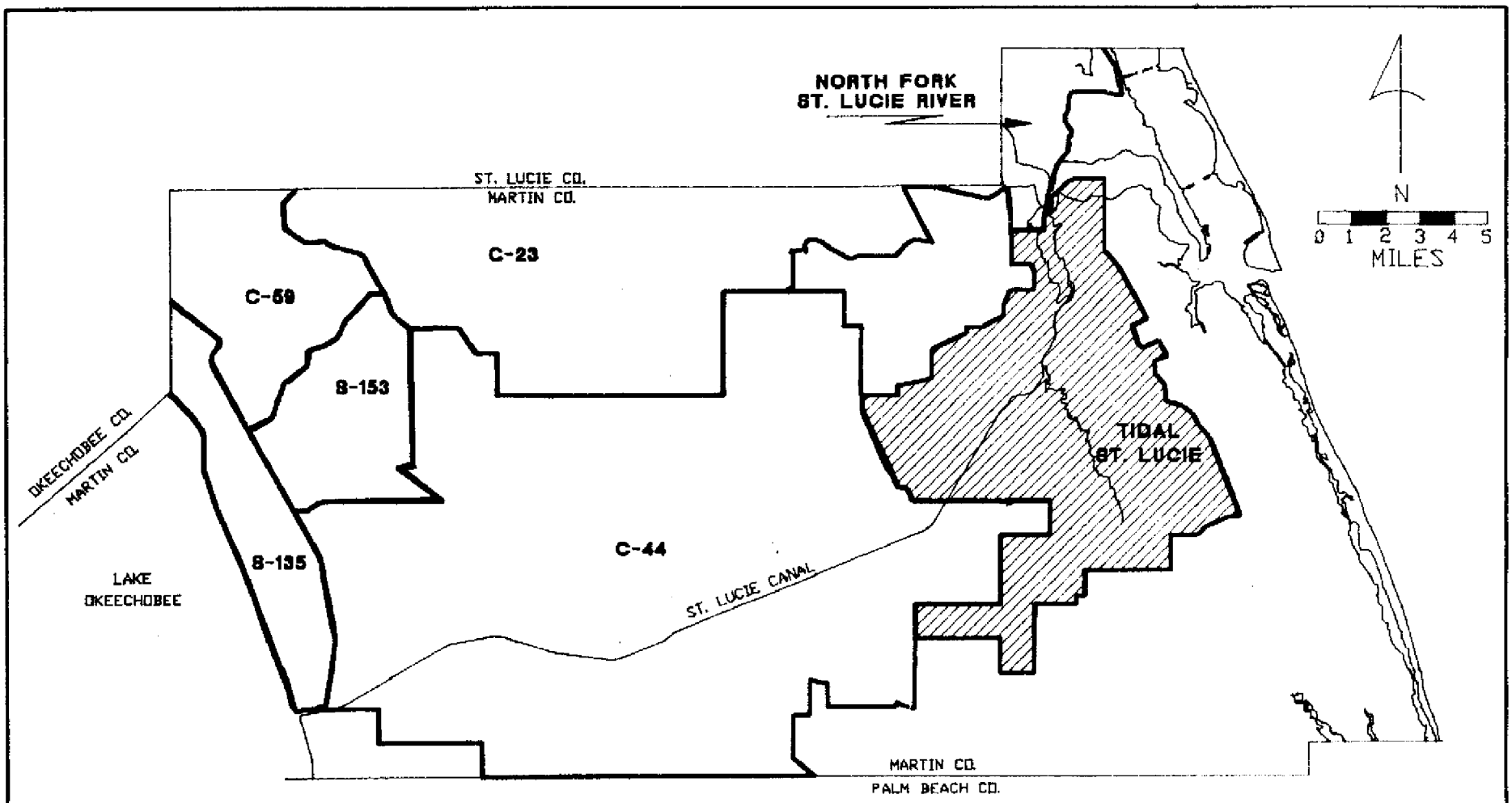

FIGURE 12. TIDAL ST. LUCIE BASIN LOCATION MAP

TIDAL ST. LUCIE BASIN

TIDAL ST. LUCIE BASIN

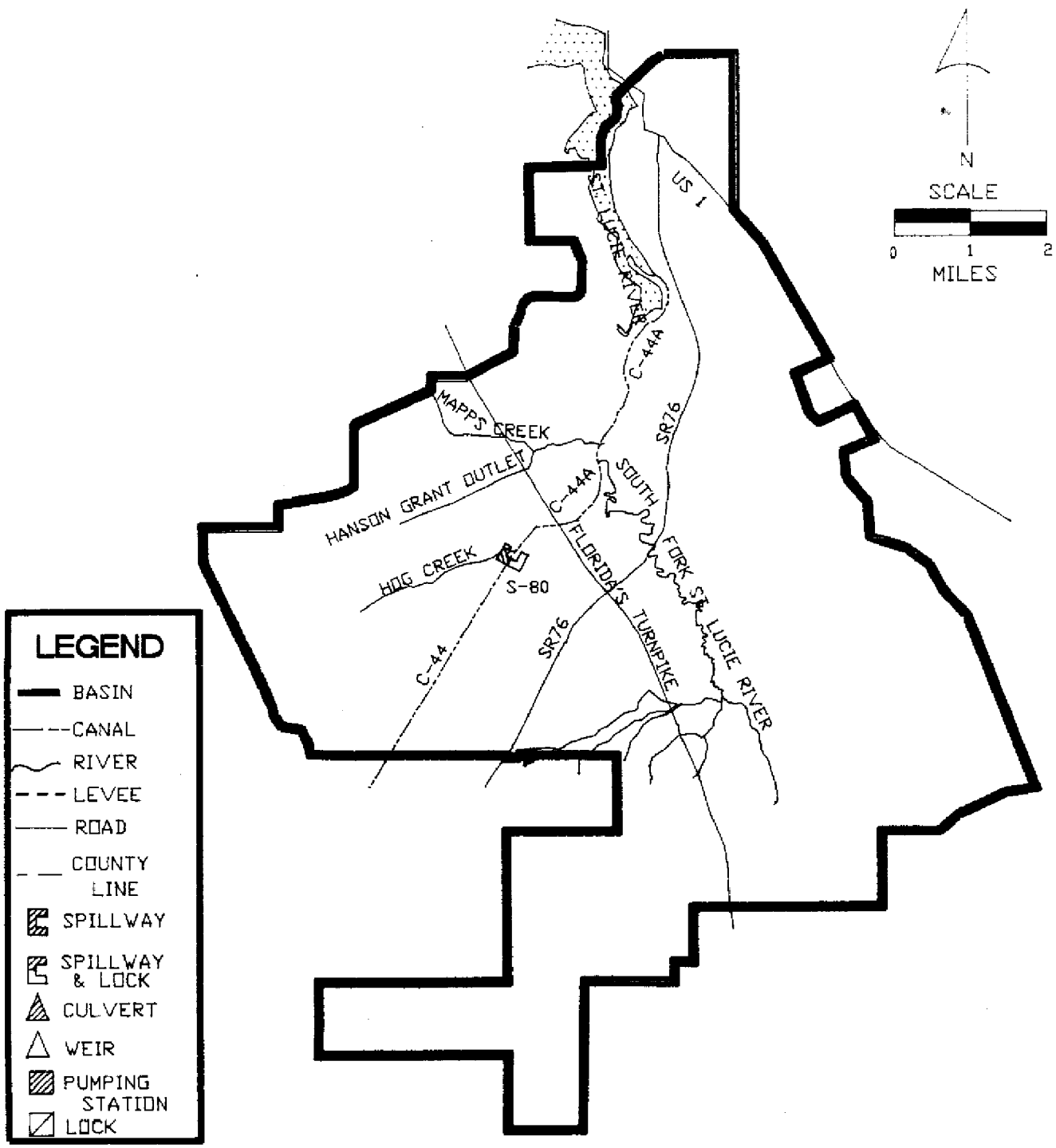

FIGURE 13. THE TIDAL ST. LUCIE BASIN

TABLE 6. Tidal St. Lucie 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-80 Stage divide and Navigation lock	Gated Spillway, 7-gates 10.5ft high x 20.0 ft wide Net Crest lgth = 140.0ft Crest elev = 0.56 Navigation Lock 50ft wide x 250ft long	12.0	6.8	14.5 ≥ HW ≥ 14.0	16900	Q = 11500 HW = 16.89 (Storm Runoff) Q = 15,000 HW = 15.8 (FPL Dike Failure)	3/26/70 3/26/70 10/31/79 10/31/79

in = inches
ft = feet
elev = elevation
lgth = Length
TW = Tail water
Q = discharge in cfs
CMP = Corrugated metal pipe
RCP = Reinforced concrete pipe
HW = Head water
CFS = Cubic feet per second
ft NGVD = Feet relative to National Geodetic Vertical Datum
ds = downstream
ups = upstream

NORTH FORK OF THE ST. LUCIE RIVER BASIN

Description of the Basin

The North Fork of the St.Lucie River drainage basin is 191.6 square miles in area and is located in eastern St. Lucie County (180.7 square miles, Figure 14) and northeastern Martin County (10.9 square miles). The basin boundary in Martin County is shown on Map A. A schematic map showing the basin boundary, canals, control structure, and tributary streams is given in Figure 15.

The Project canals and control structure in the North Fork of the St. Lucie River basin remove excess water from the North Fork of the St. Lucie River basin and from the C-24 basin. Discharge of water from the C-24 basin into the North Fork of the St. Lucie River basin is controlled by S-49.

There are two Project canals in the North Fork of the St. Lucie River basin. C-23A is a short section of canal in the lower reach of the North Fork of the St. Lucie River. It passes discharges from the North Fork of the St. Lucie River and from C-24 to the St. Lucie estuary. A short reach of the C-24 canal extends from S-49 one mile west of Florida's Turnpike to the North Fork of the St. Lucie River just north of C-23A. This reach of C-24 has no control and is tidal. S-49 is the only Project control structure regulating flow in the North Fork of the St. Lucie River basin. It is a gated spillway located in the alignment of C-24 one mile west of Florida's Turnpike. S-49 controls the water surface elevations in C-24 (in the C-24 basin), and it controls the discharge from C-24 to tide water (in the North Fork of the St. Lucie River basin). A headwater stage is maintained by S-49 adequate to prevent salt water intrusion to local groundwater. It is operated to maintain a headwater stage of between 18.5 and 20.2 ft NGVD during the wet season (i.e., May 15 to October 15) and between 19.5 and 21.2 during the dry season (i.e., October 15 to May 15).

Comments on Design and Historic Operation

C-23A was designed to pass thirty percent of the Standard Project flood from the North Fork of the St. Lucie River basin and from the C-24 basin.

With District approval, two areas in the North Fork St. Lucie River basin can be pumped to C-25 to mitigate flooding in the North Fork St. Lucie River basin: (1) an eighteen square mile parcel in the northwest corner of the North Fork St. Lucie River basin which normally drains to Ten Mile Creek by gravity flow, and (2) a three square mile parcel in the northeast corner of the North Fork St. Lucie River basin which normally drains to Five Mile Creek by gravity flow.

The District and the COE are currently (1988) investigating plans to reduce deposition of sediments in the St. Lucie Estuary. There are two significant problems:

1. Deposition of coarse, sandy sediments at the outlet of C-44A to the South Fork of the St. Lucie River creates shoals that restrict flow and are a hazard to navigation.

2. Deposition of fine clays and organic materials elsewhere in the estuary may create environmental problems. In some cases, the fine materials promote anaerobic conditions on the estuary bottom, an unsuitable environment for the organisms typically inhabiting the estuary. Additionally, these fine materials may contain high concentrations of toxic materials (e.g., heavy metals and pesticides).

The sediments involved in these depositions result in part from scouring of canal banks upstream along C-44. Continuous scour in some areas has widened the canal to the extent that purchase of additional right-of-way has been required. It is believed that C-44A, the tributaries to both C-44 and C-44A, and Lake Okeechobee are also sources of sediments, but the relative contributions of these sources has not yet been determined.

Several alternative plans have been suggested: (1) installation of rip-rap and other structural materials along the banks of the canal, (2) stabilization of the canal banks through sloping and revegetation, (3) construction of a large settlement basin, and (4) continuation of the current practice of periodic dredging of the estuary. The COE is preparing a draft General Design Memorandum which will describe the various options and make recommendations for future work.

The District, the COE, the U. S. Department of Agriculture, the Martin County Soil and Water Conservation District have sponsored a demonstration project to evaluate the use of various structural materials and vegetation to stabilize the canal banks. Three sites were chosen for study: Site 1 is located just upstream of S-80 and is subjected to lowered water levels and high water velocities during regulatory discharges. This site was stabilized with large rocks placed at or below the waterline and various types of plants placed above the waterline. Site 2 is located midway between S-80 and S-308 near Indiantown. Little fluctuation in water levels occurs at this site during regulatory releases. It was stabilized with vegetation. Site 3 is located just downstream of S-308 in an area subjected to higher water levels and high water velocities during regulatory releases. This site was stabilized with various types of structural materials placed at and above the waterline.

NORTH FORK OF THE ST. LUCIE RIVER BASIN

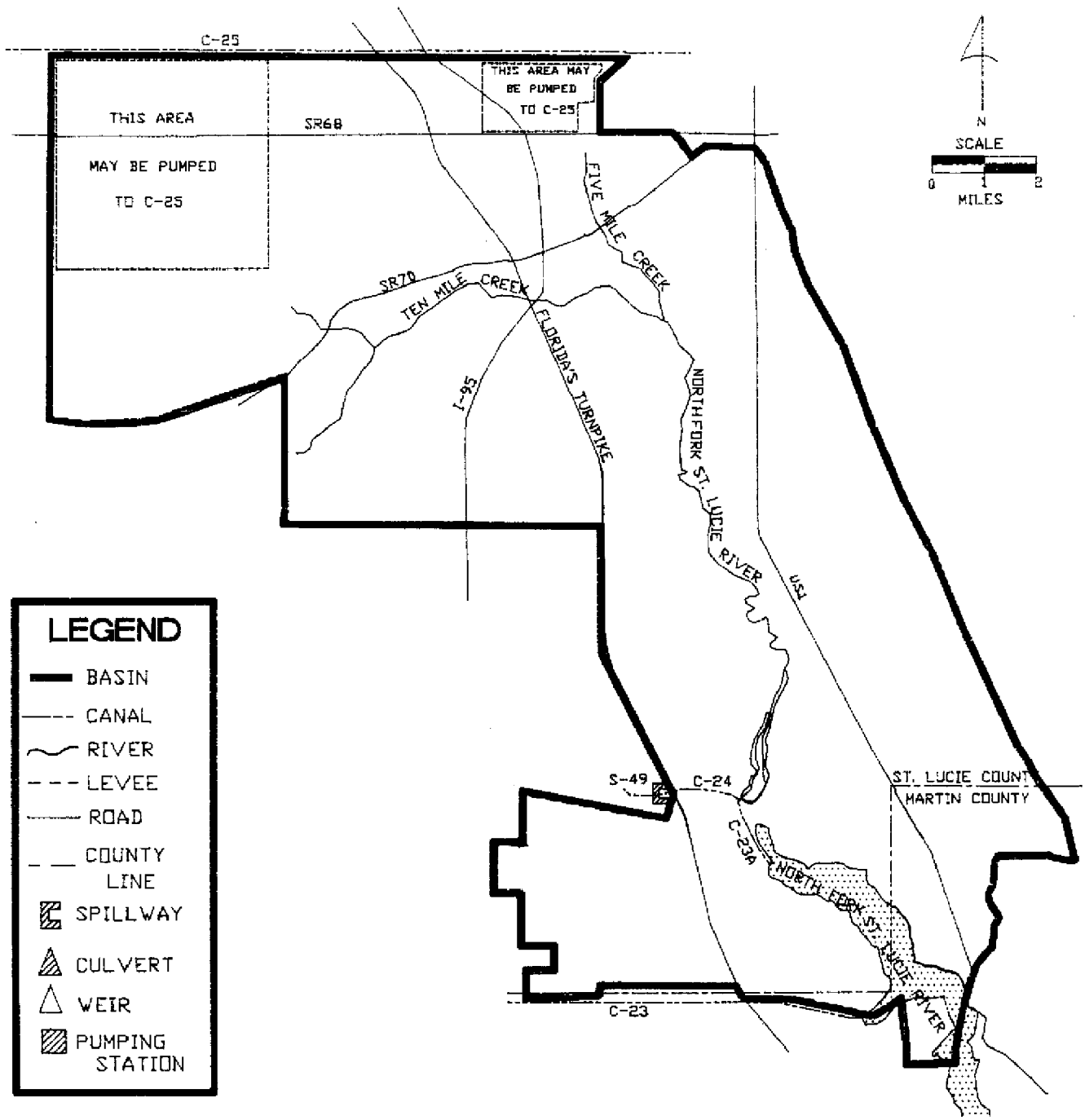

FIGURE 15. THE NORTH FORK OF THE ST. LUCIE RIVER BASIN

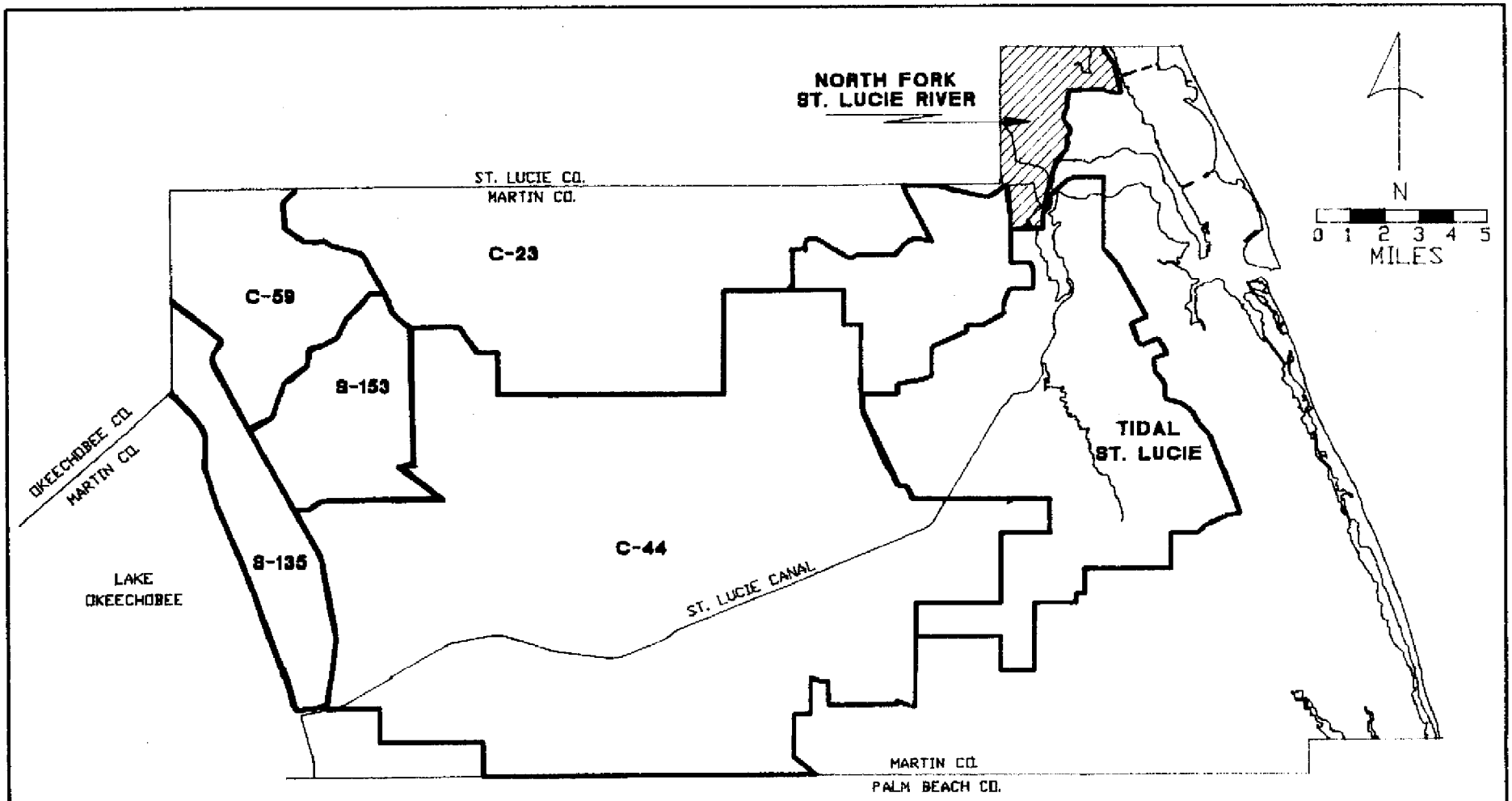

FIGURE 14. NORTH FORK ST. LUCIE BASIN LOCATION MAP

NORTH FORK ST. LUCIE BASIN

BIBLIOGRAPHY

Adams, B.P., D. Samples and C. Woehlcke. 1984. An Evaluation of Wastewater Reuse Policy Options for the South Florida Water Management District. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 84-6. 59 pp.
South Florida Management District, West Palm Beach, FL.

Anderson, J.R., E.E. Hardy, J.T. Roach and R.E. Witmer, 1976. A Land Use and Land Cover Classification System for Use with Remote Sensor Data. Geological Survey Professional Paper No. 964. United States Geological Survey, Washington, D.C. 22 pp.

Brown, M. and D. Reece. 1979. Hydrogeologic Reconnaissance of the Floridan Aquifer System, Upper East Coast Planning Area. South Florida Water Management District, West Palm Beach, FL. Tech. Map Series, No. 79-1. 25 pp.

Dickson, K. 1980. SFWMD Water Quality Monitoring Network 1980 Annual Report. South Florida Water Management District, Tech. Memorandum, October 1980. 58 pp.

Federico, T. 1983. Upper East Coast Water Quality Studies. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 83-1. 87 pp.

Gregg, R. and M. Cullum. 1984. Evaluation of the Water Management System at a Single Family Residential Site. Vol 1. Hydrology and Hydraulics of Timbercreek Subdivision in Boca Raton, Florida. Vol. 2. Analysis of selected Storm Events at Timbercreek Subdivision in Boca Raton, Florida. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 84-11. Vol. 1. 35 pp. Vol. 2. 99 pp.

Haunert, D. and J. R. Startzman, 1980. Some Seasonal Fisheries Trends and Effects of 1000 cfs Fresh Water Discharge on the Fishes and Macroinvertebrates in the St. Lucie Estuary, Florida. January, 1980. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 80-3. 58 pp.

Haunert, D. and R. Startzman. 1985. Short Term Effects of a Freshwater Discharge on the Biota of the St. Lucie Estuary, Florida. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 85-1. 36 pp.

Isern, L. and R. Brown, 1980. A Geographic Overview of 1977 Land Use Patterns in the Lower West Coast Planning Area of South Florida. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 80-8. 76 pp.

Khanal, N. 1981. Indirect Flow Measuring Devices for Agricultural Water Use Data Collection. Paper presented at Moscow (U.S.S.R.) State University, June 1981.

Khanal, N. 1980. Advanced Water Supply Alternatives for the Upper East Coast Planning Area, Parts 1 and 2. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 80-6. 73 pp.

Kuyper, W.H., J.E. Becker and A. Shopmyer. 1981. Land Use, Cover and Forms Classification System--A Tech. Manual. State of Florida, Department of Transportation, Tallahasee, FL. May 1981. 67 pp.

Lin, S. 1982. Preliminary Report on the Rainstorm of April 23-26, 1982. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, May 1982. 31 pp.

Lin, S. 1984. Summary of 1983-84 Dry Season Hydrologic Conditions. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, October, 1984. 31 pp.

Lin, S. and J. Lane, 1982. Preliminary Report on Rainstorm, March 28-29, 1982. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, April 1982. 23 pp.

Lin, S.,J. Lane and J. Marban, 1984. Meteorological and Hydrological Analysis of the 1980-1982 Drought. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 84-7. 42 pp.

MacVicar, T.K. 1983. Rainfall Averages and Selected Extremes for Central and South Florida. South Florida Water Management District, Tech. Publication 83-2. 31 pp.

MacVicar, T.K. 1981. Frequency Analysis of Rainfall Maximums for Central and South Florida. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 81-3. 70 pp.

Mierau, R., R.L. Taylor, and W.V. Storch. 1974. Surface Water Availability in the St.Lucie County Area. South Florida Water Management District, Memorandum Report, July 1974.

Morris, F.W. 1986. Bathymetry of the St. Lucie Estuary. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 86-4. 23 pp.

Morris, F.W. 1986. Modeling of Hydrodynamics and Salinity in the St. Lucie Estuary South Florida Water Management District, West Palm Beach, FL. Tech. Publication 87-1. 71 pp.

Nealon, D., G. Shih, S. Trost, S. Opalat, A. Fan and B. Adams. 1986. DRAFT Martin County Water Resource Assessment. South Florida Water Management District, Resource Planning Department, West Palm Beach, FL. Special Publication, March 1986. 195pp + Apps.

Pfeuffer, R.J. 1985. Pesticide Residue Monitoring in Sediment and Surface Water Bodies within the South Florida Water Management District. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 85-2. 41 pp.

Popalzei, S. 1981. Agricultural Water Use in the Upper East Coast Planning Area. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, November 1981.

Reece, D., S. Hynes and M. Brown. 1980. Hydrogeologic Data Collected from the Upper East Coast Planning Area, South Florida Water Management District, May,

1980. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 80-5. 6 pp.

Sculley, S. 1986. Frequency Analysis of SFWMD Rainfall. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 86-6. 57 pp.

South Florida Water Management District, Resource Control Department. 1978. General and Procedural Information, PERMIT INFORMATION MANUAL, VOLUME I. South Florida Management District, West Palm Beach, FL.

South Florida Water Management District, Resource Control Department. 1983. District Rules, Regulations, and Legislation, PERMIT INFORMATION MANUAL, VOLUME II. South Florida Management District, West Palm Beach, FL.

South Florida Water Management District, Resource Control Department. 1985. Management of Water Use, PERMIT INFORMATION MANUAL, VOLUME III. South Florida Management District, West Palm Beach, FL.

South Florida Water Management District, Resource Control Department. 1987. Management and Storage of Surface Waters, PERMIT INFORMATION MANUAL, VOLUME IV. South Florida Management District, West Palm Beach, FL.

South Florida Water Management District, Resource Control Department. 1986. Critera Manual for Use of District works, PERMIT INFORMATION MANUAL, VOLUME V.

South Florida Water Management District, Resource Planning Department. 1982. Report on Tropical Storm Dennis, August 16-18, 1981. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, June 1982. 59 pp.

South Florida Water Management District, Resource Planning Department. 1984. Summary of 1983 Hydrologic Conditions. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, May 1984. 37 pp.

South Florida Water Management District, Resource Planning Department. 1979. Preliminary Report on the Severe Storm of April 24-25, 1979. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, June 1979. 36 pp.

South Florida Water Management District, Resource Control Department. 1986. DRAFT Southeast Martin County Resource Analysis. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, October 1986. 38pp.

South Florida Water Management District, Resource Planning Department. 1980. Water Use and Supply Development Plan. Summary Status Report--Upper East Coast. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, October 1980. 60 pp.

South Florida Water Management District, Resource Planning Department. 1985. Report of Tropical Storm Bob, July 22-24, 1985. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, August 1985. 61 pp.

South Florida Water Management District, Department of Land Management, 1986. Water Management Lands Trust Fund, Save Our Rivers Five Year Plan Information

Booklet. South Florida Water Management District, West Palm Beach, FL. September 1986. 42 pp.

Trimble, P. 1986. South Florida Regional Routing Model. South Florida Water Management District, West Palm Beach, FL. Tech. Publication 86-3. 147 pp.

U.S. Army Corps of Engineers. Central and Southern Florida Control Project, Survey Review Report. U.S. Army Engineer District, Jacksonville, Corps of Engineers, Jacksonville, FL.

U.S. Army Corps of Engineers. Central and Southern Florida Control Project, General and Detailed Design Memorandums. U.S. Army Engineer District, Jacksonville, Corps of Engineers, Jacksonville, FL.

Woehlcke, C. and D. Loving. 1979. Non-Agricultural Water Use in the Upper East Coast Planning Area. South Florida Water Management District, West Palm Beach, FL. Tech. Memorandum, November 1979. 17 pp.

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, 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 are often 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 rain 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.

Water Surface Elevation - 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 (upstream) stage, and the tailwater (downstream) stage at the control structures (see **Control Structure**). The difference between these stages will affect the flow through or over the structure. Gravity flow is always from the highest to lowest elevation and, in general, flow increases as the difference in elevation increases. Note that in some basins, pumps are used to move water from lower to higher elevations.

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.

Control Structures - The structures referred to in the basin descriptions are devices (e.g., weirs, spillways, and culverts) placed in the canals to control water surface elevations (stage divide), amount of flow (stage divide or water supply structure), or direction of flow (divide structure) in the canals. A structure may have more than one function. In general, a stage divide controls water surface elevation upstream of the structure, and it controls water flow (or discharge) downstream of the structure. A divide structure is usually located at or near a basin boundary. 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).

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 in the upstream direction. 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 structures in the basin will accommodate that storm's runoff without flooding occurring in the basin. Sometimes a basin is described as having "flood protection" up to a certain design storm.

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 ten years (i.e., the storm has a ten percent chance of occurring in any given year). This is written as 1-10 years and is read as one in ten 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 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 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 recurrence interval (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 Memorandum (GDM) 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 District Works

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

G-XXX The letter G followed by a number designates a Central and Southern Florida Flood Control Project structure (see **Control Structures**, under **Basic Concepts**). For example, G-72 reads as "Control Structure 72". G structures were built by the District.

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

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

Terms

District

This refers to the South Florida Water Management District (formerly the Central and South Florida Flood Control District), the agency which operates and maintains the Project.

Free Digging Contract

This refers to an agreement between the District and an outside party whereby that party excavates a canal (or a portion of a canal). The outside party receives the excavated material as payment for the excavation. The material is generally used as fill for residential and commercial development.

General Design Memorandum

This is a document prepared by the U.S. Army Corps of Engineers that reports all work done preliminary to preparation of the final design of a project. In the General Design Memorandum for the Central and Southern Florida Flood Control Project:

- the basins are delineated.
- a design storm is specified and the resulting runoff is estimated for each basin.
- the flood protection to be afforded each basin is identified.
- the size of canals, and the size and number of control structures is determined.

The final design of the canals and structures is given in the "Detailed Design Memorandum."

1-XXX Year

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

Project This refers to the Central and South Florida Flood Control Project. The Project has been responsible for the construction of most of the major canals and structures in south Florida.

Regulation Schedule

A regulation schedule specifies the level of water to be held in a reservoir (e.g., Lake Okeechobee) as a function of the time of year.

Regulatory Release

A regulatory release is water discharged from a reservoir (e.g., Lake Okeechobee) to lower the water level in the reservoir to the regulation schedule.

ABBREVIATIONS

cfs : cubic feet per second

ft : feet

GDM : General Design Memorandum

NGVD : National Geodetic Vertical Datum (see **Water Surface Elevation**, under **Basic Concepts**)

SPF : Standard Project Flood (see **Design Storm**, under **Basic Concepts**)

SPS : Standard Project Storm (see **Design Storm**,under **Basic Concepts**)

WCA : Water Conservation Area