TECHNICAL MEMORANDUM

AN ATLAS OF THE LOWER KISSIMMEE RIVER AND LAKE ISTOKPOGA SURFACE WATER MANAGEMENT BASINS

by

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AN ATLAS OF THE LOWER KISSIMMEE RIVER AND LAKE ISTOKPOGA SURFACE WATER MANAGEMENT BASINS

EXECUTIVE SUMMARY

This atlas contains information about the surface water management basins in the Lower Kissimmee River and adjacent basins southeast of Lake Istokpoga and northwest of Lake Okeechobee, in Central Florida. The South Florida Water Management District (District) and the U. S. Army Corps of Engineers (COE) have primary authority over water management matters in these areas. The District has published this atlas to make available up-to-date nontechnical descriptions of these basins to District personnel, local governments, and to other interested persons. Text, maps, and tables of information are used to define and locate the drainage basins. Canals, levees, and water control structures within each basin under the management of the District or the COE are located, described, and discussed with regard to their design, operation, and management.

The surface water management basins of the Kissimmee River (C-38) and Lake Istokpoga were first delineated in the 1950s by the COE in their General Design Memorandum (GDM) for the Central and South Florida Flood Control Project (Project). The GDM presented a hydrologic analysis of each basin and the design criteria for water control structures, canals, dikes, and levees to control flood and regulate water level in the lakes and canals. The COE designed and constructed the C-38 canal in the 1960s with levees and water control structures to provide flood protection for part of Central Florida, and to enhance navigability of the Kissimmee River. There are six major water control structures (S-65, S-65A to S-65E) on C-38 from Lake Kissimmee to Lake Okeechobee. However, the northernmost structure on C-38, S-65, is considered part of the Upper Kissimmee River basin. It determines upstream discharges to C-38 and controls water elevations for Lakes Kissimmee, Hatchineha, and Cypress.

Canals 39A, 40, 41 and 41A and water control structures 68, 70, 71, 72, 75, S-82, 83, 84, provide flood control and irrigation for the basins southeast of Lake Istokpoga. Levees D4, 48, 50, and 62; borrow canal L-49; and interceptor dikes L-59, L-60, and L-61; structures 127, 129, 131, 133, 154, and 154C are part of the flood mitigation system in the basins north and northwest of Lake Okeechobee. Most of the works constructed by the COE are now under the management of the District for operation and maintenance.

Twenty basins are described in this atlas: S-65A, S-65B, S-65C, S-65D, S-65E, S-131, S-133, S-154, S-154C, C-40, C-41, C-41A, S-127, S-129, L-59E, L-59W, L-60E, L-60W, L-61E, and L-61W. S-65A to S-65E are names for the downstream control structures of the five reaches on C-38. The reaches are usually referred to as Pools A through E. Each basin is named for the major structure, canal, or levee in the basin.

C-38, the major canal in the Lower Kissimmee River drainage area, serves a variety of purposes; the primary of which is to provide flood protection for the Upper Kissimmee drainage basins. Secondary uses include land drainage for agricultural development and limited settlement in the Lower Kissimmee drainage basins, regulation of groundwater table elevations, navigation, and replenishing storage water for Lake Okeechobee. It can also be used to provide irrigation water for Lower Kissimmee basin during times of rainfall deficit.

The Project control structures in C-38 regulate the flow and water elevations in the canal segments and demarcate the drainage basins. In general, the structures are used to discharge excess water during flooding, and maintain minimum water levels during nonflood periods. It should be noted that during times of high flow rates, the majority of the flow through the system comes through S-65 (upstream structure), and not from local runoff. This was the main reason for the construction of C-38--to provide flood protection for upstream areas as far north as Orlando.

C-39A, C-40, C-41, and C-41A are the major canals in the Lake Istokpoga surface water management basins. The primary purposes of the canals and structures in the Lake Istokpoga basins are drainage, the Lake Istokpoga water regulation schedule, flood control, and irrigation. The Project control structures on these canals are used to maintain upstream water control stages; to pass the design flood without exceeding the required upstream stage and without creating eroding velocities. During low-flow periods, downstream stage is maintained and irrigation demand is fulfilled.

This atlas describes the 20 surface water management basins in the Lower Kissimmee River and Lake Istokpoga areas. Following the basin descriptions is the bibliography of publications used as sources of information for this atlas. For the reader unfamiliar with some of the concepts and words used in this atlas, the appendices contain a description of some basic hydrologic and hydraulic concepts, a glossary, and abbreviations.

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ABSTRACT

An atlas of the surface water management basins in the Lower Kissimmee River (C-38) and adjacent areas southeast of Lake Istokpoga and northwest of Lake Okeechobee is presented. Twenty basins are described by text, maps, and tables of information. For each basin, the Project canals and control structures within that basin are described and discussed with regard to design and operational criteria. The Project canals, water control structures and levees provide flood protection for parts of Osceola, Polk, Highlands, Okeechobee, and Glades counties. Irrigation water is supplied from Lake Istokpoga to the surrounding basins. Through the use of S-65, flood protection is provided for upstream areas as far north as Orlando. In addition to flood protection, the canals and control structures provide drainage, maintain wetlands, and facilitate navigation from the Upper Kissimmee River Chain of Lakes to the Atlantic Ocean and Gulf of Mexico. The Lower Kissimmee and Lake Istokpoga basins contribute 30 percent and 11.5 percent, respectively, of the inflow into Lake Okeechobee.

ACKNOWLEDGEMENTS

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The author extends his thanks to Jim Lane and Richard Gregg for their contributions. Jim Lane's knowledge of the study area was invaluable in collecting data from the sites. To the Water Resources Engineering Division engineering technicians Barbara Brown, Madhav Pandey, Mark Brady, and Cindy Carouche for their tremendous work in organizing the hydraulic data and graphics. Without Madhav Pandey's diligent work of developing the maps, this document would have not been completed on time. I would like to acknowledge the contributions of Nettie Winograd in the preparation of the manuscript.

The Operations Division and Geographic Sciences Division staff deserve thanks for their cooperation in providing the design criteria and operation manual of water control structures and maps. Special thanks to Joan Stockum for developing the land use map.

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AN ATLAS OF THE LOWER KISSIMMEE RIVER AND LAKE ISTOKPOGA SURFACE WATER MANAGEMENT BASINS

INTRODUCTION

This atlas contains information about the surface water management basins in the Lower Kissimmee River (C-38) and Lake Istokpoga areas. The South Florida Water Management District (District) and the U.S. Army Corps of Engineers (COE) have primary authority over water management in these areas. The District has published this atlas to make available up-to-date nontechnical descriptions of the surface water management basins in these areas to District personnel, local governments, and other interested persons. Text, maps and tables of information are used to define and locate the basins in the area. Canals, levees, and control structures within each basin and under the jurisdiction of the District or the COE are located, described, and discussed with regard to their operation and management.

The surface water management basins of the Lower Kissimmee River (C-38) and Lake Istokpoga areas were first delineated in the 1950s 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 analyses 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 the C-38 canal system and control structures to provide the desired level of flood protection for the upstream areas and the Lower Kissimmee basins. With the design of C-39A (State Road 70 borrow ditch), C-40 (Indian Prairie Canal), C-41 (Harney Pond), and C-41A (Slough ditch, Stub Canal, or Brighton Canal) canals and associated structures, it is possible to regulate the stages of Lake Istokpoga and use it as a reservoir for irrigation water supply and flood control. Designs of these works were presented in the GDM and in the Detailed Design Memorandum (DDM) for the Project. Most of the works constructed under the Project are now under the management of the District.

The overall Project is dynamic. The Project evolved in response to the population growth, changing land use, and increased water demands. Some parts of the original overall Project were never built, other parts have been rebuilt or modified, and, as the need arose, new structures were designed and constructed. In some cases the basins themselves have been redefined. At the request of the COE, the District has occasionally assumed the responsibility for the design and construction of additions or modifications to the Project, subject to COE approval.

This atlas describes 20 basins located in parts of Osceola, Polk, Highlands, Okeechobee, and Glades counties, and the Project works associated with it. Although the basin descriptions are not technical, the reader unfamiliar with the hydrology of lands within the drainage area, and/or 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 identifies the important concepts with which the reader should be familiar in order 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 various Project and District works: canals, levees, and water control structures.

Using the Basin Descriptions

Surface water management basins (sometimes referred to as drainage or water control basins) in the Lower Kissimmee River and Lake Istokpoga areas are identified by the same designation as the major Project canal, levee, or structure in a basin. For example, the S-65A basin is named for the major control structure in the drainage basin. C-41A basin is named for the major canal in the basin. S-127 basin is named for the pump station in the basin.

The drainage basins in the Lower Kissimmee River and Lake Istokpoga areas are shown in Figure 1. Map A is a large map showing the basin boundaries, canals, levees, and control structures relative to roads, local landmarks, and county lines. This map should be referenced to precisely locate basin boundaries and District works within the Lower Kissimmee River and Lake Istokpoga area. Map B is a land use map of the study area. These maps are located in the flyleaf at the back of this atlas.

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 District works: the drainage area, the general location of the basin within the area, land use in the basin, and the location, purpose, and operation of structures controlling flow. The second section, **Comments on Design and Historical Operation**, provides commentary on a variety of topics related to the basin: the design storm (see **Design Storm** under **BASIC CONCEPTS**, Appendix 1), operation schedule, and any significant changes to the basin and its works since the GDM was written. 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 Lower Kissimmee River and Lake Istokpoga areas. The second map is a schematic drawing of the basin and canals, natural waterways, and control structures. It is intended that these maps be used in conjunction with the written descriptions to understand the layout and operation of canals and structures in the basin. Major roads, landmarks, and county lines are included on the schematic maps to help the reader locate the basin within the general area. A more precise location of canals and/or structures within the basin can be obtained by referring to Map A.

The third part of each basin description is a table presenting information about control structures located in the basin. The tables provide a physical description of each structure: type of structure, method of controlling water flow, and pertinent dimensions and elevations. Where a structure was designed to pass a specified 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. The specified discharge is generally the flood discharge expected to pass the structure for the design storm event (see **Design Storm** under **BASIC CONCEPTS**). Peak water levels upstream and downstream of the structures and peak discharges through the structures are also given where this information has been recorded. Other information about the structures may be cited if considered relevant.

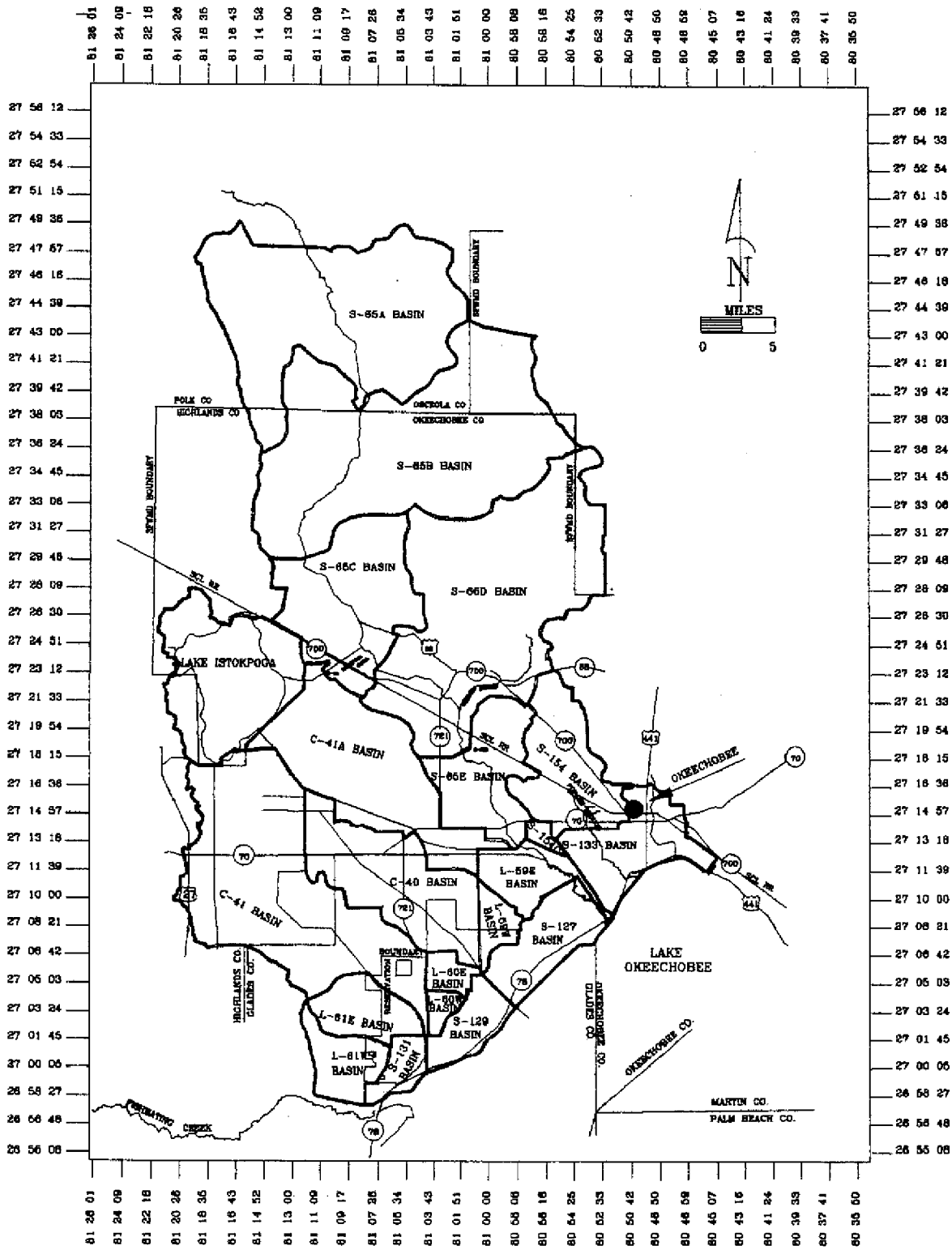

FIGURE 1. Lower Kissimmee River and Lake Istokpoga Basins

GENERAL DESCRIPTION OF THE AREA,

The Lower Kissimmee River and Lake Istokpoga surface water management basins are located in Central Florida and the areas comprise parts of Polk, Osceola, Highlands, Okeechobee, and Glades counties. The Lower Kissimmee River basins cover an area of 727 square miles from Lake Kissimmee outlet to Lake Okeechobee. The major source of water for the Lower Kissimmee River basins is the Upper Kissimmee basins with a drainage area of 1,596 square miles. This area is not included in this study. The Lake Istokpoga surface water management basins have an area of 418 square miles. These are six basins southeast of Lake Istokpoga which are included with the Lower Kissimmee River basins; however, the drainage area of Lake Istokpoga is not included in this study. The Lower Kissimmee and Lake Istokpoga basins drain to Lake Okeechobee. The Kissimmee River contributes 30 percent and the Lake Istokpoga basins contribute 11.5 percent of the total inflow into Lake Okeechobee. The other major water sources of Lake Okeechobee are direct rainfall, Fisheating Creek, Taylor Creek-Nubbin Slough basin, and backpumping from the Everglades Agricultural Area.

The Lower Kissimmee and Lake Istokpoga areas have a subtropical climate with an average rainfall of 51 inches. Approximately 72 percent of the rain is in the wet season, May through October. The remaining 28 percent occurs during the dry season, November through April. The wet season precipitation is mainly convective; the dry season is primarily associated with frontal systems. The mean daily temperature from May to October is 80°F, and from November to April it ranges from 60°F to 70°F.

A 1979 land use survey shows that 40 percent of the Lower Kissimmee River basins is agricultural land, 32 percent range land, 19 percent wetland, 3 percent forested land, and 4 percent urban land. The agricultural land is comprised of intensively managed beef pasture, semi-improved beef pasture, improved dairy pasture, and citrus groves. Most of the agricultural activities are in the lower section of the Kissimmee River. The primary land use in the Lake Istokpoga basins is agricultural. There are several citrus groves on the sandy ridges in Highlands County. The lower flatland region is dominated by improved pasture for the production of beef cattle. Winter truck crops and ornamental plant production are also important to the area.

Lake Istokpoga, a shallow lake with 33.5 feet NGVD average bottom elevation and a surface area of 43.27 square miles, is the fifth largest lake In Florida. With control structure S-68, water surface elevations are regulated between 37.5 and 39.5 feet NGVD.

The vegetation in the Lower Kissimmee River basins changes with surface water depth, elevation, type of soil, and extent of agricultural activity. The terrestrial forested areas are covered with oak, cabbage palm, wax myrtle, and woody shrub. The wetland forests contain willows, hardwood, and cypress. The marshy areas are covered with broadleaf marsh, maidencane wet prairie, aquatic grasses, buttonbush, switchgrass, sawgrass, and various other plants. The general soil type is high permeability sandy soils. Along the floodplain of the Kissimmee River, the soil type is sand and shell overlain by a variable layer of muck, peat, and undecomposed organic matter.

Generally, the groundwater table elevation is high, reaching ground surface level in the wet season and receding to 4 to 5 feet during the dry season in most areas. Domestic water source is from deep groundwater (the Floridan Aquifer).

The water entering the Kissimmee River is of good quality, but the nutrient concentration increases downstream. One of the reasons for the downstream nutrient level increase is due to the increase in agricultural activity in the lower basins of the Kissimmee River. Best Management Practices are being evaluated to alleviate the nutrient load from agricultural areas.

S-65A BASIN

Description of the Basin

The S-65A basin has an area of 161 square miles covering part of southern Osceola, southeastern Polk, and northern Highlands counties (Figure 2). It is the drainage basin which contributes to the first reach (Pool A) of C-38 (Kissimmee River). This reach of C-38 has a channel length of 10.6 miles, width of 90 feet and depth of 18 to 24 feet. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The S-65A basin has more than seven subbasins which contribute flow through their tributaries. Buttermilk Slough, Ice Cream Slough, Blanket Bay Slough, Bay Hammock, Skeeter Slough, Armstrong Slough, and River Ranch Slough have drainage areas of 4.6, 62.6, 29.3, 5.6, 7.3, 21.0, and 4.5 square miles respectively. All the unnamed tributaries have a combined area of 26.4 square miles. The land use consists of agriculture, rangeland, wetlands, with some urban and forest. A schematic map of the S-65A basin with basin demarcations, canals, and control structures is shown in Figure 3.

The major water control structure in the basin is S-65A which is located at the southern end of Pool A on C-38, about 10.5 miles downstream from Lake Kissimmee. It is a reinforced concrete gated spillway with three gates and a lock structure. The purpose of S-65A is to maintain an optimum upstream water surface elevation in the Kissimmee River (C-38), and to pass the design flood without exceeding the upstream flood stage. It also restricts the downstream flood stage and maintains nondamaging channel velocities. During low-flow periods, it passes sufficient discharge to maintain downstream stages and satisfy irrigation demands, and facilitates navigation. The design criteria for S-65A basin structures are given in Table 1.

Comments on Design and Historic Operation

Channelization of the Kissimmee River (C-38) and construction of the control structures began in 1966 and was completed in 1971. There are six structures from Lake Kissimmee to Lake Okeechobee. Each structure steps down the water level in 6 feet intervals and consequently acts as a dam, replacing the natural slope of the river with five flat pools arranged in a stairstep manner. The water level within each pool remains level, although the marshes in the northern end are usually drained and the southern end is usually underwater. Pool A is at the southern end of C-38 in S-65A basin.

The design discharge capacity of S-65A is 11,000 cfs. It is designed to pass 30 percent of the Standard Project Flood (SPF) without exceeding headwater and tailwater design stages and channel velocities. Operation of the spillway gates is automatically controlled for low flow operation, and manually controlled for flood operation. The structure is operated to maintain an optimum headwater elevation of 46.3 feet.

Recent studies by the Waterways Experiment Station has shown that the design discharge will result in downstream channel erosion. If safe discharge is exceeded, it is planned to let headwater rise to 52 feet and a 100-foot notch will be cut in the east

tie-back levee 1000 feet east of S-65A to an elevation of 53 feet. Water level will bypass the structure at 54 feet.

The schedule of lock operation is established by the COE in accordance with the River and Harbor Act of August 8, 1917. All year the lock is operated from 8:00 a.m. to 5:00 p.m., Monday through Friday. From March 1 through October 31 on Saturday and Sunday the lock is operated from 5:30 a.m. to 7:30 p.m. From November 1 through February 28 on Saturday and Sunday the lock is operated from 5:30 a.m. to 6:30 p.m.

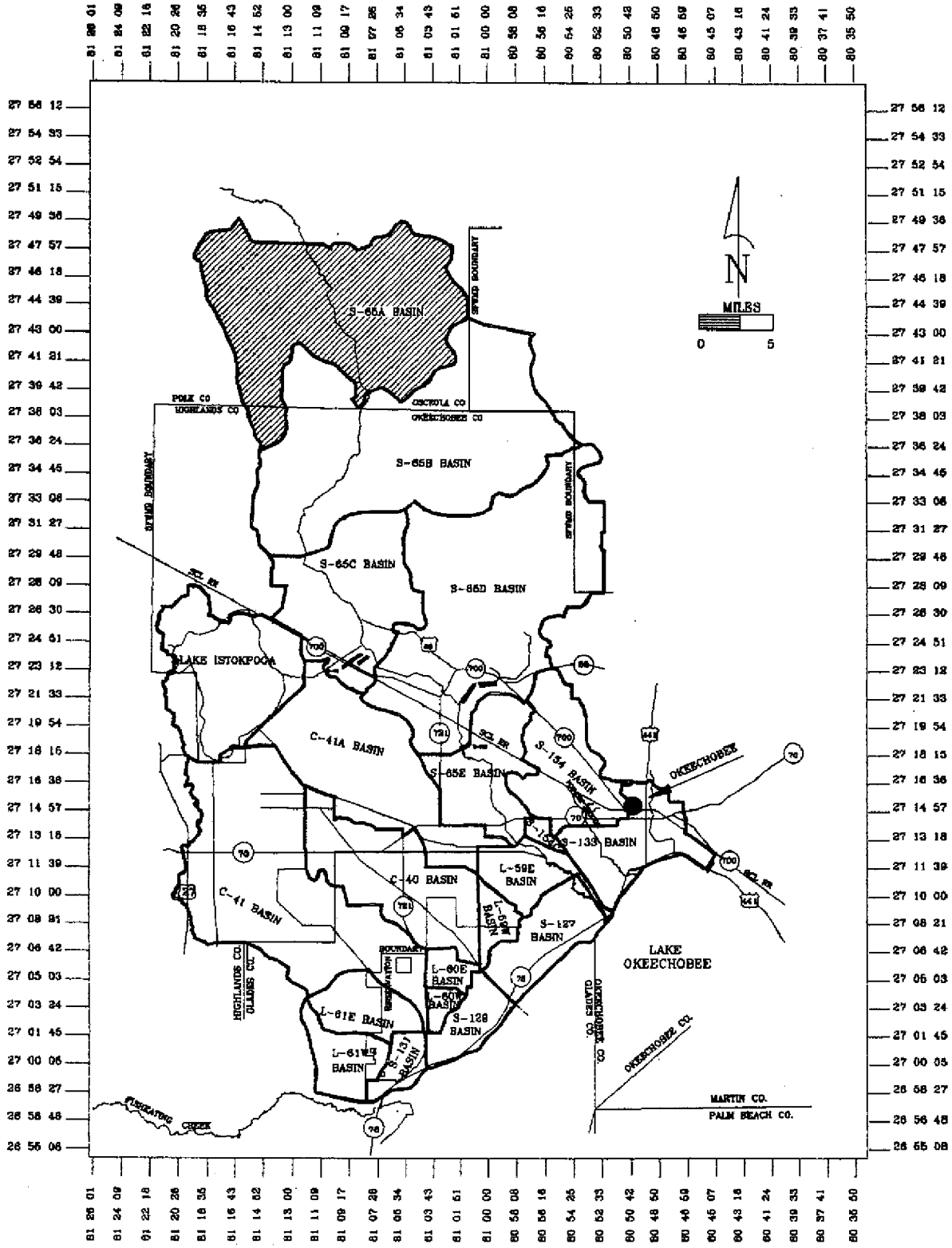

FIGURE 2. S-65A Basin Location Map

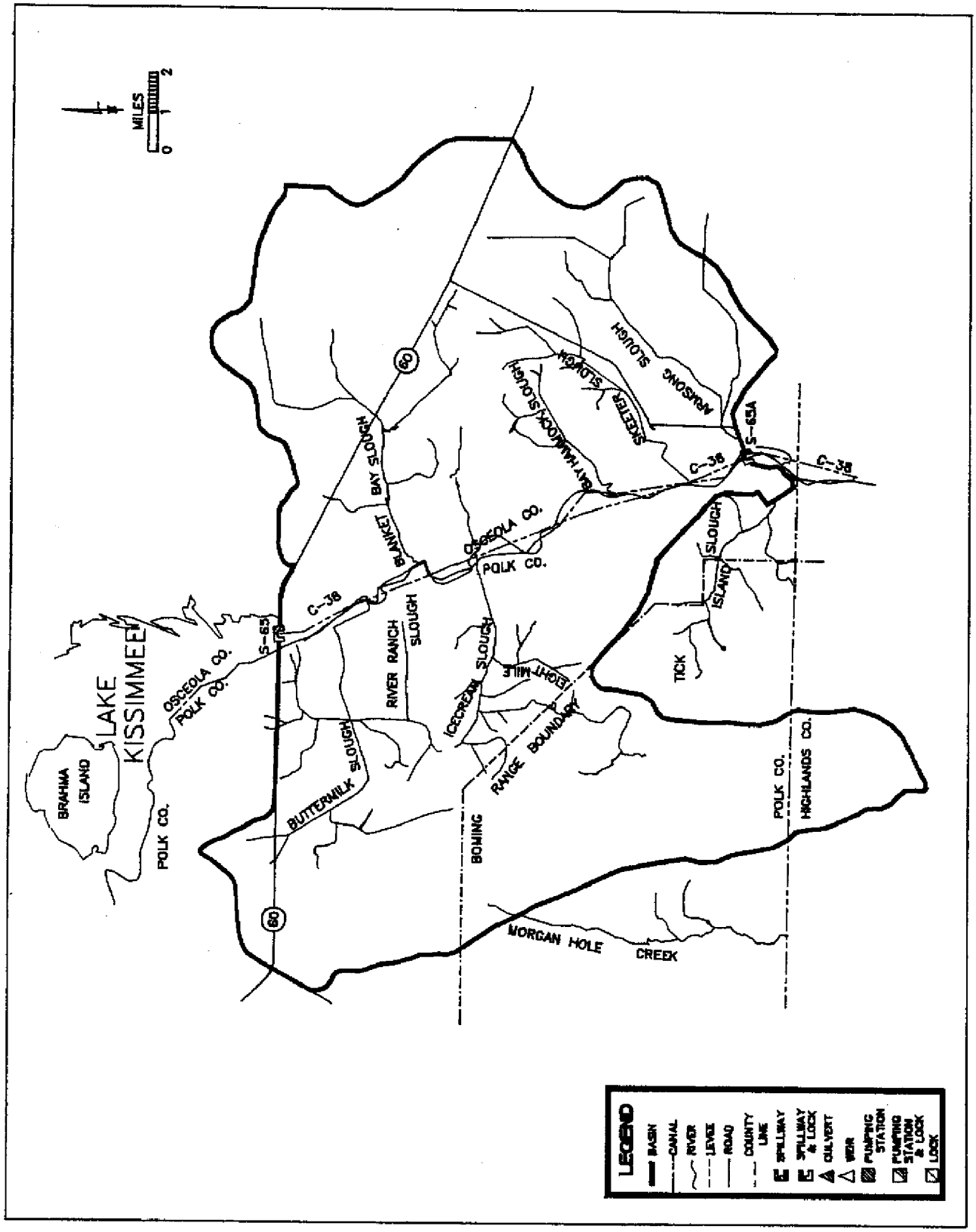

FIGURE 3. S-65A Basin Map

TABLE 1. S-65A Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-65A*	Spillway 3 gates each 13.8 ft high x 27.8 ft wide crest length = 81.0 ft crest elev = 34.5 ft	46.3	42.1	46.3	11,000	HW = 47.99(m.s.l.) Qmax = 13,114.0 E cfs Qavg = 1,879.9cfs	10/04/69 10/03/69 20.6 yrs

cfs = cubic feet per second
E = estimate
elev = elevation
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*has a reinforced concrete lock with 2 pairs of gates, width = 30.0ft, length = 90.0 ft, invert elev = 31.0 and 38.0 ft

S-65B BASIN

Description of the Basin

The S-65B basin has an area of 200.48 square miles covering southeastern Osceola and eastern Polk counties, while most of the area lies in eastern Highlands and northwestern Okeechobee counties (Figure 4). It is the drainage basin which contributes to the second reach (Pool B) of C-38 (Kissimmee River). This reach of C-38 has a channel length of 12.1 miles, width of 100 feet, and depth of 18 to 24 feet. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The S-65B basin has more than three subbasins which contribute flow through their tributaries. The Pine Island/Seven Mile Slough, the Duck Slough, and the Tick Island Slough have drainage areas of 110.2, 1.5, and 20 square miles, respectively. All the unnamed tributaries have 71.2 square miles of area. The land use consists of rangeland, wetlands, forest, and agriculture, as well as improved pastureland, beef cattle production, and citrus groves. A schematic map of the S-65B basin with basin demarcations, canals, and control structures is shown in Figure 5.

The major water control structure in the basin is S-65B which is located at the southern end of Pool B on C-38, about 12 miles downstream from S-65A. It is a reinforced concrete gated spillway with three gates and a lock structure. The purpose of structure S-65B is to maintain an optimum upstream water surface elevation in the Kissimmee River (C-38), and to pass the design flood without exceeding the upstream flood stage. It also restricts downstream flood stage and maintains nondamaging channel velocities. During low-flow periods, it passes sufficient discharge to maintain downstream stages and satisfy irrigation demands. It also facilitates navigation.

There are two auxiliary structures to make additional releases into the old channel of the Kissimmee River. The double barrel culvert S-65BX1 is 1,550 feet and the single barrel culvert S-65BX2 is 3,320 feet west of S-65B. Both culverts are manually operated with slide gates. The design criteria for S-65B basin structures is given in Table 2.

Comments on Design and Historic Operation

The channelization of the Kissimmee River (C-38) and construction of the control structures began in 1966 and was completed in 1971. There are six structures from Lake Kissimmee to Lake Okeechobee. Each structure steps down the water level in 6 feet intervals and, consequently, acts as a dam replacing the natural slope of the river with five flat pools arranged in a stairstep manner. The water level within each pool remains level, although the marshes in the northern end are usually drained. Pool B is at the southern end of C-38 canal in the S-65B basin.

The design discharge capacity of S-65B is 14,000 cfs. It is designed to pass 30 percent of the SPF without exceeding the upstream and downstream flood stages, maintaining noneroding velocity. This structure is operated according to the flow chart "Operation of Kissimmee River Demonstration Project", November 1985, subject to hydraulic limitations. In accordance with the "Interim Regulation Schedule - Kissimmee River Pools", July 1982, the headwater elevation is maintained between 39 and 42 feet as much as possible. It is manually operated at all times.

Gate openings of more than 1 foot has resulted in downstream bank erosion at S-65BX1. At present, the operation of S-65BX1 is based on the recommendations made by Steve Miller, Florida Game and Fresh Water Fish Commission, in his April 10, 1990 letter to the District. From May 1 through November 1, the low discharge pulse that flows through S-65BX1 is to be terminated gradually over an interval of several days.

The schedule of lock operation is established by the COE in accordance with the River and Harbor Act of August 8, 1917. All year the lock is operated from 8:00 a.m. to 5:00 p.m. Monday to Friday. From March 1 through October 31 on Saturday and Sunday the lock is operated from 5:30 a.m. to 7:30 p.m. From November 1 through February 28 on Saturday and Sunday the lock is operated from 5:30 a.m to 6:30 p.m.

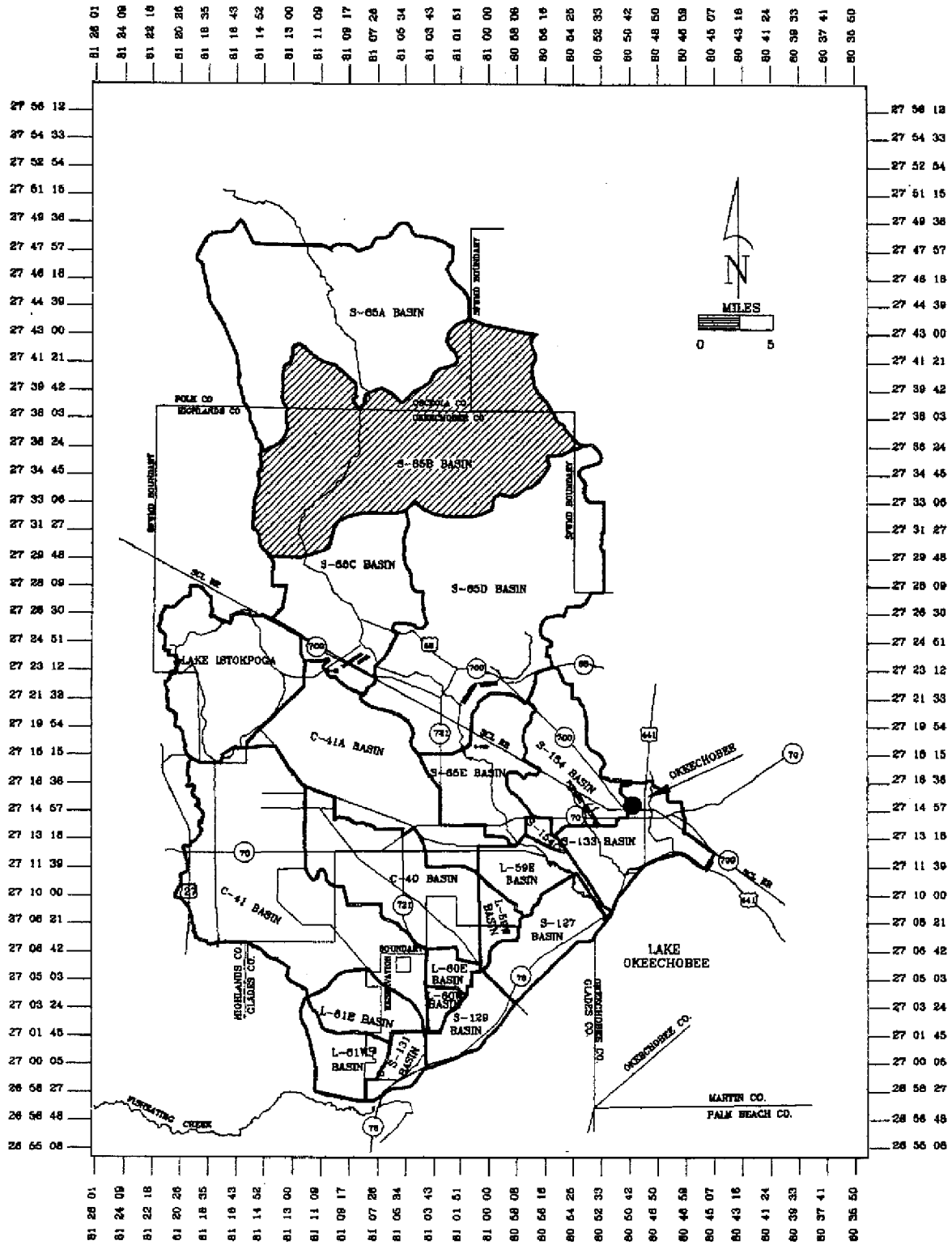

FIGURE 4. S-65B Basin Location Map

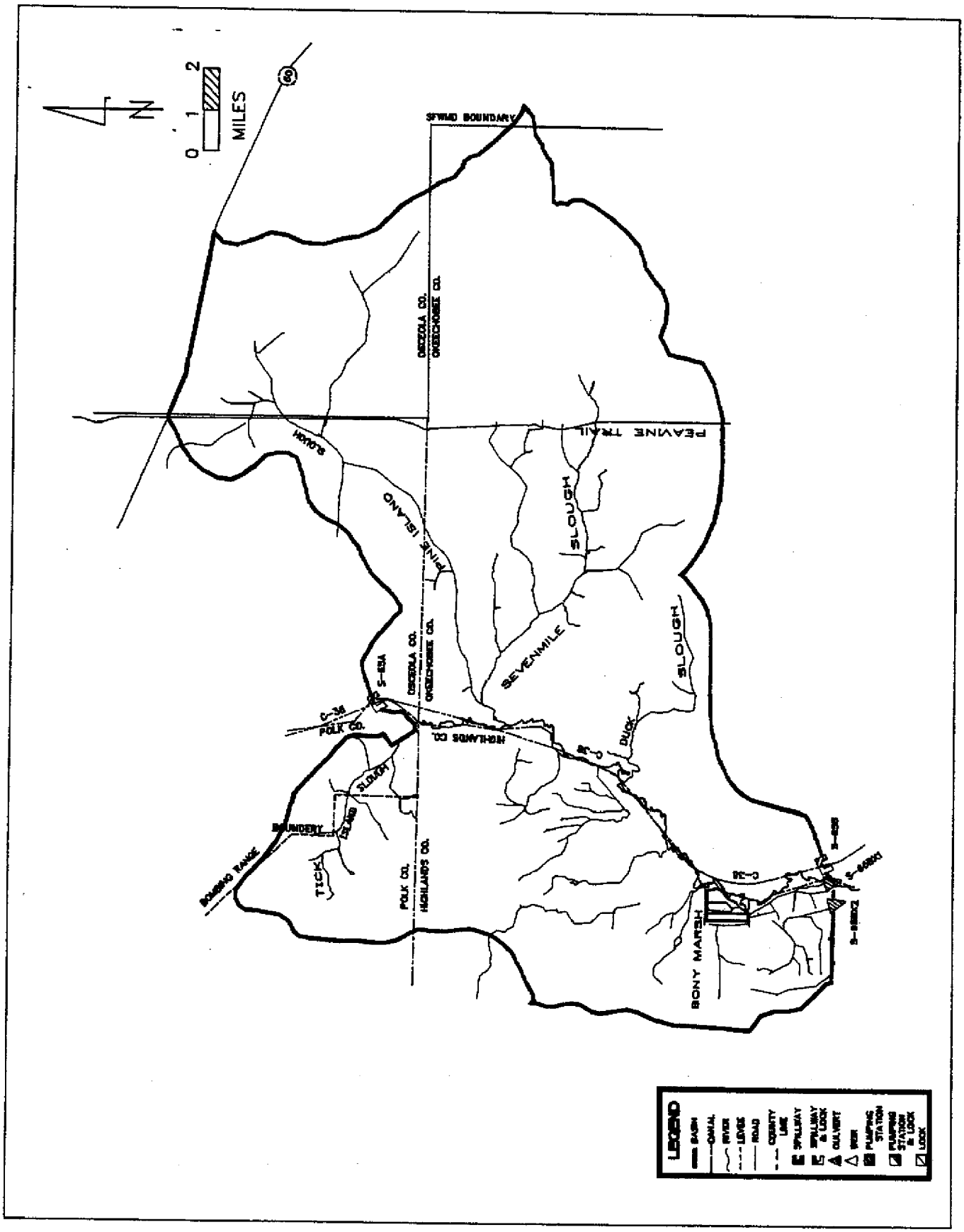

FIGURE 5. S-65B Basin Map

TABLE 2. S-65B Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-65B*	Spillway 3 gates each 13.8 ft high x 27.8 ft wide crest length = 81.0 ft crest elev = 26.3 ft	40.0	35.7	39.0 to 42.0 varies throughout the year	14,000	HW = 43.11 ft m.s.l. Qmax = 16,809.0 E cfs Qavg = 1,632.1 cfs	10/04/69 10/04/69 22.8 yrs
S-65BX1	Culvert 1 barrel length = 99ft diameter = 54 inches invert elev = 29.5 ft			not used to control stage			
S-65BX2	Culvert 1 barrel length = 99ft diameter = 54 inches invert elev = 29.5 ft			not used to control stage			

cfs = cubic feet per second
E = estimate
elev = elevation
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*has a reinforced concrete lock with 2 pairs of gates, width = 30.0ft, length = 90.0 ft, invert elev = 25.0 and 31.0 ft

S-65C BASIN

Description of the Basin

The S-65C basin has an area of 85 square miles and it covers parts of eastern Highlands and western Okeechobee counties (Figure 6). It is the drainage basin which contributes to the third reach (Pool C) of C-38 (Kissimmee River). This reach of C-38 has a channel length of 8.5 miles, width of 140 feet, and depth of 18 to 24 feet. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The S-65C basin has more than two subbasins which contribute flow through their tributaries. Starvation Slough and Oak Creek have drainage areas of 8.5 and 19.3 square miles, respectively. All the unnamed tributaries have 51 square miles of area. In the past, the natural outlet for Lake Istokpoga had been the Istokpoga Canal which flows to the C-38 reach in the S-65C basin. Since the construction of S-68, the outlet for Lake Istokpoga has been the C-41A canal. The sheet pile weir structure G-85 maintains lake stage on the Istokpoga canal. If S-68 is over capacity, a minimum of 800 cfs can be released through the Istokpoga Canal.

Land use consists of agriculture, wetlands, rangeland, and forest, as well as improved pasture, hay production, beef cattle production, dairy operations, and citrus groves. A schematic map of the S-65C basin with basin demarcations, canals, and control structures is shown in Figure 7.

S-65C, the major water control structure in the S-65C basin, is located at the southern end of Pool C on C-38, 32 miles downstream from Lake Kissimmee and 4.5 miles north of U.S. Highway 98 bridge over the Kissimmee River. It is a reinforced concrete-gated spillway with four gates and lock structure. The purpose of S-65C is to maintain an optimum upstream water surface elevation in the Kissimmee River (C-38), and to pass the design flood without exceeding the upstream flood stage. It also restricts the downstream flood stage and maintains nondamaging channel velocities. During low-flow periods it passes sufficient discharge to maintain downstream stages and satisfy irrigation demands. It also facilitates navigation.

S-65CX, an auxiliary structure, is a corrugated metal pipe culvert located in the tie-back levee 4,200 feet west of S-65C. Its purpose is to make additional releases into the old channel of the Kissimmee River. The S-65CX has two barrels with slide gates and it is manually operated. To relieve flooding upstream of the eastern part of the tieback levee, a 48-inch diameter, 61-foot long culvert was installed. The design criteria for S-65C basin structures is given in Table 3.

Comments on Design and Historic Operation

The channelization of the Kissimmee River (C-38) and construction of the control structures began in 1966 and were completed in 1971. There are six structures from Lake Kissimmee to Lake Okeechobee. Each structure steps down the water level in 6 feet intervals and consequently act as dams, replacing the natural slope of the river with five flat pools arranged in a stairstep manner. The water level within each pool remains level, although the marshes in the northern end are usually drained. Pool C is at the southern end of the C-38 canal in the S-65C basin.

The design discharge capacity of S-65C is 18,000 cfs. It is designed to pass 30 percent of the SPF maintaining the design upstream stage. This structure is operated

to maintain an optimum headwater elevation of 34 feet, subject to hydraulic constraint. It is automatically controlled for low flow and manually controlled for flood operations. At present, the operation of S-65CX is based on the recommendations of Steve Miller, Florida Game and Fresh Water Fish Commission, in his letter of April 10, 1990 to the District. From May 1 through November 1, the low discharge pulse flows through S-65C are to be terminated gradually over an interval of several days.

The schedule of lock operation is established by the COE in accordance with the River and Harbor Act of August 8, 1917. All year the lock is operated from 8:00 a.m. to 5:00 p.m. from Monday to Friday. From March 1 through October 3 on Saturday and Sunday the lock is operated from 5:30 a.m. to 7:30 p.m. From November 1 through February 28 on Saturday and Sunday the lock is operated from 5:30 a.m. to 6:30 p.m.

The flow discharge characteristic of the G-85 structure in the Istokpoga Canal is indefinite. Normally, the flashboards are in place forming a crest elevation of 39.5 feet at the top. When there is a need for auxiliary discharge, the flashboards are moved down to a required elevation. The sheet pile weir, G-85, has ten flashboard controlled bays with 18 flashboards per bay. Each flashboard is 10 feet wide, 6 inches high and 4 inches thick. Water level will bypass the structure at a stage of 42 feet.

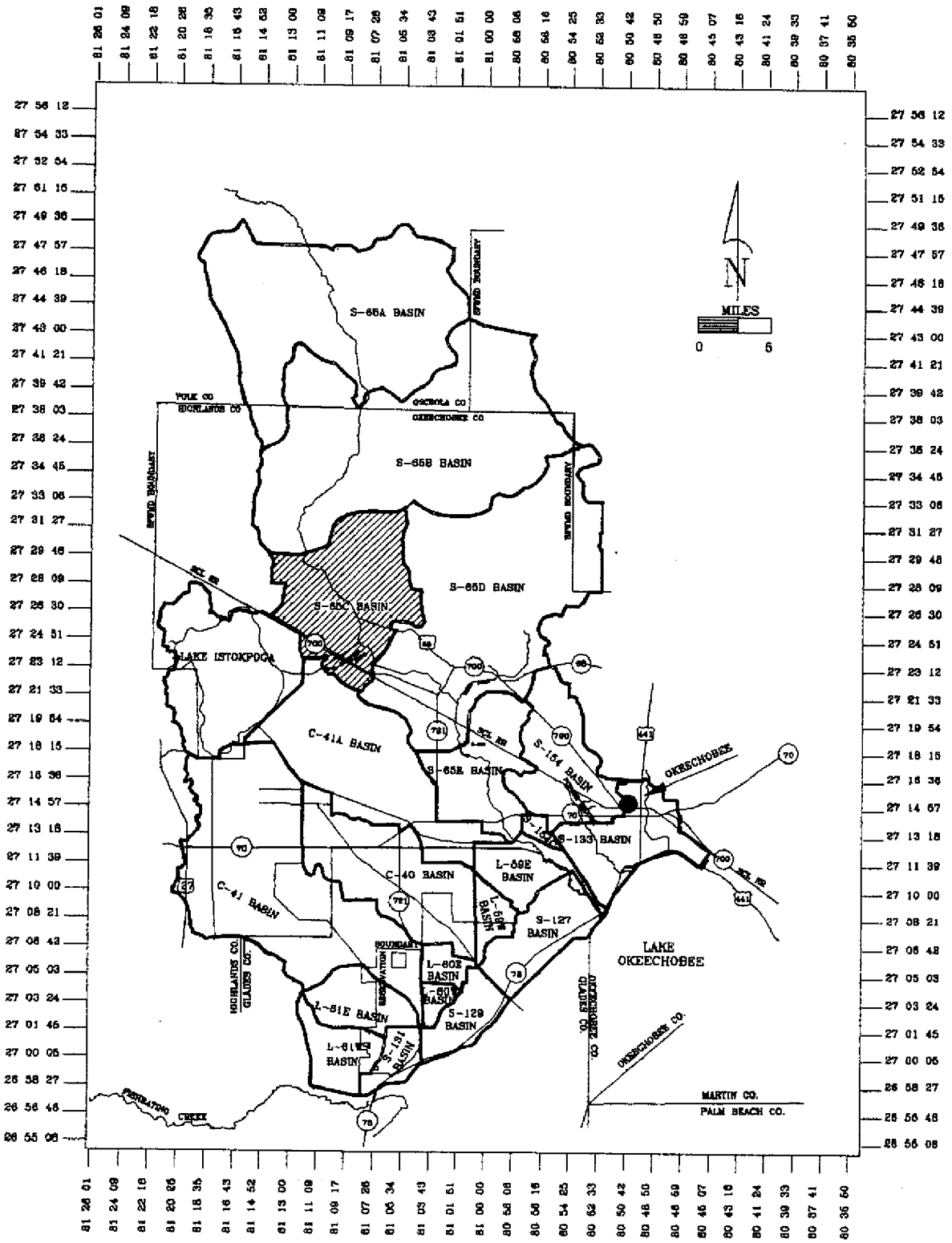

FIGURE 6. S-65C Basin Location Map

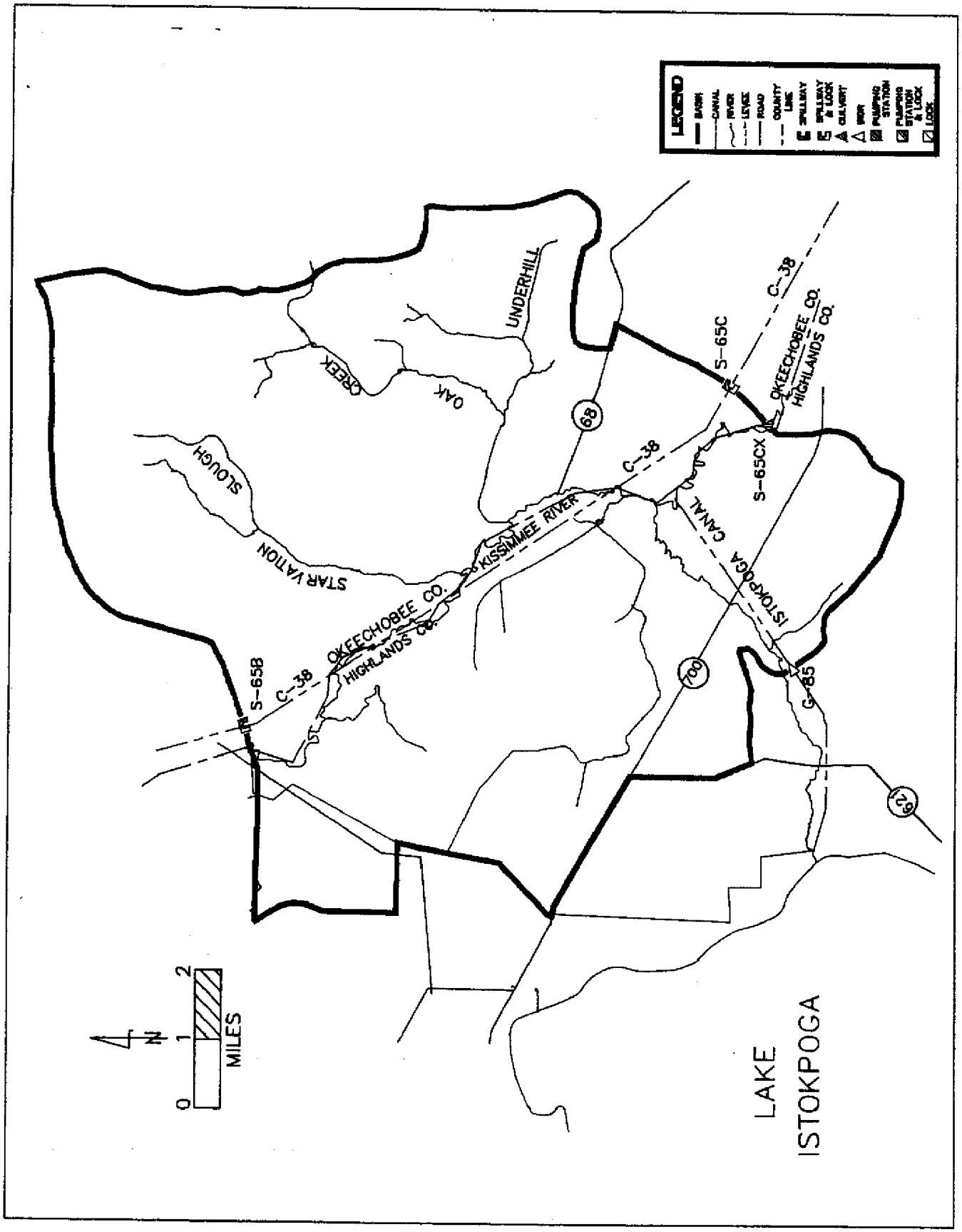

FIGURE 7. S-65C Basin Map

TABLE 3. S-65C Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Dicharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-65C*	Spillway 4 gates each 13.8 ft high x 27.8 ft wide crest length = 108.0 ft crest elev = 20.8 ft	34.0	29.8	34.0	18,000	HW = 35.94 ft m.s.l. Qmax = 19,619 E cfs Qavg = 906.76 cfs	10/04/69 10/03/69 24.17 yrs
S-65CX	CMP 2-barrel culvert length = 72.0ft diameter = 66 inches invert elev = 21.5 ± ft			not used to control stage			

cfs = cubic feet per second
CMP = corrugated metal pipe
E = estimate
elev = elevation
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*has a reinforced concrete lock with 2 paris of gates width = 30.0ft, length = 90.0 ft, invert elev = 18.0 and 25.0 ft

S-65D Basin

Description of the Basin

The S-65D basin has an area of 182.2 square miles and covers parts of southeastern Highlands County and central and northern Okeechobee County (Figure 8). It is the drainage basin which contributes to the fourth reach (Pool D) of C-38 (Kissimmee River) that has a channel length of 9.3 miles, width of 240 to 340 feet, and depth of 18 to 24 feet. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The S-65D basin has one major subbasin with a drainage area of 143.4 square miles which contributes flow through its tributary, Chandler Slough. All the unnamed tributaries have 37.2 square miles of area. The land use consists of agriculture, urban, wetlands, and rangeland, including improved pastureland, dairy operations, and beef production. A schematic map of the S-65D basin with basin demarcations, canals, and control structures is shown in Figure 9.

The major water control structure is located at the southern end of Pool D on C-38, about 41 miles downstream of Lake Kissimmee and 4 miles below U. S. Highway 98 bridge over the Kissimmee River. It is a reinforced concrete gated spillway with four gates and a lock structure. The purpose of S-65D is to maintain an optimum upstream water surface elevation in the Kissimmee River (C-38) and to pass the design flood without exceeding the upstream flood stage. It also restricts downstream flood stage and maintains nondamaging channel velocities. During low-flow periods it passes sufficient discharge to maintain downstream stages and satisfy irrigation demands.

An auxiliary structure S-65DX, a corrugated metal pipe culvert, is located through the tieback levee about 1,600 feet west of S-65D. Its purpose is to make additional releases into the old channel of the Kissimmee River. It has two barrels with slide gates and is manually operated. There is a 36-inch diameter drainage culvert through the east tieback levee. The design criteria for the structures in the S-65D basin is shown in Table 4.

Comments on Design and Historic Operation

Channelization of the Kissimmee River (C-38) and construction of the control structures began in 1966 and was completed in 1971. There are six structures from Lake Kissimmee to Lake Okeechobee. Each structure steps down the water level in 6 feet intervals, and, consequently, acts as dams replacing the natural slope of the river with five flat pools arranged in a stairstep manner. The water level within each pool remains level, although the marshes in the northern end are usually drained. Pool D is at the southern end of the C-38 canal in the S-65D basin.

The design discharge capacity of S-65D is 21,300 cfs. It is designed to pass the 30 percent SPF, maintaining the allowable water surface elevations and velocity. The structure is operated to maintain an optimum headwater elevation of 26.8 feet subject to hydraulic constraint. It is automatically controlled for low flow and manually controlled for flood operations. The maximum allowable water level drop across the structure is 8 feet.

Gate opening of more than 1 foot has resulted in downstream bank erosion at S-65DX. At present, the operation of S-65DX is based on the recommendations of Steve Miller, Florida Game and Fresh Water Fish Commission, April 10, 1990 letter to

the District. From May 1 through November 1, the low discharge pulse flowing through structure S-65DX is to be terminated gradually over an interval of several days.

The schedule of lock operation is established by the COE in accordance with the River and Harbor Act of August 8, 1917. All year the lock is operated from 8:00 a.m. to 5:00 p.m. from Monday to Friday. From March 1 through October 31 on Saturday and Sunday the lock is operated from 5:30 a.m. to 7:30 p.m. From November 1 through February 28 on Saturday and Sunday the lock is operated from 5:30 a.m. to 6:30 p.m.

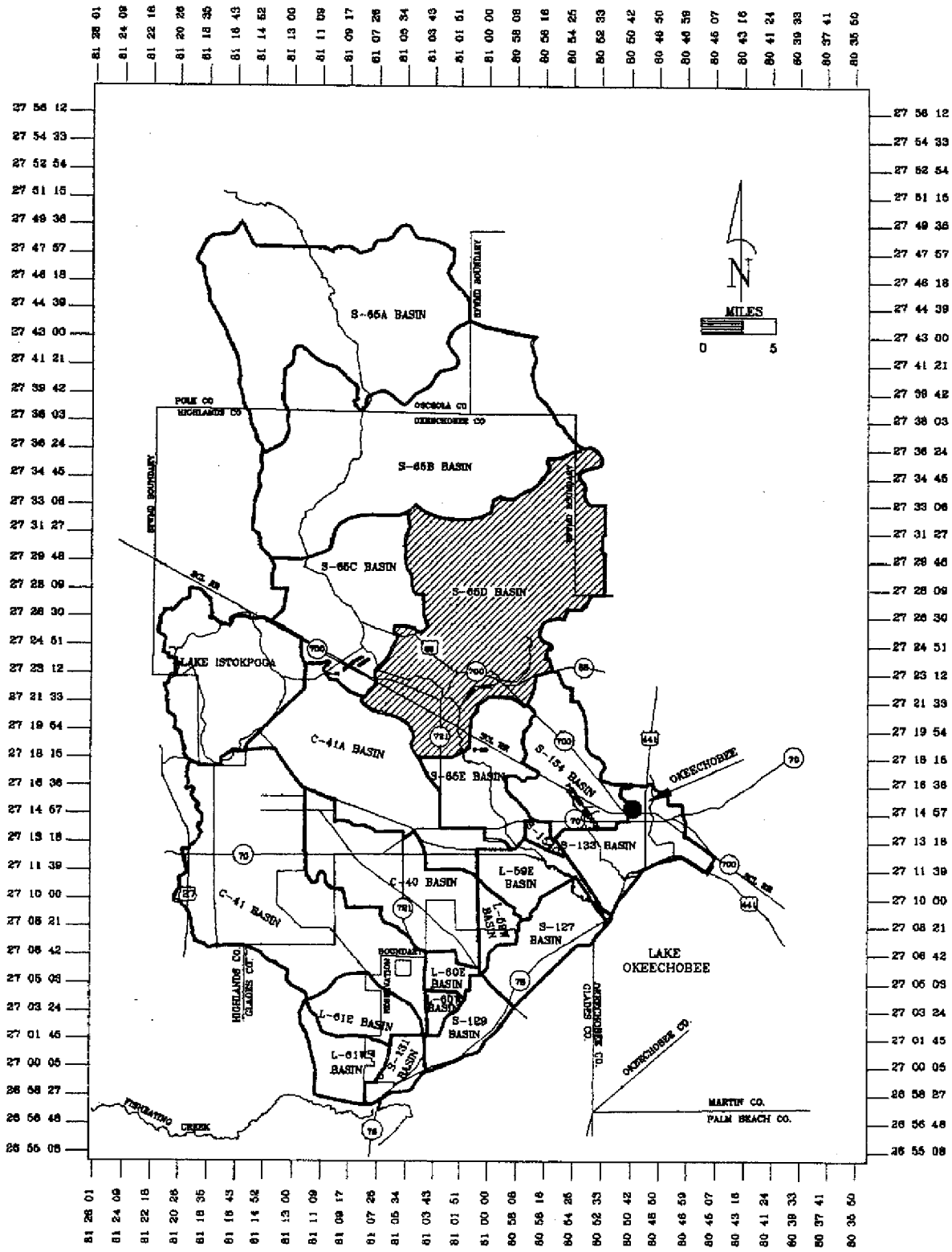

FIGURE 8. S-65D Basin Location Map

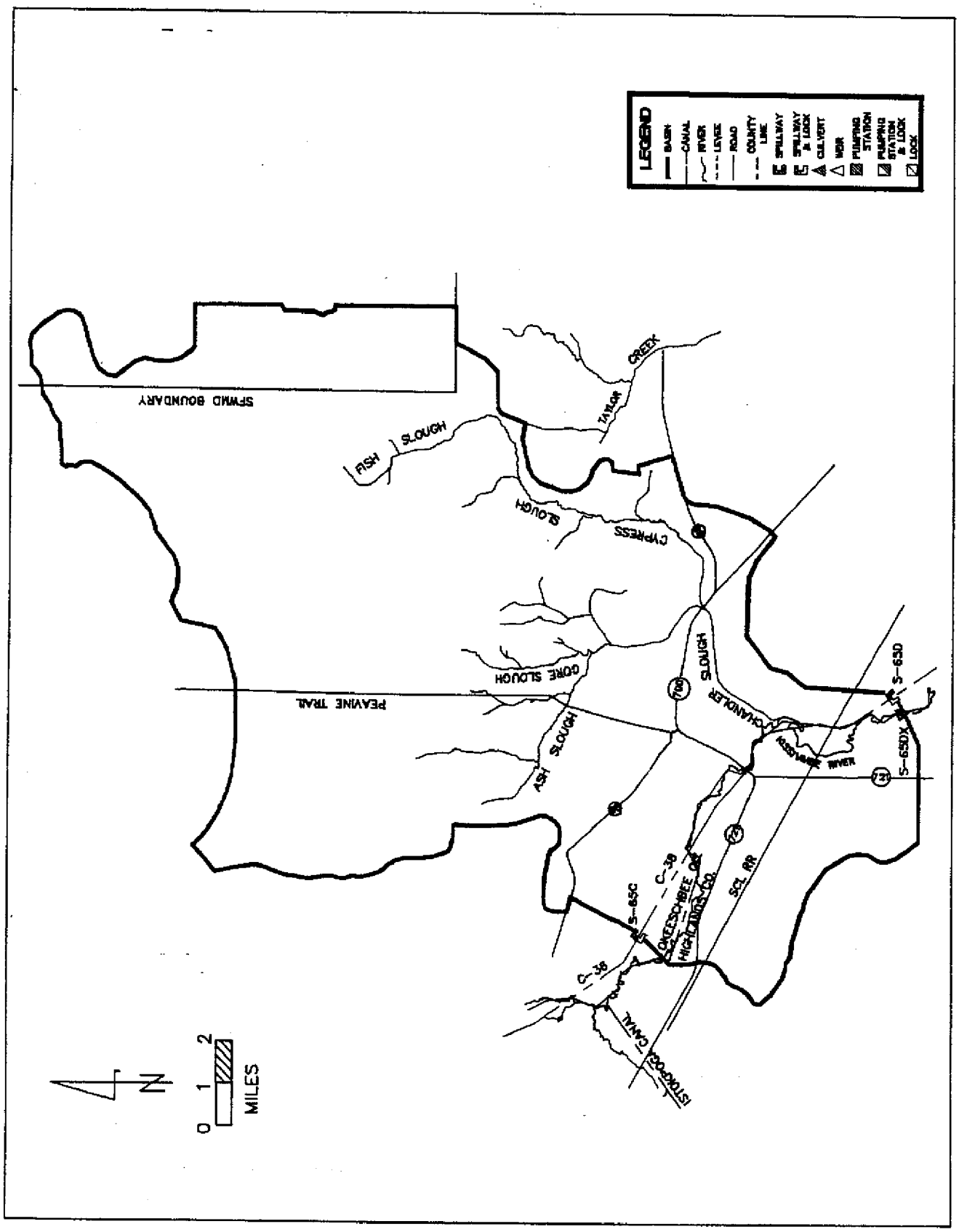

FIGURE 9. S-65D Basin Map

TABLE 4. S-65D Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-65D*	Spillway 4 gates each 13.8 ft high x 27.8 ft wide crest length = 108.0 ft crest elev = 13.1 ft	28.0	23.3	26.8	21,300	HW = 31.05(m.s.l.) Qmax = 24,055 E cfs Qavg = 1685.1 cfs	10/05/69 10/03/69 20.75 yrs
S-65DX	CMP 2-barrel culvert length = 82.0 ft diameter = 66 inches invert elev = 16.0 ft			not used to control stage			

cfs = cubic feet per second
CMP = corrigated metal pipe
E = estimate
elev = elevation
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*has a reinforced concrete lock with 2 paris of gates width = 30.0ft, length = 90.0 ft, invert elev = 12.5 and 18.0 ft

S-65E Basin

Description of the Basin

The S-65E basin has an area of 45.6 square miles and covers parts of southeastern Highlands and southwestern Okeechobee counties (Figure 10). It is the drainage basin which contributes to the fifth reach (Pool E) of C-38 (Kissimmee River) that has a channel length of 7.4 miles, width of 225 to 260 feet, and depth of 18 to 24 feet. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The S-65E basin has two subbasins which contribute flow through their tributaries, Yates Marsh and Maple River. The respective drainage area is 30.6 and 15 square miles. The land use consists of agriculture, rangeland, wetlands, forest, and urban, including dairy operations, beef cattle pasture, hay production, and citrus. A schematic map of the S-65E basin with basin demarcations, canals, and control structures is shown in Figure 11.

S-65E, the major water control structure in the S-65E basin, is located at the southern end of Pool E on C-38, about 49.0 miles downstream from Lake Kissimmee. It is a reinforced concrete gated spillway with six gates and a lock structure. The purpose of structure S-65E is to maintain an optimum upstream water surface elevation in the Kissimmee River (C-38), and to pass the design flood without exceeding the upstream flood stage. It also restricts downstream flood stage and maintains nondamaging channel velocities. The tailwater of S-65E structure is at Lake Okeechobee stage. The design criteria for the S-65E structures is shown in Table 5.

Comments on Design and Historic Operation

The channelization of the Kissimmee River (C-38) and construction of the control structures began in 1966 and was completed in 1971. There are six structures from Lake Kissimmee to Lake Okeechobee. Each structure steps down the water level in about 6.0 feet intervals and consequently act as dams, replacing the natural slope of the river with five flat pools arranged in a stairstep manner. The water level within each pool remains level, although the marshes in the northern end are usually drained and the southern end is usually underwater.

The design discharge capacity of S-65E is 24,000 cfs. It is designed to pass 30 percent of the SPF without exceeding the design water surface elevations and velocity of flow. This structure is operated, as much as hydraulically possible, to maintain an optimum headwater elevation of 21 feet. The maximum allowable water level drop across the structure is 10.5 feet. To prevent channel eroding velocity, gate opening is limited in accordance with the "Maximum Allowable Gate Opening" curve for both automatic and manual operations. The gates are manually operated for low flow and automatically operated for flood flow.

The schedule of lock operation is established by the COE in accordance with the River and Harbor Act of August 8, 1917. All year the lock is operated from 8:00 a.m. to 5:00 p.m. from Monday to Friday. From March 1 through October 31 on Saturday and Sunday the lock is operated from 5:30 a.m. to 7:30 p.m. From November 1 through February 28 on Saturday and Sunday the lock is operated from 5:30 a.m. to 6:30 p.m.

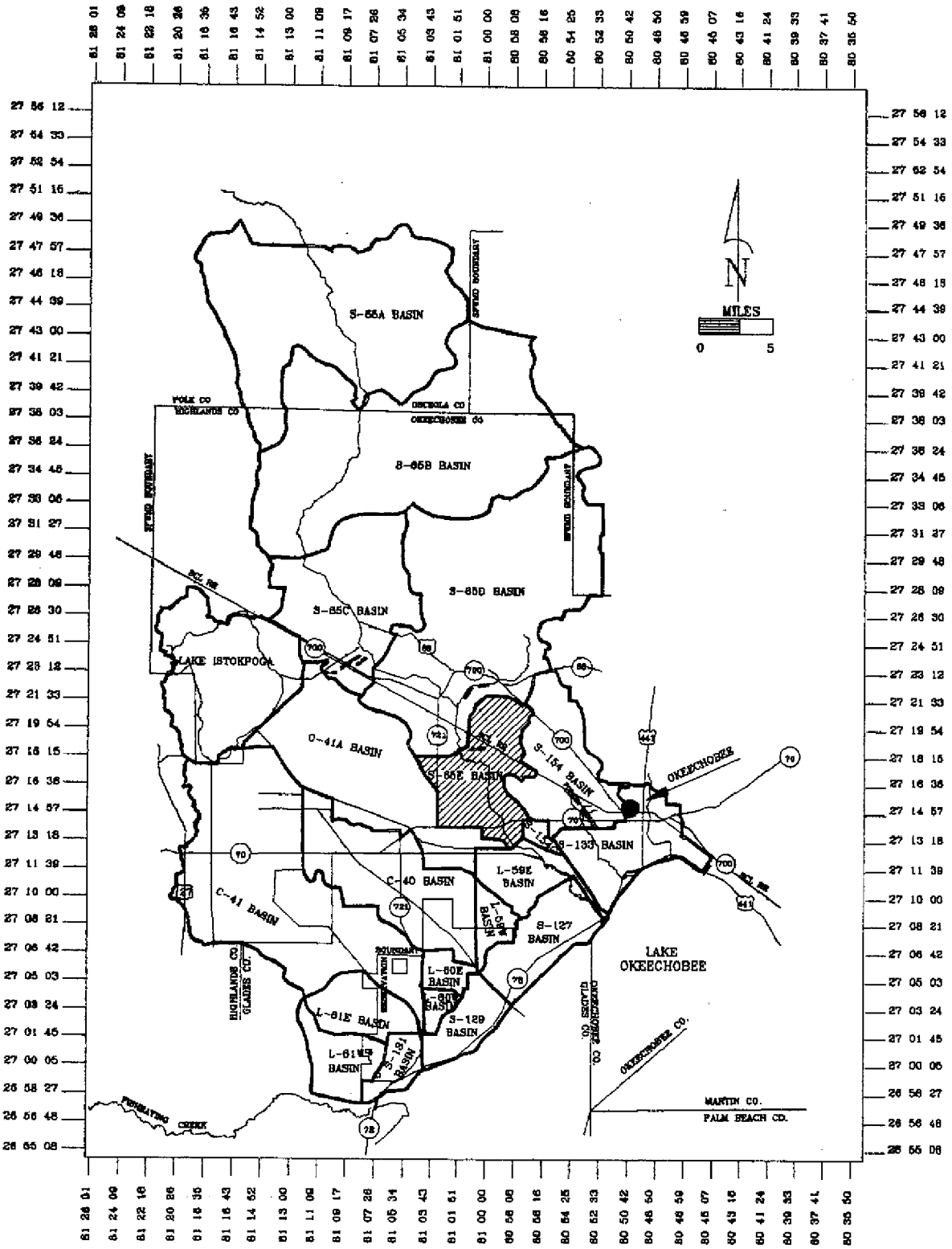

FIGURE 10. S-65E Basin Location Map

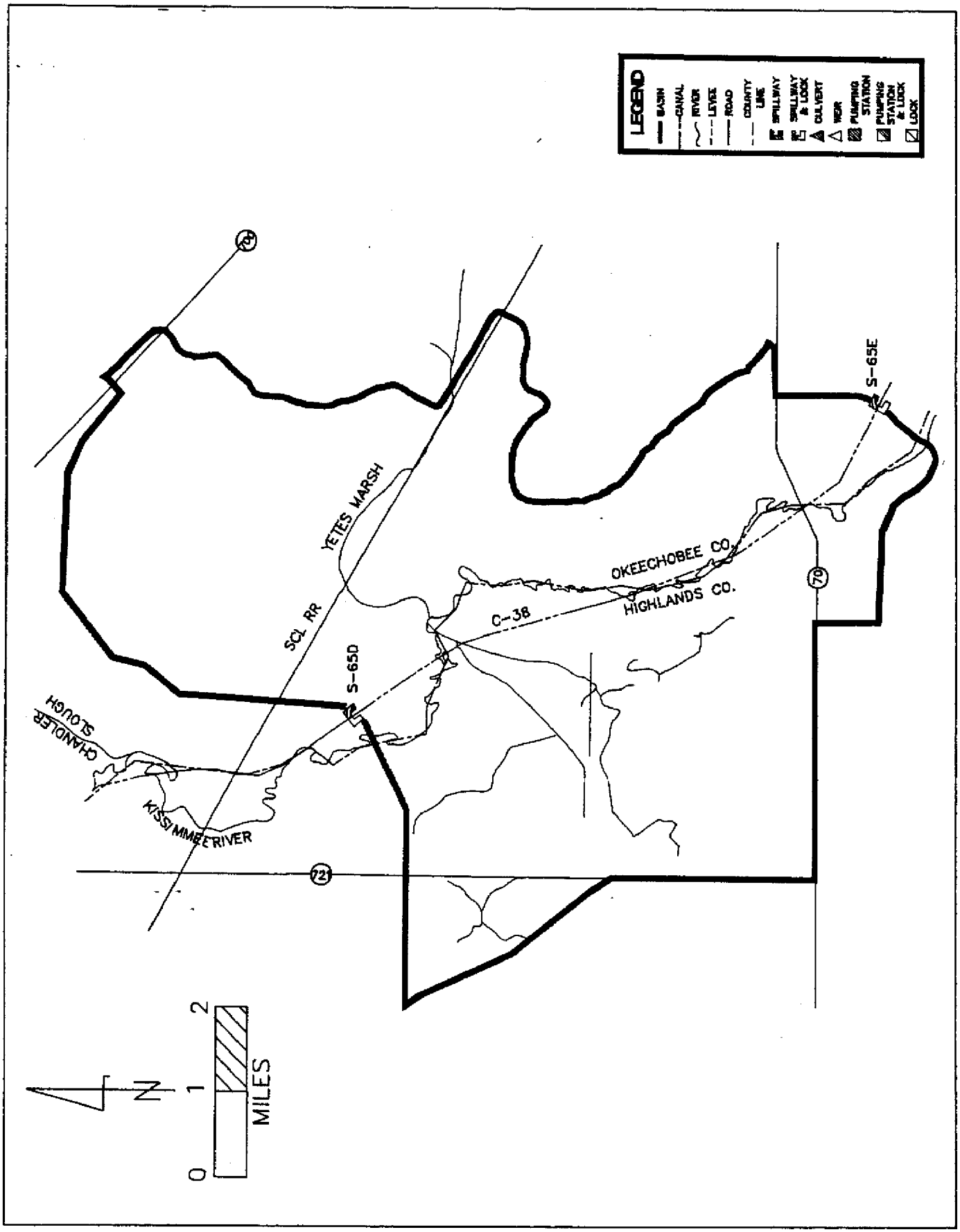

FIGURE 11. S-65E Basin Map

TABLE 5. S-65E Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-65E*	Spillway 6 gates each 13.8 ft high x 27.8 ft wide crest length = 162.0 ft crest elev = 9.7 ft	22.0	19.2	21.0	24,000	HW = 27.0ft NGVD Qmax = 27,900 cfs Qavg = 2,188 cfs	10/14/53 10/03/69 34 yrs

cfs = cubic feet per second
elev = elevation
ft = feet
HW = headwaterft
m.s.l. = mean sea level
NGVD = National Geodetic Vertical Datum
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*has a reinforced concrete lock with 2 paris of gates width = 30.0ft, length = 90.0 ft, invert elev = 6.5 and 12.5 ft

S-131 Basin

Description of the Basin

The S-131 basin has an area of 11.2 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 12). It is a basin that is completely surrounded with levees. L-50 on the lake side and L-61 on the north and west sides delineate the basin boundaries. The S-131 basin boundary relative to the local roads and landmarks is shown on Map A. Map B is included for general land use reference.

Although the major land use in this basin is beef cattle production, catfish farms and a new citrus grove are under development. Tourism (camp sites) and fishing are also an important aspect of this basin, with the town of Lake Port (about 710 pop.) as its center. The northern section of the basin is part of the Brighton Seminole Indian Reservation. A schematic map of S-131 basin demarcations, levees, and structures is shown in Figure 13.

The major structure in this basin is S-131. It is a pumping station (with a navigation lock) located on the northwest shore of Lake Okeechobee in the alignment of Levee 50. It is about 27 miles southeast of the town of Okeechobee just south of SR 78. There is a 96 inch, single-barrel, corrugated metal pipe culvert that controls flows which bypass the pumps. The purpose of S-131 is to pump out runoff from the basin into the lake which would otherwise flood the basin. The locks provide passage of boats into and out of Lake Okeechobee. The design criteria for the structures in the basin is given in Table 6.

Comments on Design and Historic Operation

The levees around the lake and high lake stages restrict gravity drainage from the basin. Runoff from the basin drains to the borrow canal along the land side of the lake levee where there is continuous stage monitoring. When runoff water removal is required, the pumps are activated and the system has a capacity of removing 0.75 inches of runoff in a day from the drainage area. The operation is manually controlled. During drought conditions when the Lake Okeechobee stage is higher than 13.5 feet NGVD and the lock is closed, water is withdrawn through the culvert into the basin; otherwise, when the lake level is above intake canal water level, the culvert remains closed.

Normally, pumping is initiated when the headwater elevation in the borrow canal reaches 13.5 feet and is terminated when it reaches 13 feet. However, during heavy rainfall conditions, the pumping station operates at full capacity and the headwater elevation is maintained at 13 feet until the storm passes. For the past two years, the pumps have not been activated for the purpose of flood control due to the low lake level and drought conditions.

The lock remains open whenever the lake stage is below 13.5 feet; however, when the lake stage is above this level, the lock is operated between 5:30 a.m. and 8:00 p.m., and fully closed between 8:00 p.m. and 5:30 a.m.

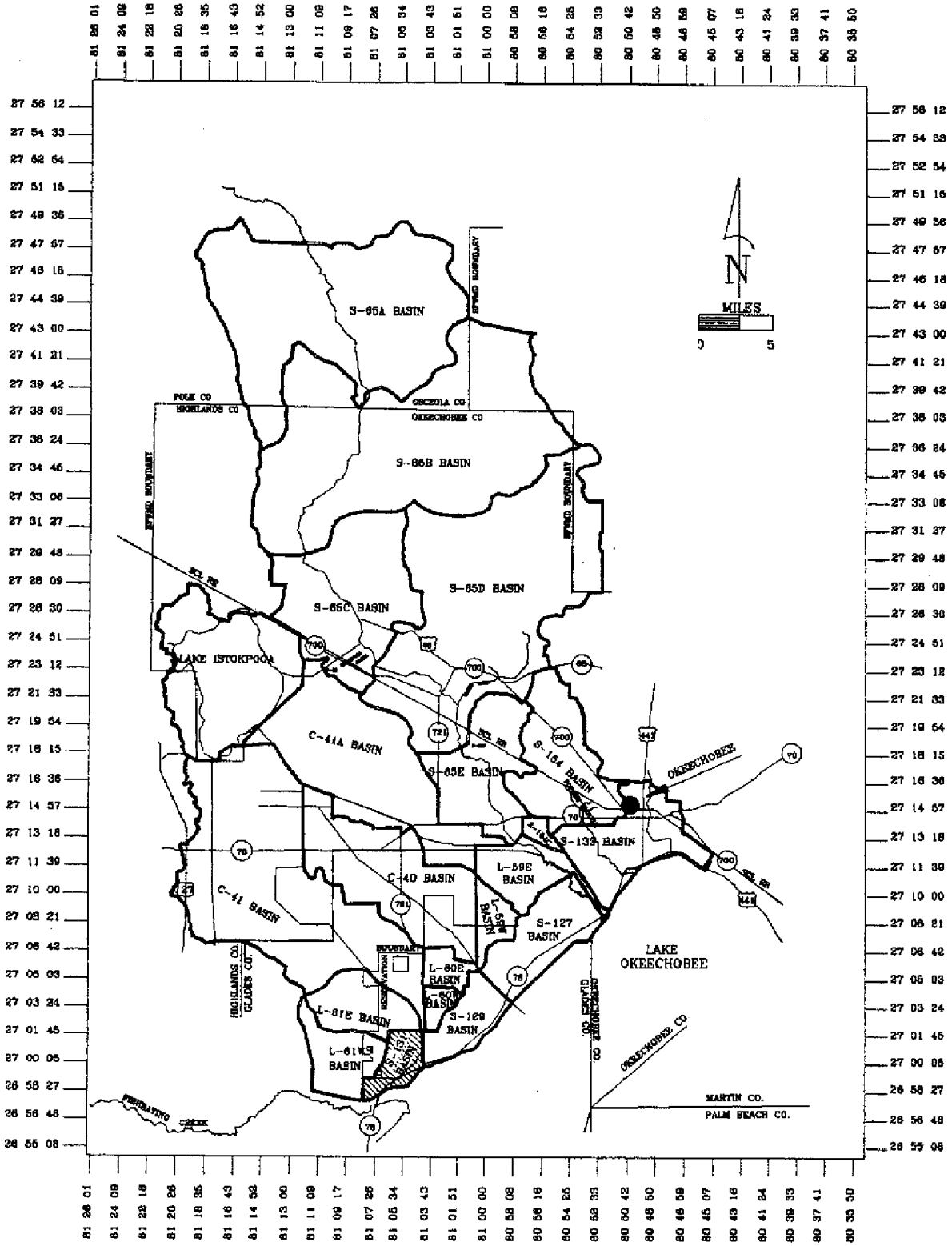

FIGURE 12. S-131 Basin Location Map

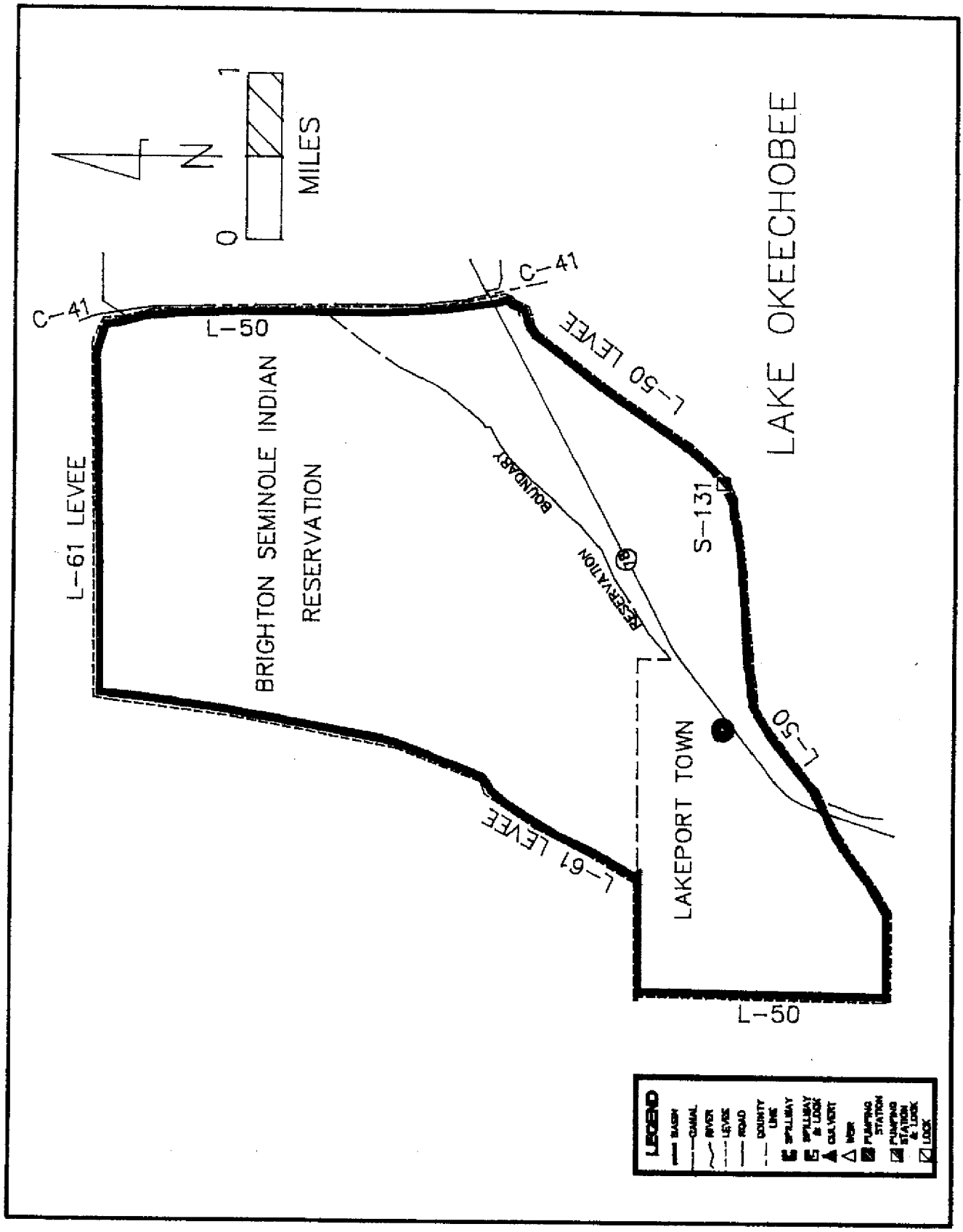

FIGURE 13. S-131 Basin Map

TABLE 6. S-131 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-131*	Pump Station 2 units Capacity 115 cfs each unit	13.0	23.5	13.0	230	HW = 18.4 ft msl Qmax = 299 cfs Qavg = 7.06 cfs	02/27/83 10/02/69 18.92 yrs
Culvert	CMP culvert single barrel length = 217 ft diameter = 96 in			Not used to control stage			

cfs = cubic feet per second
CMP = corrugated metal pipe
in = inch
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*has a reinforced concrete lock (U-shaped chamber) width = 15.0 ft, length = 50.0 ft, invert elev = 8.0 ft

S-133 Basin

Description of the Basin

The S-133 basin has an area of 39.98 square miles and is located in Okeechobee County on the north side of Lake Okeechobee (Figure 14). It is a basin surrounded by L-D4 (a section of Herbert Hoover Dike) on the south and west sides, L-62 on the north side, and L-63 on the east side. L-D4 extends from Nubbin Slough to the Kissimmee River. The lower reaches of Taylor Creek, downstream of S-192, empties through L-D4 via HGS-6.

L-D4 is about 15.0 miles long with a design grade of 34.4 to 41.1 feet NGVD The crown width is 10.0 feet with a lake side slope of 1 on 8 and a land side slope of 1 on 3. L-62 is an interceptor dike and a canal. It is a basin divide for the S-133 and the S-154 basin. L-62 is 6.2 miles long with a design grade of 29.4 feet NGVD. It has a crown width of 10 feet and side slope of 1 on 3. L-63 is the divide for the S-133 and the C-59 basin. It is 7.7 miles long with a design grade of 28.7 feet NGVD. It has a crown width of 10 feet and side slope of 1 on 3. The basin boundary relative to the local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in this basin is urban and agricultural. There are dairy farms, but most of the area is improved beef cattle pasture. The southern section of the town of Okeechobee is in this drainage basin. The Okee Tantee recreational area is located at the southern corner outside of the basin. A schematic map of the S-133 basin demarcations, levees, and control structures is shown in Figure 15.

The major flood control structure in this basin is the S-133. It is a pump station located on the northeast shore of Lake Okeechobee landward of Herbert Hoover Dike (L-D4) about 3 miles southeast of the town of Okeechobee. It is 1,200 feet west of Hurricane Gate 6 (HGS-6) or S-193 at the outlet of Taylor Creek into Lake Okeechobee. The HGS-6 or the S-193 structure allows gravity discharge from S-133 basin when tailwater stage permits. The purpose of S-133 is to remove impounded water from the basin during wet periods.

S-193 is a lock structure that is a modification of an earlier HGS-6 (Hurricane Gate 6). It is located at the mouth of Taylor Creek in L-D4 about 2.5 miles from the town of Okeechobee. The purpose of S-193 is to provide access for boats to pass between Lake Okeechobee and Taylor Creek when the lake stage is high. It also acts as a hurricane control structure by preventing hurricane tides from entering Taylor Creek. Culverts 7, 8, and 9 are flap-gated culverts through LD-4, with manually controlled submersible inlets in the LD-4 rim canal. Depending on the lake stage, water can flow from the LD-4 rim canal to the lake.

G-106 is a gated culvert in L-63N at the point where the Mosquito Creek crosses the levee. It is located 2.5 miles east of the town of Okeechobee. The purpose of this structure is to transfer water from Taylor Creek to the lower reaches of Mosquito Creek to improve water quality. The design criteria for the structures in this basin is shown in Table 7.

Comments on Design and Historic Operation

The north shore levees of Lake Okeechobee together with high lake stages restrict natural drainage from the S-133 basin into the lake. Runoff from the basin drains into the borrow canal on the landward side of the lake levee where there is continuous stage monitoring. The pump system is manually operated and, when necessary, the pump system can remove 0.58 inches of runoff from the drainage area in a day. The spillway gate is closed if the lake stage is higher than the canal stage except when backflow is needed for irrigation during drought periods.

Normally, pumping is initiated when the headwater stage reaches 14 feet and is terminated when it declines to 13 feet. However, if heavy rain is predicted and a stage above 14 feet is expected, all pumps are activated and the stages lowered and maintained at 13 feet.

G-106 structure is manually operated and is closed most of the time. S-193 lock gates are opened when the lake level is below 14 feet elevation. The lock is operated manually whenever the lake stage is above 14 feet. Flood flows from the S-133 basin are removed by the S-133 pump system.

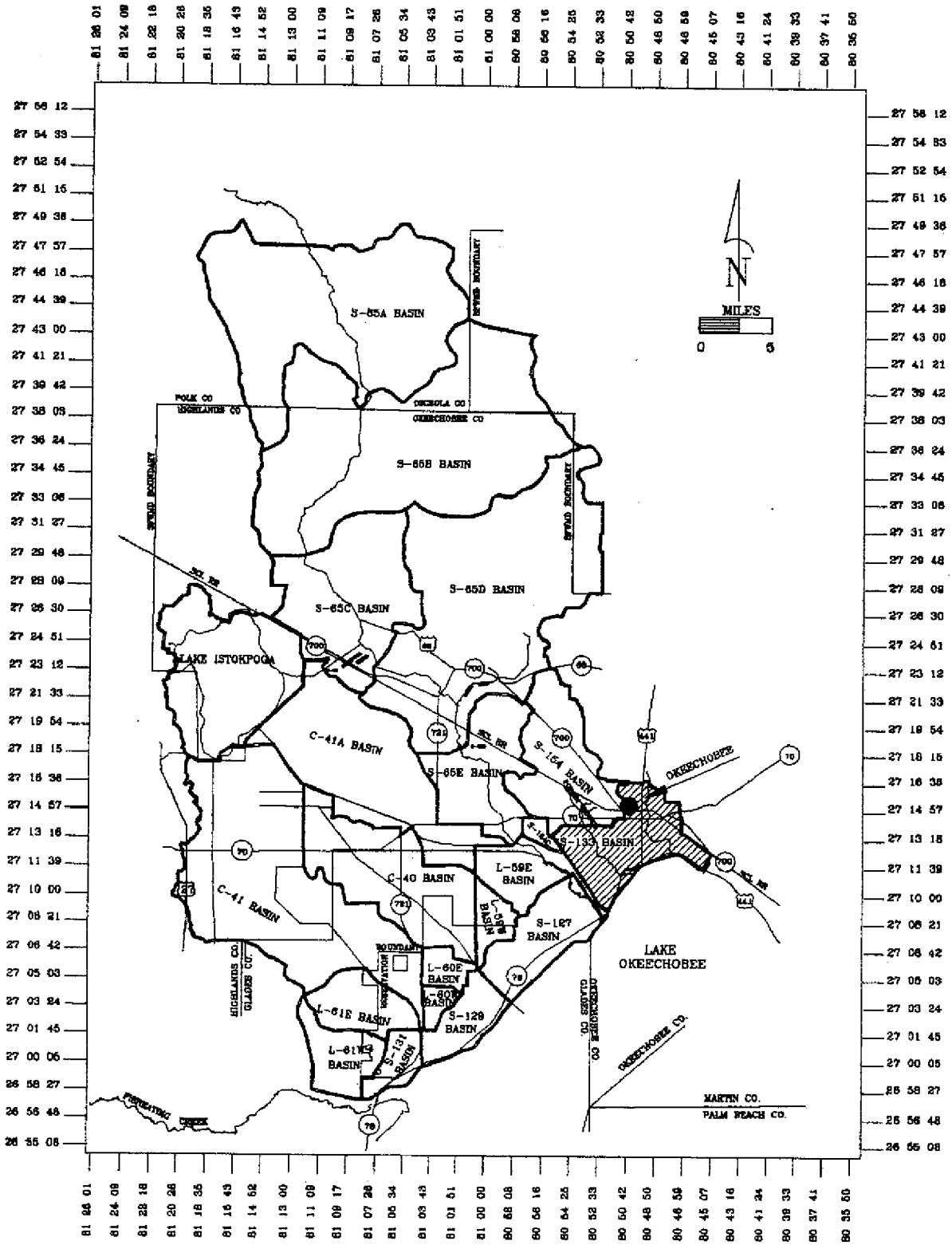

FIGURE 14. S-133 Basin Location Map

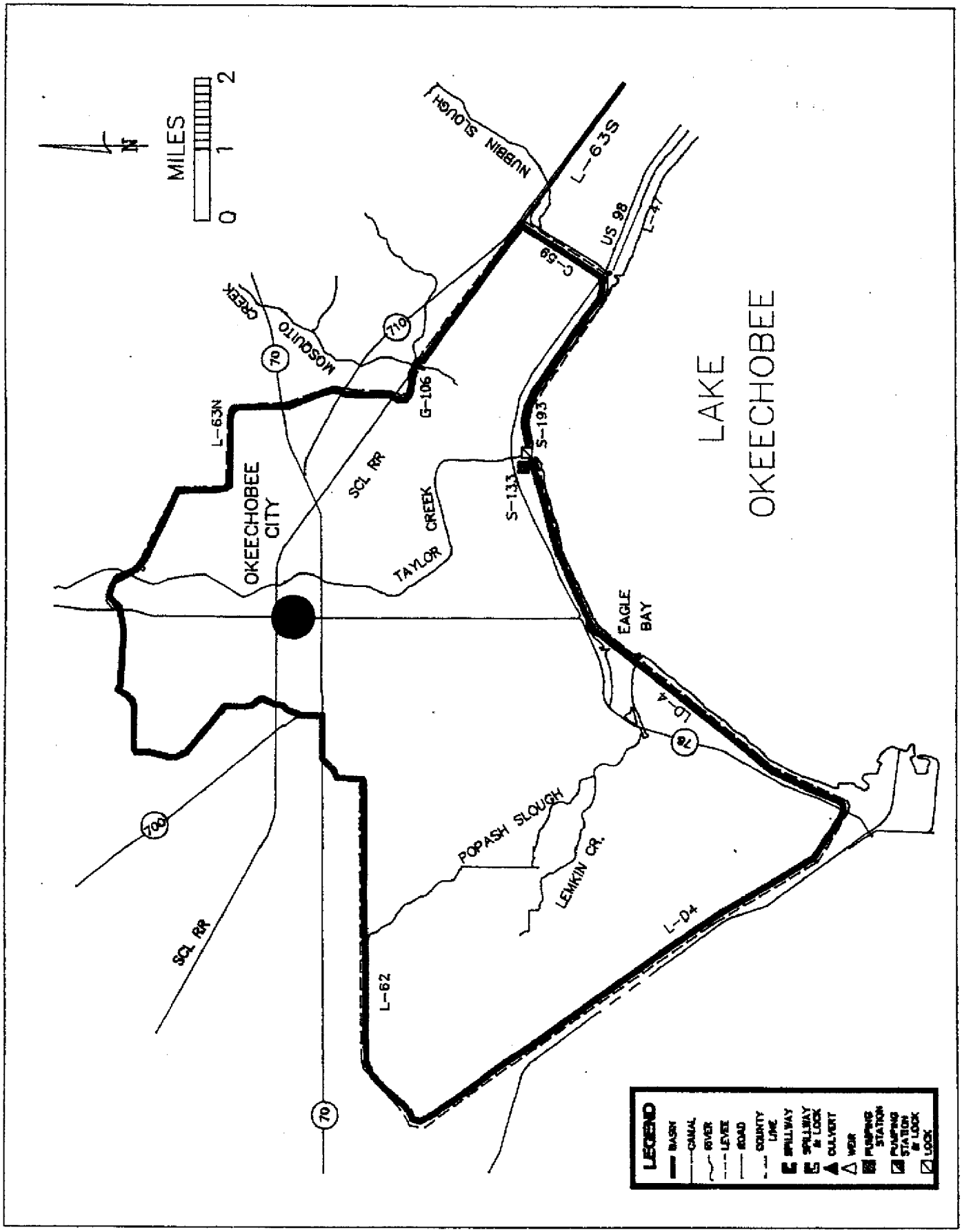

FIGURE 15. S-133 Basin Map

TABLE 7. S-133 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-133	Pump Station 5 units Capacity 125 cfs each unit	13.0	23.5	13.0	625	HW = 18.0 ft msl Qmax = 753 cfs Qavg = 22.44 cfs	03/10/83 05/10/79 17.25 yrs
G-106	Gated culvert single barrel length = 90.0 ft diameter = 36 in invert elev = 15.0 ft				Occasionally open for water supply		
S-193	Lock structure width = 50.0 ft length = 90.0 ft invert elev = 5.5 ft		lock is operated when lake stage is above 14.0 ft		Not used for flood discharge		

cfs = cubic feet per second
elev = elevation
ft = feet
HW = Headwater
in = inches
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

S-154 Basin

Description of the Basin

The S-154 basin has an area of 49.41 square miles and is located in Okeechobee County on the west side of the town of Okeechobee (Figure 16). L-62 is an interceptor dike and canal on the south side of the basin starting at L-D4 borrow canal and ending at U. S. Highway 441. It is about 6 miles long and has a crown width of 10.0 feet. The elevation of the levee is 29.4 feet and the side slope is 1 on 3. Water flows to the west and the design discharge at this end is 1,000 cfs from the drainage area. The basin boundary relative to the local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is urban and agricultural. The northwest section of the town of Okeechobee is in the S-154 basin. In this basin there are citrus groves, beef cattle production and dairy operations. A schematic map of the S-154 basin demarcations, levees, and control structures is shown in Figure 17.

S-154 is the major water control structure in this basin. It is a double-barreled reinforced concrete box culvert which is located through L-D4 about 5 miles west of the town of Okeechobee. The purpose of S-154 is to maintain upstream water control stages, and to pass the design flood without creating channel eroding velocities downstream. It prevents backflow from Lake Okeechobee during excessive stages in the lake caused by high tide or flood.

G-35 is a single-barrel corrugated metal pipe culvert, located where L-62 interceptor levee crosses Popash Slough. The purpose of structure G-35 is to allow releases through the natural waterway of the Popash Slough under levee L-62. The design criteria for the structures in the S-154 basin is shown in Table 8.

Comments on Design and Historic Operation

The drainage from the northwestern part of the town of Okeechobee and the rest of the S-154 basin flows into the L-62 borrow canal and flows out to the C-38 (Kissimmee River) through the S-154 culvert located in L-D4. S-154 is designed to remove runoff from a 30 percent SPF. S-154 has sluice gates which are automatically operated.

S-154 is operated to maintain 25 feet optimum upstream stage as much as possible. When the headwater reaches 25.4 feet, the gates begin to open. At 23.8 feet headwater stage, the gates become stationary. When the headwater elevation falls to 22.8 feet, the gates begin closing. When the difference between headwater and tailwater approaches 0.2 feet, the gates close to prevent backflow.

The original structure which was a double-barrel concrete box culvert (8 feet high, 10 feet wide and 130 feet long) failed on May 14, 1974 due to piping. It was replaced in August 1974 with a sheet pile weir (125 feet long). In 1976, the restoration of the original culvert began and the weir was replaced with a double-barrel culvert.

G-35 is not designed to pass flood flows. It is only used for maintenance purposes as an alternate outlet for the L-62 canal, which normally drains to the Kissimmee River. It is controlled manually by a sluice gate which is located on the upstream end of the structure.

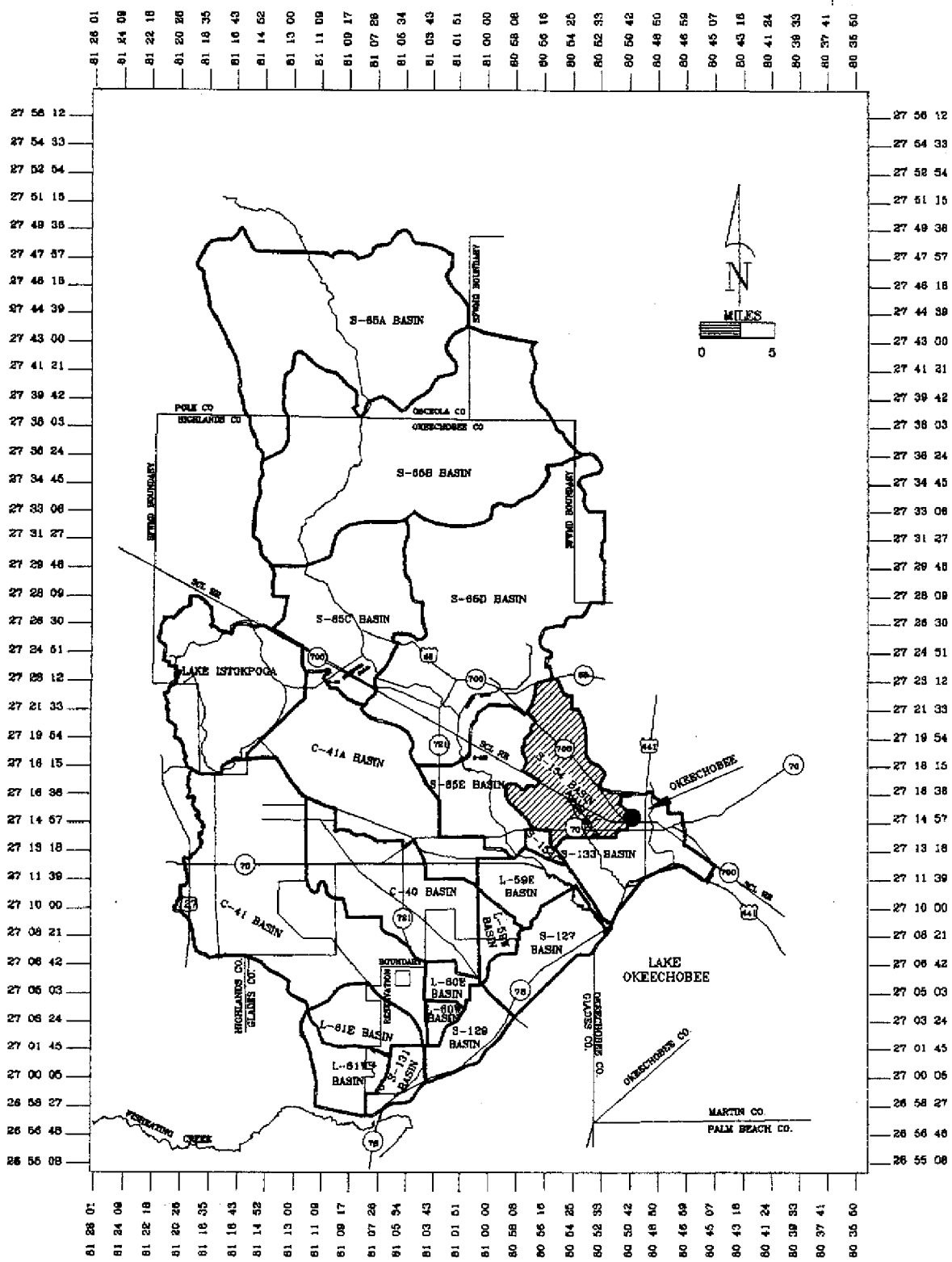

FIGURE 16. S-154 Basin Location Map

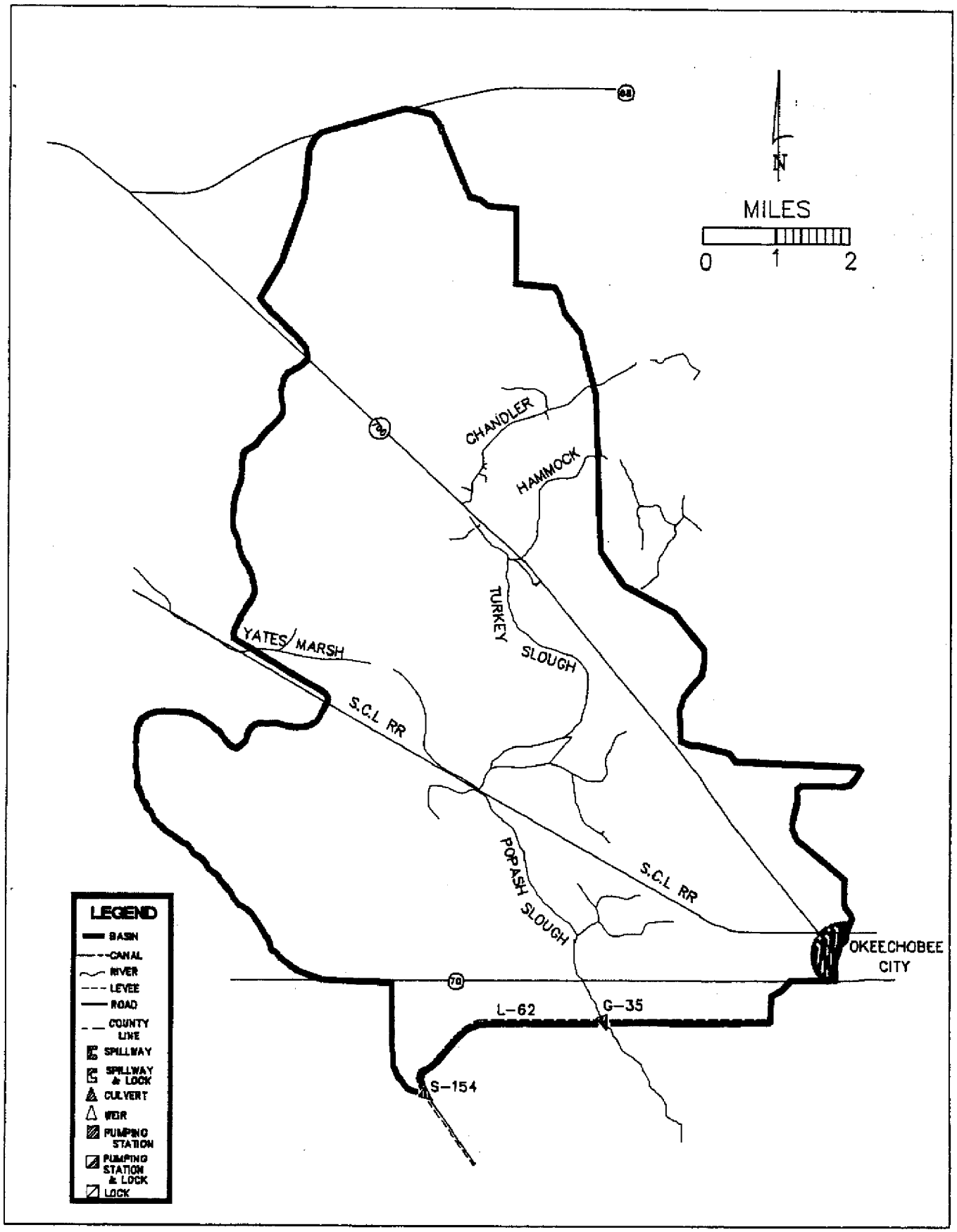

FIGURE 17. S-154 Basin Map

TABLE 8. S-154 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-154	Reinforced concrete box 2-barrel culvert each 8.0 ft highx10.0 ft wude length = 17.0 ft	25.0	19.1	25.0	1,000	HW = 25.40 ft msl Qmax = 1,197 cfs Qavg = 49.8cfs	07/16/78 11/20/87 10.42 yrs
G-35	CMP culvert single barrel length = 117.0 ft diameter = 36 in			Not used tocontrol stage			

cfs = cubic feet per second
CMP = corrigated metal pipe
in = inches
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

S-154C Basin

Description of the Basin

The S-154C basin has an area of 3.4 square miles and is located in Okeechobee County north of Lake Okeechobee, about 5 miles west of the town of Okeechobee (Figure 18). The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agricultural including improved pasture and cattle production. There are citrus groves and dairy operations, as well. A schematic map of the S-154C basin demarcations, levees, and control structures is shown in Figure 19.

The major water control structure in this basin is S-154C. It is a single-barrel concrete pipe culvert which is located through L-D4, about 5 miles west of the town of Okeechobee. The purpose of S-154C is to maintain optimum upstream water control stages, and to pass the design flood without exceeding upstream flood design stage. Its downstream flap valve prevents backflow from Lake Okeechobee during excessive stages in the lake caused by flood and wind tides. The design criteria for the structure in the S-154C basin is shown in Table 9.

Comments on Design and Historic operation

The S-154C structure is operated to maintain an optimum headwater elevation of 16 feet. The design discharge is indeterminate. The percent of SPF it can accommodate is not known. It is manually controlled by a submersible gate mounted on a concrete box inlet structure. During hurricane alerts, it is opened fully to pass the maximum discharge possible. The inlet structure is a concrete box 8 feet wide and 18 feet high.

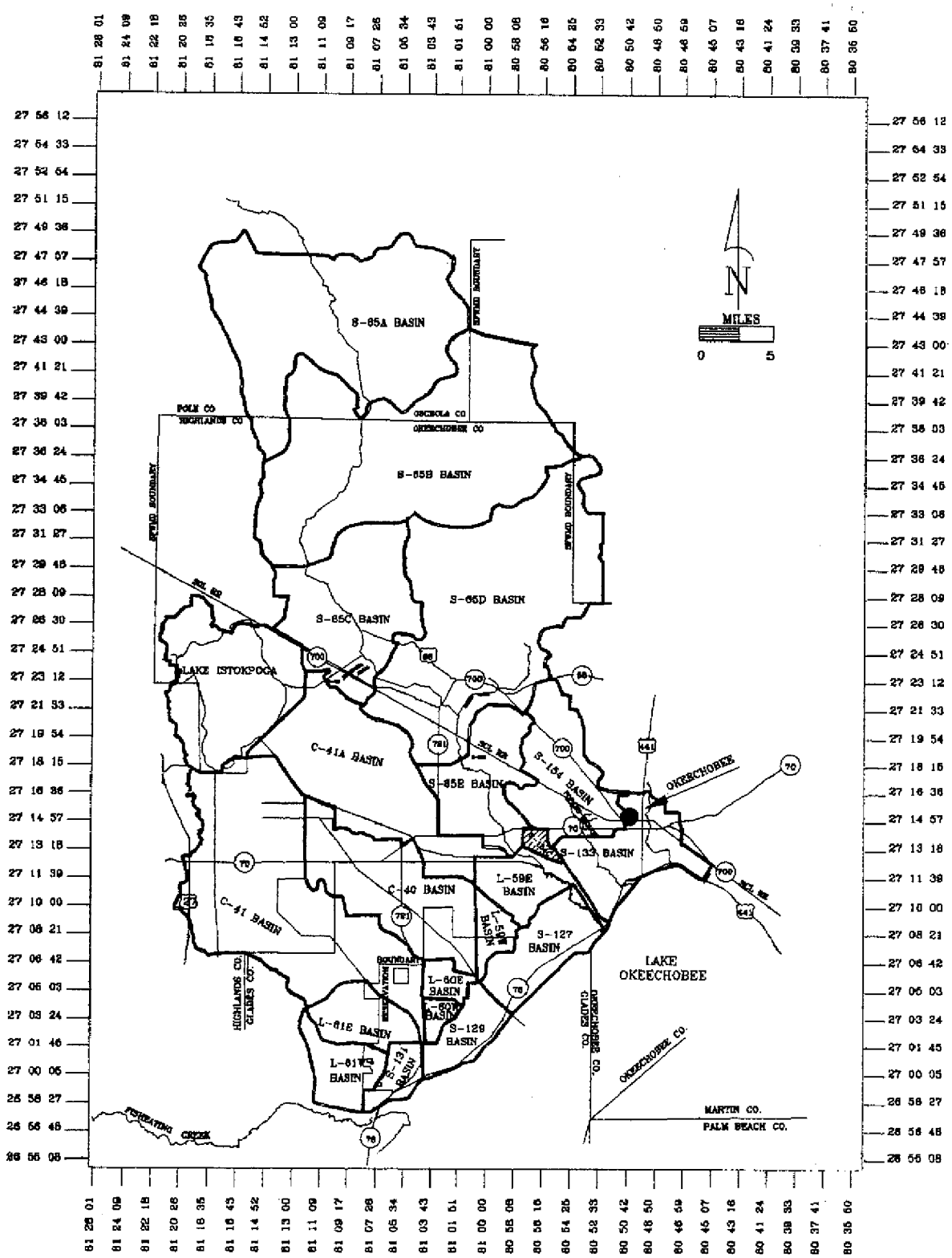

FIGURE 18. S-154C Basin Location Map

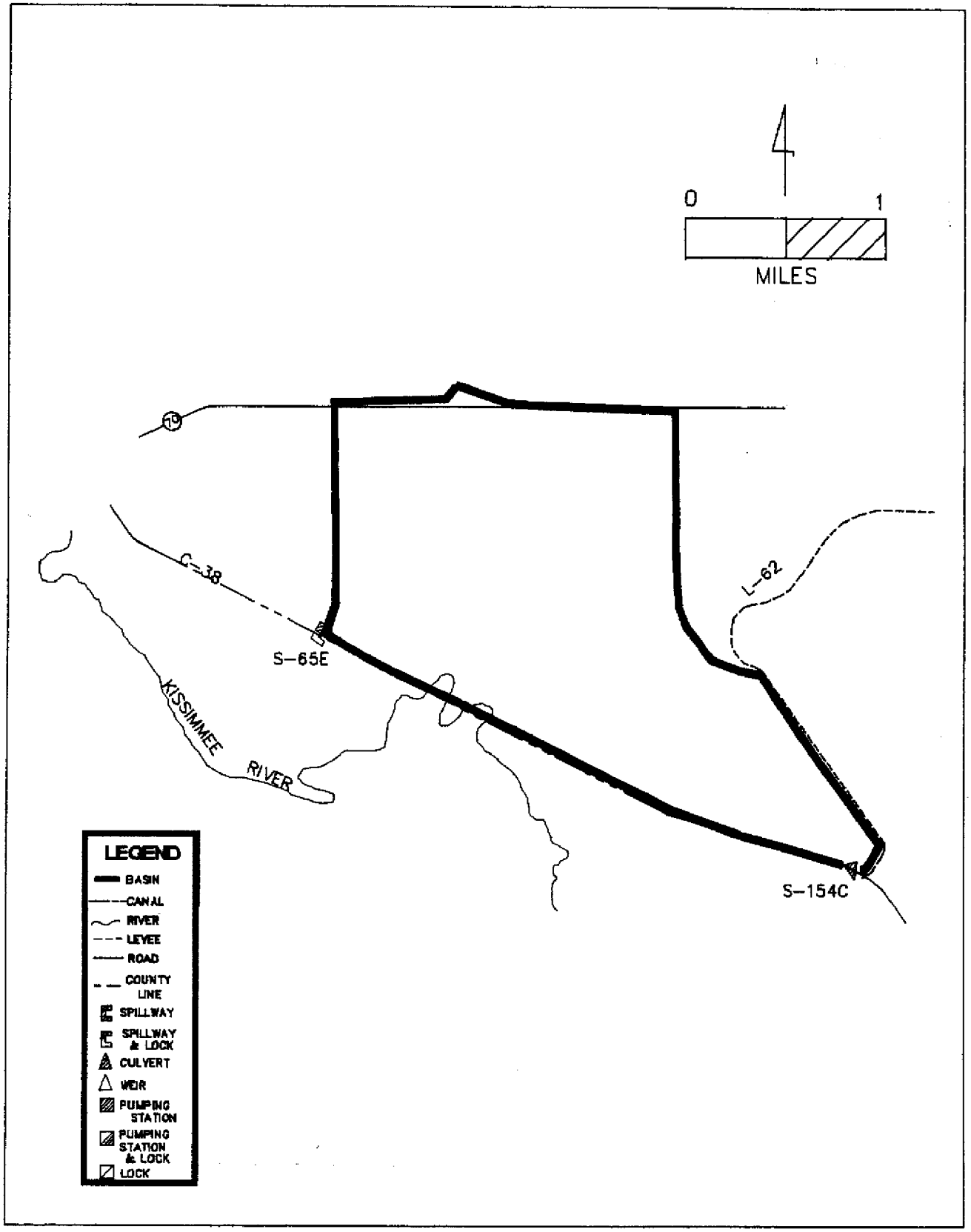

FIGURE 19. S-154C Basin Map

TABLE 9. S-154C Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-154C	Concrete pipe culvert single-barrel length = 136.0 ft diameter = 72 in	20.1	19.1	16.0	Indeterminate		

cfs = cubic feet per second
ft = feet
HW = headwater
in = inches
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

C-40 BASIN

Description of the Basin

The C-40 basin has an area of 68.8 square miles located in Glades and Highlands counties (Figure 20). The major Project canal in the basin is the C-40, which is also called the Indian Prairie Canal. C-40 is about 18.1 miles long with a bottom width of 20 to 50 feet. The bottom elevation ranges between -4.7 and 10.1 feet NGVD. The design water surface elevation is in the range of 18.6 to 25.9 feet NGVD. C-40 is designed to remove the runoff from the drainage area for the 30 percent SPF. The basin boundary relative to the local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in this basin is agricultural (citrus groves and vegetable production) as well as improved pasture and cattle production This is one of the basins in the area with high agricultural water demand. A schematic map of the C-40 basin demarcations, levees, and control structures is shown in Figure 21. There are three major structures in the C-40 basin:

S-72 is a reinforced concrete spillway with two gates. This structure is located on the C-40 canal about 4 miles upstream from Lake Okeechobee. The purpose of this structure is to maintain upstream water control stages in C-40 and to pass the design flood flow without exceeding the required upstream stage and without creating erosive velocities downstream. It also prevents backflow from Lake Okeechobee during excessive stages created by flood and wind tides.

S-75 is a reinforced concrete spillway with a single gate. It is located on the C-40 about 10 miles upstream from S-72, and about 14 miles upstream from Lake Okeechobee. The purpose of S-75 is to maintain upstream water control stages in the C-40, and to pass the design flood flow without exceeding the required upstream stage and without creating erosive velocities downstream. It also passes sufficient discharge during low-flow periods to maintain downstream stage and irrigation demands.

G-208 is a one-unit pumping station, located a few yards south of S-72. The purpose of this structure is to supply water from Lake Okeechobee to the C-40 section between S-75 and S-72 when the stage is lower than 20.2 feet NGVD. The design criteria for the structures in the C-40 basin is shown in Table 10.

Comments on Design and Historic Operation

S-72 is automatically controlled in accordance with the established operational criteria. It is operated to maintain an optimum headwater elevation between 20.2 and 21.2 feet, subject to hydraulic and structural constraints. When the headwater elevation rises to 20.7 feet, the gates will open at a rate of 6 inches per minute. At 20.7 feet headwater elevation, the gates remain stationary. When the headwater falls to 20.2 feet, the gates close at a rate of 6 inches per minute. When the tailwater rises within 0.2 feet of the headwater, the gates close to prevent backflow through the structure.

S-75 is operated automatically in accordance with the established operational criteria to maintain an optimum headwater elevation between 25.3 and 26.2 feet. When the headwater rises to 26.2 feet, the gates will open at a rate of 6 inches per minute. At a headwater elevation of 25.7 feet, the gates become stationary. When the headwater elevation falls to 25.3 feet, the gates close at a rate of 6 inches per minute. During low-flow periods, release for irrigation requirements is controlled by

tailwater elevation. When the tailwater elevation falls to 20 feet, the gates open 7.2 inches and close when the tailwater rises to 21 feet elevation.

Because of erosion problems at the downstream of the structures, the COE provided the maximum allowable gate opening curves for the operation of the structures along C-40, C-41, and C-41A. A problem in the operation of the structures, is regulating the amount of flow through each structure to deliver water to the desired area and, at the same time, maintain the limitation on gate openings. This problem is solved by combining manual and automatic operations. First, the discharge in the upstream structure is estimated, then at the junction where the canal branches into two, one structure is put on manual mode with the gate opening based on estimated required flow, and the other structure is left on automatic mode to balance the total flow.

For normal conditions, S-68 and S-75 are closed; all the flashboards in G-85 are in; S-82, S-83, S-84, S-70, S-71, and S-72 are left on automatic mode. For regulatory releases, the allowable regulation release is estimated based on discharge from the upstream and the local inflow into each structure. The proper distribution of flow is achieved by combining manual and automatic operations. A typical plan is to determine the allowable discharge at S-68 and to open S-68, S-82, and S-75 to the proper gate opening and set them on manual operation. S-83, S-84, S-70, S-71, and S-72 are set on automatic. If S-68 cannot discharge the flow, the flashboards in G-85 on the Istokpoga Canal are removed.

For agricultural demand releases, the water demand is determined first. S-68, S-82, and S-75 are set to the proper gate opening and left on manual mode. S-83, S-84, S-70, S-71, and S-72 are left on automatic, while all the flashboards in G-85 are in. During major storm conditions, all structures will have personnel on duty to monitor the gate openings and receive operational instructions. The structures are designed for the 30 percent SPF.

The construction of the G-208 pump station has been completed and is ready for operation. The total dynamic head is 18 feet during operation. During normal operation, the pump will be started manually when the upstream water elevation is 20.2 NGVD. It will automatically shut off when the upstream water elevation reaches 20.5 NGVD.

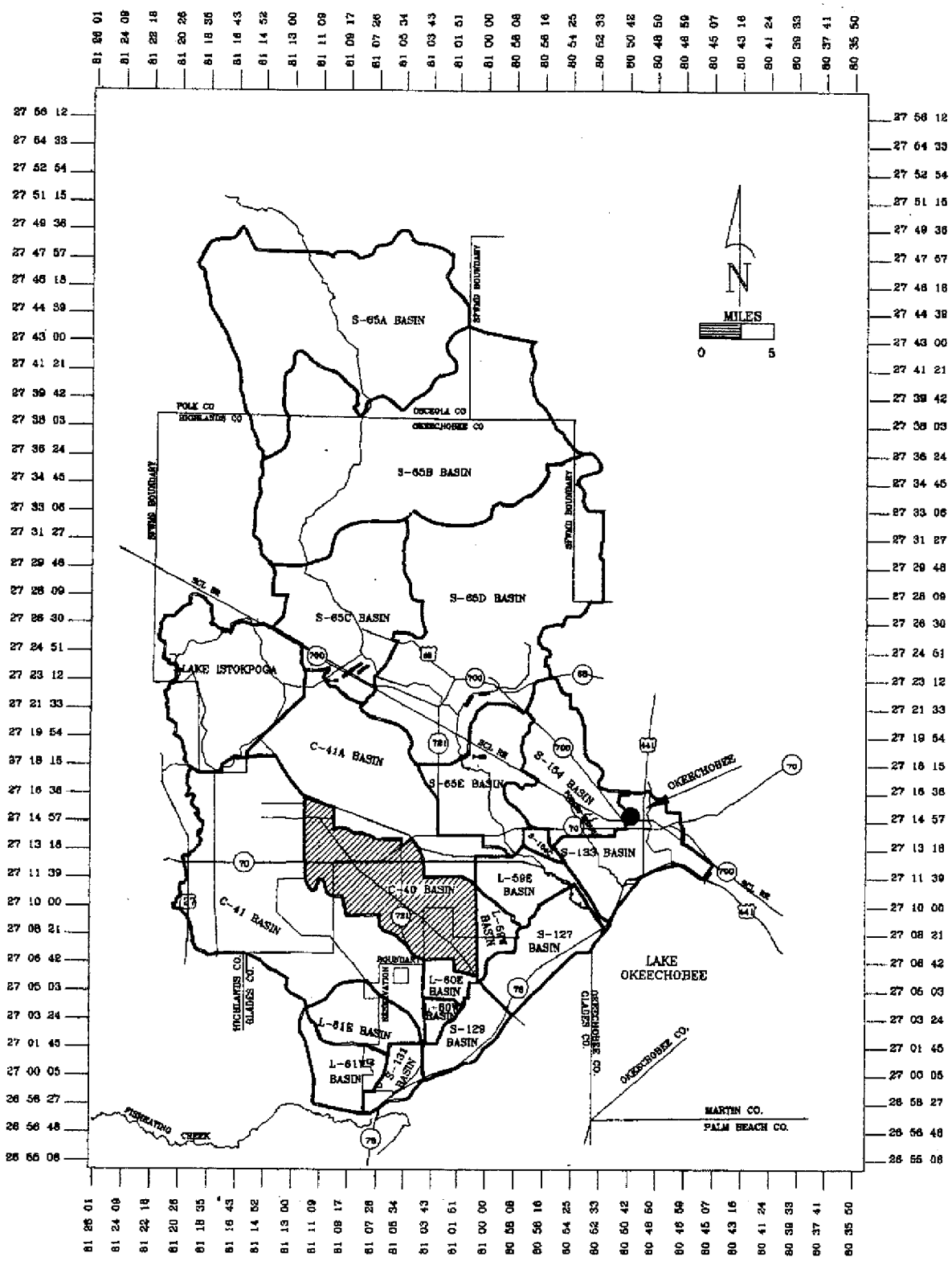

FIGURE 20. C-40 Basin Location Map

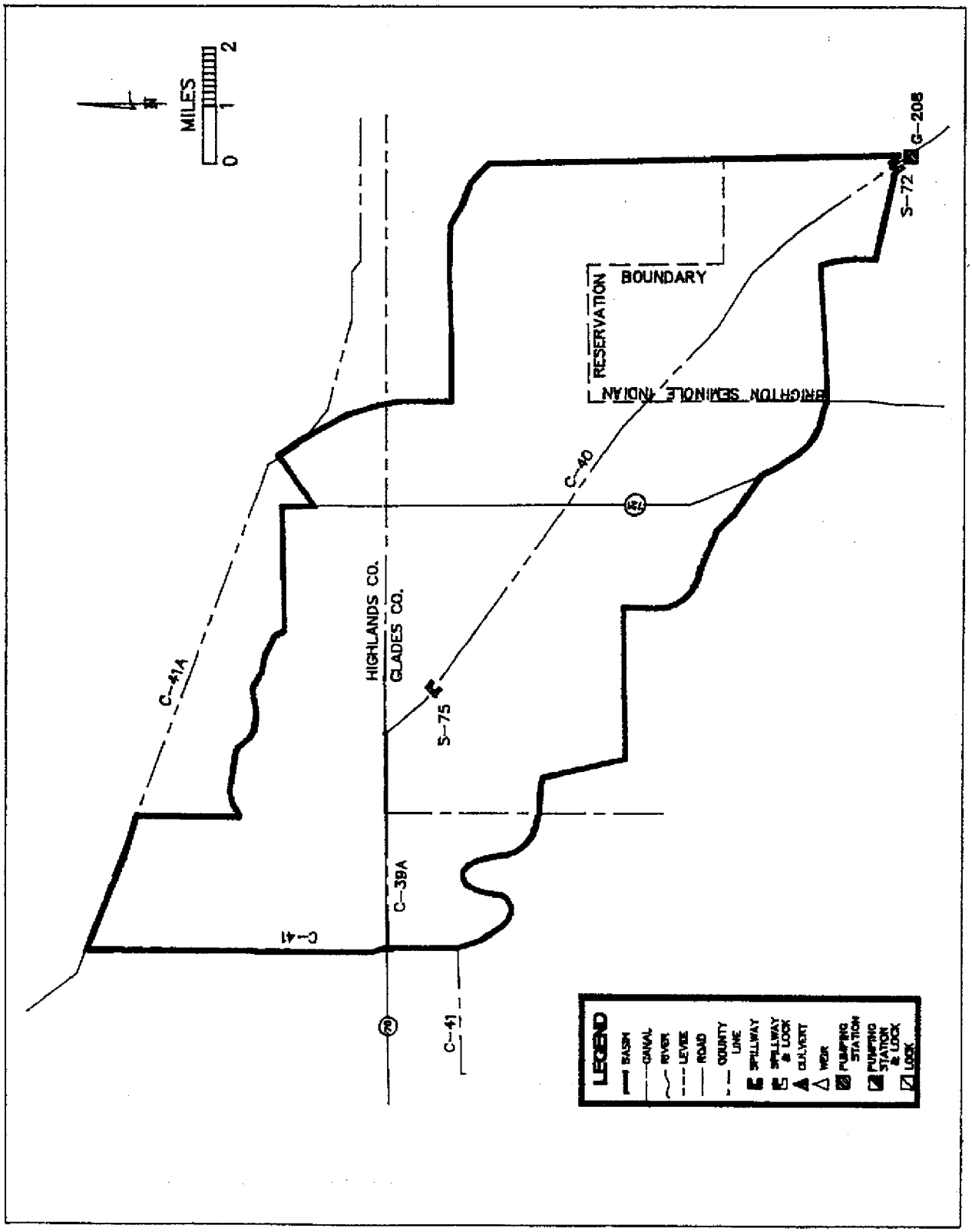

FIGURE 21. C-40 Basin Map

TABLE 10. C-40 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-72	Spillway 2 gates each 12.0 ft highx27.8 ft wide Crest length = 54.0 ft Crest elev = 9.9 ft	20.4	19.9	20.2 to 21.2	3,120	HW = 21.98 ft NGVD Qmax = 2,130 cfs Qavg = 49.3 cfs	09/18/71 10/03/69 15.83yrs
S-75	Spillway 1 gate 10.0 ft highx28.8 ft wide Crest length = 28.0ft Crest elev = 17.0ft	25.5	25.0	25.3 to 26.2	1,150	HW = 27.44ft msl Qmax = 1,173E cfs Qavg = 42.8cfs	08/02/78 10/03/69 26 yrs
G-208	Pump Station 1 unit	10.0	29.0	20.2 TW	135		

cfs = cubic feet per second
E = estimate
elev = elevation
ft = feet
in = inches
HW = headwater
m.s.l. = mean sea level
NGVD = National Geodetic Vertical Datum
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

C-41 BASIN

Description of the Basin

The C-41 basin has an area of 147.2 square miles located in Highlands and Glades counties (Figure 22). The major Project canals in the basin are C-39A and C-41 (Harney Pond Canal). C-39A is 3.2 miles long and has a bottom width of 20 feet. The bottom elevation of C-39A ranges from 19 to 20.2 feet, and has a design water surface elevation of 25.9 to 25.2 feet NGVD. C-41 is about 28.1 miles long and has a bottom width of 20 to 70 feet. The bottom elevation ranges from -13.0 to 16.7 feet NGVD. The design water surface elevation ranges between 18.6 to 32.5 feet NGVD.

C-41 is designed for the removal of runoff for the 30 percent SPF from the drainage area. The basin boundary relative to the local roads and landmarks is shown on Map A. A schematic map of C-41 basin demarcations, levees, and control structures is shown in Figure 23. Map B is included for general land use reference.

The land use in the C-41 basin is primarily agricultural. There is citrus production in the higher elevations; the lower flatland is mainly improved pasture for beef cattle production. Truck crop and caladium production is also practiced. It is one of the basins in the area with the most agricultural water demand. There are four major water control structures in C-41 basin:

S-70 is a reinforced concrete spillway with two gates located on C-41 about 8.5 miles upstream from S-71, and 10.5 miles upstream from Lake Okeechobee. The purpose of this structure is to maintain optimum upstream stage in C-41 and pass the design flood maintaining nondamaging channel velocities. During low-flow periods it maintains downstream stages and supplies required irrigation water.

S-71 is a reinforced concrete spillway with two gates. It is located on canal 41, two miles upstream from Lake Okeechobee. The purpose of this structure is to maintain the required upstream stage in C-41 canal and pass the design flood maintaining nondamaging channel velocities. During excessive stages of Lake Okeechobee, it prevents backflow into the canal.

S-82 is a reinforced concrete spillway with two gates. It is located on the C-41, 5 miles downstream from Lake Istokpoga and 500 feet downstream from the junction of C-41 and C-41A. The purpose of this structure is to restrict discharges from C-41A into C-41 whenever the capacity of C-41 is required to remove runoff from the C-41 basin.

G-207 is a one-unit pumping station which is located 2.0 miles upstream of Lake Okeechobee near S-71. The purpose of this pump station is to supply water from Lake Okeechobee to the C-41 canal section between S-70 and S-71 to maintain optimum water surface elevation. This is needed when Lake Istokpoga is below its regulatory schedule. The design criteria for the structures in the C-41 basin is given in Table 11.

Comments on Design and Historical Operation

S-70 is designed for the 30 percent SPF. The structure is automatically operated to maintain an optimum headwater elevation between 25.3 and 26.2 feet NGVD. The established operation criteria for high-flow conditions is as follows: When the headwater elevation rises to 26.2 feet NGVD, the gates will open at 6 inches per

minute. At a stage of 25.7 feet NGVD, the gates will become stationary. When the headwater elevation falls to 25.3 feet NGVD, the gates close at 6 inches per minute.

S-71 is designed for 30 percent of the SPF. The structure is automatically operated to maintain an optimum headwater elevation between 19.8 and 20.2 feet NGVD. The established criteria of operation is to open the gates at 6 inches per minute whenever the headwater elevation rises to 20.2 feet NGVD elevation. At 20.0 feet NGVD stage, the gates remain stationary. When the headwater elevation falls to 19.8 feet NGVD, the gates close at a rate of 6 inches per minute. When the difference between the headwater and the tailwater is 0.2 feet, the gates close to prevent backflow.

S-82 is operated together with the S-83 structure in C-41A. Through automatic control of both structures, an optimum headwater elevation of 31.8 to 32.5 feet NGVD is maintained in C-41. S-82 can pass as much as 2,000 cfs from Lake Istokpoga when downstream channel capacity is available. It permits agricultural releases of up to 800 cfs into C-41 and maintains optimum stage in C-41A. The flood control operation criteria includes opening the gates at 0.4 inches per minute when the headwater rises to 32.2 feet NGVD. At 32.0 feet NGVD headwater elevation, the gates remain stationary. When the headwater falls to 31.8 feet NGVD, the gates close at 3 inches per minute. Regardless of the headwater elevation, the gates close whenever the tailwater reaches 31.0 feet NGVD.

Because of erosion problems downstream of the structures, the COE provided the maximum allowable gate opening curves for the operation of the structures along C-40, C-41, and C-41A. A problem in the operation of the structures is regulating the amount of flow through each structure to deliver water to the desired area and, at the same time, maintain limitation on gate openings. This problem is solved by combining manual and automatic operations. First, discharge in the upstream structure is estimated, then, at the junction where the canal branches into two, one structure is put on manual mode with the gate opening based on estimated required flow; the other structure is left on automatic mode to balance the total flow.

For normal conditions, S-68 and S-75 are closed; all the boards in G-85 are in; and S-82, S-83, S-84, S-70, S-71, and S-72 are left on automatic mode. For regulatory releases, the allowable regulation release is estimated based on discharges from the upstream and the local inflow into each structure. The proper distribution of flow is achieved by combining manual and automatic operations. A typical mode of operation is to determine the allowable discharge at S-68 and to open S-68, S-82, and S-75 to the proper gate opening and set them on manual operation. S-83, S-84, S-70, S-71, and S-82 are set on automatic. If S-68 cannot discharge the flow, the flashboards in G-85 are removed as required. For agricultural demand releases, the water demand is determined first, then S-68, S-82, and S-75 are set to the proper gate opening and left on manual mode, while S-83, S-84, S-70, S-71, and S-72 are left on automatic and all the flashboards in G-85 are in. During major storm conditions, all structures will have personnel on duty to monitor the gate openings and receive operational instructions.

Due to periodic water shortages in the Indian Prairie basin, it was determined that an additional amount of water was required to be released from Lake Istokpoga, which resulted in the lowering of the lake water level below optimum. With this in mind, the District installed a pump station (G-207) at S-71 to supply water from Lake Okeechobee to the reach of C-41 between S-70 and S-71.

The G-207 pump station is manually operated. However, the pump will not be operated whenever the S-71 gates are open; the pump intake is blocked; and/or there is excessive motor vibration. By a 1988 agreement between A. A. Beck, the Seminole Tribe of Florida, and the District, the District will maintain water elevation no lower than 19.2 feet NGVD in the segment of C-41 between S-70 and S-71. This is achieved by regulating the water surface elevation in the L-60W borrow canal and by using the G-207 pump station.

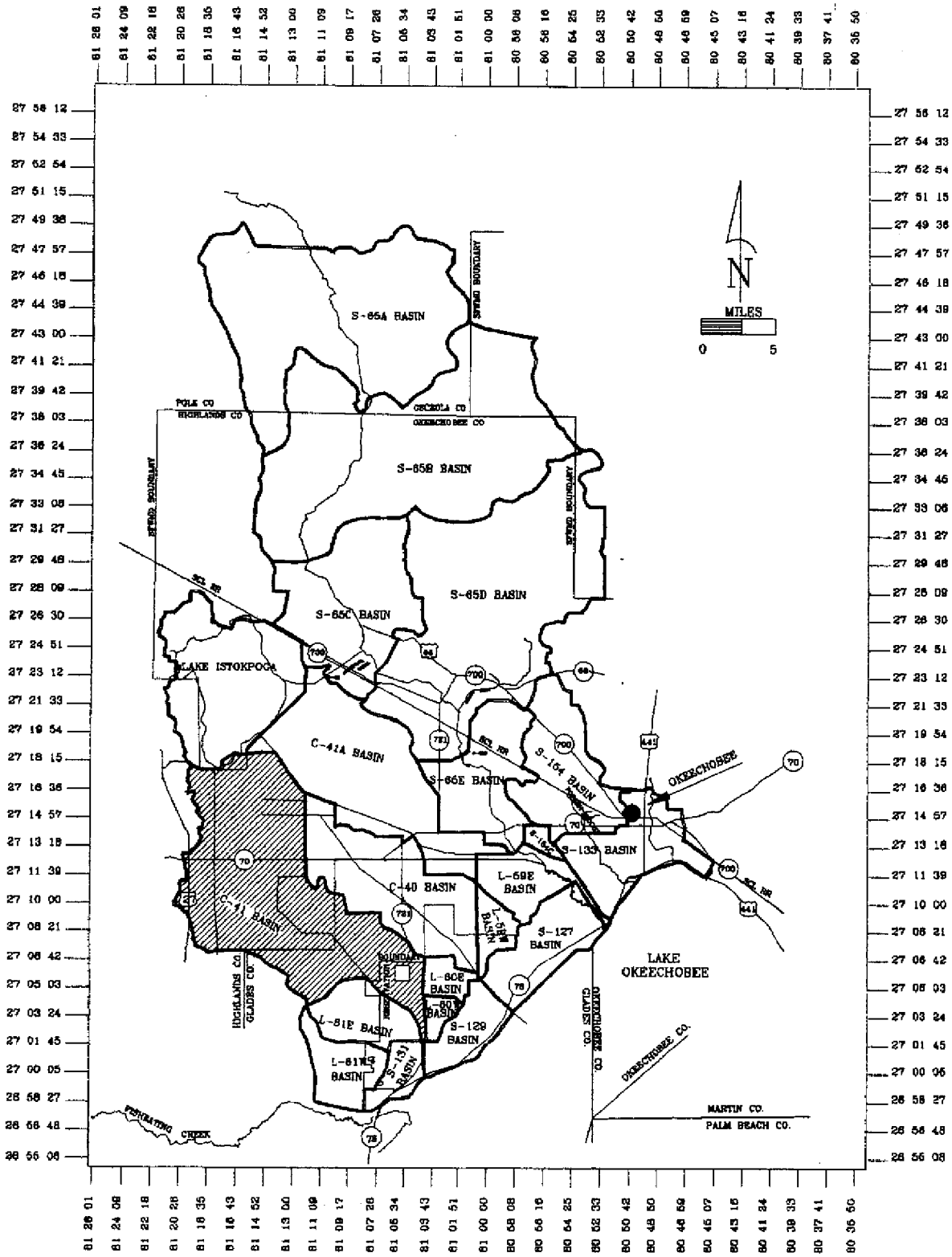

FIGURE 22. C-41 Basin Location Map

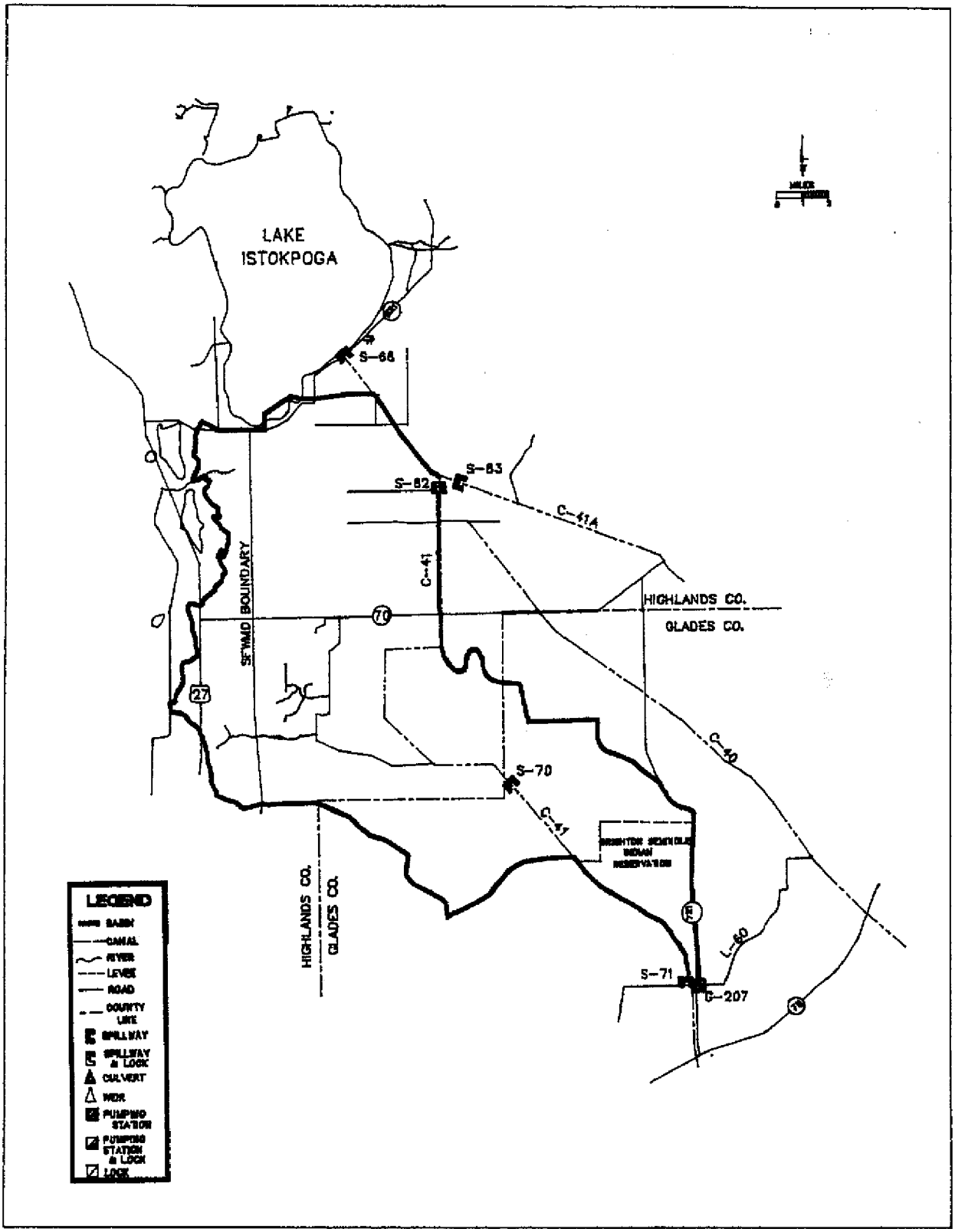

FIGURE 23. C-41 Basin Map

TABLE 11. C-41 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-70	Spillway 2 gates each 12.0ft highxx27.8 ft wide Crest length = 54.0 ft Crest elev = 15.0 ft	24.7	23.1	25.3 to 26.2	4,470	HW = 26.82 ft msl Qmax = 2,216 cfs Qavg = 131.46 cfs	06/23/86 01/13/79 10.6 yrs
S-71	Spillway 3 gates each 11.2 ft highx25.8 ft wide Crest length = 75.0ft Crest elev = 10.2 ft	20.0	19.0	19.8 to 20.0	6,000	HW = 21.98ft NGVD Qmax = 4,670 cfs Qavg = 206 cfs	08/18/71 03/27/70 26.0 yrs
S-82	Spillway 2 gates each 7.2ft highxx23.7 ft wide Crest lgth = 46.0 ft Crest elev = 26.7 ft	32.5	30.9	31.8 to 32.5	2,000	HW = 34.74 ft m.s.l. Qmax = 1,794 E cfs Qavg = 133.02 cfs	09/05/66 06/07/68 21.5 yrs
G-207	Pump Station 1 unit	10.0	19.5	19.2 TW	135		

cfs = cubic feet per second
E = estimate
ft = feet
in = inches
HW = headwater
TW = tailwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
NGVD = National Geodetic Vertical Datum

C-41A BASIN

Description of the Basin

C-41A basin has an area of 91.4 square miles and most of it lies in Highlands County except a small section that is in Glades County (Figure 24). The major Project canal in the basin is C-41A, also called the Stub Canal or Brighton Canal; it is the main outlet for Lake Istokpoga. The agricultural area in the basin drains into this canal. C-41A is about 20.1 miles long and the width varies between 30 and 130 feet. The bottom elevation ranges between -8.0 to 24.0 feet NGVD. The design water surface elevation ranges from 19.3 to 40.0 feet NGVD. C-41A is designed to handle the runoff from the drainage area for the 30 percent SPF. The C-41A basin boundary relative to the local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in this basin is primarily agricultural (citrus groves and vegetable production). There are improved pastures and beef cattle production. During wet periods, drainage water is released to C- 41A; during dry periods, irrigation water is drawn from the C-41A. A schematic map of the C-41A basin demarcations, levees, and control structures is shown in Figure 25. There are three major water control structures in the basin.

S-68 is a reinforced concrete spillway with three gates and is located at the outlet of Lake Istokpoga at the mouth of the C-41A. The purpose of this structure is to maintain optimum upstream stage in Lake Istokpoga, and during a flood to regulate releases to control tailwater stage and velocity. During low-flow periods, it maintains downstream stages and irrigation demands.

S-83 is a reinforced concrete spillway with a single gate located on the C-41A, 5 miles from Lake Istokpoga and 500 feet downstream from the junction of C-41 and C-41A. The purpose of this structure is to discharge the entire design flow of C-41A with no discharge to C-41. It is operated together with S-82 on C-41. During dry periods, it releases up to 300 cfs into C-41A and maintains required upstream stage.

S-84 is a reinforced concrete spillway with two gates located a mile upstream of the junction of C-41A and C-38 (Kissimmee River). The purpose of this structure is to maintain optimum upstream water control stages in C-41A and to pass the design flood without exceeding upstream design stage, maintaining noneroding velocities. It also prevents backflow from Lake Okeechobee through C-38 during excessive stages in the lake from floods and/or wind tides. The design criteria for the structures in the C-41A basin is shown in Table 12.

Comments on Design and Historic Operation

The S-68 structure is designed for the 30 percent SPF and is manually controlled for flood or low-water operation mode. Operation for flood conditions is controlled by headwater, while operation for low flow conditions is controlled by tailwater. The three gates are operated simultaneously to maintain a water level within 0.2 feet above or below a variable optimum headwater, as determined by the regulation schedule. When the headwater elevation reaches 0.2 feet above the variable water control elevation, the gates are opened to discharge up to 3,000 cfs until the required stage is attained. Once the required control elevation is reached, the gates remain stationary until the headwater is above or below the control elevation by 0.2 feet. When the headwater is lower than 0.2 feet of the desired

stage, the gates either fully close or close until the headwater rises to the desired stage.

S-68 was expected to pass a design discharge of 5,900 cfs, but when downstream capacity is available, the discharge can only be increased to only 3,500 cfs. The downstream capacity availability is measured by the tailwater elevation which is not allowed to rise over 34.2 feet. The maximum allowable gate opening curve is used to maintain the proper headwater elevation, tailwater elevation, and gate opening combinations that will not create turbulence and/or structural damage.

S-83 is designed to pass the entire design flood flow of C-41A including some portion of the regulatory flow from S-68. This is with no discharge into C-41 canal and without causing upstream or downstream damaging stages or flow. This structure is operated together with S-82 to maintain an optimum headwater elevation between 31.8 and 32.2 feet in C-41A, and an optimum headwater elevation of 31.8 to 32.5 feet in C-41. S-83 is automatically controlled in accordance with the seasonal operation criteria. The flood control operation is headwater controlled. When the headwater rises above 32.2 feet, the gates open at a rate of 0.4 inches per minute. At 32.2 feet, the gates remain stationary. When the headwater elevation falls to 31.8 feet, the gates close at a rate of 3 inches per minute. However, if the tailwater reaches 31 feet, an overriding control will close the gates regardless of the headwater elevation. It should be noted that when S-68 makes regulatory discharge, the larger portion goes through S-83 rather than S-82.

S-84 is designed to pass the 30 percent SPF. It is automatically controlled in accordance with the established operational criteria. It is operated to maintain an optimum headwater elevation between 24.3 and 25.2 feet. When the headwater elevation rises to 25.2 feet, the gates open at a rate of 0.4 inches per minute and remain stationary at 25.2 feet headwater elevation. When the headwater elevation falls to 24.2 feet, the gates close at a rate of 3 inches per minute. The maximum allowable gate opening curve is used to maintain proper headwater elevation, tailwater elevation, and gate opening combinations that will not damage the structure.

G-85 is a sheet pile spillway structure on the Istokpoga Canal between Lake Istokpoga and the Kissimmee River. The purpose of this structure is to provide an auxiliary outlet for Lake Istokpoga whenever the lake stage is above regulation, and when the S-68 or the lower canals are not able to remove the high flows.

Because of an erosion problem at the downstream of the structures, the COE provided the maximum allowable gate opening curves for the operation of the structures along C-40, C-41, and C-41A. A problem in the operation of the structures is regulating the amount of flow through each structure to deliver water to the desired area and, at the same time, maintain the limitation on gate openings. This problem is solved by combining manual and automatic operations. First, the discharge in the upstream structure is estimated; then, at the junction where the canal branches into two, one structure is put on manual with the gate opening based on estimated required flow, and the other structure is left on automatic to balance the total flow.

For normal conditions, S-68 and S-75 are closed; all the flashboards in G-85 are in; and S-82, S-83, S-84, S-70, S-71, and S-72 are left on automatic mode. For regulatory releases, the allowable regulation release is estimated based on discharge

from the upstream and the local inflow into each structure. The proper distribution of flow is achieved by combining manual and automatic operations. A typical plan is to determine the allowable discharge at S-68 and to open S-68, S-82, and S-75 to the proper gate opening and set them on manual operation. S-83, S-84, S-70, S-71, and S-72 are set on automatic. If S-68 cannot discharge the flow, the boards in G-85 are removed, as required. For agricultural demand releases, the water demand is determined first. S-68, S-82, and S-75 are set to the proper gate opening and left on manual mode. S-83, S-84, S-70, S-71, and S-72 are left on automatic, while all the flashboards in G-85 are in. During major storm conditions, all structures will have personnel on duty to monitor the gate openings and receive operational instructions. The structures are designed for the 30 percent SPF.

Recent tests performed by the COE, the U. S. Geological Survey, and the District, have shown design deficiencies in the S-68, S-82, and S-83 structures. These design deficiencies will significantly reduce the capacity of the structures.

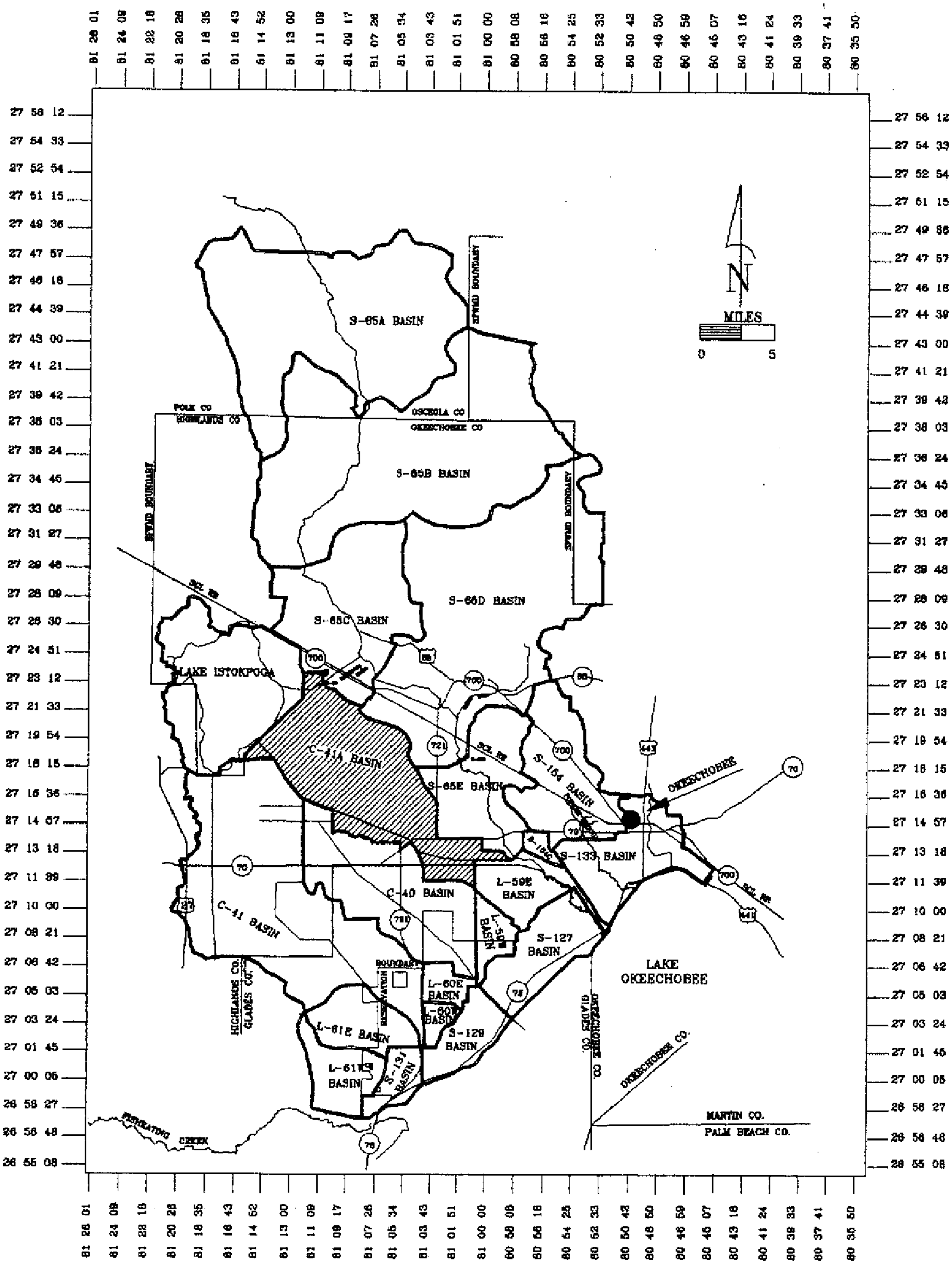

FIGURE 24. C-41A Basin Location Map

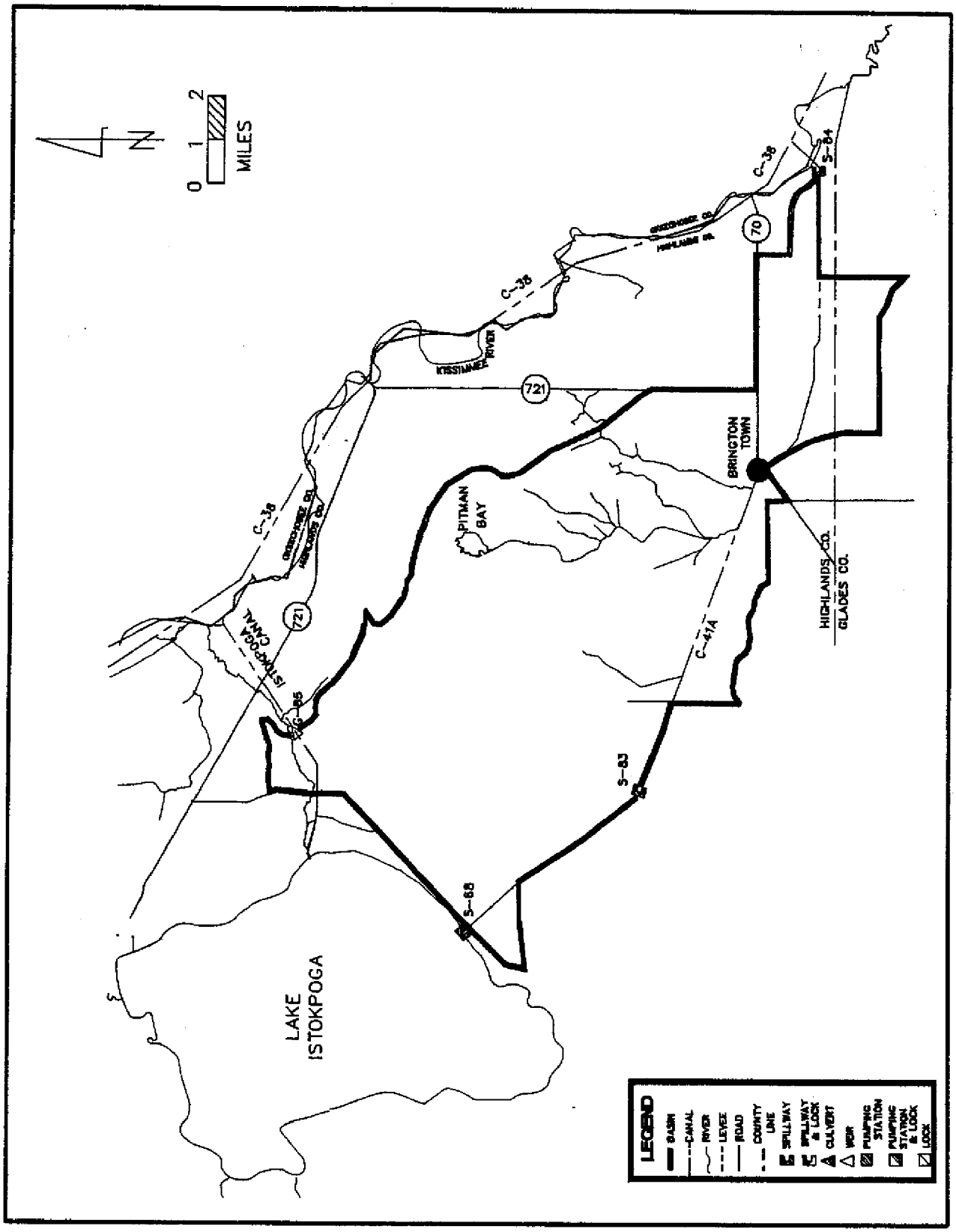

FIGURE 25. C-41A Basin Map

TABLE 12. C-41A Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-68	Spillway 3 gates each 10.2 ft high x 21.8 ft wide crest length = 63.0 ft crest elev = 31.2 ft	Static HW = 40.0ft wind tide HW = 42.7 wind tide + breaking wall HW = 47.3	33.1	variable	3,600	HW = 40.23 ft (NGVD) Qmax = 4,500 cfs Qavg = 254 cfs	12/10/69 09/06/65 24 yrs
S-83	Spillway 1 gate 13.6 ft high x 25.8 ft wide crest length = 25.0 ft crest elev = 18.4 ft	32.0 ft	28.5	31.8 to 32.2	3,830	HW = 34.88 ft (NGVD) Qmax = 2,789 cfs Qavg = 125.45 cfs	09/05/66 01/13/79 22.6 yrs
S-84	Spillway 2 gates each 11.0 ft high x 21.0 ft wide crest length = 42.0 ft crest elev = 31.0 ft	24.5 ft	19.3	24.3 to 25.2	5,680	HW = 26.87 ft (NGVD) Qmax = 4,080 cfs Qavg = 187 cfs	07/08/84 10/03/69 24 yrs
G-85	reinforced concrete sheet pile weir crest length = 100.0 ft crest elev = 31.0 ft			not used to control stage			

cfs = cubic feet per second
elev = elevation
ft = feet
HW = headwater
m.s.l. = mean sea level
NGVD = National Geodetic Vertical Datum
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

S-127 BASIN

Description of the Basin

The S-127 basin has an area of 32.5 square miles and is located in Glades County on the north side of Lake Okeechobee (Figure 26). It is a basin that is completely surrounded by levees with L-48 on three sides and interceptor dike L-59 on the west side. L-48 is 8.6 miles long with a design grade of 32.2 feet NGVD. The crown width is 10 feet and the land side slope is 1 on 3, while the canal side slope is 1 on 6. Interceptor dike L-59 has an elevation of 23.0 feet NGVD and a crown width of 10 feet. The side slope is 1 on 3. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

Land use is primarily beef cattle production. On the eastern corner of the basin there is a small town, Buckhead Ridge. Like the rest of the shore-side communities, there is fishing and tourism. There is a lock structure which allows access to Lake Okeechobee for recreational boats. A schematic map of the S-127 basin demarcations, levees, and control structures is shown in Figure 27.

The major structures in this basin are the S-127 pump station and the navigation lock. S-127 is located on the northwest shore of Lake Okeechobee in the alignment of L-48, 12 miles southwest of the town of Okeechobee just south of State Road 78. There is a 96-inch culvert to control flows that bypass the pump. The purpose of this structure is to remove impounded water from the basin during wet periods.

There are two culverts through the eastern segment of L-48. Culvert #1 is a concrete pipe culvert with three barrels located about 2.5 miles west of State Road 78. Its purpose is to maintain optimum upstream water control stages and to pass the design flow without exceeding upstream flood design stage. It also prevents backflow from Lake Okeechobee during excessive stage caused by flood and/or wind tides.

Culvert #2 is a single-barrel concrete pipe culvert located about 6.4 miles west of State Road 78. Its purpose is to maintain optimum upstream water control stages; to pass the design flow without exceeding upstream flood design stage when lake stages allow. It also prevents backflow from Lake Okeechobee during excessive stage caused by flood and/or wind tides. The design criteria for the structures in the S-127 basin is shown in Table 13.

Comments on Design and Historic Operation

The northwest shore levees of Lake Okeechobee, together with high lake stages, restrict natural drainage of the S-127 basin into the lake. Runoff from the basin drains to the L-48 borrow canal where there is continuous stage monitoring. The S-127 pump system is designed to remove as much as 0.75 inches of runoff from the drainage area in a day. The system is manually operated. The spillway is used to allow gravity discharge during periods when Lake Okeechobee stage is below 13 feet. During drought conditions, when the lake stage is higher than the canal water level, water is drawn from the lake into the basin through the pipe spillway.

Normally, pumping is initiated when the headwater elevation reaches 13.5 feet and is terminated when it falls to 13 feet. If heavy rainfall is predicted, however, and headwater is expected to rise above 14 feet, all pumps are activated and the stage

lowered to and maintained at 13 feet until the storm passes. Whenever the lake level is above intake canal water level, the pipe spillway is closed unless there is irrigation water demand.

Culverts #1 and #2 are operated to maintain an optimum headwater elevation of 16.4 feet. Both culverts are manually controlled with submersible gates at the inlets and flap gates at the downstream sides.

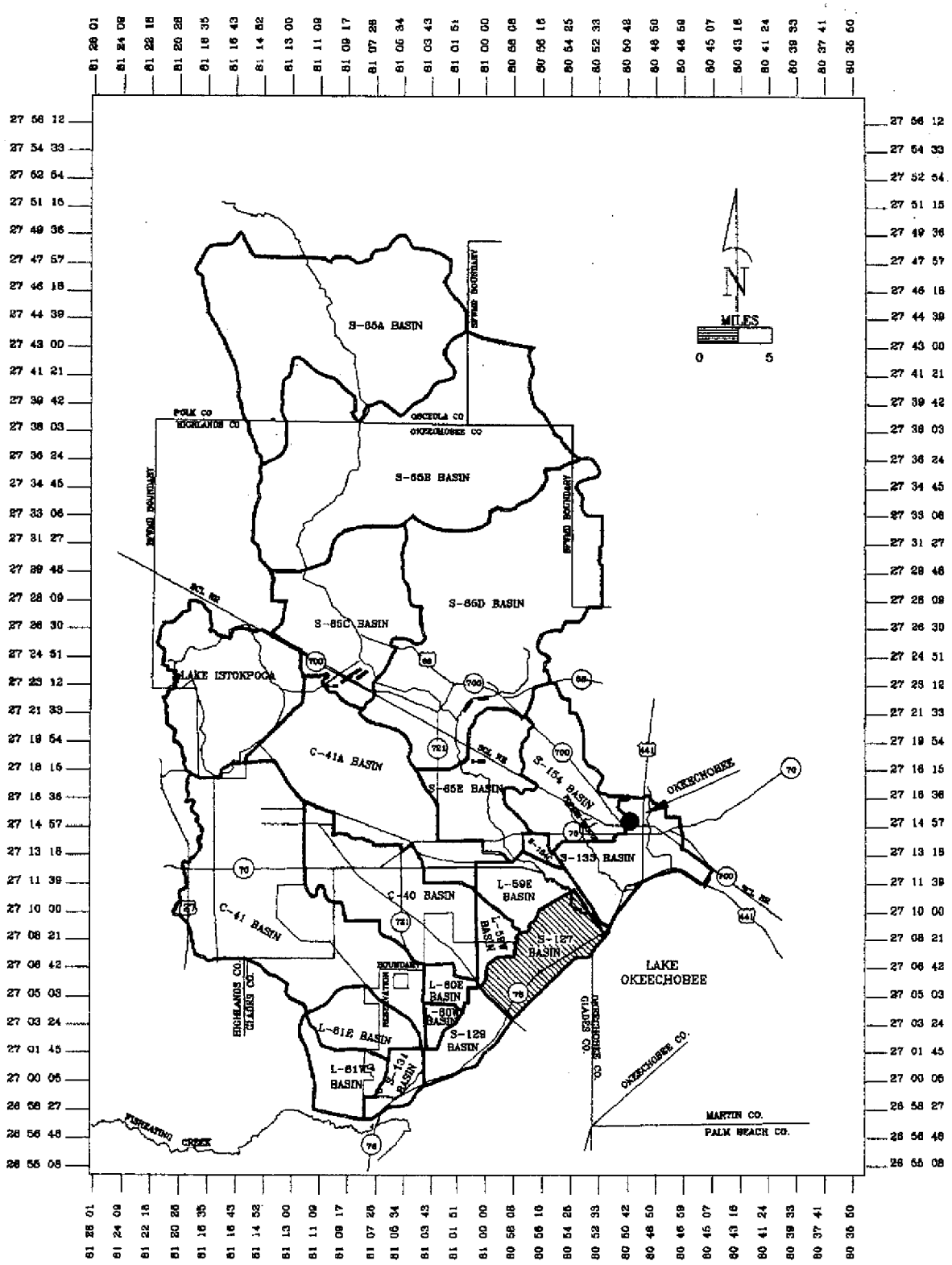

FIGURE 26. S-127 Basin Location Map

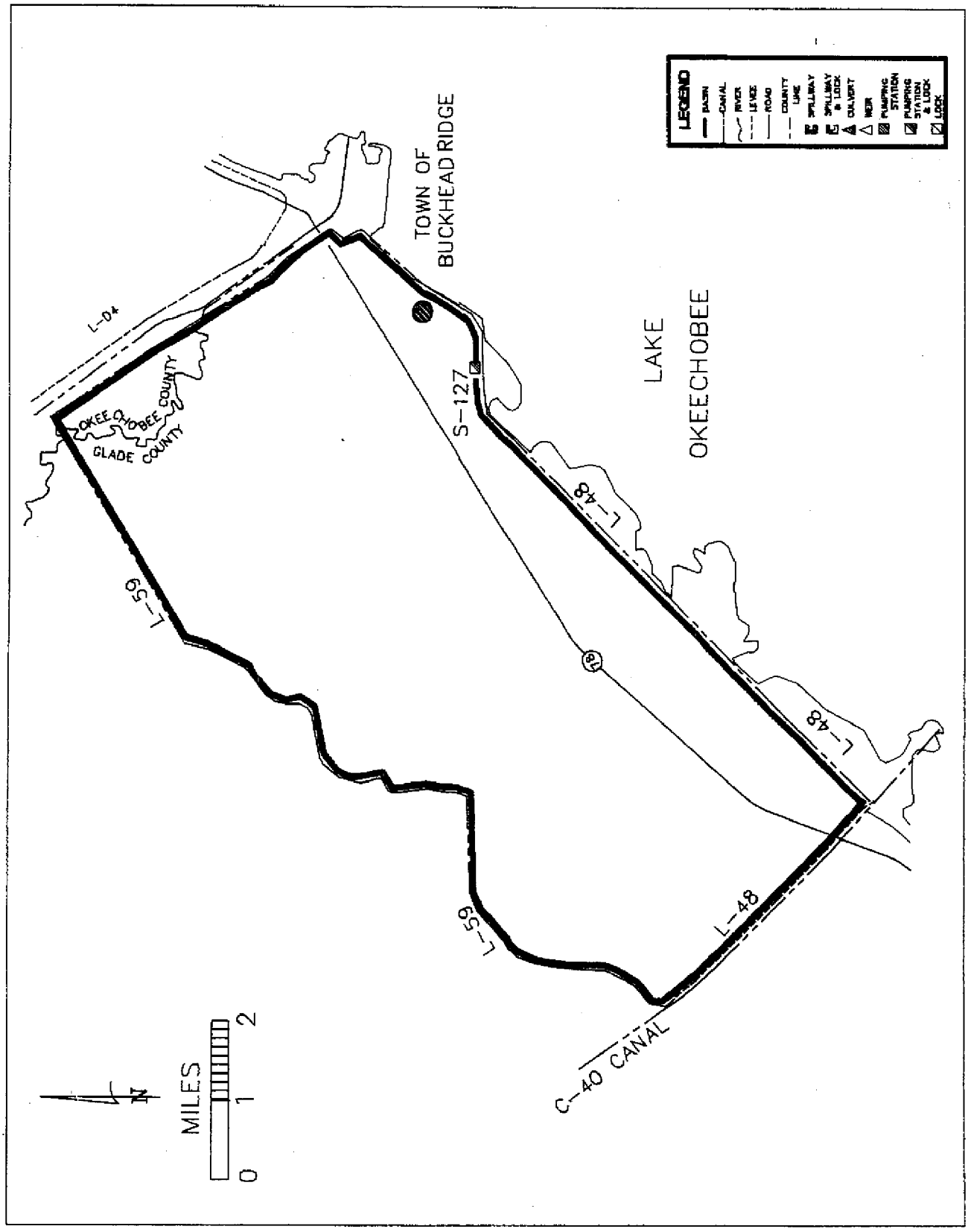

FIGURE 27. S-127 Basin Map

TABLE 13. S-127 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-127*	Pumping Station 5 units Capacity 125 cfs each unit	13.0	23.5	13.0 ft	630	HW = 18.20 ft m.s.l. Qmax = 753 cfs Qavg = 21.88 cfs	03/05/83 06/19/72 19.33 yrs
Culvert	CMP culvert single barrell length = 13.0 ft ± diameter- = 96 inches			not used to control stage			
L-48 Culvert #1	Concrete pipe culvert 3 barrels length = 139.0 ft diameter = 72 inches	19.0		16.4 ft	300 +		
L-48 Culvert #2	Concrete pipe culvert single barrel length = 139.0 ft diameter = 72 inches	19.2		16.4 ft	85		

cfs = cubic feet per second
CMP = corregated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater
*There is a reinforced concrete lock (U-shaped chamber) width = 15.0 ft, length = 50.0 ft, and invert elevation = 8.0 ft.

S-129 BASIN

Description of the Basin

The S-129 basin has an area of 18.9 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 28). It is a basin that is completely surrounded by levee 49 and interceptor dike L-60 with L-49 on the lakeside. L-49 has elevation of 32.3 to 39.0 feet NGVD, and a crown width of 10 feet. The lakeside slope is 1 on 6 while the landside slope is 1 on 2 and 1 on 4. Interceptor dike L-60 has elevation of 23.0 feet NGVD and a crown width of 10 feet. The lakeside slope is 1 on 3. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The major land use in this basin is beef cattle production. There are campsites, fishing camps, a few permanent residential structures and citrus groves (under development). There is a boat ramp but no lock structure. A schematic map of the S-129 basin demarcations, levees and control structures is shown in Figure 29.

The major structure in this basin is S-129. It is a pumping station located on the northwest shore of Lake Okeechobee in the alignment of L-49 about 20 miles southwest of the town of Okeechobee. There is a 96 inch culvert to control flows that bypass the pumps. The purpose of this structure is to remove impounded water from the basin during wet periods. The design criteria of the structures in the S-129 basin is given in Table 14.

Comments on Design and Historic Operation

The northwest shore levees of Lake Okeechobee, together with high lake stages, restrict natural drainage of the S-129 basin into the lake. Runoff from the basin drains to the L-49 borrow canal where there is continuous stage monitoring. The system is manually operated, and when required, the pump system can remove as much as 0.75 inches of runoff from the drainage area in a day. The culvert is used to allow gravity discharge when the lake stage is lower than the canal stage. During drought conditions, when the lake stage is higher than the canal water level, water is withdrawn by gravity from the lake into the basin through the pipe spillway. Otherwise, when the lake stage is higher than the intake canal water level, the pipe spillway remains closed.

Normally, pumping is initiated when the headwater elevation reaches 13.5 feet and is terminated when it falls to 13 feet. If heavy rain is expected, however, all pumps are activated and the headwater in the borrow canal is maintained at 13 feet until the storm passes. For the past two years, the pumps have not been activated for flood control purposes due to the low lake level and drought conditions.

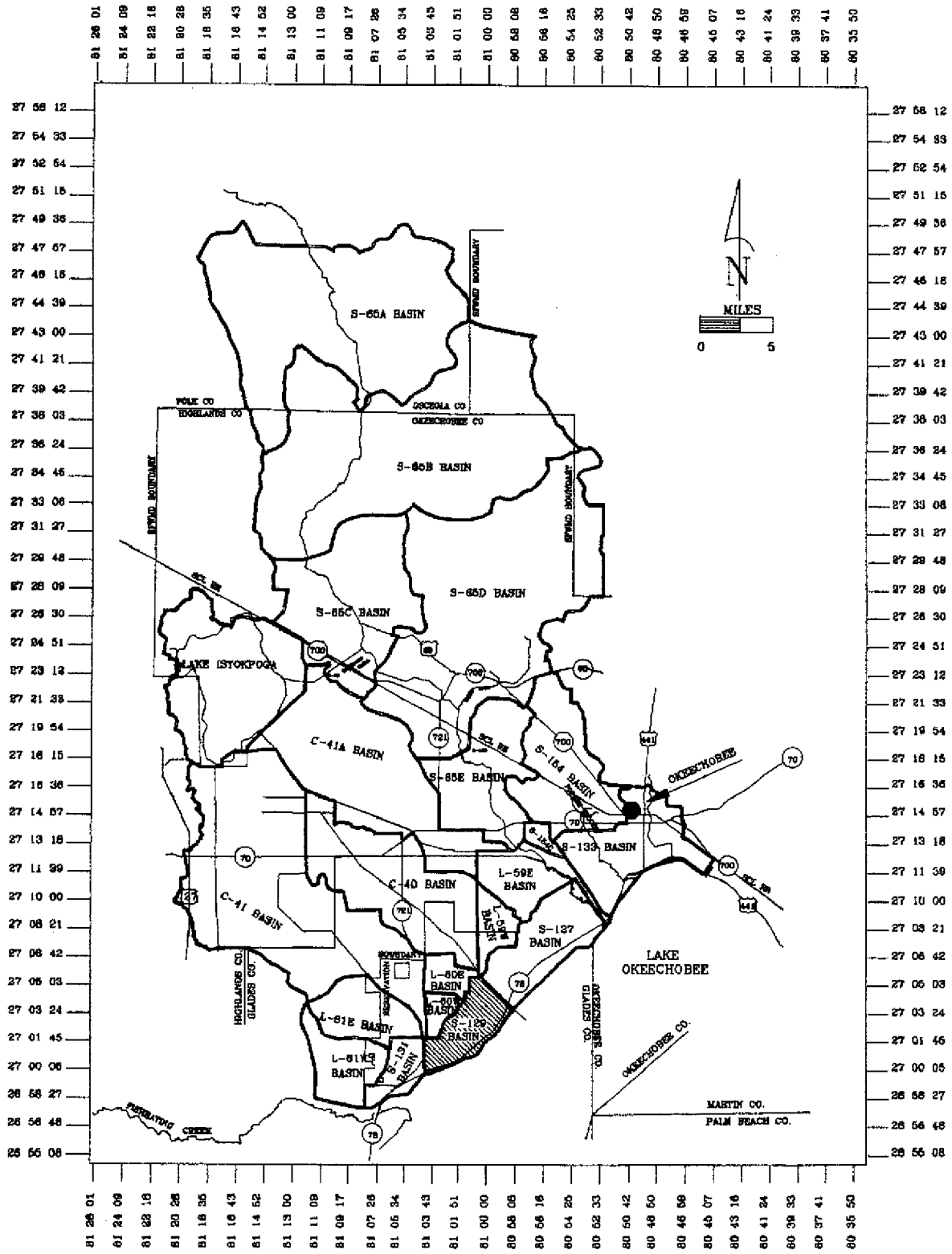

FIGURE 28. S-129 Basin Location Map

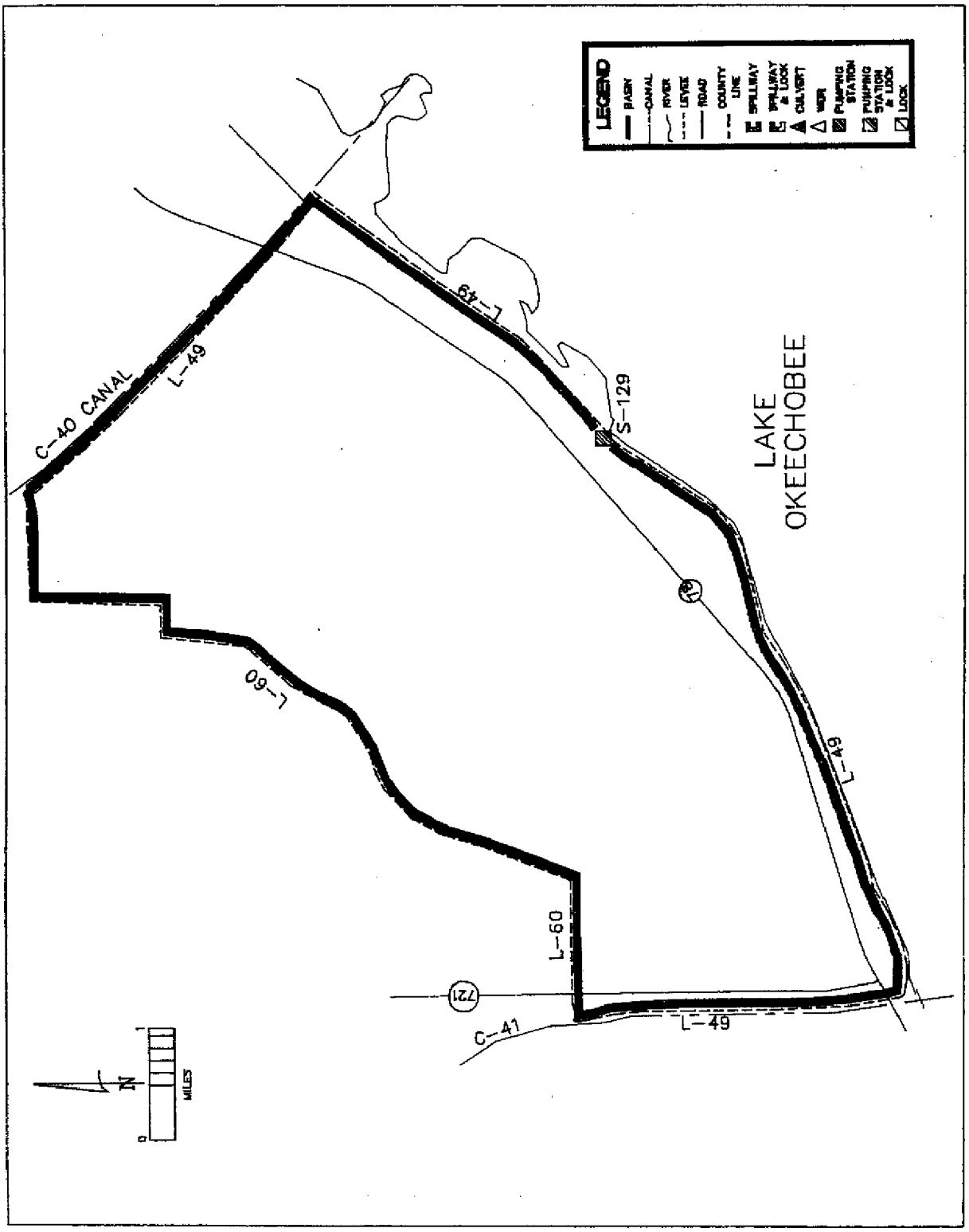

FIGURE 29. S-129 Basin Map

TABLE 14. S-129 Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
S-129	Pumping Station 3 units Capacity 125 cfs each	13.0	23.5	13.0	375	HW = 18.11 ft m.s.l. Qmax = 449 cfs Qavg = 16.49 cfs	03/05/83 02/27/70 06/19/72 18.92 yrs
Culvert	CMP culvert length = 119.0 ft ± diameter- = 96 inches			not used to control stage			

cfs = cubic feet per second
CMP = corrugated metal pipe
ft = feet
HW = headwaterf
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

L-59E BASIN

Description of the Basin

The L-59E basin has an area of 22.5 square miles and it is located in Glades County on the north side of Lake Okeechobee (Figure 30). The L-59 interceptor dike separates this basin from S-127 basin. The elevation of interceptor dike L-59E is 23.0 feet NGVD and it has a crown width of 10 feet. The side slope is 1 on 3. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agricultural, although most of the area is improved pasture for beef cattle production. A schematic map of the L-59E basin demarcations, levees, and control structures is shown in Figure 31.

The major structure in this basin is a three-barrel, 96-inch corrugated metal pipe culvert located through the C-38 levee. The purpose of this culvert is to remove excess water from L-59E basin and discharge to C-38 (Kissimmee River). The design criteria for the structures in the L-59E basin is shown in Table 15.

Comments on Design and Historic Operation

L-59 is an interceptor dike which blocks the drainage water of L-59E basin from passing to the L-48 basin. Runoff from the L-59E basin collects in the L-59E borrow canal and flows east to C-38 through the culvert. Flow through the culvert is manually controlled with screw gates.

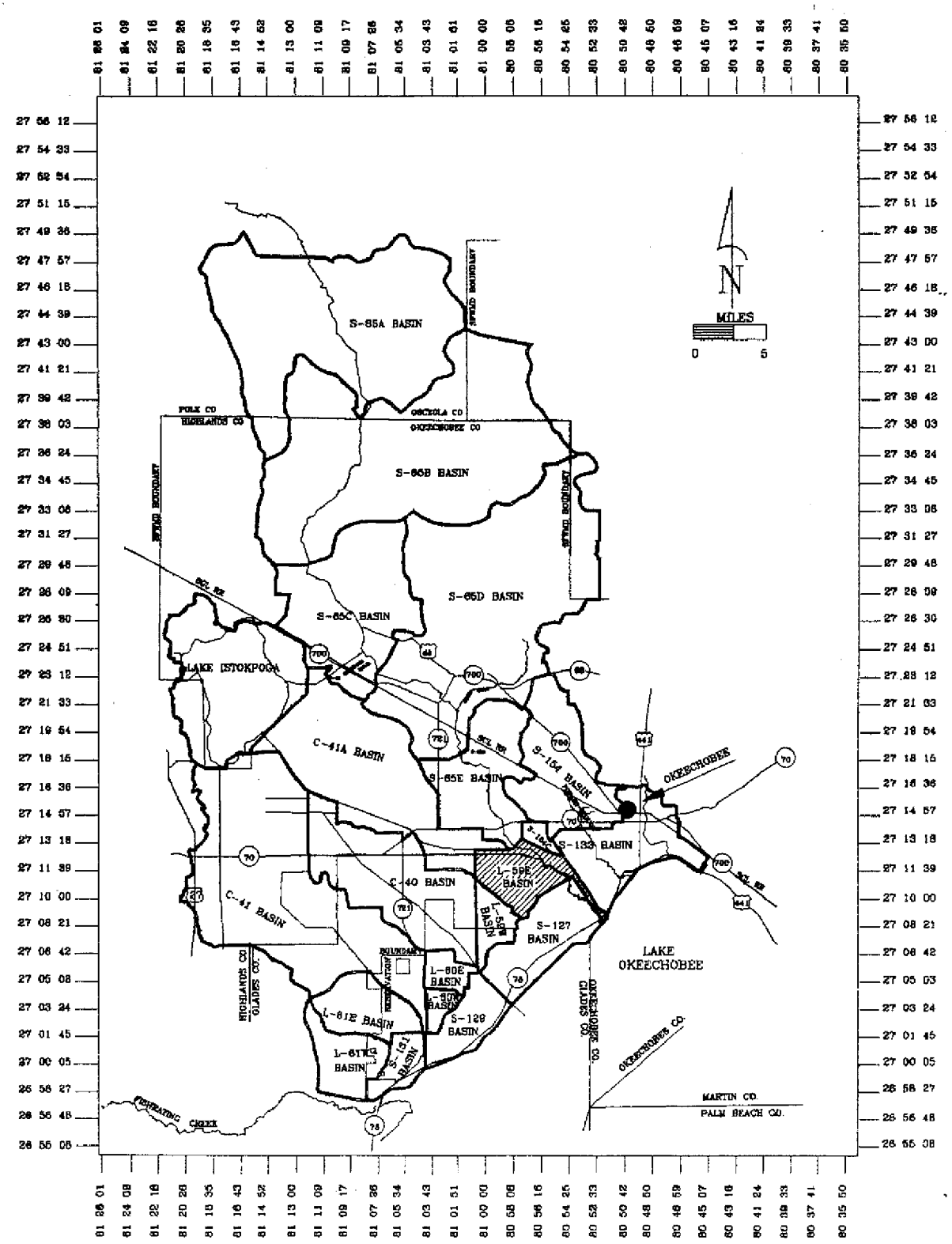

FIGURE 30. L-59E Basin Location Map

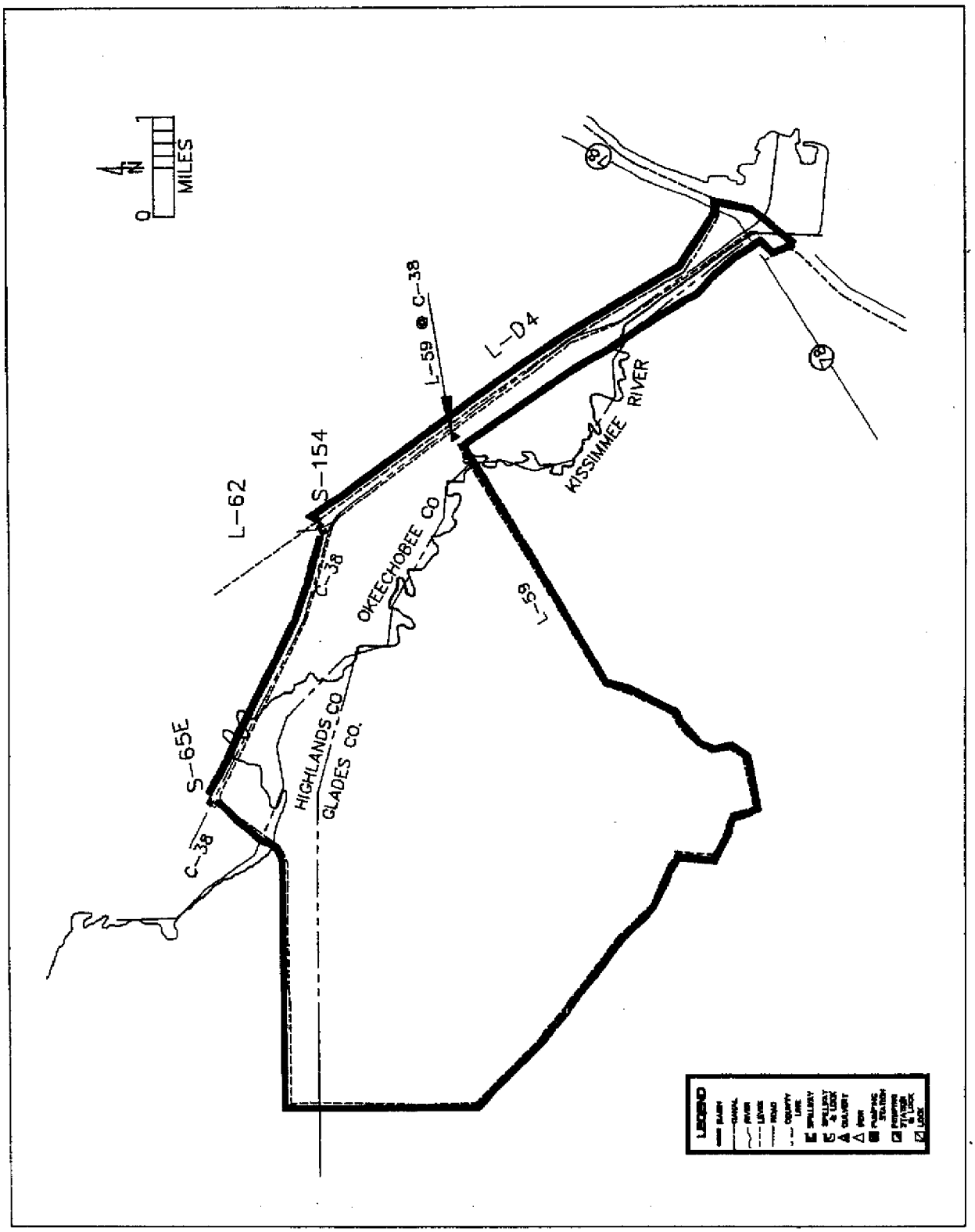

FIGURE 31. L-59E Basin Map

TABLE 15. L-59E Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
L-59 at C-38	CMP 3-barrel culvert diameter = 96 inches			≈ 15.5			

cfs = cubic feet per second
CMP = corrugated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

L-59W BASIN

Description of the Basin

The L-59W basin has an area of 9.96 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 32). The L-59 interceptor dike separates this basin from L-48 basin. The L-59 interceptor dike has an elevation of 23.0 feet NGVD and a crown width of 10 feet. The side slope is 1 on 3. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agriculture, although most of the area is improved pasture for beef cattle production. A schematic map of the L-59W basin demarcations, levees, and control structures is shown in Figure 33.

The major structure in this basin is a double-barrel, 96-inch corrugated metal pipe culvert (L-59 at 72) that drains into C-40 (Indian Prairie Canal). The purpose of this culvert is to remove excess water from the L-59W basin, discharging to C-40 to maintain optimum headwater elevation. The design criteria for the structures in the L-59W basin is shown in Table 16.

Comments on Design and Historic Operation

L-59W is an interceptor dike which blocks the drainage water of L-59W basin from passing to the S-127 basin. Runoff from the L-59W basin collects into the L-59W borrow canal, and flows west to C-40 through the culvert. Flow through the culvert is manually controlled with flashboards. Water surface elevation in the L-59W borrow canal is maintained using the flashboards.

There has been a reduction in water levels in the canals and borrow canals of the basins adjacent to C-40. These shortages have been relieved with releases from Lake Istokpoga resulting in dropping the lake level below optimum stage. In 1989, an agreement was made between Pearce Ranch, Indian Prairie Groves, R Bar Ranch Estates, the Seminole Tribe of Florida, and the District to improve conditions. The District has installed a 134 cfs capacity pump station (G-208) to maintain water surface elevation no lower than 20.2 feet NGVD in the segment of C-40 between S-75 and S-72. The L-59W culvert flashboards are to be set to maintain an elevation of 18.5 feet NGVD. Pearce Ranch and R Bar Ranch Estates will continue to operate the bypass upstream from S-72 on the notheast side of C-40 and use water from the L-59W borrow canal under the stated conditions. Indian Prairie Groves will continue to use water from L-59W for irrigation as authorized by the permit.

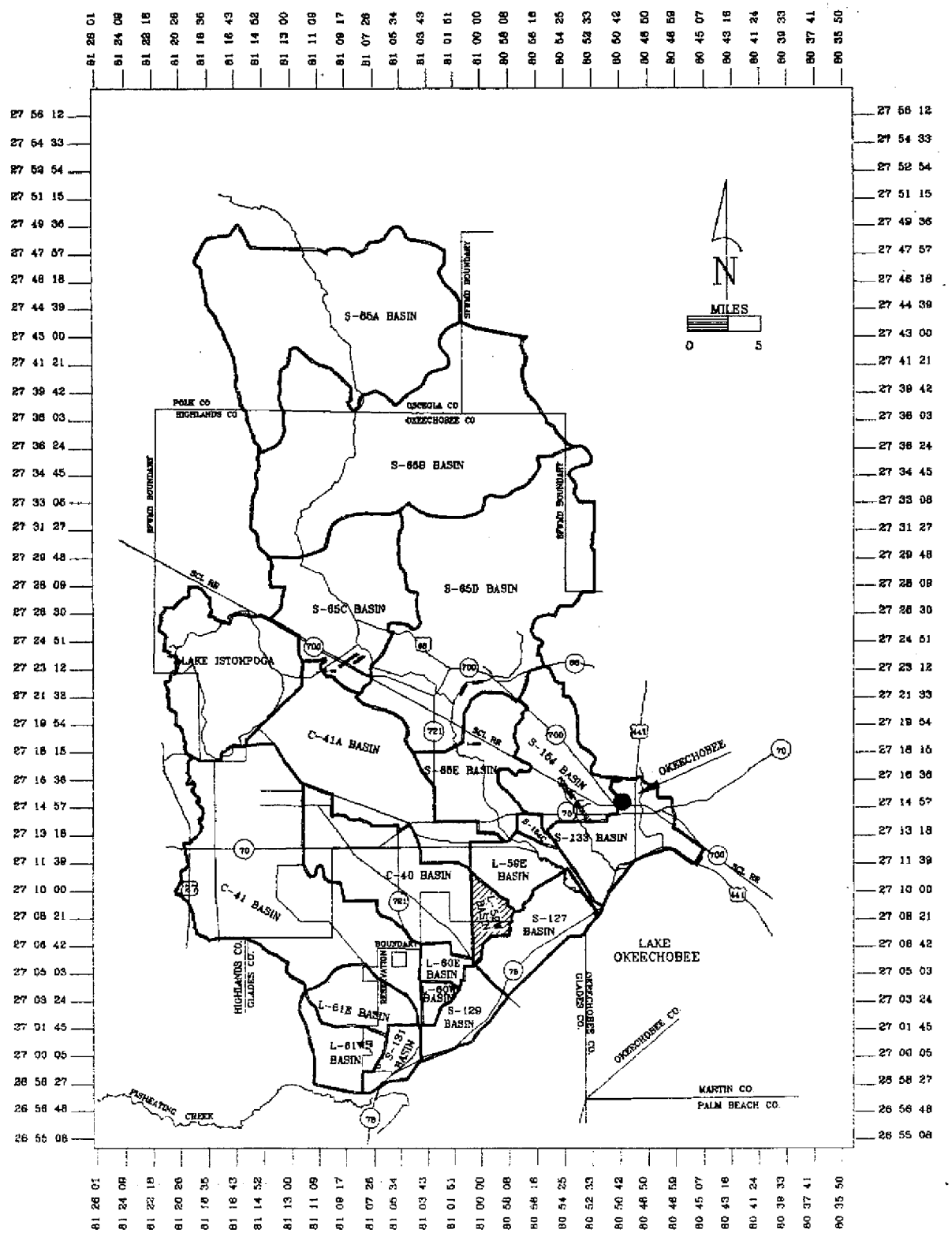

FIGURE 32. L-59W Basin Location Map

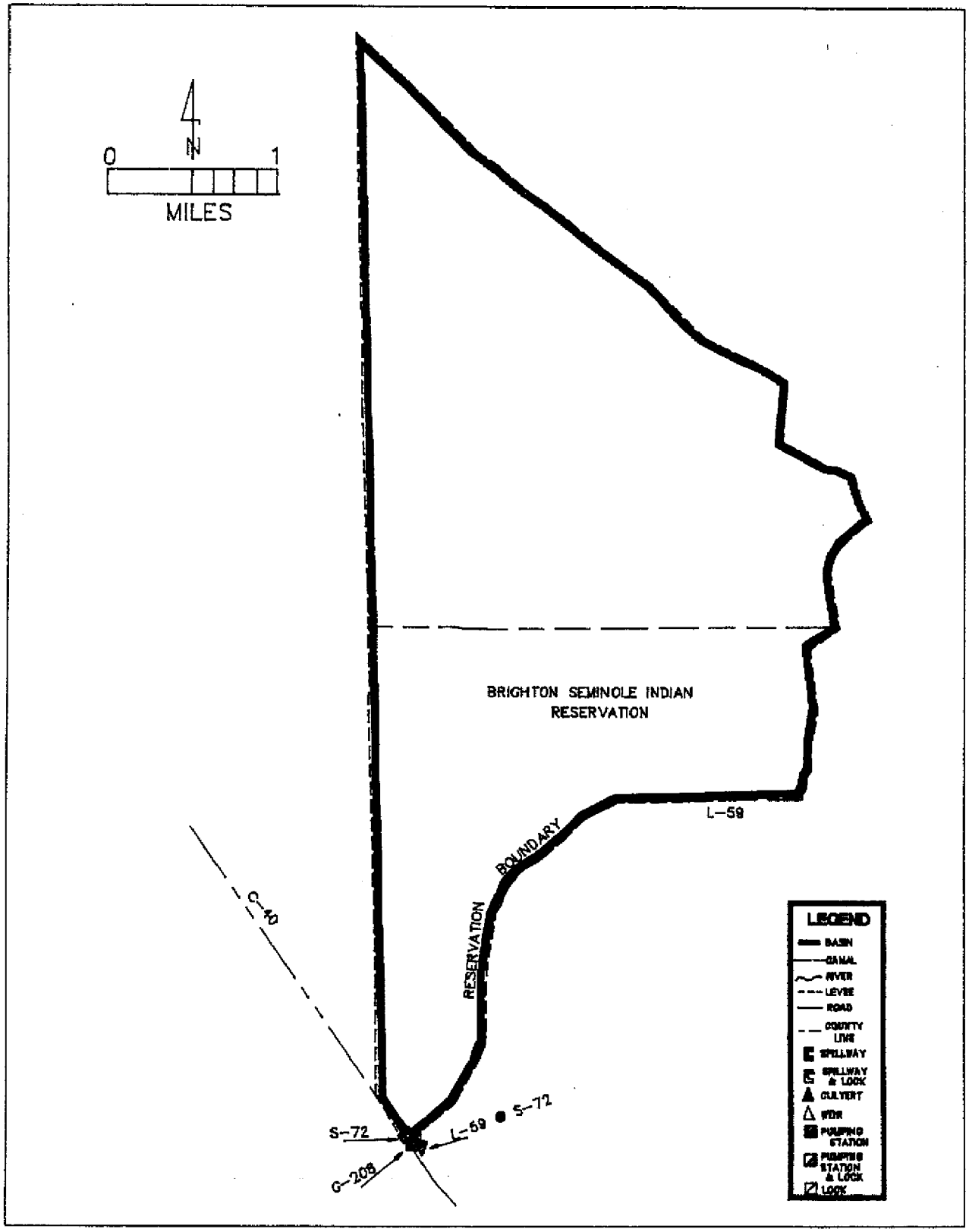

FIGURE 33. L-59W Basin Map

TABLE 16. L-59W Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
L-59 at S-72	CMP 2-barrel culvert diameter = 96 inches			18.5			

cfs = cubic feet per second
CMP = corrugated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
TW = tailwater
Qavg = average discharge
Qmax = maximum discharge

L-60E BASIN

Description of the Basin

The L-60E basin has an area of 7.9 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 34). Interceptor dike L-60 separates this basin from S-129 basin. L-60 has an elevation of 23.0 feet NGVD and a crown width of 10 feet. The side slope is 1 on 3. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agricultural, although most of the area is improved pasture for beef cattle production. A schematic map of the L-60E basin demarcations, levees, and control structures is shown in Figure 35.

The major structure in this basin is a double-barrel, 84-inch corrugated metal pipe culvert (L-60 at 72) that drains to C-40 (Indian Prairie Canal). The purpose of this culvert is to remove excess water from the L-60E basin and discharge to C-40 and to maintain headwater elevation. The design criteria for the structures in the L-60E basin is shown in Table 17.

Comments on Design and Historic Operation

L-60E is an interceptor dike which blocks the drainage water of L-60E basin from passing to the S-129 basin. Runoff from the L-60E basin collects in the L-60E borrow canal and flows east to C-40 through the culvert. Flow through the culvert is manually controlled with flashboards. Water surface elevation in the L-60E borrow canal is maintained using flashboards. At present the water surface elevation is 18.55 feet. Supplemental irrigation water is drawn from C-40.

There has been a reduction in water levels in the canals and borrow canals of the basins adjacent to C-40. These shortages have been relieved with releases from Lake Istokpoga resulting in a drop below optimum stage in the lake level . In 1989 an agreement was made between S. J. & W. Ranches Inc., the Seminole Tribe of Florida, and the District to improve the condition. The District is installing a 134 cfs capacity pump station (G-208) to maintain water surface elevation no lower than 20.2 feet NGVD in the segment of C-40 between S-75 and S-72. The L-60E culvert flashboards are to be set to maintain an elevation of 17.5 feet NGVD. S. J. & W. Ranches Inc., will continue to operate the bypass upstream from S-72 on the southwest side of C-40 and use water from the L-60E borrow canal under the stated conditions.

G-208 is a one-unit pumping station (Figure 35), located a few yards south of S-72. During normal operation, the pump will be started manually when the upstream water elevation is 20.2 NGVD and will automatically shut off when the upstream water elevation reaches 20.5 NGVD. The design criteria for the pump is given in Table 10.

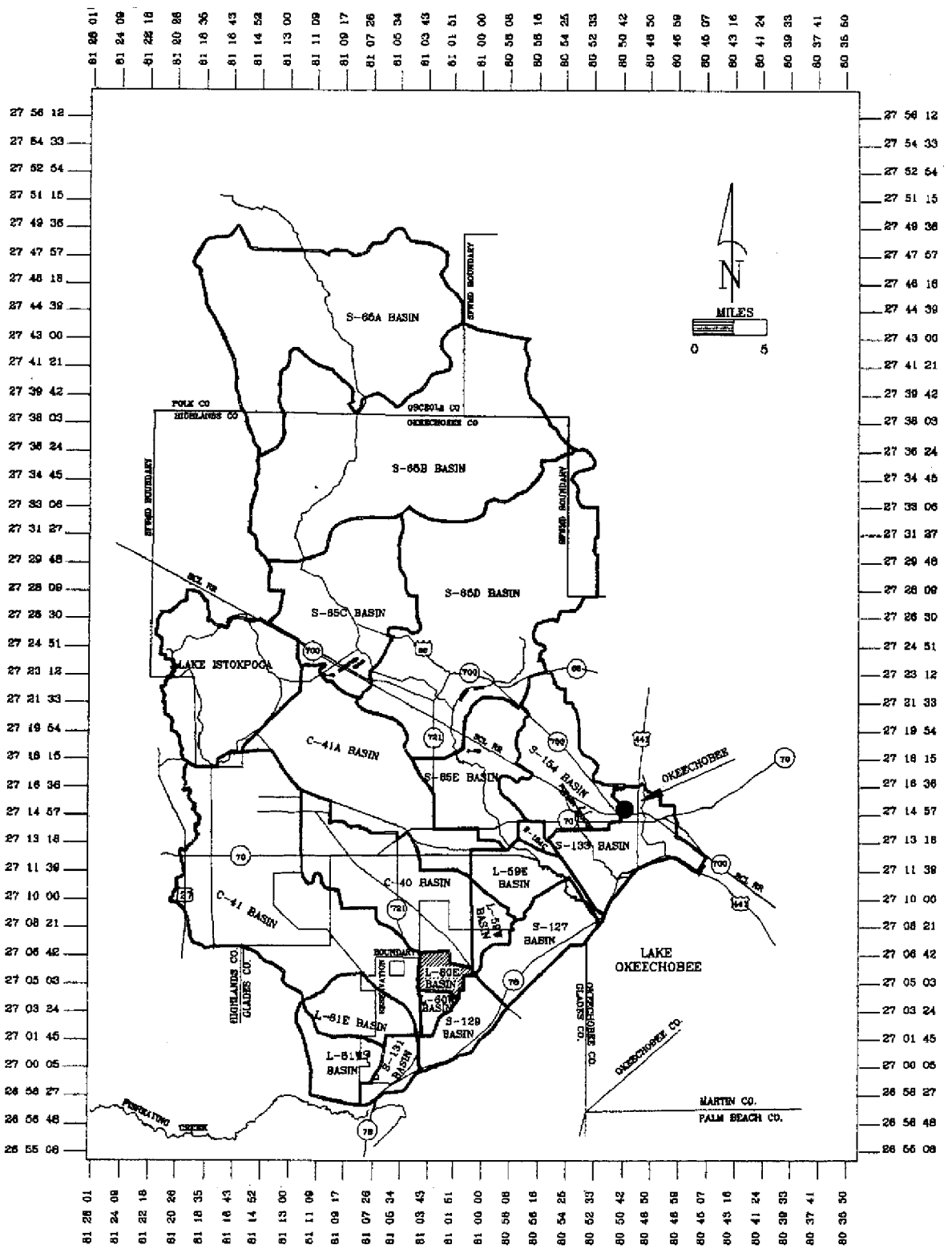

FIGURE 34. L-60E Basin Location Map

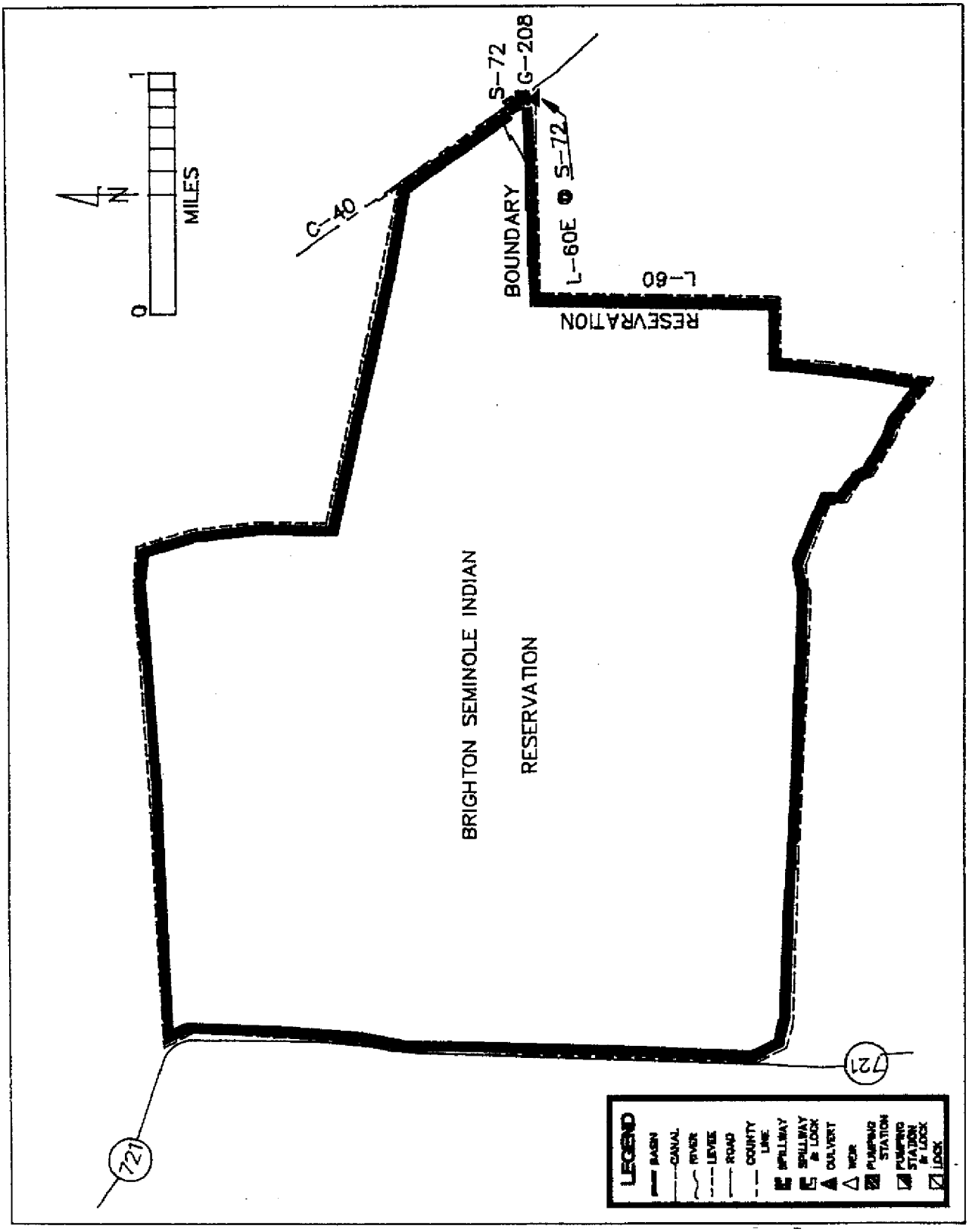

FIGURE 35. L-60E Basin Map

TABLE 17. L-60E Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
L-60E at S-72	CMP 2-barrel culvert diameter = 84 inches			17.5			

cfs = cubic feet per second
CMP = corregated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

L-60W BASIN

Description of the Basin

The L-60W basin has an area of 5.1 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 36). Interceptor dike L-60 separates this basin from the S-129 basin. Interceptor dike L-60 has an elevation of 23.0 feet NGVD and a crown width of 10 feet. The side slope is 1 on 3. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agricultural. Most of the area is improved pasture for beef cattle production. A schematic map of the L-60W basin demarcations, levees, and control structures is shown in Figure 37.

The major structure in this basin is a double-barrel 84-inch corrugated metal pipe culvert (L-60W at S-71) that drains to C-41 (Harney Pond). The purpose of this culvert is to remove excess water from the L-60W basin and discharge to C-41, and to maintain optimum headwater elevation. The design criteria for the structures in the L-60W basin is shown in Table 18.

Comments on Design and Historic Operation

L-60W is an interceptor dike which blocks the drainage water of L-60W basin from passing to the S-129 basin. Runoff from the L-60W basin flows to the west to C-41 through the culvert. Flow through the culvert is controlled by flashboards. Water surface elevation in the L-60W borrow canal is maintained using flashboards. Supplemental water is drawn from C-41.

There has been a reduction in water levels in the canals and borrow canals of the basins adjacent to C-41. These shortages have been relieved with releases from Lake Istokpog, resulting in the lake level dropping below optimum stage. In 1988 an agreement was made between A. A. Beck, the Seminole Tribe of Florida, and the District to improve this condition. The District installed the G-207 pump station to maintain water surface elevation no lower than 19.2 feet NGVD in the segment of C-41 between S-70 and S-71. The L-60W culvert flashboards are to be set to maintain an elevation of 17.0 feet NGVD. Mr Beck will operate the bypass above S-71 under the stated conditions. The Tribe will operate its 90 cfs pump in basin L-61E to supply water to the L-61E basin. The Tribe will also operate its bypass from S-71 under the stated conditions.

G-207 is a one-unit pump station that is located 2 miles upstream of Lake Okeechobee near S-71. This pump supplies water from Lake Okeechobee for the segment of C-41 between S-70 and S-71. The design criteria is given in Table 11.

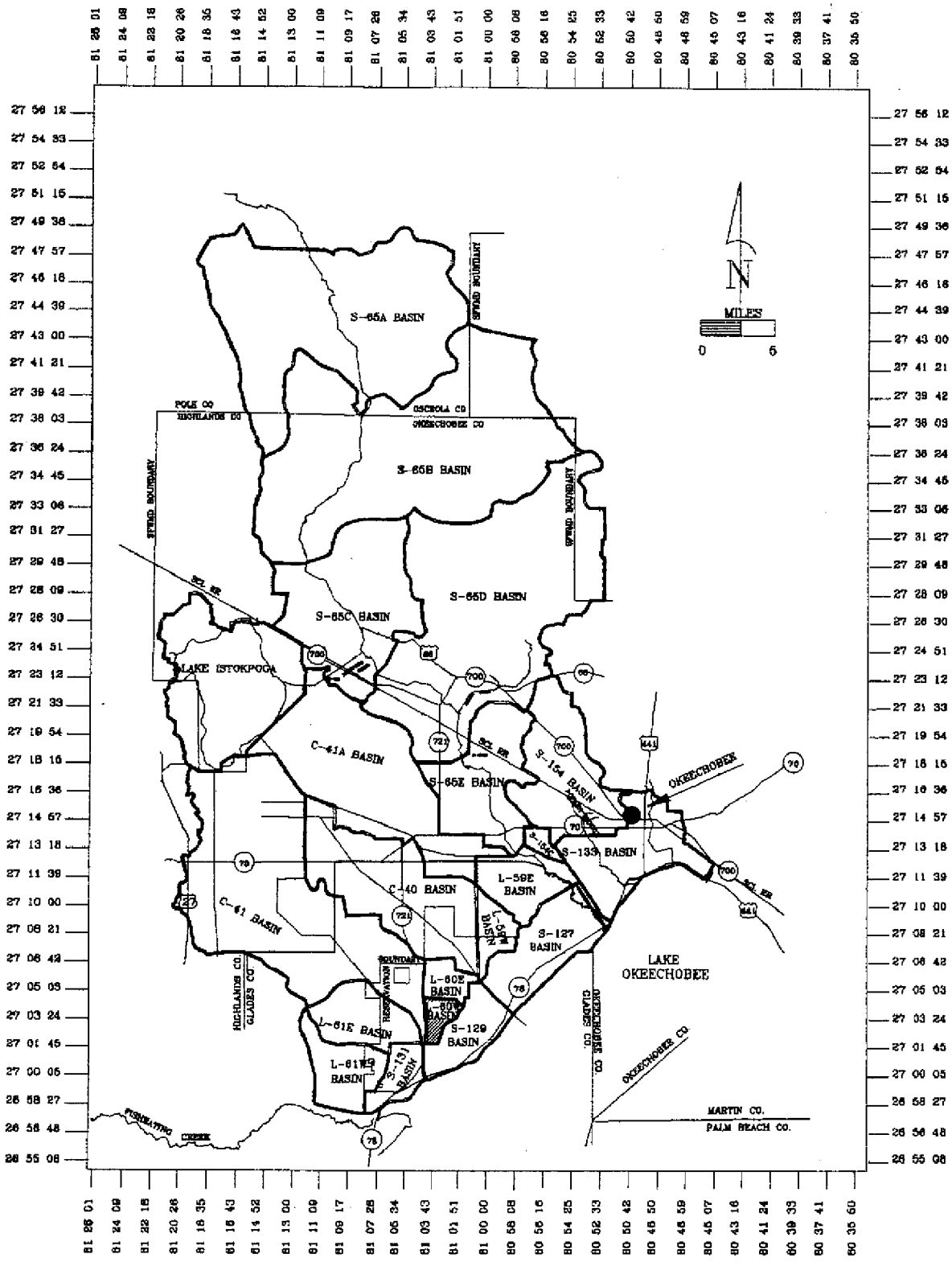

FIGURE 36. L-60W Basin Location Map

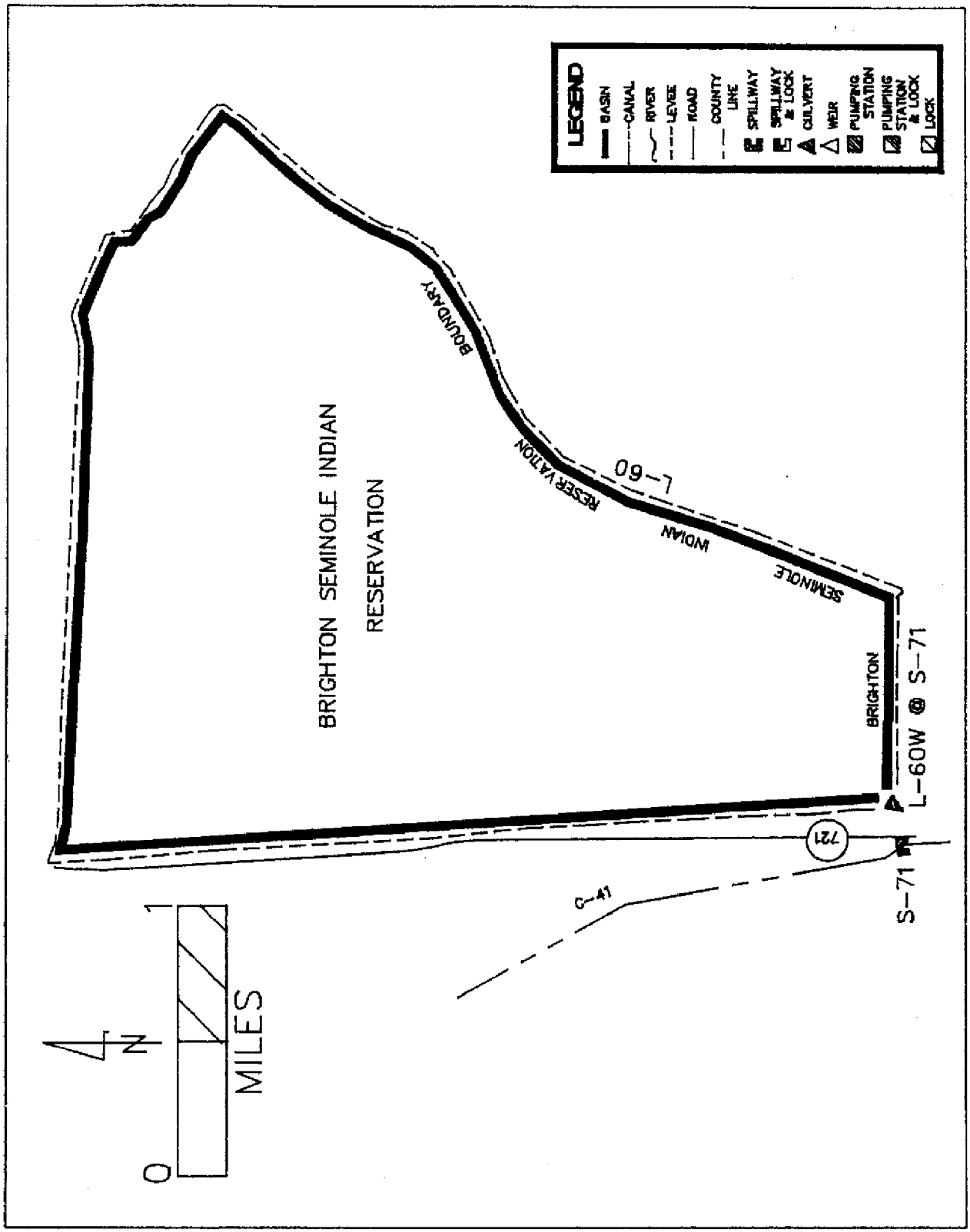

FIGURE 37. L-60W Basin Map

TABLE 18. L-60W Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
L-60W at S-71	CMP 2-barrel culvert diameter = 84 inches			17.0			

cfs = cubic feet per second
CMP = corregated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

L-61E BASIN

Description of the Basin

The L-61E basin has an area of 23.4 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 38). The L-61 interceptor dike is the basin divide for the L-61E and the S-131 basins. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agricultural. There are some citrus groves, but most of the area is improved pasture for beef cattle production. A schematic map of the L-61E basin demarcations, levees, and control structures is shown in Figure 39.

The major structure in this basin is a double-barrel 108-inch, corrugated metal pipe culvert (L-61E at C-41) that drains to C-41 (Harney Pond). The purpose of this culvert is to remove excess water from the L-61E basin and discharge to C-41 and to maintain optimum headwater elevation. The design criteria for the structures in the L-61E basin is shown in Table 19.

Comments on Design and Historic Operation

L-61E is an interceptor dike which blocks the drainage water of L-61E basin from passing to the S-131 Basin. Runoff from the L-61E basin collects in the L-61E borrow canal and flows east to C-41 through the culvert. Flow through the culvert is manually controlled by flashboards. Water surface elevation in the L-61E borrow canal is maintained using the flashboards. At present, the water surface elevation is 19.40 feet. Supplemental irrigation water is drawn through a culvert from C-41 with pumps. The Seminole Tribe operates a bypass from S-71 to supply water to the L-61E basin under the 1988 stated agreement with the District. The Tribe also operates a 90 cfs pump to supply water to this basin.

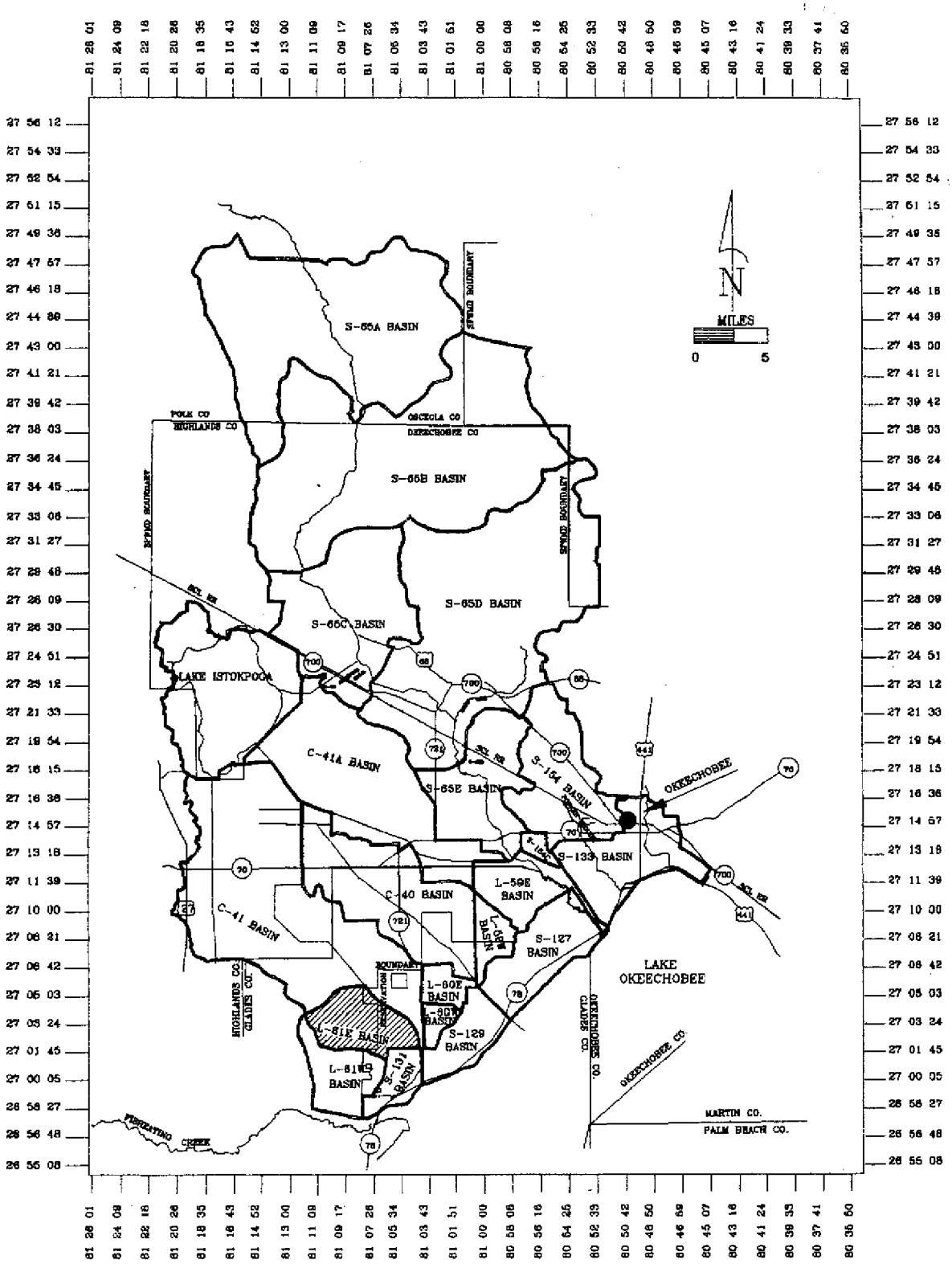

FIGURE 38. L-61E Basin Location Map

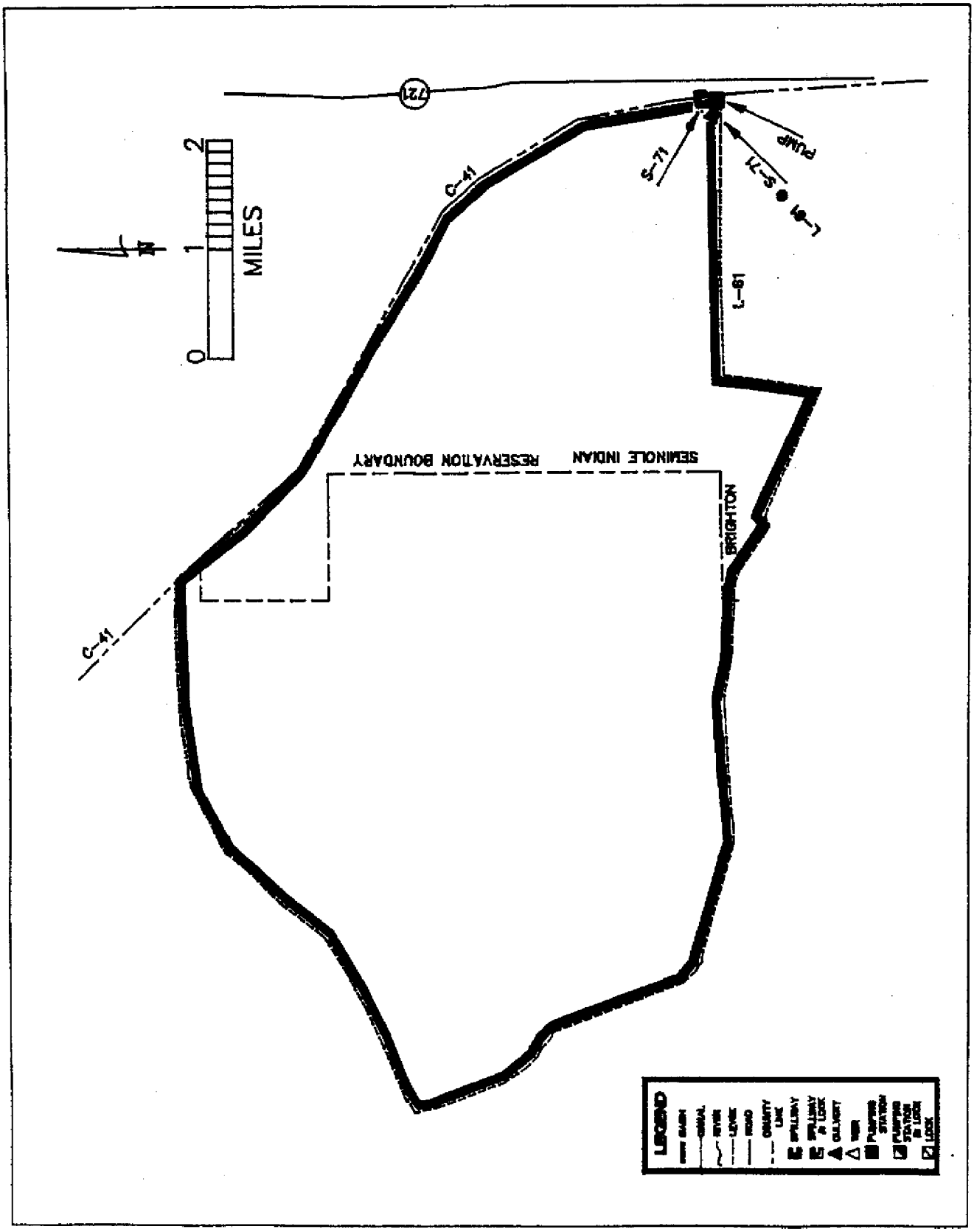

FIGURE 39. L-61E Basin Map

TABLE 19. L-61E Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
L-61E at S-71	CMP 2-barrel culvert diameter = 108 inches			19.40			

cfs = cubic feet per second
CMP = corregated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

L-61W BASIN

Description of the Basin

The L-61W basin has an area of 21.2 square miles and is located in Glades County on the northwest side of Lake Okeechobee (Figure 40). The L-61 interceptor dike is a basin divide for the L-61W and the S-131 basins. On the west side, the basin divide is the L-50 levee. The interceptor dike L-61 has an elevation of 23.0 feet NGVD and a crown width of 10 feet. The side slope is 1 on 3. The L-50 has an elevation of 32.3 to 39.0 feet NGVD and a crown width of 10 feet. The side slope is 1 on 2 and 1 on 4. The basin boundary relative to local roads and landmarks is shown on Map A. Map B is included for general land use reference.

The land use in the basin is agricultural, although most of the area is improved pasture for beef cattle production. A schematic map of the L-61W basin demarcations, levees, and control structures is shown in Figure 41.

The major structure in this basin is a double-barrel, 104-inch corrugated metal pipe culvert (L-61W at Fisheating Creek) that drains to Fisheating Creek. The purpose of this culvert is to remove excess water from the L-61W basin and discharge to Lake Okeechobee via Fisheating Creek, and to maintain optimum headwater elevation. The design criteria for the structures in the L-61W basin is shown in Table 20.

Comments on Design and Historic Operation

L-61W is an interceptor dike which blocks the drainage water of L-61W basin from passing to the S-131 basin. Runoff from the L-61W basin collects in the borrow canal of L-61 and flows to the west to Fisheating Creek through the culvert. Flow through the culvert is manually controlled by flashboards.

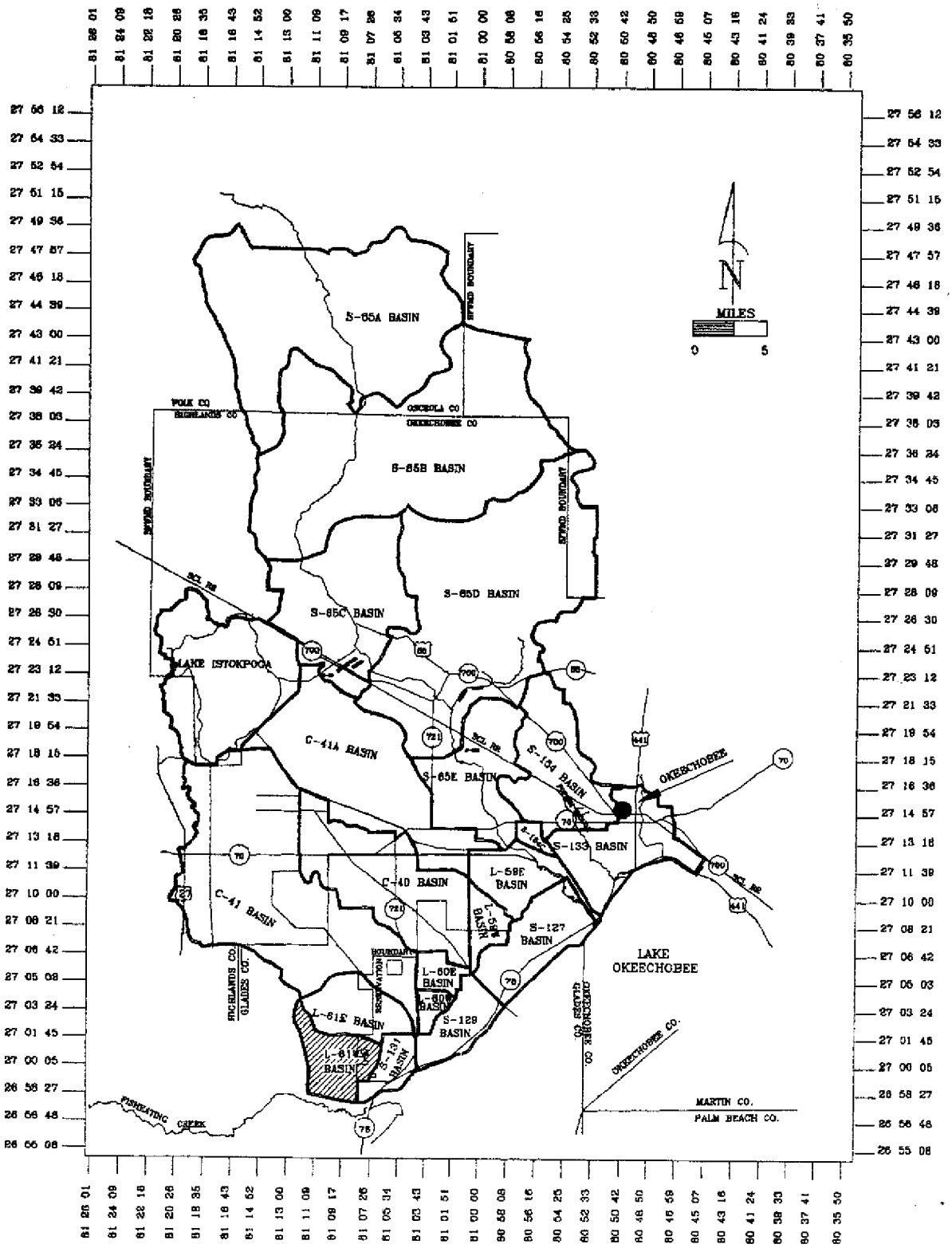

FIGURE 40. L-61W Basin Location Map

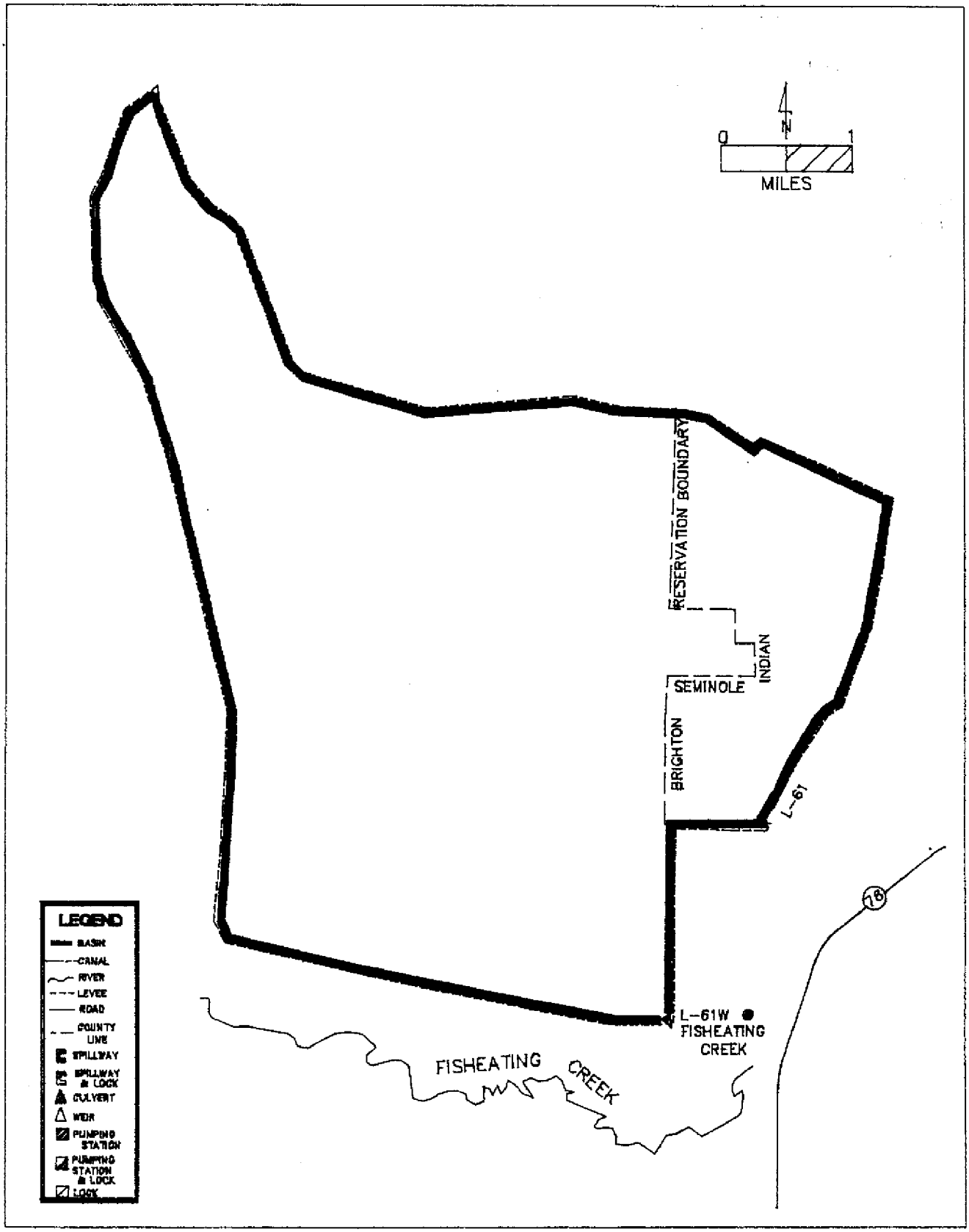

FIGURE 41. L-61W Basin Map

TABLE 20. L-61W Basin Structures - Design Criteria

Structure	Type	Design HW Stage (ft m.s.l.)	Design TW Stage (ft m.s.l.)	Optimum Stage (ft m.s.l.)	Design Discharge (cfs)	Peak Stage Qmax Qavg	Date of Peak
L-61W at Fisheating Creek	CMP 2-barrel culvert diameter = 108 inches			-			

cfs = cubic feet per second
CMP = corregated metal pipe
ft = feet
HW = headwater
m.s.l. = mean sea level
Qavg = average discharge
Qmax = maximum discharge
TW = tailwater

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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 the rain event, the rain will most likely seep into or "infiltrate" the soil. As the 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 is higher than the 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. 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").

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 intensity of the rainfall, the soil type, the depth to the water table, the relief of the area, 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 runoff to local streams.

Land use at large has 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. The 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 for a comparable urban area. As a result, stream flow in vegetated areas are moderated compared to urban areas. The relief of the area and

the soil type also determines the amount and rate of runoff generation. Steep slope and tight soils generate more runoff than flat land with sandy soils.

Drainage Basin - If rain falls over a large enough area, some of the runoff from that storm will likely enter in 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 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 structure (see **Control Structure**). The difference between this 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. 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 headwater to 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 overtopping 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 had 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 for which the canals and water control structures in the basin will accommodate the storm's runoff without 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 not 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 25 years (i.e., the storm has a 4 percent chance of being equalled or exceeded in any given year). This is written as 1-25 years and reads 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 an average of 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 amount of surface runoff to be expected from the basins (see **Runoff and Drainage**). Urban areas will often have more surface runoff than 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 U.S. 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. Runoff is measured as discharge in cfs or depth of water (inches) over the drainage area per unit time.

APPENDIX 2 - GLOSSARY

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.

Crest Elevation - The crest elevation of a structure is the level below which water can not 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 - 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.

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 finial design of the canals and structures are given in the **Detailed Design Memorandums**.

Project - This refers to the Central and South Florida Flood Control Project. 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 the year. In general, a regulation schedule optimizes the reservoirs 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.

Spillway - A spillway is a means of passing water from one location to another (e.g., from a reservoir 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 Weir.

Water Conservation Areas - The five Water Conservation Areas (WCAs 1, 2A, 2B, 3A, and 3B) are located in western Dade County and Broward County and in central Palm Beach County. 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 the WCAs according to a set of 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.

Abbreviations

cfs - Cubic feet per second

DDM - Detailed Design Memorandum

GDM - General Design Memorandum

m.s.l. - mean sea level

NGVD - National Geodetic Vertical Datum (see **Control Structures**, 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