APPENDIX B.1

DESCRIPTION OF THE INDIAN RIVER LAGOON

PHYSICAL FEATURES

The Indian River Lagoon system includes three, interconnected estuarine lagoons: Mosquito Lagoon, Indian River Lagoon and the Banana River Lagoon (see Figures 1.5-1.11 in B-2). The lagoon system extends about 155 miles through six coastal counties from Ponce de Leon Inlet in Volusia County south to Jupiter Inlet in Palm Beach County. The lagoons have an average depth of four feet and a width that varies from a half mile to five and a half miles.

Hydrology and Hydrodynamics

The hydrologic basin of the lagoon system covers approximately 2,284 square miles and comprises 22 major surface water drainage subbasins (see Figures 1.5-1.11 inb-2). Rainfall averages about 50.2 inches annually over the region, and the potential evaporation loss is about 49 inches. Freshwater drainage generated by rainfall enters the lagoons principally by overland runoff, ground water seepage, natural streams, canals, and storm water outfalls. Major tributaries are located along the entire length of the Indian River Lagoon from Turnbull Creek at the north end to the St. Lucie River. The water quantity and quality of these tributaries and the lagoon are affected by a rather extensive series of drainage canals built for the agricultural and urban development of lowlands. Much of these drained and developed lowlands are west of the relict dune ridges (Atlantic Coastal Ridge, Ten Mile Ridge and Green Ridge) and were once part of a vast, herbaceous marsh contiguous with either the Upper St. Johns River or Lake Okeechobee/Everglades system. As a result, over 1,150 square miles has been added to the natural drainage basin, increasing the watershed of the lagoon system by over 100 percent. Due to interbasin diversion and pumpage of ground water for irrigation by agricultural interests, the rate of freshwater discharge into the lagoon is much greater than what the natural drainage basin would produce (Rao, 1987).

Circulation and flushing in the Indian River Lagoon system are greatly affected by wind, freshwater inflows (especially storm water discharge), tides (principally in the vicinity of inlets), water depth, and bottom contours. In the north Indian River Lagoon, Mosquito Lagoon, and Banana River Lagoon, wind is the principal driving force on circulation. Water balance calculations suggest that the northern portion of the lagoon system (Ponce De Leon Inlet to Melbourne) is prone to stagnation and long pollutant residence times, although it is occasionally flushed by large storms (Windsor and Steward, 1987). Hydrodynamically, the central and southern portions (Melbourne to Jupiter Inlet) of the lagoon system are dominated by a combination of tidal exchange, freshwater inflows and winds (Dombrowski *et al.*, 1987). Major modifications to the system's circulation and flushing have occurred as a result of dredging and construction, particularly for vehicular causeways. Except for narrow openings for navigational channels and some small relief channels, major portions of these causeways are constructed on dredged spoil, which significantly restricts lagoon circulation (Evink, 1980).

Mosquito Lagoon has relatively little freshwater inflow and is poorly flushed. It has only one direct connection to the Atlantic Ocean through Ponce de Leon Inlet. Freshwater inflow to Mosquito Lagoon is primarily from direct land runoff, ground water seepage, many small canals, and a few wastewater treatment facilities.

The Banana River Lagoon is also poorly flushed. There is some water exchange with the Atlantic Ocean via a system of locks at Port Canaveral and with the Indian River Lagoon at the southern tip of Merritt Island. General sources of freshwater inflow to the Banana River Lagoon are overland runoff, ground water seepage, and Sykes Creek.

The Indian River Lagoon proper has four connections to the Atlantic Ocean: Sebastian Inlet, Fort Pierce Inlet, St. Lucie Inlet, and Jupiter Inlet via Hobe Sound. Tidal mixing often does not extend beyond one mile from the inlets during normal tidal exchange. Tidal amplitudes are 10 cm or less except in the immediate vicinity of inlets where they range up to 35 cm (Smith, 1987). Sources of freshwater inflow are numerous natural streams, drainage canals, storm water outfalls, overland runoff, ground water seepage, and wastewater treatment facilities.

Soils and Sediments

In general, the eastern corriders of the barrier islands and mainland have sandy, well-drained soils. Moderately- to poorly drained soils exist in the tidal swamps along the western portion of the barrier islands and in the low-lying areas between and west of the mainland's coastal hills.

Sediments of the Indian River Lagoon system are generally sand or sand-shell combinations and, in a few areas, coquina rocks and coral fragments. Sediments in the areas of major freshwater input are generally overlain with layers of fine-grained material (approximately 10 percent organic in composition), largely derived from erosion of upland soils and characterized by hydrogen sulfide generation (Trefry *et al.*, 1987; Windsor and Steward, 1987).

USES OF THE LAGOON SYSTEM

Historical Uses and Events

The record of human existence in the Indian River Lagoon region spans approximately 8,000 years. The lagoon system provided the Indians and early settlers with food, materials for tools and their major means of transportation. In the late 1800s, the Indian River Lagoon region was already established as a major area of commerce (tourism, fisheries, shipping and agriculture). The lagoon was used for safe harbor and transportation of cargo, especially citrus. Because of tremendous growth in the Indian River Lagoon region in the early 1900s, extensive drainage projects were conducted to prepare land adjacent to the lagoon for urban and agricultural development. More recently, the lagoon has been used to transport materials and equipment to develop the Kennedy Space Center and to transport fuel to electric generating plants.

Certain events since the mid-1850s have especially contributed to the condition of the Indian River Lagoon basin, which now influences the environmental and socioeconomic conditions of the region.

The chronicle of major events are:

1896:	Henry Flagler completes railroad from Jacksonville to Miami.
1905-1907:	Legislative drainage acts creating local agricultural drainage districts.
1919-1927:	Extensive agricultural drainage canal construction.
1912:	Intracoastal Waterway completed from Jacksonville to Miami.
1930:	In the wake of devastating hurricanes, massive flood control projects initiated in south Florida.
1931-1945:	Droughts and saltwater intrusion in ground water supplies, marsh and peat fires.
1942-1945:	Intracoastal Waterway deepened and widened for war effort.
1950-Present:	Population boom, primarily a result of improved living conditions (air conditioning, mosquito control, extensive urban drainage works) and economic opportunities created by the "Space Age," and the service and tourist industries. Current population is approximately 591,000 (1985), an order of magnitude greater than 1940 levels.

Current Uses

The quality of life and economic welfare of the area's residents have long been associated with the Indian River Lagoon. While employment patterns and forms of recreation may have changed over time, the lagoon system remains a major force in defining the character of the region.

The commercial fisheries harvesting sector based in the Indian River Lagoon has contributed a substantial portion of both the value of the Florida east coast (65 percent dockside value) and statewide fisheries catch (21.7 percent dockside value) over the past several years (National Marine Fisheries Service, 1985). Seafood processing, the wholesale and retail sector of the commercial fisheries industry, is another current use of the lagoon. The sector generates added value to the dockside value through processing and handling, wholesale and retail sales, and expenditures for supplies and equipment. The total primary economic impact was estimated at $73 million in 1983 for seafood processing and wholesaling (Yingling, 1987).

The recreational fishing industry and the marine service sector are also major users of the lagoon. These industries include such associated user services as boat sales, rentals, engine and hull repair, launch facilities, dockage, commercial and recreational fishing bait, tackle and supplies, charter and head boats, yacht clubs, marine resort areas, and other facilities and services. The economic impact of these activities is significant. For example, in 1984, recreational saltwater fishing was estimated to account for over $46 million in expenditures in the Indian River Lagoon region (Yingling, 1987).

Two of Florida's deepwater ports are located in the Indian River Lagoon system. In terms of combined import and export values, Port Canaveral and Ft. Pierce ranked sixth and tenth, respectively, among Florida's twelve major ports in 1984. Port

Canaveral has led Florida in fisheries landings, and the Port of Fort Pierce exports one-third of the citrus from Florida.

LAND USE AND POPULATION

The Indian River Lagoon basin (2284 square miles) is comprised of significant portions of Volusia, Brevard, Indian River, St. Lucie, and Martin counties, as well as small portions of Okeechobee and Palm Beach counties.

The dominant land use in the basin is agriculture (covering approximately 45 percent of the basin). Agricultural activities include 228,000 acres of citrus, 211,000 acres in range and citrus, and 9,500 acres of vegetable crops (SCS, 1994). The present urban land use (17 percent of the basin) is concentrated along the coast and the lagoon shorelines. Urban growth is rapidly extending westward, replacing agricultural land. Future land use patterns indicate that this trend will continue as urbanization intensifies along the coast, especially in the southern counties (Swain and Bolohassen, 1987). Present forested uplands and wetlands (11 and 18.8 percent of the basin, respectively) may be lost to both agriculture and urban development. This loss of upland forest communities and wetland habitats could have a significant effect on the Indian River Lagoon. These natural environments serve important functions such as storm water runoff control, water purification and wildlife habitat for endangered species. The intent of current Florida planning legislation is to restrict future developments of certain types of shoreline land uses that are not dependent on the existence of an adjoining water body. The state has also developed marina siting criteria that should preclude the potential adverse habitat impacts that marina development has posed in the past.

Land use activities within the basin largely account for the present environmental conditions of the lagoon system and have great potential to further degrade it. Nutrients from urbanand agricultural fertilizer application and other practices alter lagoon water chemistry and contribute to algae production. High concentrations of algae may cause a depletion of oxygen and account for fish kills. Suspended silts and clays from erosion at construction sites and agricultural areas combine with algae to reduce sunlight penetration and contribute to the declines in seagrass coverage and densities. This is a particularly critical situation since seagrass habitats form the basic nursery environment for most of all the economically important fishes in the lagoon. In addition, minimal tidal flushing, the existence of large drainage canals that provide a direct conduit of pollutants to lagoon waters, and man-made obstructions to lagoon flow such as causeways, all contribute to concentrating pollutants in certain segments of the lagoon.

Wetlands of the lagoon system provide many benefits to water quality and species productivity. In the 1940s and 1950s, much of the high salt marsh was impounded for mosquito control purposes. These impoundments' function is to hold water and therefore eliminate locations for salt marsh mosquito egg laying. The creation of impoundments isolated critically important foraging and nursery areas from the lagoon. Mosquito control practices have recently been changing in a manner that has allowed more connectivity of the impounded marshes with the lagoon and permit these habitats to again function as nursery and feeding areas.

Within the Indian River Lagoon basin, there are 33 incorporated municipalities. Population projections based on data from the counties and the Bureau of Economic and Business Research at the University of Florida indicate that this region has been developing rapidly and can be expected to develop further at an accelerated rate. In

1985, the basin had an estimated population of 591,378 and the projected population for the year 2000 is 901,462. This represents an increase of about 50 percent over a fifteen year period (Glatzel and Swain, 1987).

ENVIRONMENTAL CONDITIONS

The lagoon system is a biogeographic transition zone, rich in habitats and species, with the highest species diversity of any estuary in North America (Gilmore, 1986). Approximately 2,200 species have been identified in the lagoon system (Barile, 1987), 35 of which are listed as threatened or endangered. Species diversity is generally high near inlets and toward the south, and low near cities, where nutrient input, sedimentation, and turbidity are high and where large areas of mangroves and seagrasses have been lost. For biological communities and fisheries, seagrass and mangrove habitats are extremely important (Virnstein and Campbell, 1987). Much of the habitat loss has occurred as the result of the direct effects of shoreline development, navigational improvements, and marsh management practices.

As was previously alluded to, habitats and species diversity in the lagoon system may be seriously affected by the decline in water and sediment quality. Basically, there are two major types of impact responsible for this decline: (1) pollution from anthropogenic point and nonpoint sources, and (2) alterations in the natural patterns of circulation in the lagoons and freshwater flow into the lagoons. The combined effects of these impacts are jeopardizing the aesthetic value and ecological health of the lagoon system. Specifically, the intensification and expansion of human activities have altered hydrologic and hydrodynamic patterns; increased amounts of nutrients, suspended matter, and manufactured substances released to the lagoon; increased sedimentation rates in tributaries, navigational channels, and harbors; and promoted high levels of fecal coliform bacteria.

Three FDEP reports, The Florida East Coast Basin Assessment (Fitzgerald and Hadley, 1985), The Indian River Lagoon Water Quality Survey (Davis, 1986), and the Water Quality Assessment for the State of Florida (Hand *et al.*, 1988 and 1990), present results of FDEP water quality investigations in the lagoons. These reports noted the negative effects of urbanization, sewage, marinas, and drainage canals on tributary and lagoon water quality as indicated by high levels of nutrients, fecal coliform bacteria, chlorophyll a, turbidity, and low dissolved oxygen.

Other publications have also documented or indicated that certain conditions and uses of the lagoon system are ecologically disruptive --

- Intrabasin and interbasin drainage systems discharge large volumes of water into the Indian River Lagoon. Ten of the major canals have a peak discharge of over 10 billion gallons per day based on the maximum average recorded discharge for a 24-hour period. Direct surface runoff to the lagoon from waterfront residential and commercial property also contributes to the pollutant loadings. Sustained high volume storm water discharges can directly impact estuarine-dependent organisms and their habitats and can produce biologically undesirable fluctuations of salinity, as well as excessive sedimentation. Alternatively, these same drainage systems can effectively curtail freshwater flows to the lagoon during dry seasons. This can elevate salinities, impacting habitats and their indigenous organisms dependent on brackish or freshwater areas for at least part of their life cycles (Windsor and Steward, 1987).

- Domestic and industrial wastewater treatment plants discharge pollutants, in potentially harmful quantities, into the Indian River Lagoon (Hand *et al.*, 1986).
- The operation of marinas and boatyards contributes toxic or deleterious substances (e.g., heavy metals, hydrocarbons and raw sewage) to the Indian River Lagoon (Indian River Lagoon Field Committee, 1986).
- Circulation and flushing are excessively limited in some areas of the lagoon (Evink, 1980).
- A fine-grained sediment has been observed in several lagoon bottom areas adjacent to developed drainage basins. This "muck" sediment is largely composed of organic material and eroded upland soils, the amounts of which are apparently being generated at an accelerated rate commensurate with high rates of algal productivity and land use intensification. Muck is a repository for a variety of pollutants and may be a significant source of internal pollutant loading to lagoon waters. Furthermore, this sediment can easily be resuspended by boat traffic and dredge and fill operations, thereby, contributing to the lagoon's turbidity problem (Trefry *et al.*, 1987).
- Emergent wetlands and seagrass beds are critical components of the Indian River Lagoon and play important roles in biological productivity and species diversity. Since the 1950s, the Indian River Lagoon has lost, through destruction and impoundment, approximately 75 percent of its emergent wetland vegetation (Indian River Lagoon Field Committee, 1985). For three areas, near Ponce de Leon Inlet, Sebastian Inlet and north of Ft. Pierce, FDNR (1985) estimated seagrass losses of 100, 38, and 25 percent, respectively, since the 1950s. There is a concern that existing seagrass beds are threatened by adverse water quality conditions (e.g. nutrient overload and high turbidities) (Windsor and Steward, 1987).

Several specific areas in the lagoon system have been documented have some or all of the problems cited above. The references that document the problem areas are listed in Table 1 of the SWIM Plan. Hand and Paulic (1992) and Hand *et al.* (1988 and 1990) are the most current publications that attempt to qualify the water quality conditions of the lagoon system based on available data. Areas of the lagoon system are generally "good" or "fair" in quality and, with few exceptions, meet their designated use status (either Class II or III).

The following assessment of the twelve problem areas in the Indian River Lagoon system is primarily taken from Hand and Paulic (1992) and Hand *et al.* (1988 and 1990):

Mosquito Lagoon. The Mosquito Lagoon has sparse development, few point sources of pollution, and generally "fair" water quality. Most of the lagoon is classified as Class II waters and are conditionally approved for shellfish harvesting. Periodic closures of the shellfish harvesting waters by the FDEP have occurred as a result of storm-induced coliform bacteria contamination. Volusia County Environmental Health Department suspects OSDS as one of the major contributors of coliform loads to the lagoon.

Titusville. The Titusville vicinity of the north Indian River Lagoon has "poor" water quality due to nutrient and organic material loadings from wastewater treatment plants and a large urban storm water system. Chlorophyll a, organic load,

and suspended solid levels are apparently increased during winter months due to the effects of heated effluent discharges. This portion of the lagoon is also affected by naturally poor hydraulic circulation and flushing.

Banana River Lagoon and Cocoa/Rockledge. The highly urbanized southern reach of the Banana River Lagoon and the Cocoa/Rockledge area has a "poor" rating. The area receives effluent from several wastewater treatment facilities. The heavily developed Sykes Creek area has the worst water quality in the Banana River Lagoon subbasin and does not meet its Class III use designation. The creek has high concentrations of nutrients and chlorophyll a (persistent algal blooms), and low secchi values.

Eau Gallie River, Crane Creek and Turkey Creek. Further south, the Indian River Lagoon has "good" water quality except near Eau Gallie River, Crane Creek and Turkey Creek. Eau Gallie River is impacted by urban and construction runoff, various marina pollutant inputs, and, possibly, internal pollutant loading from the river's sediments. Crane Creek is impacted by urban runoff. The Turkey Creek subbasin has pollution problems similar to many of those mentioned for Eau Gallie River and Crane Creek. Most significantly, Turkey Creek and the adjacent lagoon waters receive controlled drainage laden with nutrients and suspended matter (particularly during storm events) from a 100 square mile drainage area (Water Control District of South Brevard). The segment of the lagoon near these tributaries are similarly affected by the same types of pollution sources, with the effects exacerbated by the vehicular causeways that obstruct lagoon circulation. Freshwater quantity and delivery times are suspected of causing biologically undesirable fluctuations in salinity in this lagoon segment.

Lagoon Between Turkey Creek and Sebastian River. The lagoon between Turkey Creek and Sebastian River has "good" water quality and generally meets its Class II use designation. The FDEP is concerned that this area does not meet the bacteriological quality criteria for Class II waters.

Sebastian River. The Sebastian River, including its North and South prongs, has "fair" to "poor" quality with high bacteria and low dissolved oxygen concentrations. Suspected pollution sources are a variety of agriculture (e.g., row crop, citrus, rangeland) and urban drainage (including septic drainage). The North Prong does not meet its designated Class III use. The North Prong receives WWTP effluent from the Barefoot Bay community. Under FDEP permit conditions, the effluent should not be discharged to the river.

Vero Beach. In the Vero Beach vicinity water quality ranges from "fair" to "good." Pollution problems do exist and are related to increased levels of suspended matter and nutrients (especially phosphorus) from urban and agricultural runoff, septic drainage, and treated wastewater.

Moores Creek. Moores Creek in the Ft. Pierce area, including Canal 25 (C-25), has elevated levels of coliform bacteria, turbidity, and low dissolved oxygen concentrations. The source of these problems is nonpoint runoff from adjacent urban development.

Five-Mile and Ten-Mile Creeks. The water quality in Five-Mile and Ten-Mile creeks is generally "fair." However, levels of pesticides are relatively high, apparently as a consequence of runoff from surrounding citrus groves. Point sources that discharge to these waters include two citrus processing plants. Bacteria and nutrient problems

have been encountered from at least one of these plants. In addition, high rates of floodwater discharge from this drainage area have been implicated in the transport of excessive amounts of sediments into the North Fork-St. Lucie River Aquatic Preserve.

St. Lucie River Estuary. The St. Lucie River Estuary has "fair" water quality with elevated concentrations of nutrients, chlorophyll a and reduced dissolved oxygen. The high concentrations of organic material in the bottom sediments may directly affect dissolved oxygen in this naturally poorly flushed river estuary.

Manatee Pocket. Manatee Pocket has generally "fair" water quality, with relatively high phosphorus concentrations and reduced secchi depths and dissolved oxygen. Nonpoint sources appear to be the culprit, including urban storm water and marina discharges, worsened by poor hydraulic circulation and flushing. (Studies by the SFWMD and FDEP have revealed sediments highly contaminated by pesticides and heavy metals. A probable source of these materials is runoff from the marine industries in Port Salerno).

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APPENDIX B.2

SURFACE DRAINAGE SUBBASINS

The Indian River Lagoon basin extends from Ponce De Leon Inlet in Volusia County to Jupiter Inlet in Palm Beach County. This basin has been greatly enlarged by construction of man-made drainage features and currently has a drainage area of 5915 sq km (2,311 sq mi). To facilitate the presentation of data, the basin has been geographically divided into four segments (north, north central, south central, and south segments as shown Figure 1-5). Each of the geographic segments include hydrologic subbasins that represent the larger drainage features. Subbasins are futher subdivided into smaller drainage areas. Surface water hydrologic units within the basin and the size of each unit (km^2) are given in Table 1-2.

NORTH INDIAN RIVER LAGOON SEGMENT

The North Indian River Lagoon Segment extends from the Ponce de Leon Inlet to the Eau Gallie Causeway (Figures 1-6 and 1-7) and includes the Mosquito, North Indian River and Banana River lagoons. The major tributary in this segment is Turnbull Creek, which discharges into the northern end of the Indian River Lagoon.

Mosquito Lagoon Subbasin

The Mosquito Lagoon subbasin extends from Ponce De Leon Inlet in the north to a dune ridge between Mosquito and Banana River lagoons in the south (Figure 1-6). Mosquito Lagoon is connected to the North Indian River Lagoon by Haulover canal. The northern portion of Mosquito Lagoon is characterized by many saltmarsh and mangrove islands. A poorly defined dune ridge to the west separates Mosquito Lagoon from the North Indian River Lagoon. South of Haulover canal, this dune ridge forms part of the northern portion of Merritt Island. New Smyrna Beach and Edgewater are population centers in the northern section of the basin.

North Indian River Lagoon Subbasin

The North Indian River Lagoon subbasin extends from Turnbull Creek to the NASA Parkway West Causeway and is divided into two drainage areas -- Turnbull Creek and Titusville (Figure 1-6).

Turnbull Creek is the northern drainage area within the North Indian River subbasin. The coastal hills which bound this area to the west are broad and flat, and have a maximum elevation of 7 to 9 m (25 to 30 ft. NGVD). These hills slope down into Turnbull Hammock, which is a hydric hammock that forms the headwaters of Turnbull Creek. Turnbull Hammock is believed to have been filled by sediment caused by erosion in the Eastern Valley (Scott, 1978). Some urban/residential development has occurrred in the northeastern portion of this basin near the town of Edgewater.

The Titusville drainage area is located south of Turnbull Creek and extends from the northern portion of the Indian River Lagoon south to the NASA Parkway West Causeway. Merritt Island, located to the east, has a series of dune ridges on its eastern flank that slope to the west into broad flat wetlands, and to the south into

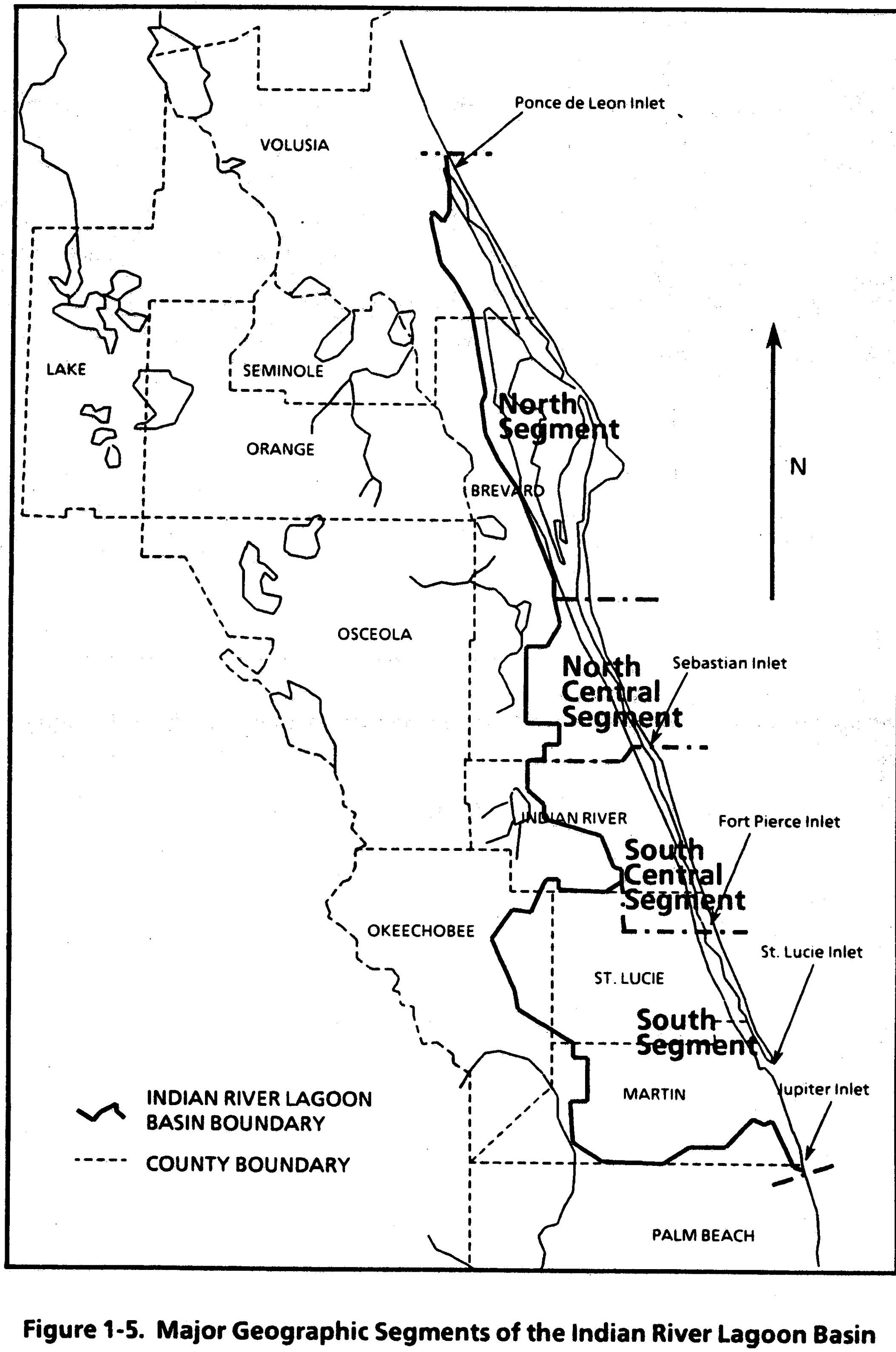

Figure 1-5. Major Geographic Segments of the Indian River Lagoon Basin

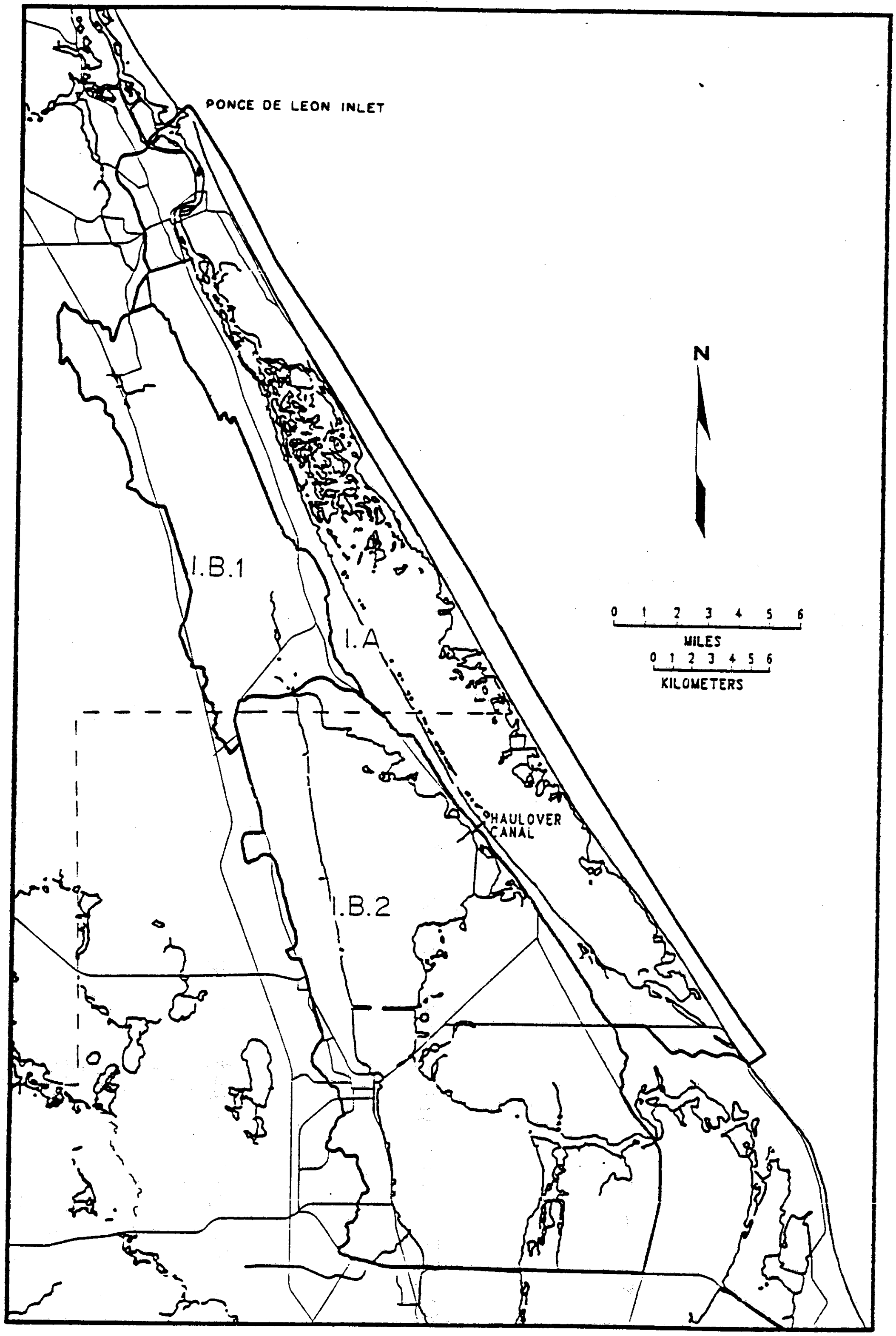

Figure 1-6. Sub-basin Boundaries within Mosquito Lagoon and the North Indian River Lagoon (Sub-basin numbers refer to the listing in Table 1-2).

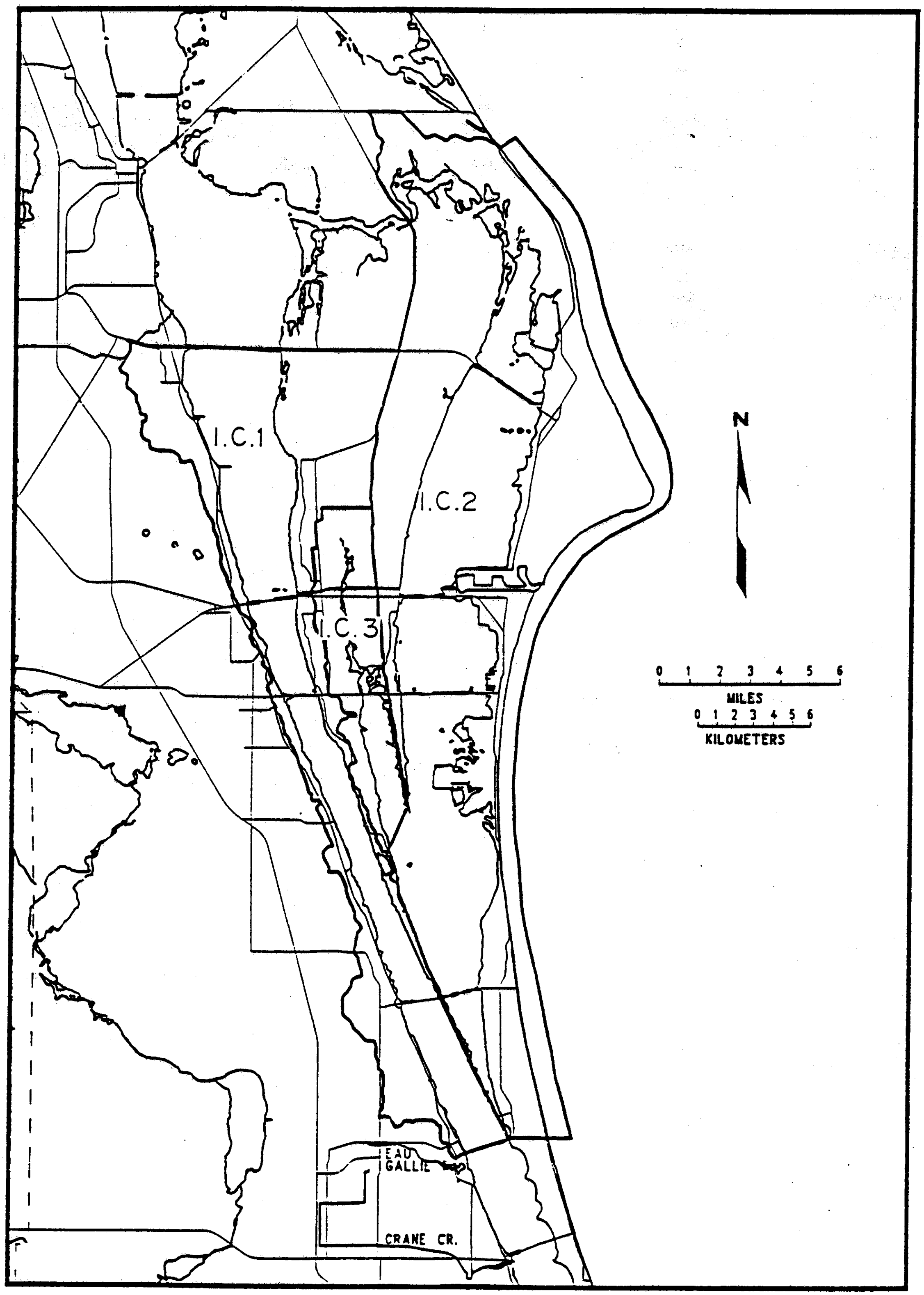

Figure 1-7. **Sub-basin Boundaries within the Banana River/North Indian River Lagoon** (Sub-basin numbers refer to the listing in Table 1-2).

Table 1- 2. Areas of Drainage Subbasins (square kilometers) within the Indian River Lagoon Basin.

ID No.	Unit	Area (sq. km.)
I.	North Indian River Lagoon Segment	1509.6
I.A	Mosquito Lagoon Subbasin	288.5
I.A.1	Barrier Island	45.6
I.A.2	Mainland	90.1
I.A.3	Lagoon	152.8
I.B	North Indian River Lagoon Subbasin	533.2
I.B.1	Turnbull Creek	132.4
I.B.2	Titusville	400.9
I.B.2.a	Merritt Island	152.8
I.B.2.b	Mainland	75.8
I.B.2.c	Lagoon	172.3
I.C	Banana River/North IRL Subbasin	687.9
I.C.1	Cocoa	238.1
I.C.1.a	Merritt Island	65.0
I.C.1.b	Mainland	59.9
I.C.1.c	Lagoon	113.2
I.C.2	Banana River Lagoon	398.8
I.C.2.a	Barrier Island	140.0
I.C.2.b	Merritt Island	79.6
I.C.2.c	Lagoon	179.2
I.C.3	Sykes Creek	50.9
I.C.3.a	Merritt Island	37.4
I.C.3.b	Lagoon	13.6
II.	North Central Indian River Lagoon Segment	732.6
II.A	Eau Gallie	20.7
II.B	Melbourne Village Subbasin	19.2
II.C	Crane Creek Subbasin	29.4
II.D	Turkey Creek Subbasin	297.2
II.D.1	Turkey Creek	35.1
II.D.2	WCDSB/Turkey Creek	10.2
II.D.3	WCDSB	251.9
II.E	Goat Creek Subbasin	26.4
II.F	Kid Creek Subbasin	4.4
II.G	Trout Creek Subbasin	36.9
II.H	North Sebastian River Subbasin	155.9
II.H.1	Sebastian River North Prong	57.6
II.H.2	Sottile Canal	32.0
II.H.3	Mary A Farms/C-54	11.3
II.H.4	C-54	55.0
II.I	IRL: Eau Gallie Cswy. to Sebastian Inlet Subbasin	142.6
II.I.1	Barrier Island	28.2
II.	North Central IRL Segment (Continued)	
II.I.2	Mainland	21.2
II.I.3	Lagoon	93.2
III.	South Central Indian River Lagoon Segment	937.0
III.A	South Sebastian River Subbasin	414.0
III.A.1	Sebastian River South Prong	156.4
III.A.2	Sebastian River Drainage District	45.1
III.A.3	Fellsmere Canal	9.5
III.A.4	Fellsmere Water Control Dist. "A" (by Gravity to Fellsmere Canal)	88.6
III.A.5	Fellsmere Water Control Dist. "B" (by Pumpage to Fellsmere Canal)	114.4
III.B	Indian River Farms Drainage District Subbasin	199.7
III.C	Ft. Pierce Farms Drainage District Subbasin	108.5
III.D	IRL: Sebastian Inlet to Ft. Pierce Inlet Subbasin	214.8
III.D.1	Barrier Island	53.5
III.D.2	Mainland	71.7
III.D.3	Lagoon	89.6
IV.	South Indian River Lagoon Segment	2735.9
IV.A	C-25 Subbasin	406.0
IV.B	North St. Lucie Subbasin	647.4
IV.B.1	North St. Lucie Drainage District	492.3
IV.B.2	IRL: Ft. Pierce Inlet to St. Lucie Inlet	155.1
IV.B.2.a	Barrier Islands	24.8
IV.B.2.b	Mainland	32.3
IV.B.2.c	Lagoon	98.0
IV.C	C-24 Subbasin	426.5
IV.D	C-23 Subbasin	428.8
IV.E	South St. Lucie-IRL	341.5
IV.E.1	Bessey Creek	32.0
IV.E.2	West of Interchange Rt. 52 (Basin 4)	3.8
IV.E.3	Danforth Creek	18.4
IV.E.4	Tidal St. Lucie Basin	178.6
IV.E.5	Manatee Creek (Basin 2)	35.8
IV.E.6	Non Tidal St. Lucie Basin	5.9
IV.E.7	IRL: St. Lucie Inlet to Jupiter Inlet	71.9
IV.E.7.a	Barrier Island	8.7
IV.E.7.b	Mainland	47.1
IV.E.7.c	Lagoon	16.1
IV.F	Okeechobee Waterway (C-44) Subbasin	485.6
Total	**Indian River Lagoon Basin**	**5915.1**

Banana Creek. Historically, this creek provided a northern connection between the Banana River and Indian River lagoons. However, NASA built causeways out to launch pads in this area, thus eliminating flows from Banana Creek to the Banana River Lagoon.

The mainland portion of the Titusville drainage area is bounded on the west by well-defined coastal hills that reach elevations up to 21 meters (70 ft). Titusville is the major population center with many smaller developments to the south. Ellis canal (Addison canal) was an interbasin diversion canal prior to construction of the McDonald Douglas complex. This complex effectively blocks flow from the Upper St. Johns River basin into the Indian River Lagoon.

Banana River/North Indian River Lagoon Subbasin

The Banana River/North Indian River Lagoon subbasin extends from NASA Parkway West Causeway south to the Eau Gallie Causeway (Figure 1-7). This basin contains the Cocoa drainage area, the Banana River Lagoon and Sykes Creek_

The Cocoa drainage area extends from the NASA Parkway West Causeway to the Eau Gallie Causeway, and includes the southern portion of the North Indian River Lagoon. The Kennedy Parkway and SR 3 on Merritt Island mark the eastern drainage divide. These roads roughly follow an ill-defined dune ridge to the narrow southern tip (60 m width) of the island. On the mainland, the well-defined coastal hills have elevations up to 24 meters (80 ft. NGVD) and form the western boundary. The major urban centers are Cocoa and Rockledge on the mainland, and the town of Merritt Island.

The Banana River Lagoon lies east of Merritt Island and west of the Barrier Islands. The western boundary is the Kennedy Parkway until the parkway turns west, at which point the boundary follows a dune ridge south. The prominent physical feature in this drainage area, as well as the entire Indian River Lagoon basin, is Cape Canaveral on the barrier island.

South of the Cape is the Canaveral Barge canal, a navigational channel which connects the Indian River and Banana River lagoons with Port Canaveral and the Atlantic Ocean. South of the Barge canal, residential land use intensifies on Merritt Island and urban land use intensifies within the municipality of Cocoa Beach on the barrier island.

Sykes Creek is a small lagoon system that lies between the Banana River Lagoon and Cocoa drainage areas. North of the Barge canal, this drainage area is characterized by low flat saltmarshes between two sets of relic dune ridges; whereas south of the Barge canal the land use is urban/residential.

NORTH CENTRAL INDIAN RIVER LAGOON SEGMENT

The North Central Indian River Lagoon segment extends from the Eau Gallie Causeway to the Sebastian River Inlet and includes several subbasins and streams (Figure 1-8). In the northern portion, the Ten Mile Ridge splits from the coastal Ridge and the coastal hills become less well defined. The valley between the Ten Mile Ridge and the coastal ridge is drained by many streams that flow through the coastal ridge and discharge into the Indian River Lagoon. This low valley historically was flat with many poorly drained swamps. Drainage, however, has been improved in recent times by construction of numerous canal systems for urban and agricultural drainage, which allow freshwater flow into the lagoon from the Upper St. Johns River basin. Without these diversion canals, water would have discharged into the Indian River Lagoon only during major floods. Various interbasin diversion canals and control structures in this segment are shown on Figure 1-8.

Eau Gallie River

The Eau Gallie River (Figure 1-8) is the northernmost stream that drains the valley between the coastal hills and Ten Mile Ridge. This subbasin, which is located in the northern portion of the rapidly growing Melbourne area, has numerous stormwater drainage canals that have greatly increased drainage over natural conditions.

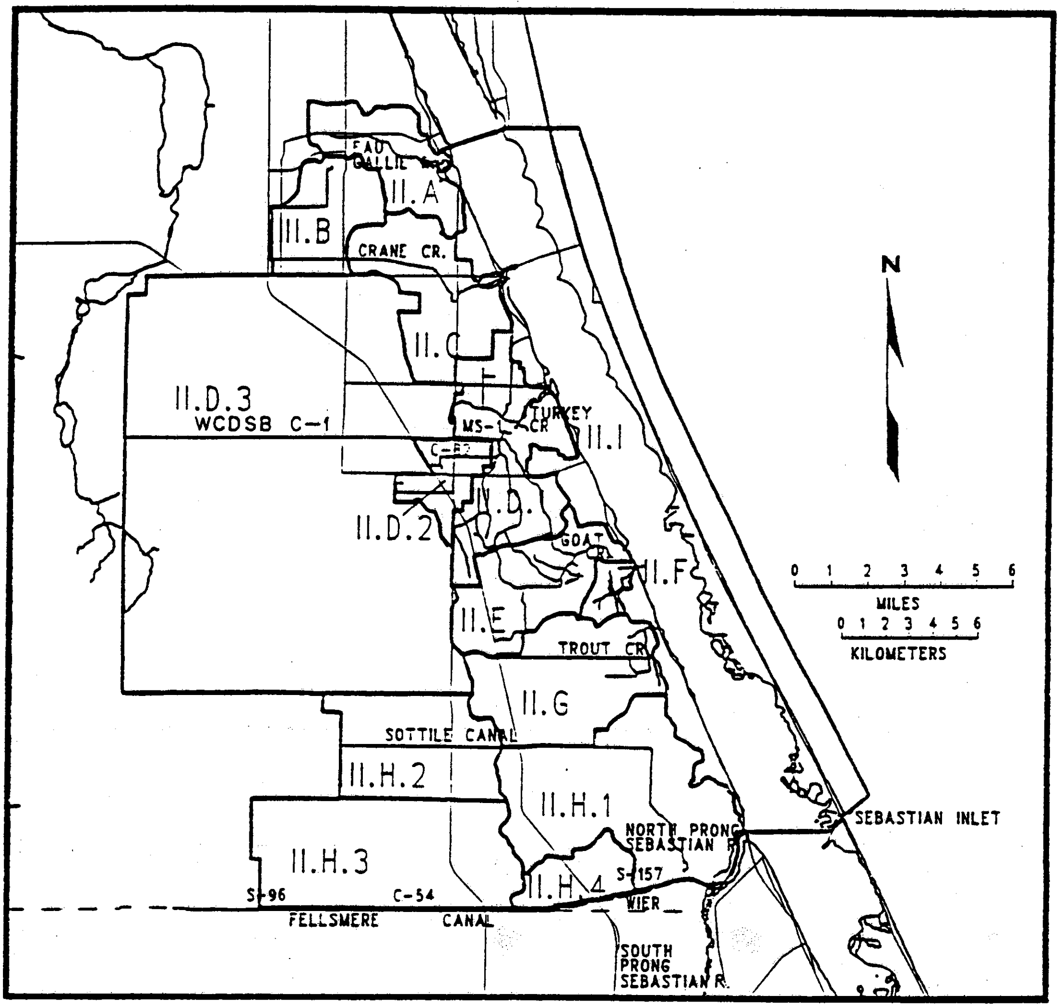

Figure 1-8. Sub-basin and Drainage Area Boundaries within the North Central Segment of the Indian River Lagoon (Sub-basin numbers refer to the listing in Table 1-2).

Melbourne Village Subbasin

Melbourne Village subbasin drains the western portion of Melbourne (Figure 1-8). This subbasin lies west of the Ten Mile Ridge and, therefore, would naturally have discharged into the St. Johns River. However, with the rapid development of the area, urban drainage canals were extended to Crane Creek, diverting stormwater into the Indian River Lagoon.

Crane Creek Subbasin

Crane Creek subbasin (Figure 1-8) is located within the city of Melbourne. In addition to the increased stormwater contributed by numerous urban drainage canals, Crane Creek also receives flow from the Melbourne Village subbasin.

Turkey Creek Subbasin

Turkey Creek subbasin lies south of Melbourne and includes most of Palm Bay (Figure 1-8). Most of this subbasin is located within the Water Control District of South Brevard (WCDSB). Similar to other subbasins in the North Central Segment, drainage canals in the valley between the Atlantic Coastal Ridge and Ten Mile Ridge have increased drainage to the Indian River Lagoon.

The Turkey Creek drainage area consists of those lands that contribute most of the natural drainage into Turkey Creek. The City of Palm Bay generates a significant portion of the runoff from the north, while agricultural drainage accounts for most of the runoff from the south (Suphunvorranop and Clapp, 1984).

The WCDSB/Turkey Creek discharges into Turkey Creek through the WCDSB C-82 canal, immediately downstream of the MS-1 structure. This portion of the Turkey Creek subbasin is being developed for residential, commercial and industrial uses.

The Water Control District of South Brevard drainage area discharges from the WCDSB C-1 canal into Turkey Creek through the MS-1 Structure (Clapp and Wilkening, 1984). The WCDSB was originally established as the Melbourne-Tillman Water Control District, an agricultural drainage district. However, the General Development Corporation has been developing the eastern two-thirds of the WCDSB for residential use, within the City of Palm Bay. West of the City of Palm Bay the WCDSB is still used for agriculture.

Goat Creek

Goat Creek has a poorly defined northern boundary with Turkey Creek, as some canals connect the two subbasins (Figure 1-8). Some drainage improvements have occurred in this subbasin but many wetlands still exist.

Kid Creek

Kid Creek drains a subbasin that is located just west of the coastal hills between Goat and Trout creeks (Figure 1-8). This area includes much of the eastern portion of the Valkaria Airport and Missle Tracking Annex. Little development has occurred in the area.

Trout Creek

Trout Creek (Figure 1-8), similar to Goat Creek, has many poorly drained wetlands; although some agricultural development has occurred in the western portion of this subbasin.

North Sebastian River Subbasin

North Sebastian River subbasin's southern boundary is the Brevard County-Indian River County line (Figure 1-8).

The Sebastian River North Prong drainage area is the natural portion of the North Sebastian River and lies between the coastal hills and Ten Mile Ridge. Drainage in this area has been improved for agricultural and some residential development. There is, however, some undeveloped land in the western portion which is poorly drained. This Sebastian River North Prong drainage area also receives water from the Sottile canal.

The Sottile canal drainage area is located west of the Ten Mile Ridge in the St. Johns River Valley. Sottile canal is the major canal for the old San Sebastian Drainage District. This drainage district historically extended west to the western boundary of the WCDSB. However, there is currently a blockage of Sottile canal, 5 km west of SR 507, creating the present boundary (Clapp and Wilkening, 1984).

Mary A Farms/C-54 is an agricultural drainage area that has many canals which drain into C-54 (Clapp and Wilkening, 1984). These canals, depending on water levels, can be used either to drain water into C-54 or to supply water to agricultural lands from C-54. C-54 canal was constructed by the United States Army Corps of Engineers (USCOE) as a flood control canal for the Upper St. Johns River basin (USCOE, 1962; 1985). During large storm events, the S-96 water control structure at the western end of the canal can be opened to release water from the Upper St. Johns River basin, and that portion of Fellsmere Farms west of S-96, into C-54 and eventually into the Sebastian River via S-157. Four water control structures are located between Fellsmere canal and C-54 which can be opened to allow discharge into C-54 canal (Clapp and Wilkening, 1984).

The C-54 drainage area is located east of the Ten Mile Ridge and is the only drainage into C-54 that does not constitute interbasin diversion. This area is virtually undeveloped with only two canals draining into C-54 canal. The S-157 structure at the eastern end of C-54 canal controls all flow out of C-54 into the Sebastian River. This structure, under current operational limits, does not open until water levels in C-54 canal reach 4.95 meters (16.25 ft.) NGVD as described in Clapp and Wilkening (1984).

Indian River Lagoon/Eau Gallie Causeway to Sebastian Inlet

Indian River Lagoon/Eau Gallie Causeway to Sebastian Inlet (Figure 1-8) is the lagoonal portion of the north central segment of the Indian River Lagoon. The barrier islands in this area exhibit both agricultural and urban development. The mainland portion, also well developed, lies east of the coastal hills and drains directly into the Indian River Lagoon.

SOUTH CENTRAL INDIAN RIVER LAGOON SEGMENT

South Central Indian River Lagoon segment extends from the Sebastian Inlet to the Ft. Pierce Inlet and contains several subbasins and drainage districts (Figure 1-9). The Ten Mile Ridge is poorly defined in the southern portion of Indian River County, and during storms some runoff reached the Indian River Lagoon through low areas south of this ridge. Historic drainage conditions have been altered to promote agricultural use of the land by four local drainage districts -- Fellsmere Water Control District, Indian River Water Control District, Sebastian Water Control District and Ft. Pierce Water Control District. Nearly all of the population in this basin is concentrated along the coast, especially within the municipalities of Vero Beach and Ft. Pierce.

South Sebastian River Subbasin

The South Sebastian River subbasin (Figure 1-9) has primarily been drained and developed for citrus by the Fellsmere Water Control District and the Sebastian Water Control District. Under natural conditions, this area was poorly drained and contained wetlands. With the advent of agricultural development came the construction of a complex system of canals that drains to the Sebastian River.

Sebastian River South Prong is located northwest of the Sebastian Water Control District. Runoff from much of the southern portion of this drainage area flows east into the Sebastian Water Control District and then discharges into the Sebastian River South Prong. Urban development occurs in the northern portion of this area, in and around the municipalities of Sebastian and Roseland.

Sebastian River Drainage District (SRDD) is a highly developed citrus area west of the Indian River Farms Drainage District. Most discharges from the SRDD are directed to the north into the Sebastian River south prong. However, some water is also discharged east through the North canal in the Indian River Farms Drainage District.

The Fellsmere canal drainage area is a sparsely developed area east of the Fellsmere Water Control District (FWCD). The southern portion discharges into FWCD while the northern portion discharges directly into the Fellsmere canal (Clapp and Wilkening, 1984).

Fellsmere Water Control District "A" is the eastern portion of the Fellsmere Water Control District. Although this area contains the Town of Fellsmere, this area remains relatively undeveloped. This area drains by gravity directly into the Fellsmere canal (Clapp and Wilkening, 1984).

Fellsmere Water Control District "B" is the western portion of Fellsmere Water Control District (FWCD). The FWCD utilizes the Upper St. Johns River marsh as a source of irrigation water and, following storm events, pumps excess water back to the marsh. The FWCD can also discharge water into Fellsmere Main canal through pump stations located on the canal. These pump stations are only used during times of high water. When completed, the Upper St. Johns River Basin Project (USCOE, 1985) will discontinue flow of water from this area into the Fellsmere canal. As previously mentioned, four control structures connect the Fellsmere canal to the C-54 canal, which are opened during high water to allow flow into C-54 canal and prevent flooding to the south.

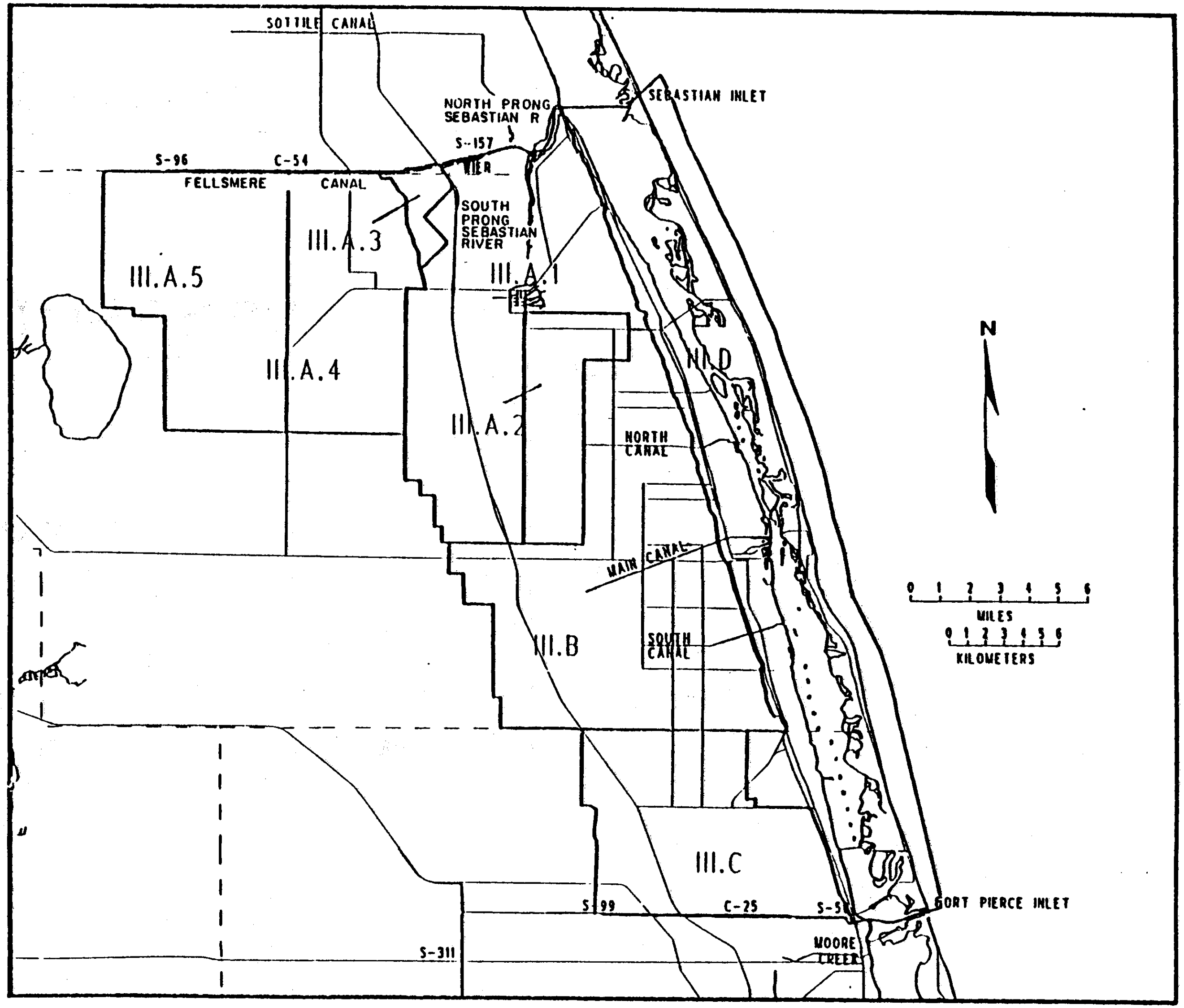

Figure 1-9. **Sub-basin and Drainage Area Boundaries within the South Central Segment of the Indian River Lagoon** (Sub-basin numbers refer to the listing in Table 1-2).

Indian River Farms Drainage District

The Indian River Farms Drainage District is located in southeastern Indian River County west of the coastal hills and is primarily developed for citrus (Figure 1-9). Drainage within this basin is very complex, but results in discharge to the Indian River Lagoon through North, Main, and South canals.

Ft. Pierce Farms Drainage District

The Ft. Pierce Farms Drainage District is located in northeastern St. Lucie County (Figure 1-9). This subbasin, similar to the previous subbasins, was historically very flat and poorly drained. Drainage improved significantly when the marshlands were diked and drained to support agricultural uses. Drainage from this subbasin flows south into C-25 canal, east of the S-99 water control structure.

Indian River Lagoon/Sebastian Inlet to Ft. Pierce Inlet

Indian River Lagoon/Sebastian Inlet to Ft. Pierce Inlet is the lagoon portion of the South Central segment of the Indian River Lagoon and is bordered by the Atlantic Coastal Ridge on the west and barrier islands on the east (Figure 1-9). The barrier islands have many areas of scattered agriculture and residential development. The mainland section is a narrow strip, located between the coastal hills and the lagoon, which drains directly into the lagoon. This area has many residential developments. The major municipalities are Vero Beach and Ft. Pierce.

SOUTH INDIAN RIVER LAGOON SEGMENT

The South Indian River Lagoon segment (Figures 1-10, and 1-11), under natural conditions, was poorly drained with many isolated wetlands. This area is currently developed for agriculture and urban/residential uses, with a complex systems of drainage canals. Many of these canals provide connections between subbasins. The four major canals in this segment are C-25, C-24, C-23 and C-44 canals.

C-25 Canal

The C-25 canal is the northwestern subbasin in the south segment of the Indian River Lagoon (Figure 1-10). A complex system of canals exists in this basin for agricultural drainage. Under natural conditions, however, this basin would not discharge into the Indian River Lagoon. Generally, runoff from the eastern portion of this subbasin flows east through the S-99 structure on the C-25 canal. Stormwater originating in the western portion of this subbasin can be discharged into the C-24 canal through S-311.

North St. Lucie Subbasin

The North St. Lucie subbasin extends from Ft. Pierce Inlet southward to the St. Lucie Inlet and westward to C-24 canal (Figure 1-10). There are several drainage areas within this subbasin. Although this subbasin naturally discharged into the Indian River Lagoon, agricultural canals have greatly improved drainage. This subbasin occasionally receives inflow from the C-24 canal.

The North St. Lucie Drainage District drainage area drains primarily into the North St. Lucie River. The North St. Lucie Drainage District is located in the northern

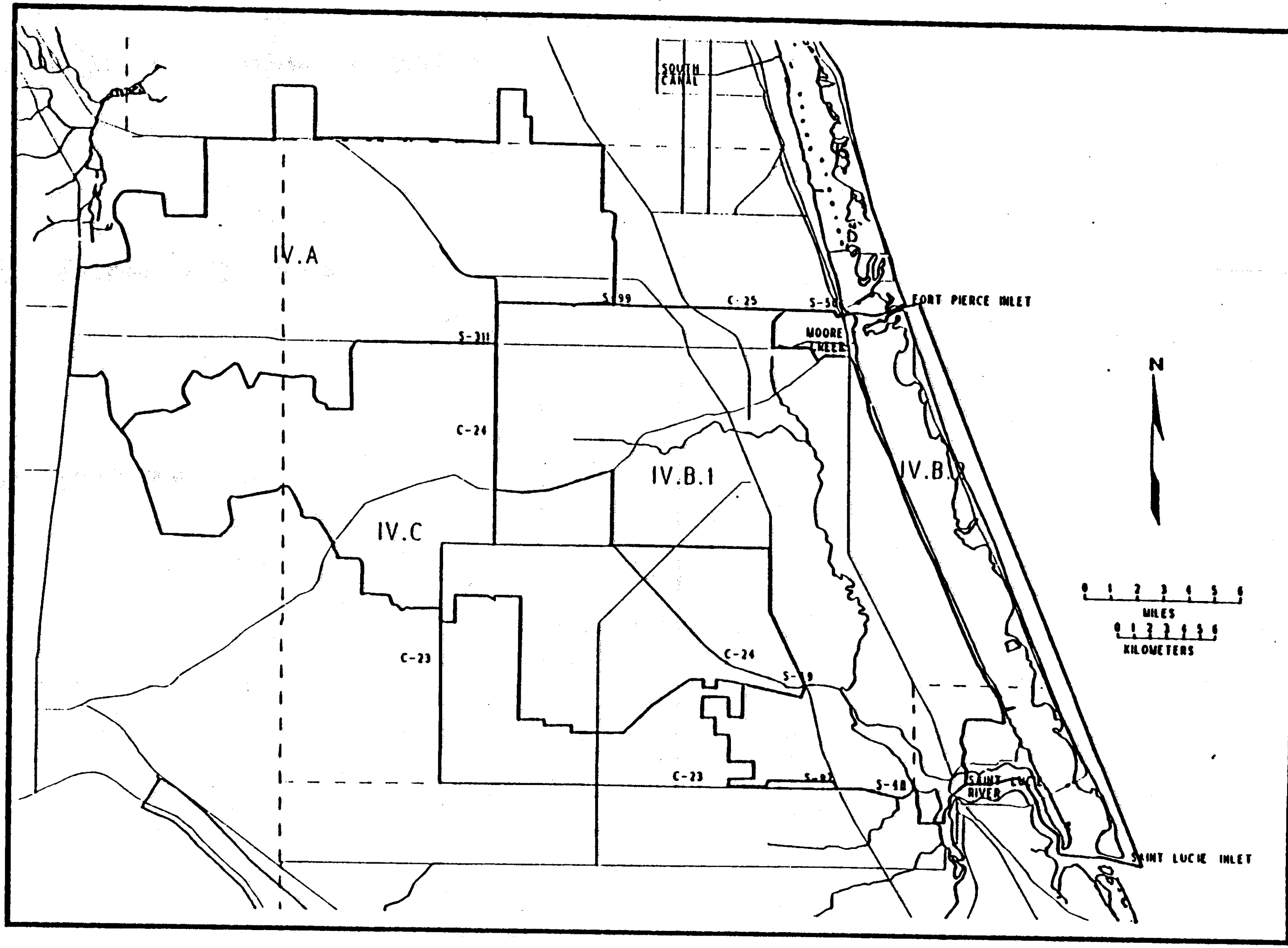

Figure 1-10. Sub-basin and Drainage Area Boundaries within the Northern Portion of the South Segment of the Indian River Lagoon (Sub-basin numbers refer to the listing in Table 1-2).

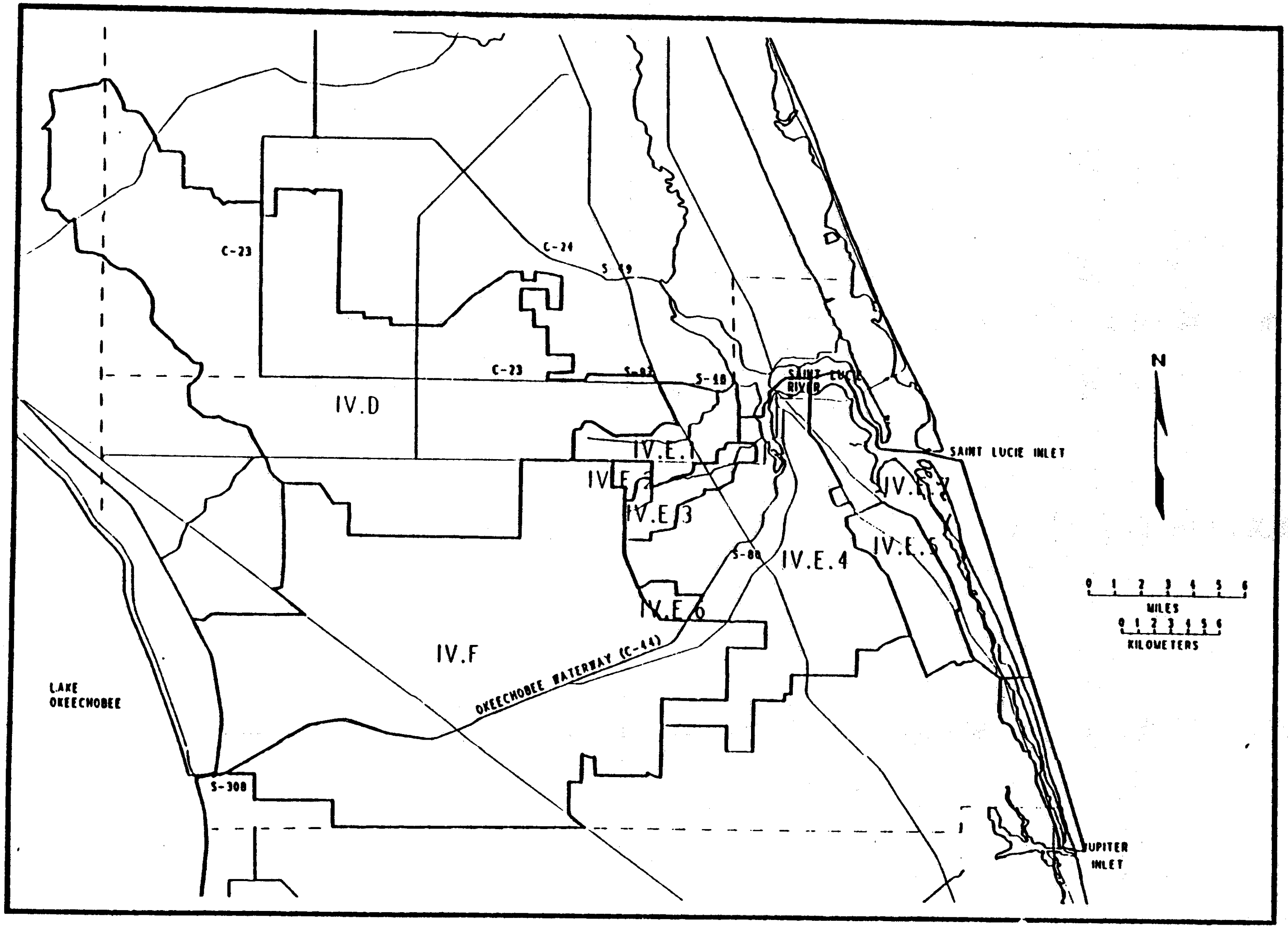

Figure 1-11. Sub-basin and Drainage Area Boundaries within the Southern Portion of the South Segment of the Indian River Lagoon (Sub-basin numbers refer to the listing in Table 1-2).

portion of this area and drains to the C-25 canal from the north and to the C-24 canal from the west. South and east of the North St. Lucie Drainage District are several urban developments, of which the City of Port St. Lucie is the largest.

The Indian River Lagoon/Ft. Pierce Inlet to St. Lucie Inlet area is bordered by the barrier island to the east and the coastal hills on the west. Very little development has occurred on the barrier Islands in this area with the exception of the Florida Power and Light Company's nuclear power plant on Hutchinson Island. The mainland portion of this area is very narrow and has experienced some development.

C-24 Canal Subbasin

The C-24 canal subbasin is located west of the North St. Lucie basin and is mostly outside the area that would naturally discharge into the Indian River Lagoon. This subbasin discharges into the North St. Lucie River through the S-49 structure (Figure 1-10). Agricultural canals have greatly improved drainage. Besides discharge into the C-24 canal from within the subbasin, C-24 also receives water from the western portion of the C-25 subbasin and the western portion of the North St. Lucie Drainage District.

C-23 Canal Subbasin

The C-23 canal subbasin is located south of C-24 (Figure 1-11). Under natural conditions much of this area would not have drained into the Indian River Lagoon. Agricultural canals have improved drainage from the area. Discharge from C-23 canal in this subbasin is controlled by the S-97 structure, which is located just west of Florida's Turnpike.

South St. Lucie River Subbasin

The South St. Lucie River subbasin is the natural drainage for the South St. Lucie River and contains several drainage areas (Figure 1-11). The City of Stuart lies in the northeastern portion of this subbasin between the South St. Lucie River and the Indian River Lagoon.

Bessey Creek is a natural creek that is located south of the C-23 canal. The S-96 structure is a weir within C-23 canal that is located immediately upstream of the confluence of C-23 canal and Bessey Creek. The eastern portion of Bessey Creek drainage area contains scattered pockets of residential development, while the western portion is mostly agricultural. Although drainage improvements have occurred, these have been less extensive than improvements that have occurred in the northern subbasins.

The West of Interchange Route 52 (basin 4) drainage area is a small area that is hydrologically isolated from the rest of the Indian River Lagoon basin. Drainage from this area has been essentially blocked.

The Danforth Creek drainage area is another small area that has experienced some drainage improvement. This natural creek has drainage characteristics that are very similar to those of Bessey Creek.

The Tidal St. Lucie drainage area is the major natural drainage into the Indian River Lagoon from the South St. Lucie River. The City of Stuart lies in the

northeastern portion of this basin. Although some drainage improvements have occurred in this area, there are still many of the natural isolated wetlands in the southern portion. The S-80 structure, which is the control structure for C-44 canal into the St. Lucie River, is located about one mile west of Florida's Turnpike.

The Manatee Creek (basin 2) area drains north into Manatee Creek. Few drainage improvements have occurred in this area.

The Non-Tidal St. Lucie is a small drainage area that historically would have discharged into C-44 canal just above the S-80 structure. However, drainage from this area has been blocked, causing the area to be isolated from the Indian River Lagoon basin.

The Indian River Lagoon/St. Lucie Inlet to Jupiter Inlet is the southernmost drainage area of the Indian River Lagoon (Figure 1-11). Many residential developments occur on both the barrier island and the mainland portions of this area. The major developments occur in the north, around the City of Stuart.

Okeechobee Waterway (C-44)

The Okeechobee Waterway (C-44) subbasin (Figure 1-11) contains the C-44 canal which is a part of the major navigational route between the east and west coast of Florida, connecting Lake Okeechobee to the South St. Lucie River. The S-308 structure controls flow from Lake Okeechobee into C-44. This subbasin has many agricultural developments, mostly pasture, which have improved drainage. However, these agricultural areas are interspersed with areas of natural, poorly drained wetlands.

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