Technical Report No. 99-02

SYNTHESIS OF EXISTING INFORMATION

Volume 1:

A CHARACTERIZATION OF WATER QUALITY, HYDROLOGIC ALTERATIONS, AND FISH AND WILDLIFE HABITAT IN THE GREATER CHARLOTTE HARBOR WATERSHED

Buteo lineatus
Red-shouldered Hawk

- ***Peace River & Watershed*** • ***Myakka River & Watershed***
- ***Coastal Venice/Lemon Bay/Gasparilla Sound/Cape Haze***
- ***Charlotte Harbor Proper*** • ***Pine Island Sound/Matlacha Pass***
- ***Estero Bay & Watershed*** • ***Tidal Caloosahatchee River & Watershed***

April 1999

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for the

Charlotte Harbor National Estuary Program

• Peace River & Watershed • Myakka River & Watershed
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April 1999

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A second volume was prepared to supplement this "Synthesis of Existing Information" document. The specific materials contained within this second volume are presented as a series of independent appendices, each of which addresses a highly technical issue. As such, these materials were included in a separate document due to the limited nature of their audience.

CHARLOTTE HARBOR NATIONAL ESTUARY PROGRAM
GLOSSARY OF ABBREVIATIONS

ASR	Aquifer Storage and Recovery
AWT	Advanced Wastewater Treatment
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BOR	Basis of Review
CARL	Conservation and Recreation Lands
CCMP	Comprehensive Conservation and Management Plan
CHNEP	Charlotte Harbor National Estuary Program
CUP	Consumptive Use Permit
DO	dissolved oxygen
EQL	Environmental Quality Laboratory
ETB WRAP	Eastern Tampa Bay Water Resources Assessment Project
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use Code Classification System
FLUMS	Florida Land Use Map System
FMRI	Florida Marine Research Institute
GIS	Geographic Information Systems
HSG	hydrologic soil group
IPM	Integrated Pesticide Management
LWCWSP	Lower West Coast Water Supply Plan
MSL	mean sea level
NOAA	National Oceanographic and Atmospheric Administration
NRCS	National Resource Conservation Service
OP	Ortho-phosphorus
PRMRWSA	Peace River/Manasota Regional Water Supply Authority
SFWMD	South Florida Water Management District
SWFRPC	Southwest Florida Regional Planning Council
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
SWUCA	Southern Water Use Caution Area
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UFAS	Upper Floridan Aquifer System
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WUP	Water Use Permit
WWTP	Wastewater Treatment Plant

UNITS GLOSSARY

cfs	cubic feet per second
cm	centimeter
gpm	gallons per minute
in	inches
µg/l	micrograms per liter
mg/l	milligrams per liter
mmhos/cm	millimhos per centimeter
NTU	Nephelometric Turbidity Units
ppt	parts per trillion
Pt-Co units	platinum-cobalt units

1. Introduction

The Charlotte Harbor National Estuary Program (Charlotte Harbor NEP) process involves the completion of four major elements:

- establishment of the Management Conference,
- characterization of the estuary and its watersheds (Synthesis of Existing Information),
- development of the Comprehensive Conservation and Management Plan (CCMP), and
- implementation of the CCMP.

1.1 Management Conference

The Management Conference is the decision-making framework for carrying out the NEP process. The members of the Management Conference work together in partnership to develop, through consensus, a master plan for the estuary called the CCMP. After the NEP has developed and adopted the CCMP, the CCMP is supported and carried out under state and local auspices. Essentially the members of the Conference identify major and significant potential problems (if any) in their estuaries, decide where to focus corrective actions, and agree to specific political, financial, and institutional commitments. Figure 1-1 illustrates the agencies, organizations, and interested parties, including the committees of the Management Conference, who provide critical input to, and review of, the CCMP.

The **Management Conference** is composed of a Policy Committee, a Management Committee, a Technical Advisory Committee (TAC), and a Citizen Advisory Committee (CAC). Through its committee structure and public outreach efforts, the Conference provides a forum for collaborative decision-making and consensus building around often conflicting issues.

The **Policy Committee** is composed of key officials (mayors, county commissioners, agency chiefs, etc.) or their designees, who help provide the resources to support the Management Conference. This committee makes the final decisions after considering the needs of the estuary ecosystem, the cost and benefits of restoration and protection strategies, and the value the community may be placing on the estuary.

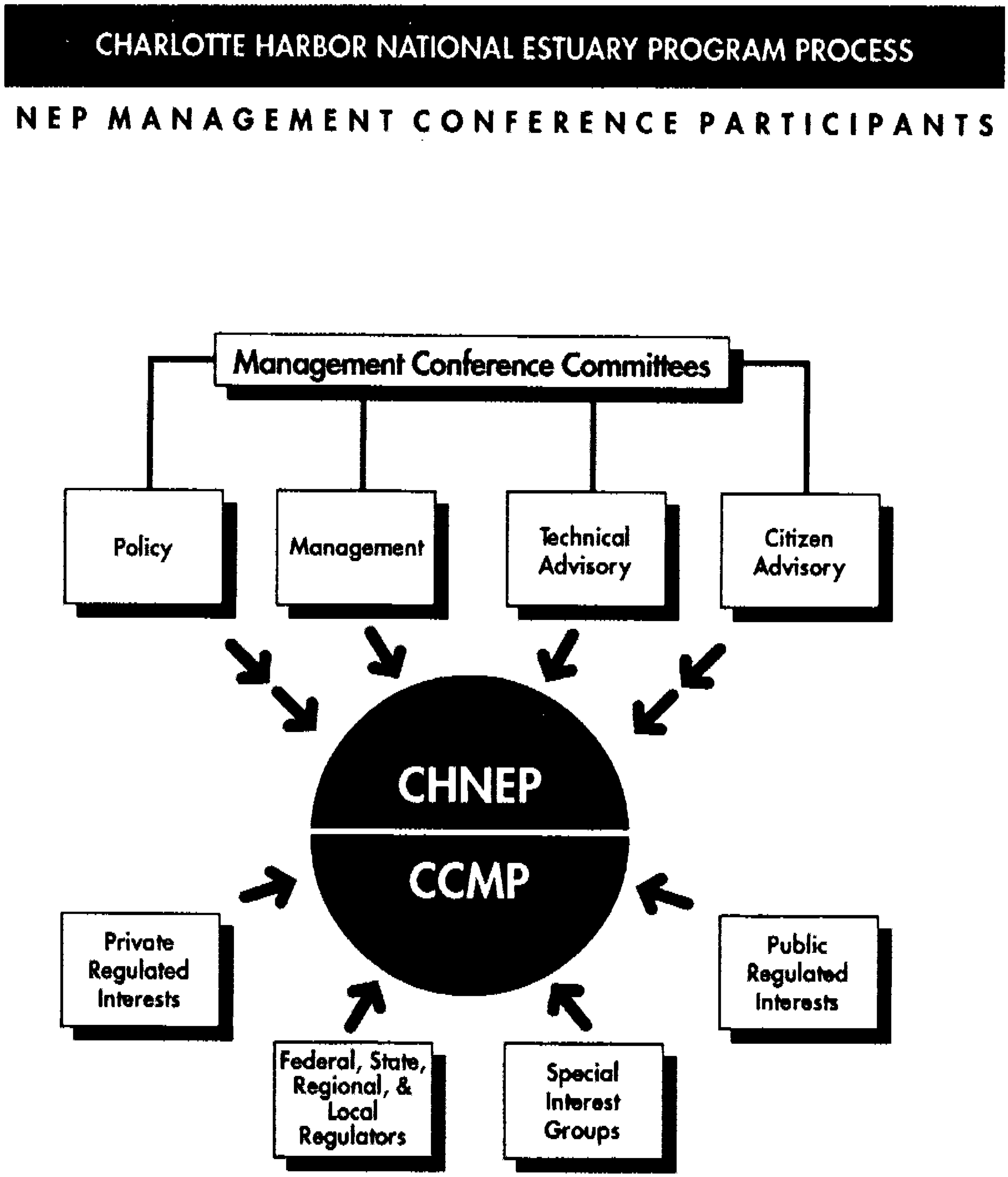


Figure 1-1. Organization of agencies, organizations, and interested parties, including the committees of the Management Conference, who provide critical input to, and review of, the CCMP.

The **Management Committee** is composed of local, regional, state, and federal agency managers who have environmental resource management responsibilities in the designated area of the estuary program. Through this committee, the Conference builds its support base from the key government agencies responsible for estuary-related activities which include: agricultural management, land use planning, fish and wildlife management, water management, and sewage treatment. Agencies represented on this committee also have potential CCMP implementation responsibilities, thus their input is crucial during the early development of the CCMP.

The **Technical Advisory Committee** is composed of interested technical experts working in, and with responsibility for, estuarine- and watershed-related scientific issues and projects in the NEP study area. Membership includes local scientists from both private and public sector organizations, and qualified individuals. This committee provides a forum to discuss and develop technical issues from the characterization of the system and the identification of priority problems, to the development of the most feasible and cost-effective management actions appropriate for implementation of the CCMP.

The **Citizen Advisory Committee** includes a representative cross-section of the general public living in the NEP study area. Members include representatives of major businesses, industries and their associations; environmental and civic groups; farmer and fishing groups; educators and other affected and/or interested citizens. This committee serves to inform the Conference of the concerns of the people living in the watersheds of the NEP and is instrumental in the dissemination of the plans and results of the NEP program.

A major responsibility of the committees comprising the Management Conference, therefore, is to build public support and political cooperation needed to complete a series of tasks leading to the development and implementation of the CCMP. Other interested entities will also provide input into the development of the CCMP.

1.2 Synthesis of Existing Information

The following document comprises the characterization element of the NEP process. This Synthesis of Existing Information is a critical step in providing an analysis and characterization of information in a form that will provide an appropriate foundation for the CCMP development process. The information contained within this document, when combined with other elements of the Charlotte Harbor NEP process (e.g., Compendium of Monitoring Programs, Base Program Analysis and Data Management Strategy), will provide the base information from which the CCMP will be developed.

In compiling and analyzing the information contained within this Synthesis of Existing Information document, the focus has been to establish the existing background information necessary to address the three Priority Problems that have been identified as having the greatest potential for degrading the Charlotte Harbor system. These problems are:

1) **Hydrologic Alterations** - adverse changes to amounts, locations, and timing of freshwater flows, hydrologic function of floodplain systems, and natural river flows.

2) **Water Quality Degradation** - including but not limited to pollution from agricultural and urban runoff, point source discharges, septic tank system loadings, atmospheric deposition, and groundwater.

3) **Fish and Wildlife Habitat Loss** - degradation and elimination of headwater streams and other habitats caused by development, conversion of natural shorelines, cumulative impacts of docks and boats, invasion of exotic species, and cumulative and future impacts.

The CHNEP study area encompasses over 4,500 square miles along the southwest coast of Florida (Figure 1-2), and covers eight distinct sub-areas, or major basins, based on hydrologic, ecologic, and management characteristics (State of Florida, 1995). These previously identified basins include:

- Peace River,
- Myakka River,
- Coastal Venice,
- Charlotte Harbor Proper,
- Lemon Bay/Gasparilla Sound/Cape Haze Complex,
- Pine Island Sound/ Matlacha Pass,
- Tidal Caloosahatchee River, and
- Estero Bay.

Addressing elements of the three identified Priority Problems as they relate to each of these major basins will be a primary focus in development of the Charlotte Harbor NEP CCMP. To accomplish this, the following Synthesis of Existing Information seeks to:

- identify and compile relevant sources of information;

- to assess trends in the estuary's water quality, natural resources, and uses;

- to assess pollution loadings to the estuary and relate them to observed changes in water quality, natural resources, and land use; and

- to identify potential environmental problems.

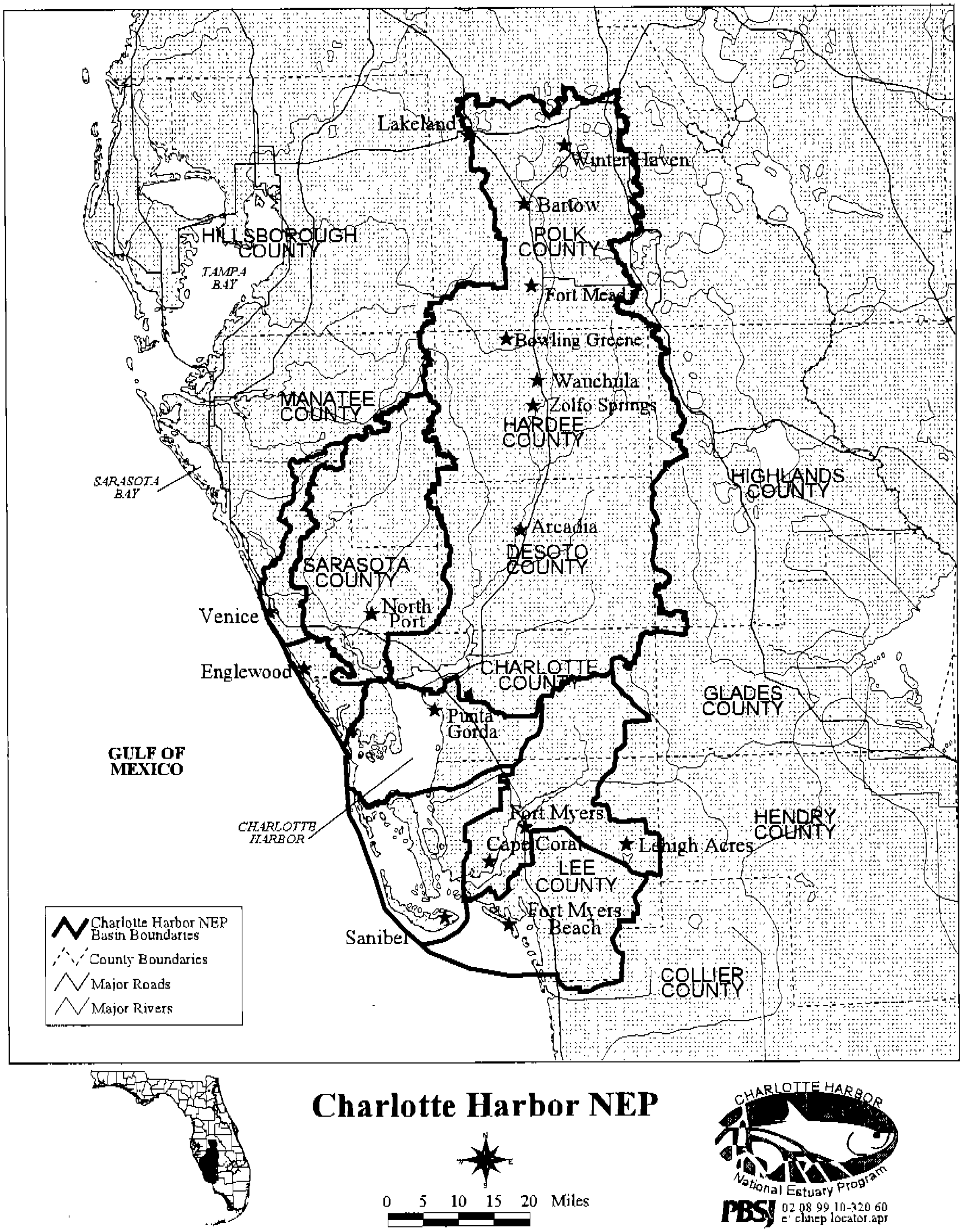


Figure 1-2. Charlotte Harbor NEP study area.

2. Myakka River Basin

This chapter presents a compilation and synthesis of information regarding the Myakka River Basin portion of the Charlotte Harbor NEP area (Figure 2-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

2.1 Physical Setting

The Myakka River Basin is located in the northwestern portion of the Charlotte Harbor NEP study area, with the Peace River to the east, the Manatee River to the north, Charlotte Harbor to the south, and a number of smaller coastal streams to the west. The headwaters of the river are in eastern Manatee County near Myakka Head, and the river flows in a southerly direction through Manatee, Sarasota, and Charlotte counties, where it empties into northwestern Charlotte Harbor at Hog Island. The basin is approximately 600 square miles in area. The basin can be divided into two subbasins:

- the Upper Myakka River subbasin (area=372 square miles), which extends from the headwaters to the USGS gaging station near Sarasota; and
- the Coastal Lower Myakka Basin (area=225 square miles), which extends from the USGS gage to the mouth of the river near Hog Island (Figure 2-1).

Deer Prairie Creek and Big Slough are the principal tributaries to the Myakka River. Near the headwaters there is a large depression known locally as Flatford Swamp and marshes and swamps within the Myakka River Basin provide surface water storage. The Myakka River is the only stream channel that is primarily well-defined and naturally entrenched throughout its course in the basin.

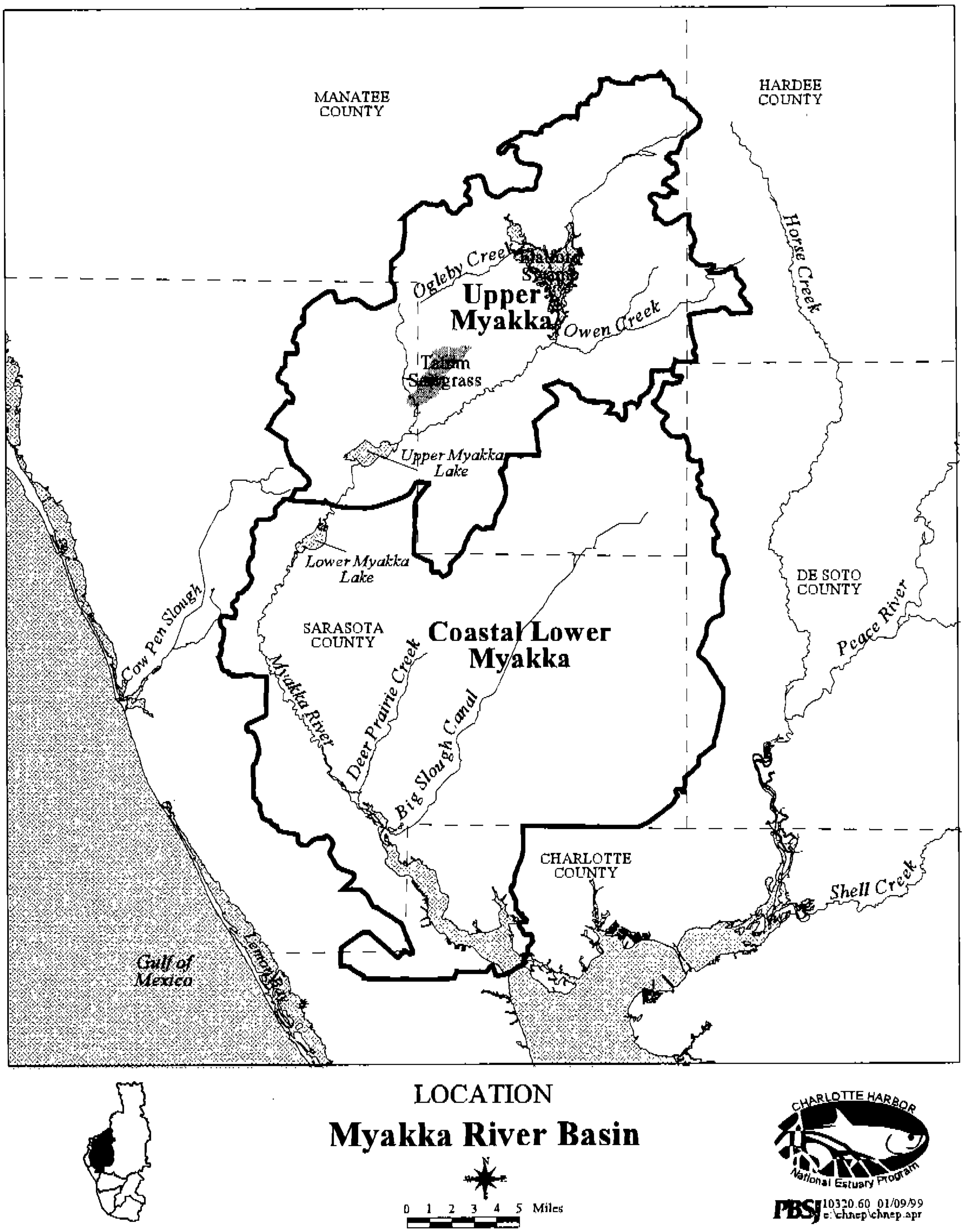


Figure 2-1. Location of the Myakka River basin in the Charlotte Harbor NEP study area.

2.1.1 Physiography

This section describes the topography, geology, soils, and land use in the Myakka River.

2.1.1.1 Topography

The maximum elevation within the Myakka River watershed is 116 feet (Joyner and Sutcliffe, 1976). Upper Myakka Lake has a water surface elevation of 13.6 feet above mean sea level (MSL) and the surface of Lower Myakka Lake is 9.9 feet above MSL.

The topography of the Myakka River Basin represents a series of relict marine terraces and is characterized as low flatlands, with moderate to gentle slopes limited to the peripheral areas in the northern half of the watershed. The terrain is generally flat and elevations along the Myakka River range from 0 feet above MSL along the tidally influenced coastal portion at the mouth of the river in Charlotte County to 50 feet above MSL in Sarasota County and to about 115 feet above MSL at the headwaters. The land along the upper reaches of the Myakka slopes about five feet per mile and then decreases to about 1 foot per mile near the mouth of the river. In some of the lower reaches, the floodplain may reach three miles in width.

The basin is characterized by lowlands along the coast, including most of the Myakka River Basin within Sarasota County. Farther north and east, within the DeSoto Plain, elevations gradually decrease from 100 to about 30 feet above MSL beyond the Myakka River Basin, separated by the Wicomico Terrace from the higher and more irregular terrain of the Bone Valley Uplands.

2.1.1.2 Geology

The Myakka River lies within two prominent physiographic regions, the Gulf Coastal Lowlands and the DeSoto Plain of the Central or Mid-Peninsular Zone of Florida. The watershed is part of the Manasota Basin and dominates the eastern and central portions of Manatee and Sarasota Counties, respectively. Most of the basin lies within the Gulf Coastal Lowlands. The Gulf Coastal Lowlands physiographic area parallels and borders the western coastal areas of the state. The surface and subsurface geology of the Myakka River basin are directly related to fluctuations in sea level. The rise and fall of sea level through geologic time resulted in the deposition of limestone and other sedimentary rocks.

The primary hydrogeologic units in the Myakka River Basin include the surficial aquifer, two intermediate aquifers and confining units, and the Floridan aquifer. The surficial aquifer is contained within the surface deposits, the Caloosahatchee Marl and the Bone Valley formation. The intermediate aquifers are contained in the Tamiami and Hawthorn Formations and parts of the Tampa Limestone. The Floridan aquifer includes part or all of the Tampa limestone, Suwannee Limestone, Ocala Limestone, and the Avon Park Limestone (Joyner and Sutcliffe, 1976).

In the northern portion of the Myakka River basin, the Floridan aquifer is the primary source of groundwater for irrigation and human consumption. The water table is approximately within 5 feet of land surface in the basin. There are seasonal fluctuations in the water table. Lowest water table levels typically occur during May or June and the highest water table levels occur in September or October. The quality of water in the surficial and intermediate aquifers is usually acceptable for potable water except near the coast where water from the Floridan aquifer is too mineralized for potable water use and is used primarily for agricultural purposes (Hammett, 1988).

The intermediate aquifers consist of an upper (Tamiami-upper Hawthorn) unit containing phosphatic marl, shell, sand, clayey sand, and phosphatic limestone of mid-Miocene to Pliocene age, and a lower (lower Hawthorn-upper Tampa) unit made up of permeable limestone and dolomite of lower and mid-Miocene age (Duerr and Wolansky, 1986; Hammett, 1988). Thickness of the upper unit ranges from 200 to 400 feet, and the lower unit from 150-300 feet. The two aquifers are separated by a confining bed of relatively impermeable clay material, although breaches of the confining layer hydraulically connect the two.

There are two major springs, Little Salt Springs and Warm Mineral Spring, within the Myakka River basin. These springs discharge to the Myakka River via tributary channels. Little Salt Springs currently generates little if any flow. Warm Mineral Springs discharges through a tributary to the Myakka River. The discharge water is very saline and results from artesian flow from the Floridan aquifer.

Springs, seeps, and sinkholes indicate the presence of connections between the surficial aquifer and deeper water bearing units in the watershed. In the Myakka River Basin, the river channel and most lakes are underlain by impermeable clays. Surficial materials are dominantly sandy, occasionally with relatively clayey substrata, and with significant organic deposits. The Upper Myakka subbasin lies partially within the Central Lake district, a sandhill karst terrain with innumerable solution basins, and the principal recharge area of the Floridan aquifer (Stewart, 1980). The Upper and Lower Myakka Lakes appear to be solution features connected to lower aquifers.

The lower Hawthorn-upper Tampa aquifer is recharged by lateral flows and upward leakage from the Floridan aquifer, and discharges to the Tamiami-upper Hawthorn aquifer. In some portions of the basin the Tamiami-upper Hawthorn aquifer is also recharged by downward leakage from the surficial aquifer. A dense layer of impermeable clay in the most northern portion of the basin forms an impermeable layer between the overlying sandy material and underlying limestone and produces numerous collapse sinkholes in which the clay initially forms a bridge over a developing limestone cavity. Failure of the bridge leads to a sinkhole that may be small or very large. These sinkholes are rare farther south in the basin where the sedimentary cover is more than 60 meters thick.

2.1.1.3 Soils

The National Resource Conservation Service (NRCS) county soil reports and map provided most of the information discussed in this section. Flatwoods soils comprise the majority of the Myakka River Basin in Sarasota County, including the Eugallie-Myakka-Holopaw-Pineda and Pomello-Myakka-Eugallie series. They are nearly level, poorly drained to very poorly drained and have a sandy surface layer and sandy and loamy subsoils. Flatwoods and sloughs soils occur predominantly as Myakka, Oldsmar, and Immokalee soils series, or combinations of these. These soils are nearly level, poorly drained, sandy, and have loamy subsoils and the differences in these soil types are primarily related to the depth of organic-stained subsoils. Soils associations adjacent to the river channel occur as Felda series combinations. These soils are poorly drained sands over beds of sandy and loamy marine sediments and are characteristic of floodplains. The lower portion of the Myakka River in Sarasota County is a Kesson-Wulfert soil and is associated with mangrove swamps.

In the Coastal Lower Myakka subbasin, dominant soil types are Oldsmar-Myakka, Wabasso-Pineda-Boca, and Immokalee-Myakka soils across nearly 90% of the watershed in Charlotte County. Myakka and Immokalee soils are very poorly drained, while the Pomello and Cassia soils are moderately to well-drained soils of low ridges. The mouth of the Myakka River is characterized by Peckish-Estero-Isles tidal and barrier island soils (poorly drained mucky fine sands) in Charlotte County.

The Upper Myakka subbasin occurs in Manatee County where the flatwoods soils occur on Waveland-Pomello-Myakka and Myakka-Waveland-Cassia series across approximately 75% of the county. Hammock, floodplain, depression, and marsh soils also occur along the rivers. The soils in the DeSoto Plain in the most northeastern portion of this subbasin are characterized as nearly level, poorly drained, sandy soils, with weakly cemented sandy subsoil and poorly drained sandy soils throughout. The soils at the headwaters are nearly level sandy soils with dark subsoil.

Each soil series can be classified into a hydrologic soil group (HSG) based on its runoff-producing characteristics. The most important of these characteristics is the capacity of the soil to permit infiltration when bare of vegetation. The four major hydrologic soil groups are described below.

> **Group A** (low runoff potential) - soils with high infiltration rates even when thoroughly wetted. Composed primarily of sands and gravel that are deep and well to excessively drained. These soils have a high rate of water transmission. Minimum infiltration rate is 0.30-0.45 in/hr.
>
> **Group B** (low to moderate runoff potential) - soils with moderate infiltration rates when thoroughly wetted. The soils are typically moderately fine to moderately coarse in texture and have a moderate rate of water transmission. Minimum infiltration rate is 0.15-0.30 in/hr.

Group C (moderate to high runoff potential) - soils with slow infiltration rates when thoroughly wetted, often with a layer of soil that impedes the downward movement of water. The soils typically have a moderately fine to fine texture and a slow rate of water transmission. Minimum infiltration rate is 0.05-0.15 in/hr.

Group D (high runoff potential) - soils with very slow infiltration rates when thoroughly wetted. Primarily clay soils with a high permanent water table or shallow soils over nearly impervious materials, such as a clay pan or clay layer. These soils have a very slow rate of water transmission. Minimum infiltration rate is 0.0-0.05 in/hr.

A and B soils exhibit lower runoff potential and are better drained when compared to C and D soils. Most soils within the Myakka River Basin are classified hydrologically as hydrological soil group (HSG) B/D, as assigned by the NRCS. The B/D designation is assigned when a soil type exhibits different runoff characteristics under developed ("improved") and undeveloped conditions. "Improved" conditions which provide better drainage to a soil type are then designated B, while soils remaining in a less well-drained undeveloped condition are designated as a D soil. The Myakka River Basin includes approximately 73% B soils, nearly 20% D soils, and almost 8% of the basin with A or C soils (Table 2-1) (Figure 2-2).

Table 2-1. Hydrologic Soil Types in the Myakka River Basin.

Soil Type	Upper Myakka		Lower Coastal Myakka	
	Acres	%	Acres	%
A	6,101	4.2	104	< 0.0
B	114,742	79.7	165,196	69.4
C	14,093	9.8	9,016	3.8
D	8,978	6.2	63,881	26.8
TOTAL	143,913	100.0	238,197	100.0

2.1.2 Rainfall

The data discussed in this section were obtained from the National Weather Service, SWFWMD, or SFWMD. Rainfall in the Myakka River Basin, like the other basins, is a product of a wet subtropic (humic mesothermal) climate with a warm summer and no dry season, similar to the entire Charlotte Harbor NEP watershed. Annual precipitation on the Myakka River is about 50-55 inches,

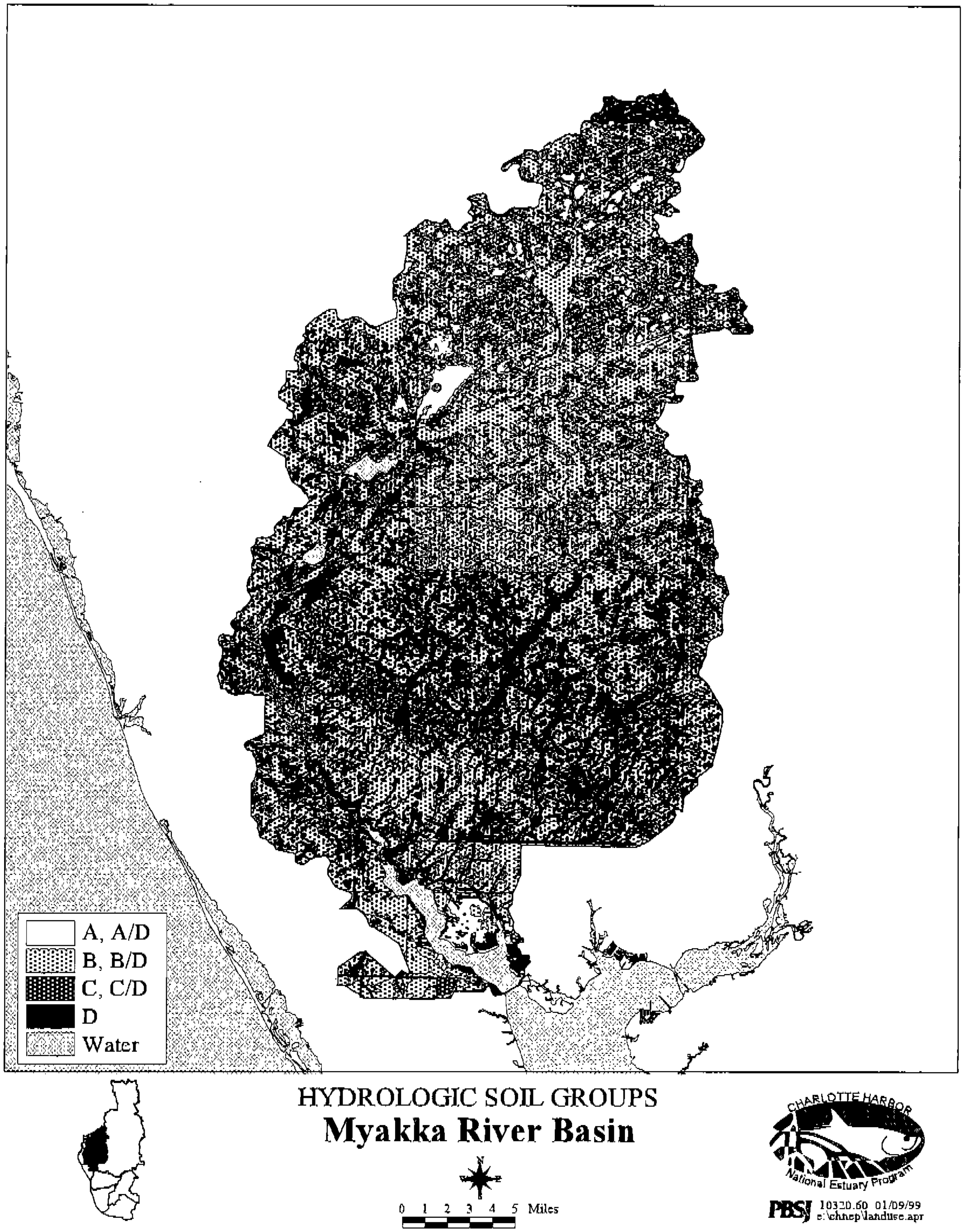


Figure 2-2. Hydrologic soil groups in the Myakka River basin.

with generally 6-8 months of low rainfall (2.0-2.5 inches/month) and 4-6 months of heavy, but spatially variable rains (5-8 inches or more/month). November is the driest dry season month as a result of the absence of both summer convection and winter frontal systems and the shift of tropical storms to the west of Florida. In mid-spring the frontal systems move north and the local seabreeze/convection circulation dominates the wet season rainfall. Most wet season rainfall is associated with frequent, but highly localized thunderstorms. Day-long wet season storms are infrequent and are generally associated with tropical disturbances. Heaviest wet season rainfall is associated with an up air trough that is centered over southern Florida in early and late summer.

Basin rainfall patterns were modeled using data from a network of rainfall gages throughout the Charlotte Harbor watershed. Data from a total of 18 rainfall gages were used in modeling the rainfall for the Myakka River Basin. Locations of these rainfall stations are shown in Figure 2-3. Total annual precipitation and average monthly precipitation from 1970 to present for the Coastal Lower Myakka and Upper Myakka subbasins are presented in Figures 2-4 and 2-5, respectively.

Total annual precipitation and average monthly precipitation were very similar in the two subbasins. Minimum total annual precipitation ranged from approximately 40 inches of rain (observed in 1990) to about 75 inches of rain in both subbasins. Average monthly precipitation patterns were seasonal and typical for Florida. Rainfall was highest from June to September, and wet season average values ranged from 7 to nearly 9 inches. Average monthly rainfall values were lowest during November and December (approximately 2 inches) and did not exceed 4 inches through May. Although there was a peak of nearly 4 inches in March, a bimodal pattern of wet season rainfall characteristic of south Florida was not apparent. Coastal Environmental (1996) examined the long-term trends in rainfall and flow in both the Peace and Myakka rivers and found a declining trend in rainfall for the Upper Myakka River with the estimated annual percent decline of 0.15%/year for the period 1948-1993.

2.1.3 Existing and Future Land Use/Cover

Land use data were obtained from SWFWMD, SFWMD, and the Southwest Florida Regional Planning Council (SWFRPC). Although other sources of data were available for various portions of the Charlotte Harbor NEP study area, these data sources provide a complete and consistent coverage for the entire study area.

Existing and future land use GIS coverages for the Charlotte Harbor NEP area are not always consistent in land use codes and coverages. Existing land use coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SFWMD) land use data. Land Use data from

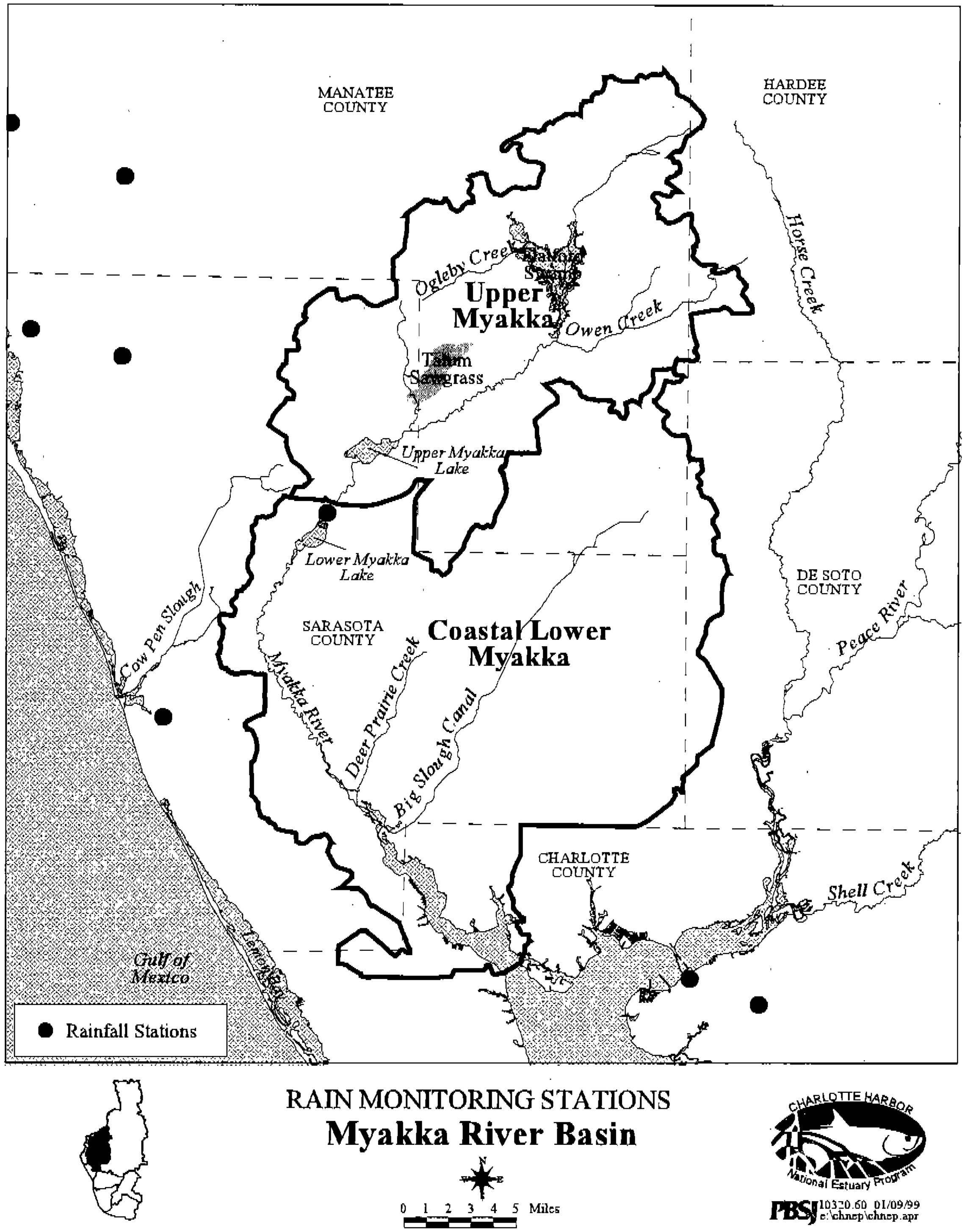
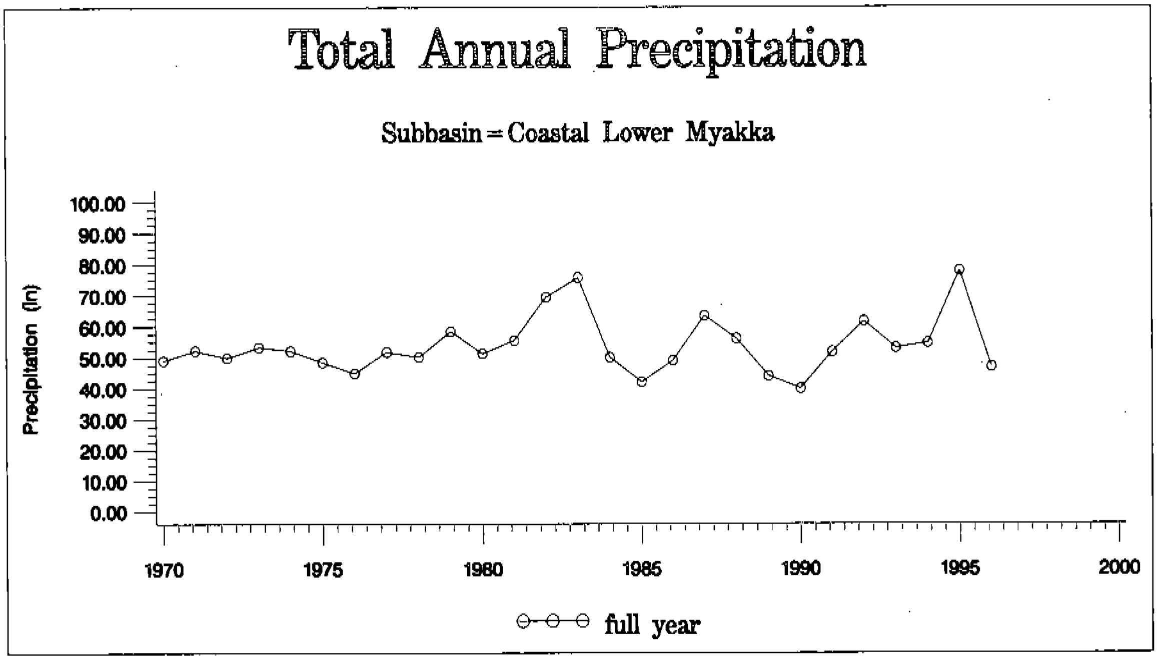


Figure 2-3. Rain station locations in the Myakka River Basin.



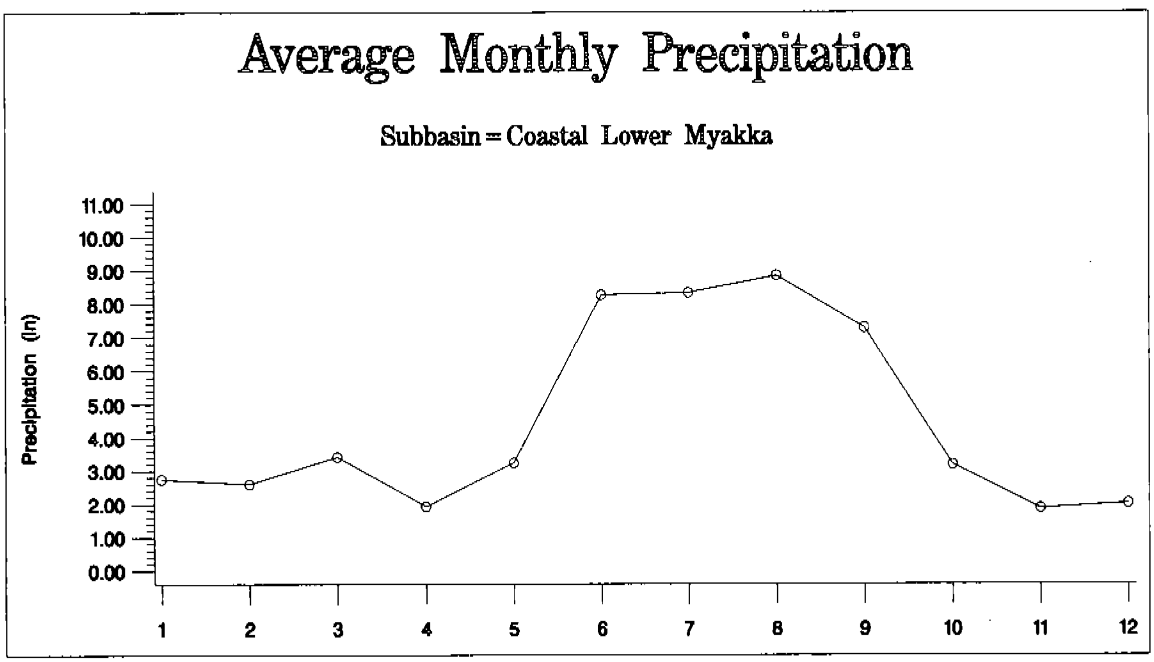
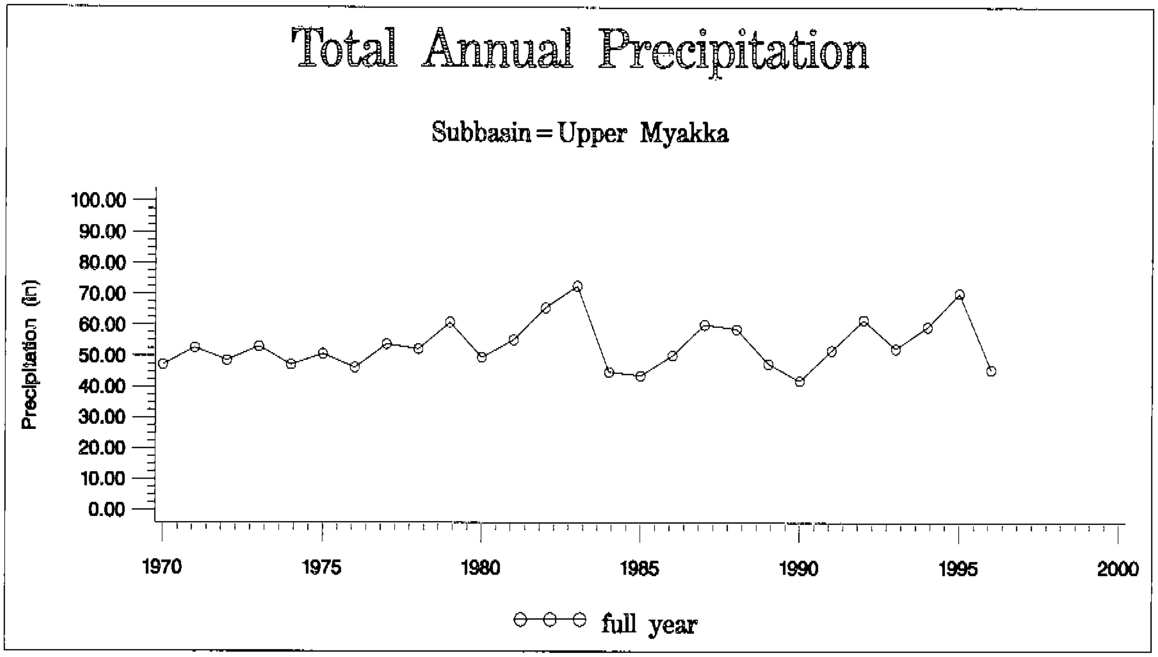


Figure 2-4. Total annual and monthly rainfall plots for the Coastal Lower Myakka subbasin.



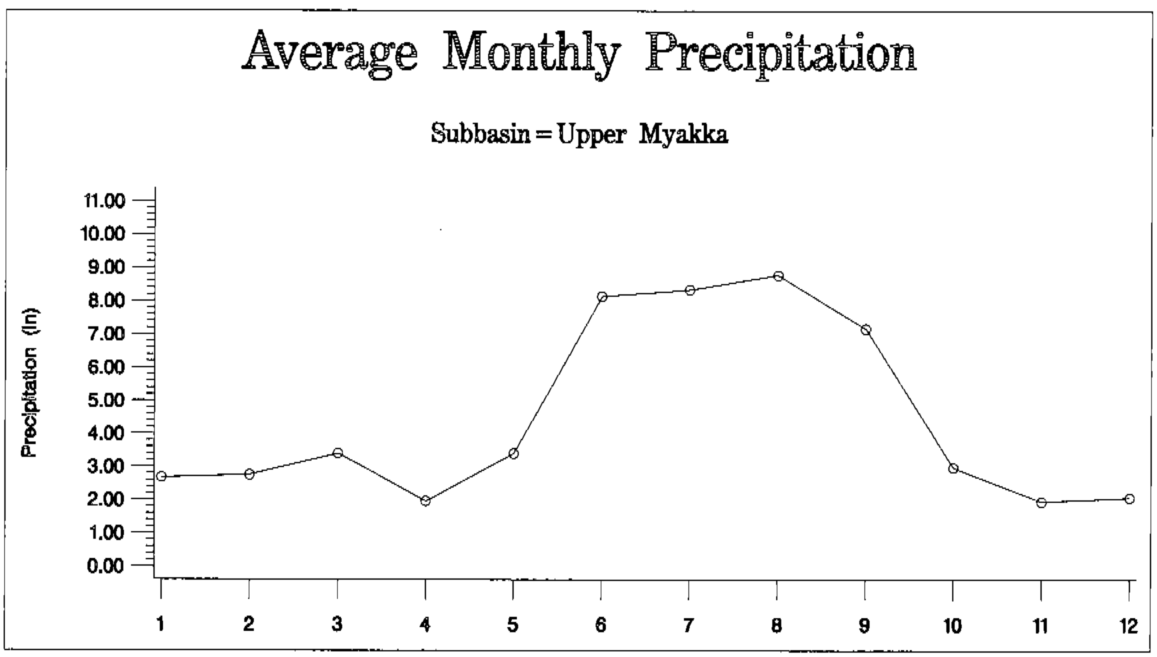


Figure 2-5. Total annual and monthly rainfall plots for the Upper Myakka subbasin.

SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We evaluated the two systems and developed a hybrid that is now in use for this project.

Future land use coverages for the Charlotte Harbor NEP were developed by the SWFRPC. SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions.

The FLUMs use a different and much simpler, land use classification system than either of the existing land use coverages and does not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). Residential areas, then, may increase tremendously under future scenarios because existing development is not taken into account.

As a result, direct comparisons between acreages of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category. In the Upper Myakka basin, existing single family residential land use includes 2,436 acres (Table 2-2), while this same land use includes only 170 acres under future land use (Table 2-3). Total future residential (1,734 acres) is much more consistent with existing residential (2,436 acres) in light of the other limitations to FLUMs, described above.

2.1.3.1 Existing Land Use and Land Cover

Existing land use in the Myakka River Basin includes 13% agriculture and 5% urban (Table 2-2). Areas of urban development occur primarily along the coastal areas in Sarasota and Charlotte counties (Figure 2-6) and increases in urban development are expected to be higher for the Coastal Lower Myakka subbasin when compared with the Upper Myakka subbasin. Single family and medium density residential land use acreages are presently nearly twice as high for the Coastal Lower Myakka subbasin (3.5%) when compared with the Upper Myakka subbasin (1.8%) (Table 2-2). Away from the coast, agricultural use is predominant and percentages of land use in pasture and rangelands are 45% and 57% for the lower and upper subbasins, respectively.

During 1990, phosphate mining resumed near Wingate Creek near the headwaters of the river and is expected to continue (Sarasota County, 1993). Most hydrological alterations in the watershed were initiated between the early 1940's and early 1950's. Dredging and canal excavation have continued since that time.

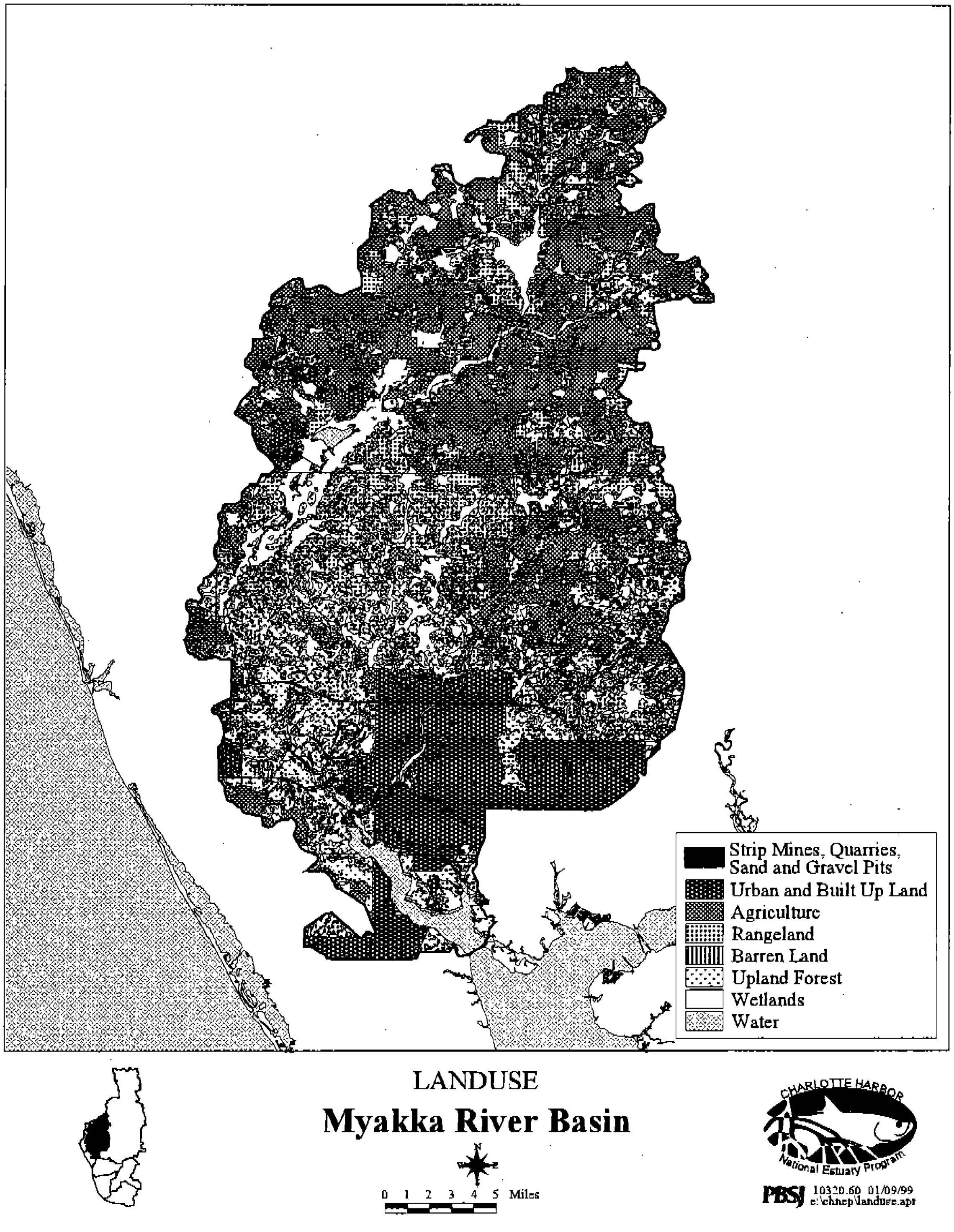


Figure 2-6. Existing land use map (SWFRPC, 1990) for the Myakka River Basin.

Table 2-2. Current (1990) land use/cover in the Myakka River Basin.

Land Use/Cover	Upper Myakka		Lower Coastal Myakka	
	Acres	%	Acres	%
Single Family Residential	2,436	1.7	5,846	2.5
Medium Density Residential	92	0.1	2,265	1.0
Multi-family Residential	0	0.0	1,465	0.6
Commercial	19	< 0.1	268	0.1
Industrial	0	0.0	71	< 0.1
Mining	416	0.3	321	0.1
Institutional	303	0.2	1,895	0.8
Range Lands	29,098	20.2	77,804	32.7
Barren Lands	518	0.4	359	0.2
Pasture	54,424	37.8	28,828	12.1
Groves	2,598	1.8	1,075	0.5
Feedlots	281	0.2	5	< 0.1
Nursery	43	< 0.1	122	0.1
Row and Field Crops	6,559	4.6	1,326	0.6
Upland Forested	16,174	11.2	56,277	23.6
Freshwater - Open Water	2,264	1.6	3,269	1.4
Saltwater - Open Water	0	0.0	5,461	2.3
Forested Freshwater Wetland	16,625	11.6	17,492	7.3
Saltwater Wetland	2	0.0	2,204	0.9
Non-forested Freshwater Wetland	12,058	8.4	31,848	13.4
Tidal Flats	0	0.0	31	< 0.1
TOTAL	143,913	100.0	238,197	100.0

Forested uplands comprise 11.2% and 23.6% of the Upper Myakka and Coastal Lower Myakka subbasins land cover, respectively (Table 2-2). Forested freshwater wetland comprise 11.6% and 7.3% of the Upper Myakka and Coastal Lower Myakka subbasins land cover, respectively. Nonforested freshwater wetlands are the other major natural land cover, comprising 8.4% and 13.4% in the upper and lower basins, respectively.

2.1.3.2 Future Land Use

Future land use changes defined by the SWFRPC (Figure 2-7) indicate a substantial increase in agriculture and a smaller increase in urban land use in the Coastal Lower Myakka subbasin (Table 2-3). In contrast, an increase to 90% agriculture and a decrease to less than 1% urban are included in the county future land use maps for the Upper Myakka River subbasin (Table 2-3, Figure 2-7). Categories other than agricultural and urban, such as upland forest, rangeland, and pasture land uses may convert to urban land uses in the unlikely event of 100% build-out in the basin.

Table 2-3. Future (2010) land use/cover in the Myakka River Basin.

Land Use/Cover	Upper Myakka		Lower Coastal Myakka	
	Acres	%	Acres	%
Single Family Residential	170	0.1	45,725	19.5
Multi-family Residential	280	0.2	4,528	1.9
Rural Residential	1,287	0.9	27,747	11.9
Commercial	0	0	4,577	2.0
Industrial	0	0	1,362	0.6
Mining	56	< 0.1	5,058	2.2
Agricultural	129,163	89.3	95,114	40.6
Wetlands	939	0.6	764	0.3
Protected Resource	12,719	8.8	49,229	21.0
TOTAL	144,614	100.0	234,104	100.0

2.1.4 Surface Water Hydrology and Water Management Practices

This section discusses the spatial and temporal patterns of surface water hydrology and examines urban and agricultural water management practices.

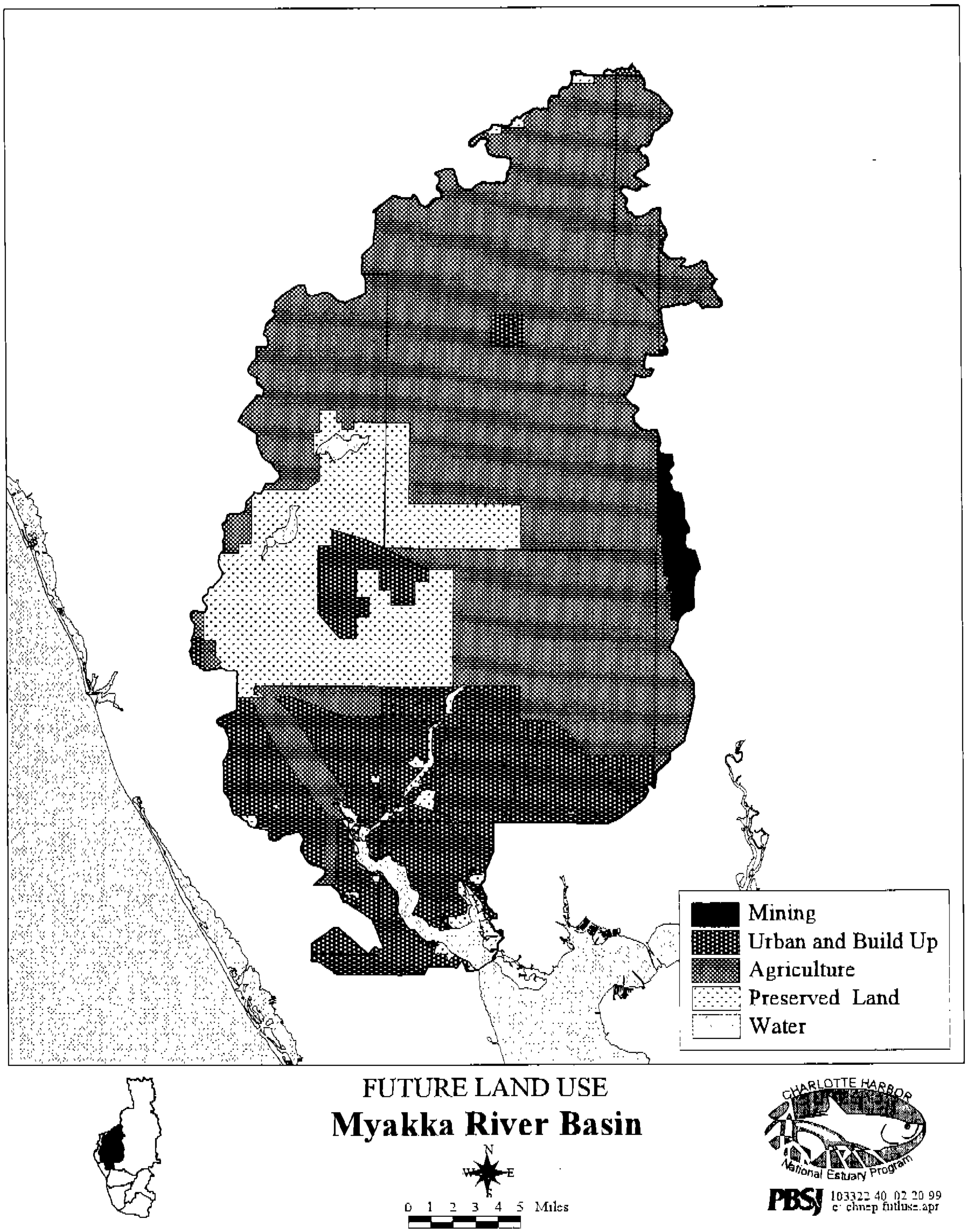


Figure 2-7. Future land use map (SWFRPC, 1990) for the Myakka River Basin.

2.1.4.1 Surface Water Hydrology

The primary conveyance in this basin is the Myakka River. Two springs flow into the lower Myakka River, Little Salt Spring and Warm Mineral Spring. Little Salt Spring currently has negligible flow, and historically flowed at only a few cubic feet per second (cfs). Warm Mineral Spring discharges to a pool and then flows two miles to the Myakka River, with an average discharge of approximately 10 cfs. In addition, Big Slough Canal and Deep Prairie Creek flow into the Myakka River in its southern reaches from the northeast, both draining largely rangeland areas, with Big Slough Canal channelized in its upper reaches to enhance drainage. The downstream portion of Big Slough Canal flows through some urbanized areas and receives drainage from residential canals. In the upper reaches of the Myakka River are found Lower and Upper Myakka Lakes, while farther upstream are the Tatum Sawgrass and Flatford Swamps.

There are remnants of two streamflow control structures on the Myakka River and they affect the river morphology. In 1941, a levee was constructed at the upper lake outfall to divert water away from adjacent low-lying pastureland and to retain water in the lake during droughts (Flippo *et al.*, 1968). Although a control weir was included in that levee, it is no longer operated and remains open. However, it is estimated that the levee impedes flow in the river sufficiently to keep the water level of Upper Myakka Lake one to two feet higher than prior to levee construction. The south structure remnant is a dam or levee that was constructed to stabilize the water level in Lower Lake Myakka. Although only traces of this levee remain, it still impedes flow to a small degree.

Other streamflow control structures include Down's Dam, a private dam located 0.25 miles south of the Myakka River State Park, and Dams on Deer Prairie Creek and Big Slough Canals. Curry Creek, also called Blackburn Canal, is dammed between the river and Dona Bay.

Total monthly streamflow data were obtained from USGS monitoring records for the Charlotte Harbor watershed and streamflow patterns were examined. The locations of gaging stations in the Myakka River Basin are shown in Figure 2-8. Flow records from these stations are presented in Appendix B. There is an atmospheric-deposition monitoring station at the Verna Wellfield, as well.

The Myakka River near Sarasota station provides the longest period of record and the total annual flow and average monthly flow are presented in Figure 2-9. Over the period of record the total annual flow was typically in the range of 2,000 - 4,000 cfs. Streamflow exhibited large variation in discharges with mean monthly flows ranging from 100 to 700 cfs, but have seasonally characteristic patterns. Maximum discharges occurred in September, near the end of the summer rainy season and are generally associated with hurricanes or tropical storms. Streamflow is lowest in winter and late spring. As would be expected, flow patterns are consistent with rainfall patterns as described above). A long-term decline in wet season stream flow in the Myakka has been described previously using data for the period 1940 through 1992 (Coastal Environmental, 1994).

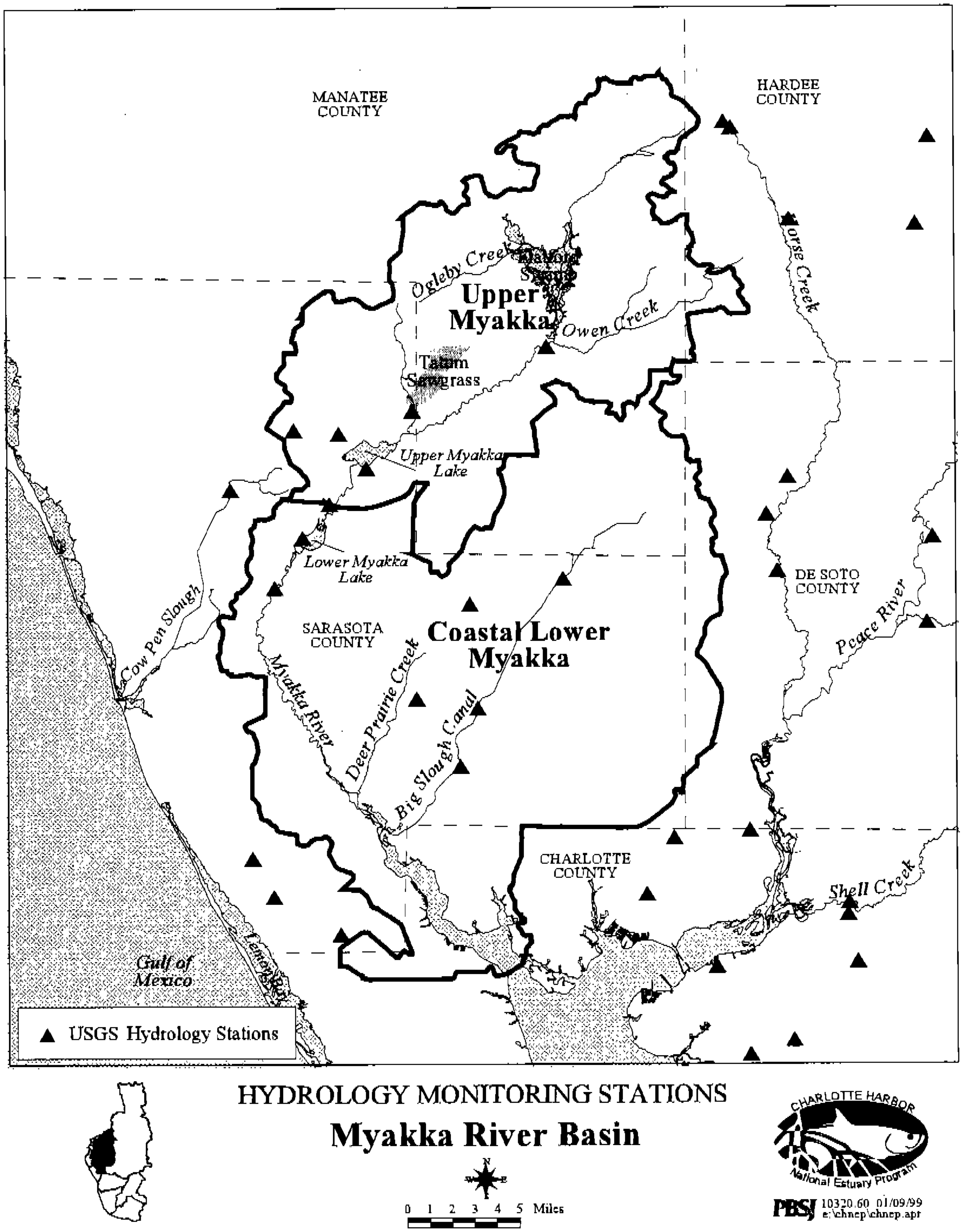
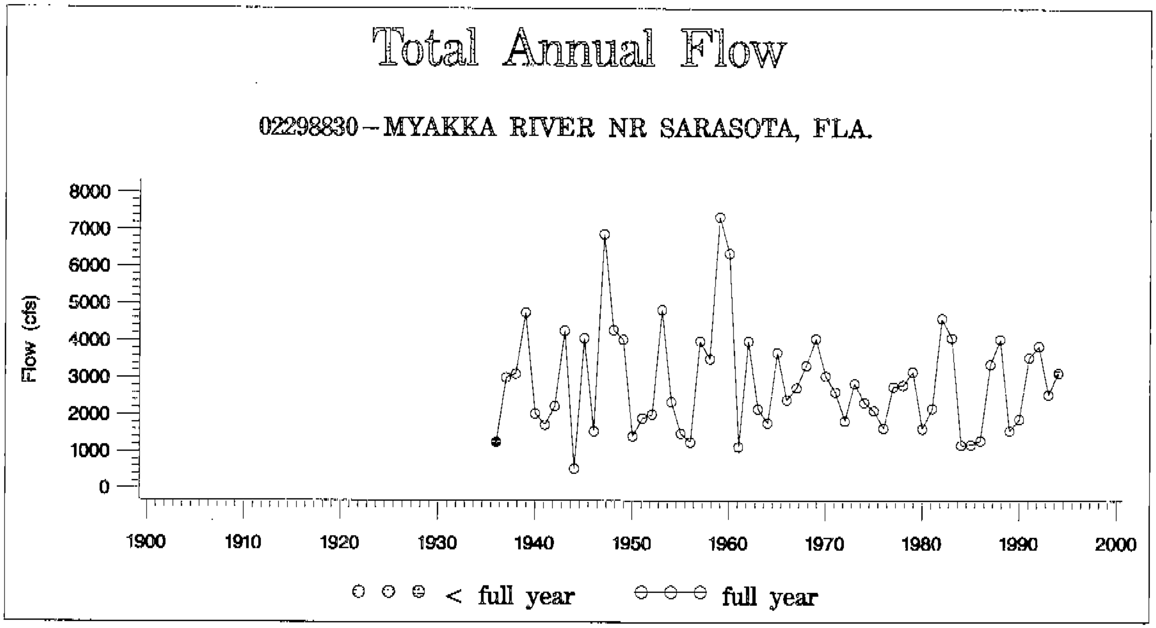


Figure 2-8. USGS monitoring stations in the Myakka River Basin.



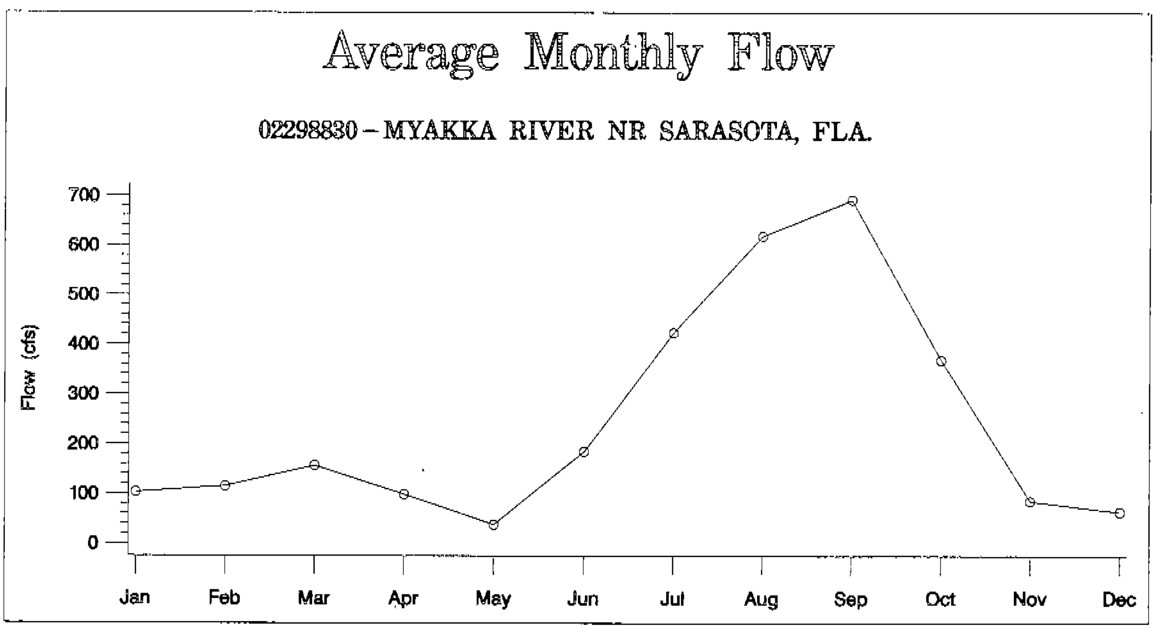


Figure 2-9. Plots of total annual flow and average monthly flow at station 02298830 in the Myakka River Basin.

Figure 2-9 illustrates the decline in wet season flows for the Myakka River near Sarasota. This same trend was not identified by Hammett (1988) for a twenty-five year period ending in 1981.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. This discussion of water use is focused on facilities with an average permitted quantity greater than 0.5 million gallons per day (MGD). All water use information for those parts of the Charlotte Harbor NEP study area within the borders of the SWFWMD, including the entire Myakka River Basin, is from SWFWMD (1997) and SWFWMD (1992).

- Public Supply

Table 2-4 shows the public water supply facilities in the Myakka River Basin with permitted withdrawals of more than 0.5 MGD, as well as the withdrawal sources for the facilities. A discussion of the populations served by each plant, withdrawal amounts, and withdrawal methods follows.

Table 2-4. Public water supply facilities in the Myakka River Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
City of North Port	2.1	Myakkahatchee Creek
City of Sarasota	12.0	Upper, Intermediate Floridan aquifers

The City of North Port obtains its public water supply from a water treatment facility via surface water withdrawal from Myakkahatchee Creek (Big Slough Canal). This plant was previously owned and operated by General Development Utilities (GDU) (SWFWMD, 1992), but is currently owned and operated by the Peace River/Manasota Regional Water Supply Authority (PRMRWSA). Withdrawals from Myakkahatchee Creek in the future may be limited due to supply and water quality problems, with future supply being likely supplemented by the Peace River Regional Water Treatment Plant (SWFWMD, 1992). Permitted average withdrawal for the facility is 2.1 MGD. This facility supplied an estimated population of 12,181 with 1.63 MGD during 1990 (SWFWMD, 1992).

The City of Sarasota utilizes groundwater from the Myakka River Basin for its public water supply. The Verna Wellfield, located near the boundary of Manatee County and Sarasota County approximately 17 miles east of Sarasota, is partially in the northwestern portion of the Myakka River Basin. The City of Sarasota withdraws from 39 wells in Verna Wellfield. The wells are between 500 and 600 feet deep, and withdraw from the Upper Floridan aquifer. The permitted withdrawal from this source for the City of Sarasota averages 6.0 MGD. The city also operates six wells located within the city limits. These wells are 345-650 feet deep, and withdraw from the Intermediate and Upper Floridan aquifers. The permitted average quantity for the entire system is 12.0 MGD. An estimated population of 54,186 was provided with 8.41 MGD during 1990 by this plant (SWFWMD, 1992).

- Mining

Mining land use accounts for 737 acres of the Myakka River Basin, only 0.2% of the total area of the basin. Mining is confined to the Manatee and Sarasota counties portions of the basin. Within the Myakka River Basin are found two mining facilities. Table 2-5 lists the mining operations, permitted average and maximum withdrawals, and withdrawal source for each mine.

Table 2-5. Mining operations water use in the Myakka River Basin.

Company	Permitted Average Withdrawal (MGD)	Permitted Maximum Withdrawal (MGD)	Source
Myakka River Resource, Inc.	1.21	----	Groundwater
Nu-Gulf Industries, Inc.	6.41	----	Groundwater

The Myakka River Resources, Inc., mining operation is in Sarasota County, and has a permitted average withdrawal from groundwater sources of 1.21 MGD. During 1994, the facility utilized its entire permitted withdrawal. The remaining mining facility is operated by Nu-Gulf Industries, Inc., in Manatee County. This facility has a permitted average withdrawal from groundwater sources of 6.41 MGD, and also utilized its entire permitted withdrawal in 1994.

- Industrial

Industrial land use in the Myakka River Basin totals 71 acres, only 0.02% of the basin total. No facilities are identified in SWFWMD, 1997, within the Myakka River Basin which have greater than 0.5 MGD average permitted withdrawals.

- Recreational

Golf courses and landscape (parks, medians, attractions, cemeteries, and other green areas) water use locations are not identified by SWFWMD (1997), so no basin-specific water use is associated with these land uses. However, water use by county for golf courses and landscape for that portion of the county within the SWFWMD is provided. Sarasota County water use for golf courses in 1994 was 7.9 MGD, and landscape water use for the same time period was 0.4 MGD, for a total recreational use of 8.3 MGD for the county. In Manatee County, golf course water use was 3.0 MGD in 1994, and landscape water use was 0.1 MGD, totaling 3.1 MGD for the county. Portions of Charlotte County within the SWFWMD had water use for golf courses in 1994 of 2.9 MGD, and landscape water use for 1994 was 0.5 MGD, for a total recreational usage of 3.4 MGD for the county.

Water Discharge and Reuse

The Myakka River Basin is provided wastewater treatment services by two plants located in the southern portion of the basin. These two domestic waste water treatment plants are associated with the urbanized areas in the southern part of the basin. The Myakka Utilities Waste Water Treatment Plant (WWTP) discharges some effluent to percolation ponds, with the remainder used for spray irrigation (Zarbock *et al.*, 1995). The City of North Port WWTP discharges effluent to percolation ponds as well, with the remainder of its effluent utilized for spray irrigation.

Industrial point source waters are discharged by the two Nu-Gulf Industries Wyngate Creek Mine outfalls in the northern half of the basin.

2.1.4.2 Agricultural Management Practices

The description of agricultural management practices in the Myakka River Basin, and all remaining basins of the Charlotte Harbor NEP study area, depends upon a knowledge of the types of management practices utilized in the area, specifically those dealing with irrigation. The following discussion of general background information precedes the specific description of the practices in the Myakka River Basin.

Irrigation types may be divided into overhead, low volume, and seepage systems. Overhead sprinkler systems apply irrigation water over the top of the irrigated crop. Low volume systems deliver irrigation water through a network of plastic pipes to the immediate vicinity of the individual plant, and include drip, trickle, and micro jet systems. Seepage systems involves the application of irrigation waters to a crop via a network of ditches or underground pipes, with water delivered directly to the root zone (SWFWMD, 1992).

Irrigation types may vary for an individual crop through its establishment and growth phases. For example, establishment of strawberry crops may utilize overhead irrigation, with low volume irrigation used during the growing phase of the crop. Similarly, vegetable crops may be established utilizing seepage irrigation, with low volume systems used later for crop growth and production (SWFWMD, 1992).

As discussed previously, agriculture is a major land use within the study area of the Charlotte Harbor NEP watershed. As such, the management practices utilized on agricultural lands can have adverse impacts on the quantity and quality of soils, surface water, and groundwater in much of the study area. Likewise, through improved environmental performance of farming systems, an excellent opportunity exists for large-scale improvement in water and soil quality and quantity.

The prevalent land uses within the Myakka River Basin, according to the 1990 SWFWMD land use coverage, are dominated by rangeland and pasture land uses. Agricultural land uses in addition to pasture only cover approximately 3% of the basin, with the largest of these being row and field crops (7,885 acres). Citrus groves only occur on approximately 3,673 acres (see Table 2-2).

The 1990 SWFWMD and 1988 SFWMD land use coverages provide a general depiction of the areal distribution of agricultural crops in the Charlotte Harbor NEP study area. For the purposes of defining existing agricultural management practices at the resolution of each study basin, other more detailed sources of agricultural information were combined and integrated.

The agricultural information obtained describes crop types and acreages, water usage, and irrigation practices for each county within the SWFWMD portion of the watershed, and crop types, acreages, and water usage in the Lower West Coast region of the SFWMD. The information available from the SWFWMD and the SFWMD (SWFWMD, 1992, and SWFWMD, 1997; SFWMD, Vols. II and III, 1994, respectively) was considered the most recent and accurate information in terms of which crop types and irrigation practices are utilized in specific areas of the watershed. The land use coverages from the Districts were considered the best information available to delineate field boundaries of crop types. The county-wide totals for irrigation practices by crop type only allowed general descriptions of irrigation practices. Irrigation types as referenced in SWFWMD (1994) include overhead, low volume, and seepage irrigation for vegetables, citrus, irrigated pasture, sod, nursery, and other agronomic crops, as determined from SWFWMD Water Use Permits.

The agricultural land use area within Manatee County in 1990 was estimated by SWFWMD (1994). The areas given to all major crops, including agronomic crops (corn, peanuts, soybeans, tobacco, etc.), row and field crops, citrus, nurseries, sod, and irrigated pasture were included in these estimates. Irrigated acreages for each of these crops was also estimated, as well as estimated water use. Total 1990 agricultural acreage from this estimate for the entire county was 52,325 acres, with an associated estimated water use of 121.0 MGD (SWFWMD, 1994). The estimated crop acreages, irrigation types, and estimated water use for all of Manatee County are listed in Table 2-6.

The agricultural land use area within Sarasota County in 1990 was estimated by SWFWMD (1994). The areas given to all major crops, including agronomic crops, row and field crops, citrus, nurseries, sod, and irrigated pasture were included in these estimates. Irrigated acreages for each of these crops was also estimated, as well as estimated water use. Irrigated acreages for each of these crops was also estimated, as well as estimated water use. Total 1990 agricultural acreage from this estimate for the entire county was 10,875 acres, with an associated estimated water use of 24.9 MGD (SWFWMD, 1994). Table 2-7 shows the estimated crop acreages, irrigation types, and estimated water use for all of Sarasota County.

Table 2-6. 1990 estimated crop acreages, irrigation types, and water use in Manatee County.

Crop	Acreage	Irrigation Type -Acreage		Water Use (MGD)
Agronomic	2,000	Seepage	2,000	2.1
Row/Field Crops	24,200	Low volume Seepage	2,800 20,900	77.0
Citrus	19,300	Overhead Low Volume Seepage	965 13,510 965	18.5
Nursery	2,175	Overhead Low Volume Seepage	975 100 1,100	14.6
Sod	3,200	Overhead Low volume	2,200 1,000	6.4
Irrigated Pasture	1,450	Seepage	1,450	2.4
TOTALS	52,325	Overhead Low Volume Seepage	4,140 17,410 26,415	121.0

Table 2-7. 1990 estimated crop acreages, irrigation types, and water use in Sarasota County.

Crop	Acreage	Irrigation Type -	Acreage	Water Use (MGD)
Agronomic	200	Seepage	200	0.2
Row/Field Crops	3,100	Seepage	3,100	9.1
Citrus	1,800	Low Volume Seepage	1,530 180	3.2
Nursery	220	Overhead	220	1.5
Sod	5,000	Seepage	5,000	10.0
Irrigated Pasture	555	Seepage	555	0.9
TOTALS	10,875	Low Volume Seepage	1,530 9,035	24.9

Southern Water Use Caution Area (SWUCA)

In August of 1994, the SWFWMD published a notice stating that the District intended to adopt a set of rules to "prevent further adverse effects resulting from excessive withdrawals" in the proposed Southern Water Use Caution Area (SWUCA). The set of rules was intended to provide specific regulatory guidelines concerning water use permitting. The proposed set of rules involved amendments and additions to the District's existing water use permitting rules, modifications to the District's Basis of Review (BOR), and a new rule which would establish minimum aquifer levels within the SWUCA. By October 1994, several organizations had challenged the proposed rules. The final list of petitioners included Charlotte, Pinellas, DeSoto, Hardee, and Polk counties, the Environmental Confederation of Southwest Florida, Inc., G B S Groves, Inc., and Citrus Grower Associates, Inc.

The proposed SWUCA was the result of several District studies of water resources within its boundaries. The SWUCA comprises most of the District south of the Hillsborough River, totaling 5,100 square miles, including all of DeSoto, Hardee, Manatee, and Sarasota counties, and portions of Charlotte, Highlands, Hillsborough, and Polk counties. Coastal areas of Hillsborough, Manatee and Sarasota counties have been a source of concern since the mid-to-late 1980's because of deteriorating water quality in wells drilled into the Upper Floridan Aquifer System (UFAS), which is more confined in the Southern Groundwater Basin, as identified by the District, than in other portions of the District. This concern lead to initiation of the Eastern Tampa Bay Water Resources Assessment Project (ETB WRAP) during the 1980's.

One of the principal objectives of the ETB WRAP was to develop tools or mechanisms for the District to utilize in regulating water use. The District sought to develop a safe yield for the region, with safe yield being the level of use which can be sustained without causing unacceptable effects, comprised of both hydrologic and socioeconomic components. During the ETB WRAP, unacceptable impact was considered to be any further landward movement of saltwater-freshwater interface, so that safe yield was viewed as a quantification of the amount of water that could be withdrawn from existing wells in the ETB WUCA without producing significant additional movement of the transition zone.

As part of the ETB WRAP, two safe yield scenarios were analyzed. The first was a reduction in groundwater withdrawals to 100 MGD in the ETB WUCA, and the second was a reduction in groundwater withdrawals in the ETB WUCA to 150 MGD and a limitation on groundwater withdrawals in the remainder of the basin to about 500 MGD. Modeling efforts showed that 1) if pumping continued to increase as projected, the saltwater interface would affect water quality further inland, and 2) if 1989 water use levels continued into the future, saltwater would continue to replace fresh water in the aquifer. The District decided that results of the modeling using 1989 water use were unacceptable, and thus selected potentiometric surfaces that occurred in 1991 as the proposed minimum level within the SWUCA. The 1991 levels reflect a reduction in groundwater pumpage from 1989 of approximately 30% within the ETB WRAP and approximately 15% throughout the SWUCA.

The ETB WRAP determined there had been a significant lowering of potentiometric surface levels in the Southern Basin since pre-development, and those changes were directly related to groundwater pumping. The study also concluded that the UFAS in the Southern Basin was a highly transmissive, well confined aquifer, and groundwater levels at any location in the Southern Basin were found to be a function of cumulative groundwater withdrawals occurring throughout the Basin. Information obtained from this study, and from similar efforts in other regions of the District, prompted the District to focus its efforts on development of a water resources strategy for the entire Southern Basin. In June 1989, the District established the ETB Water Use Caution Area (WUCA), along with two other WUCAs in its borders, because of its growing concerns regarding wetlands impacts, saltwater intrusion, and lowered lake levels. According to the District, final, long-term remediation and resource protection measures for ETB are embodied in the proposed SWUCA Rules.

The SWUCA includes portions of central and southern Hillsborough County that serve as sources for current and anticipated future water production for the West Coast Regional Water Supply Authority and its member governments. The South Central Hillsborough Regional Wellfield in western Hillsborough County, is one of the wellfield facilities owned and operated by West Coast, and is the only West Coast wellfield currently in operation in the SWUCA. South Central is not currently linked with the Interconnected System. The effect of proposed SWUCA Rules on South Central could have restricted production from the wellfield and necessitated West Coast's diversion of other system waters to service the South Central area, so that with no allowable increase in production from South Central, the Interconnected System would have been more highly relied upon for water delivery for Hillsborough and other West Coast members, thus impacting water availability for Pinellas.

In the Southern Basin, saline water intrusion into freshwater within the UFAS is caused by a decline in hydraulic potentials resulting from groundwater withdrawals from the UFAS. Within 6-10 miles of the coast, the chloride-rich portion of freshwater/saltwater transition zone in the Floridan aquifer has approximately one degree of slope and almost always appears within the Avon Park Formation of the UFAS. The upward and landward movement of this interface causes the lens of freshwater in the aquifer to be replaced by non-potable water in some areas.

The District has calculated that an immediate fix for the problem is not necessary or even possible without drastic reductions in pumping. The District is not only concerned with saltwater intrusion that is currently occurring, but also with the existence of conditions in the potentiometric surface that encourage further and potentially more serious intrusion. While potentiometric levels will equilibrate quickly throughout the basin, the saltwater transition zone moves at the rate of groundwater flow, so that if all pumping within the basin were halted, potentiometric surfaces throughout basin would recover relatively quickly, but the saltwater transition zone would take longer to return to pre-development conditions.

In April 1994, the District published a SWUCA Management Plan with the primary goal of developing a long-term strategy to significantly curtail or reduce the advance of saltwater intrusion and stabilize lake levels in Polk and Highlands Counties. Additional goals included preservation of the resource (including environmental features) and protection of existing legal uses. The Plan included a number of proposed water conservation measures, including basing agricultural use on higher efficiencies, permitting public supply use based on lower per-capita usage rate, and requiring other water users to increase water conservation as appropriate for the particular activity. The Plan projects that new alternative water sources can reasonably be pursued to offset existing groundwater demand and/or extend existing surface water sources. However, even if these projections are met, to stabilize saltwater interface and lake levels within the SWUCA, actual withdrawals from the confined aquifers within the ETB area and the remaining SWUCA area had to be limited to 150 MGD and 550 MGD, respectively.

A Supplemental Investigations Report, published in October 1994, concluded that the northern section of the Southern Basin was more susceptible than the southern section to water quality deterioration from saltwater intrusion, and that the ETB WRAP's and the SWUCA Management Plan's prior estimates of cutbacks necessary to achieve safe yield may not halt landward movement of the saltwater interface.

The SWUCA Rules would impact water use permitting in several ways. No new withdrawals from the Floridan aquifer in the SWUCA would be considered until the minimum aquifer level is achieved and sustained for five years. Existing permitted quantities could be reallocated to different uses and locations, and water use permit duration would be 10 years or less. Water use efficiency parameters and per capita water use assumptions were modified to encourage permittees' use of water conservation measures. For agricultural water users, credits could be accumulated based on the difference in permitted and actual water use.

The formal administrative hearing held concerning the petitions filed against the proposed SWUCA rules ran from February to November 1995, with conclusions reached in March 1997. The hearing concluded that the District's information regarding groundwater resources in the SWUCA demonstrated the need for a consistent, basin-wide regulatory program. The minimum aquifer levels selected by the District would not halt saltwater intrusion, with continued movement of the saltwater interface for at least the next 50 years even if the minimum levels were achieved, and may or may not protect wetlands from adverse impacts. However, minimum levels would help ensure a seaward gradient of freshwater flow within the UFAS.

The hearing also concluded that, although the District's analysis of the water resource problem in the SWUCA is supported by the evidence, the District's proposed method of applying the minimum levels would give existing users priority inconsistent with the statutory framework, and the proposed re-allocation program would create water rights previously unrecognized in Florida. The hearing declared as an invalid exercise of delegated authority the following sections of the proposed SWUCA Rules:

- inclusion of that portion of Polk County known as the Polk County Nub within the SWUCA in proposed Rule 40D-2.801(3)(b),
- the portion of proposed Rule 40D-8.628(1) providing current permitted quantities not be considered in violation of the minimum level, even on renewal,
- proposed Rules 40D-2.301(2) and 40D-2.331(3), and the proposed BOR Sections 1.15 and 4.3
- the portion of proposed BOR Section 4.2.B.3.d(2) which automatically allows new groundwater withdrawals to replace existing surface water withdrawals,
- the proposed subsection to BOR Section 3.6 titled "Wholesale Customers within the SWUCA", and the portion of the proposed subsection to BOR 3.1 titled "Alternative Sources within the SWUCA" which requires applicants to implement reuse where "economically, environmentally and technically feasible.", and
- the portion of proposed BOR Section 3.1 which requires an investigation of the feasibility of desalination.

The hearing also concluded that the District's existing water use permitting rules "...allowed unbridled discretion to the District without any meaningful basis to review the exercise of that discretion" with respect to the District's conditions for issuance of a water use permit. Also with respect to current water use permitting rules, the hearing concluded that the "...District's use of hydrologic presumptions is not adequately explained in the rules and there is an insufficient scientific basis for many of the presumptions as they are currently written..." and that the presumptions are invalid. It was also concluded that "...portions of the existing rules seek to grant the District unbridled discretion to determine which user groups will be required to incur the cost of developing alternative water resources..." with "...the current rules...unacceptably vague in delineating the factors that will be considered."

The hearing thus declared as invalid the following provisions of the District's existing rules as an invalid exercise of delegated authority:

- Rules 40D-8.041(2), (3) and (4),
- the presumptions in BOR Section 4,

- the portion of Rule 40D-2.301(1) which requires an applicant to satisfy each subsection of the rule in order to obtain a water use permit. In addition, the requirement in subsection (j) of this rule that an applicant exhaust local resources before an application from a more remote source will be considered is inconsistent with Chapter 373,

- Rules 40D-2.381(3)(1) and (m), and

- BOR Sections 4.7, 4.9, and 7.3.6.4.

The hearing also concluded that "... the District's failure to adopt the Design Aids as a rule constitutes a violation of Section 120.535, FS (1993)."

2.2 Water Quality Conditions

Current and previous water quality data gathered in the Myakka River Basin are presented and examined in this section.

2.2.1 Data Sources

Data from three sources were used to examine current and long-term water quality in the Myakka River Basin and included:

- historic EQL long-term monthly data collected between 1975 and 1990 at three locations in the Lower Myakka River: near the El Jobean Bridge, near Big Slough, and at the U.S. 41 crossing.

- ongoing data which have been gathered since 1992 by the SWFWMD at the mouth of Tippecanoe Bay and just north of the El Jobean Bridge.

- USGS data gathered since 1960 from the Upper Myakka River near Sarasota at USGS gaging station 02298830.

The locations of these water quality monitoring sites are presented in Figure 2-10.

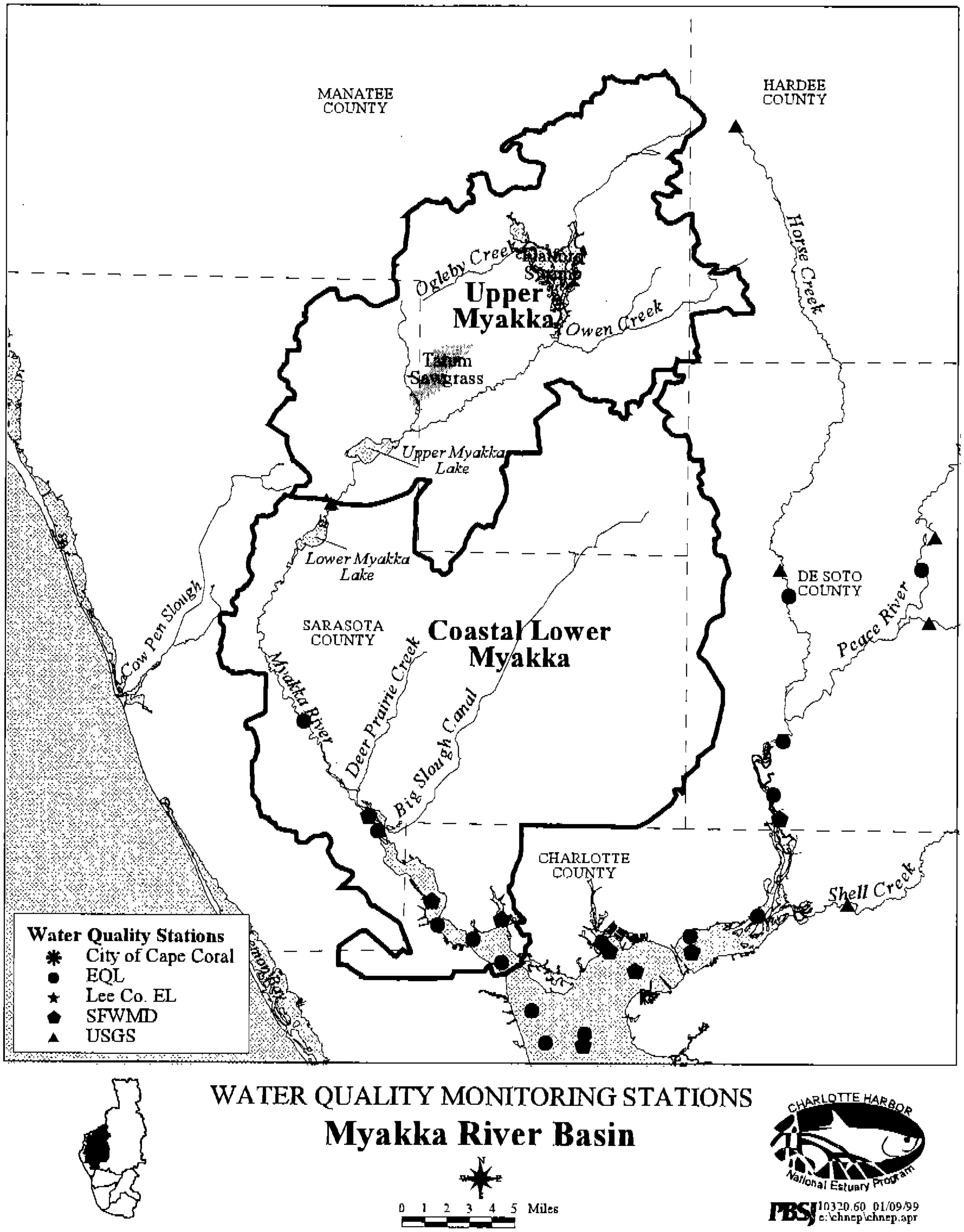


Figure 2-10. Location of water quality sampling sites in the Myakka River Basin.

2.2.2 Data Analyses

The EQL and SWFWMD monitoring data were typically collected on a monthly basis. Water quality data were collected less frequently by the USGS. The data analysis approach included:

- visual examination of time series plots of monthly mean values, and
- more formal statistical tests for significance of trends in mean annual water quality conditions employing methods developed by Coastal Environmental (1996) for the Florida Department of Environmental Protection. The procedures use seasonally weighted yearly averages. Depending on the observed distribution of the sampling frequency, the procedure examines for either trends over the entire sampling period or differences between periods within the data record, depending upon the continuity and length of the data record. A detailed description of the methodology used for defining trends is contained in Appendix C.

2.2.2.1 EQL Data

Figures 2-11 and 2-12 present monthly mean water quality data collected in the Lower Myakka River for the period 1975 through 1990. The following describes the current and long-term water quality conditions by constituent. Summary results of statistical test for long-term trends for each of these constituents are presented in Table 2-8.

Conductivity - Conductivity displayed very pronounced seasonal and long-term variability in the estuarine portion of the Lower Myakka River (Figure 2-11). Values range from being almost fresh in both surface and bottom waters during the wet season, to almost 50 mmho/cm (ca. 20 ppt salinity) during periods of low freshwater inflow. From 1982 through 1984, conductivity was generally depressed during a period of higher than normal rainfall. Conductivity was higher during the mid to late 1980's; during this period the minimum conductivity values were generally high. In recent years the conductivity of the Lower Myakka River has been in the range of 20-40 mmho/cm. No significant trend in mean annual conductivity values was detected.

Color - Color in the Lower Myakka River is strongly influenced seasonally by periods of high river flow. A significant trend in mean annual color was detected for the period of 1975 through 1990. This change seems to have occurred independently of any corresponding equivalent increase in flow and appears to be related to a general increase in the lower color values (Figure 2-11).

Table 2-8. Summary of trend tests computed for water quality data from the Lower Myakka River Estuary. ▲ - indicates increasing trend ($p < 0.05$); ▼ - indicates decreasing trend ($p < 0.05$); NS - indicates no significant trend; ID - insufficient data to detect trend.

Water Quality Constituent	Trend Test Result
Conductivity (mmhos/cm)	NS
Color (Pt-Co units)	▲
Turbidity	NS
Nitrite-nitrate Nitrogen	▲
Total Kjeldahl Nitrogen (mg/L)	▲
Ortho-phosphate (mg/L)	▲
Total Phosphorus (mg/L)	NS
Chlorophyll *a* (µg/L)	▲

Turbidity - The most notable trend in turbidity in the Lower Myakka River is the decrease in the observed amplitude in both the within-year and between-year changes in turbidity (Figure 2-11). However, no significant trend in the mean annual turbidity values was detected.

Nitrate + nitrite nitrogen - The trend in nitrate + nitrite nitrogen concentrations has been toward increases in the number and magnitude of higher values, while annual minima have not changed (Figure 2-11). A significant increasing trend in mean annual nitrate + nitrite nitrogen concentrations was detected for the period 1975 through 1990.

Total Kjeldahl nitrogen - Concentrations of total Kjeldahl nitrogen increased significantly in the Lower Myakka River during the period of 1975 through 1990

(Figure 2-11). Much of the observed increase in concentrations has occurred in measurements made after 1984.

Ortho-phosphate - Unlike the observed changes in nitrogen concentrations, most of the observed increase in ortho-phosphate concentrations occurred during the first five years of record (Figure 2-12). The period between 1978 and 1981 was characterized by several periods of elevated concentrations in samples taken near the bottom. This increasing trend was statistically significant (Table 2-8). The peaks in the Lower Myakka River correspond in time to several peaks in phosphorus concentrations in the Lower Peace River (discussed later in this document). It is quite possible that the observed increases in the Lower Myakka during this period may have been due to the influences of Peace River water moving up into the Lower Myakka Estuary. It should be noted however that ortho-phosphate concentrations in the Lower Myakka do not show any indication of the major declines which were observed in all forms of phosphorus in the Peace River basin during the same period of time.

Total phosphorus - Total phosphorus concentrations also increased between 1976 and 1981 (Figure 2-12). However, since that period, total phosphorus concentrations tended to decline, especially the highest annual concentrations. Over the entire period of record no significant trend in mean annual total phosphorus concentrations was detected.

Chlorophyll *a* - Chlorophyll *a* concentrations increased over the period 1975 through 1990 (Figure 2-12). Seasonally, the annual lows during the cooler winter months remained similar. However, the data show an increase in the frequency and magnitude in the higher chlorophyll concentrations which typically occur in the spring and fall of each year. The observed increase in chlorophyll *a* in the Lower Myakka River agree with the measured increases in nitrogen concentrations.

2.2.2.2 SWFWMD Data

Figures 2-13 and 2-14 present mean monthly water quality data collected in the Lower Myakka River between 1992 and 1996. These data provide the best representation of current water quality within the Lower Myakka River.

In general, these data agree well with the latter portion of the period of record in the EQL data. There are two differences of note. With the exception of the peaks observed during the very high flows in 1994 and 1995, color values in the 1993-1996 period tend to be lower than those observed in the late 1980's. While total Kjeldahl nitrogen concentrations increased relatively consistently from 1980 through 1990, more recent concentrations have leveled off in the range of 0.75 to 1.25 mg/L.

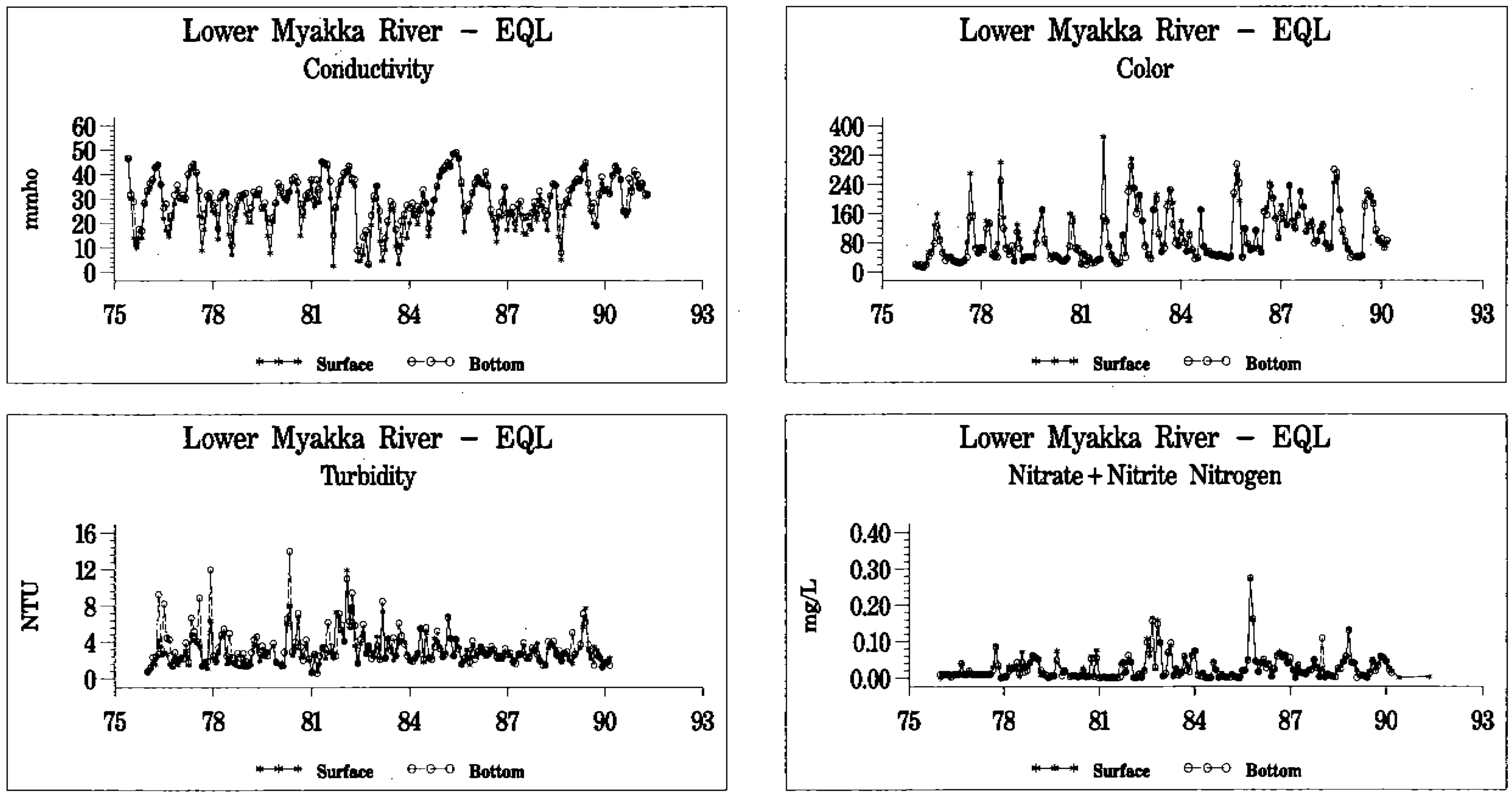


Figure 2-11. Time series graphs of water quality consituents measured in the Myakka River Basin (EQL stations).

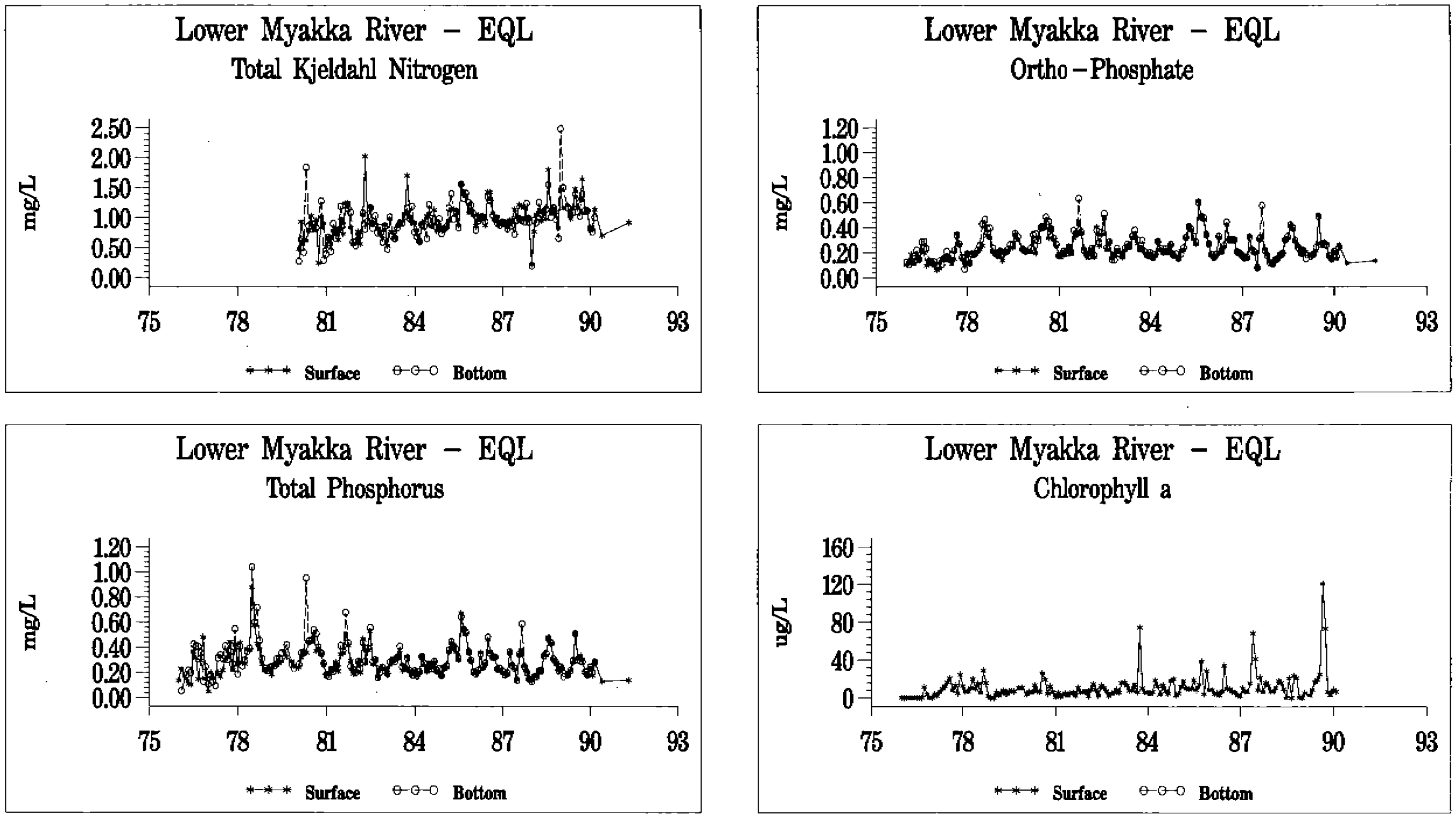


Figure 2-12. Time series graphs of water qualily constituents in the Myakka River Basin (EQL stations).

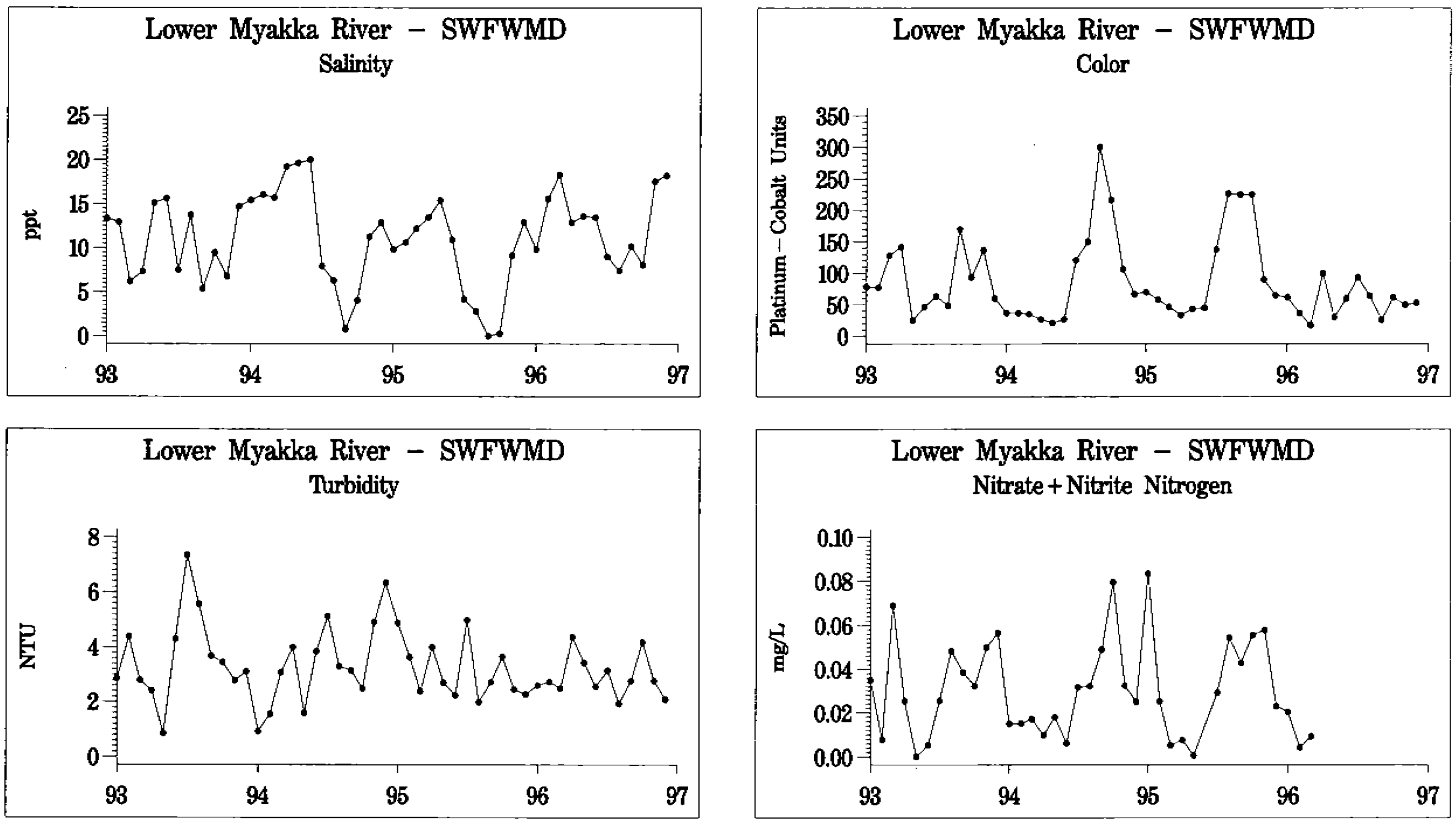


Figure 2-13. Time series graphs of water quality constituents in the Myakka River Basin (SWFWMD stations).

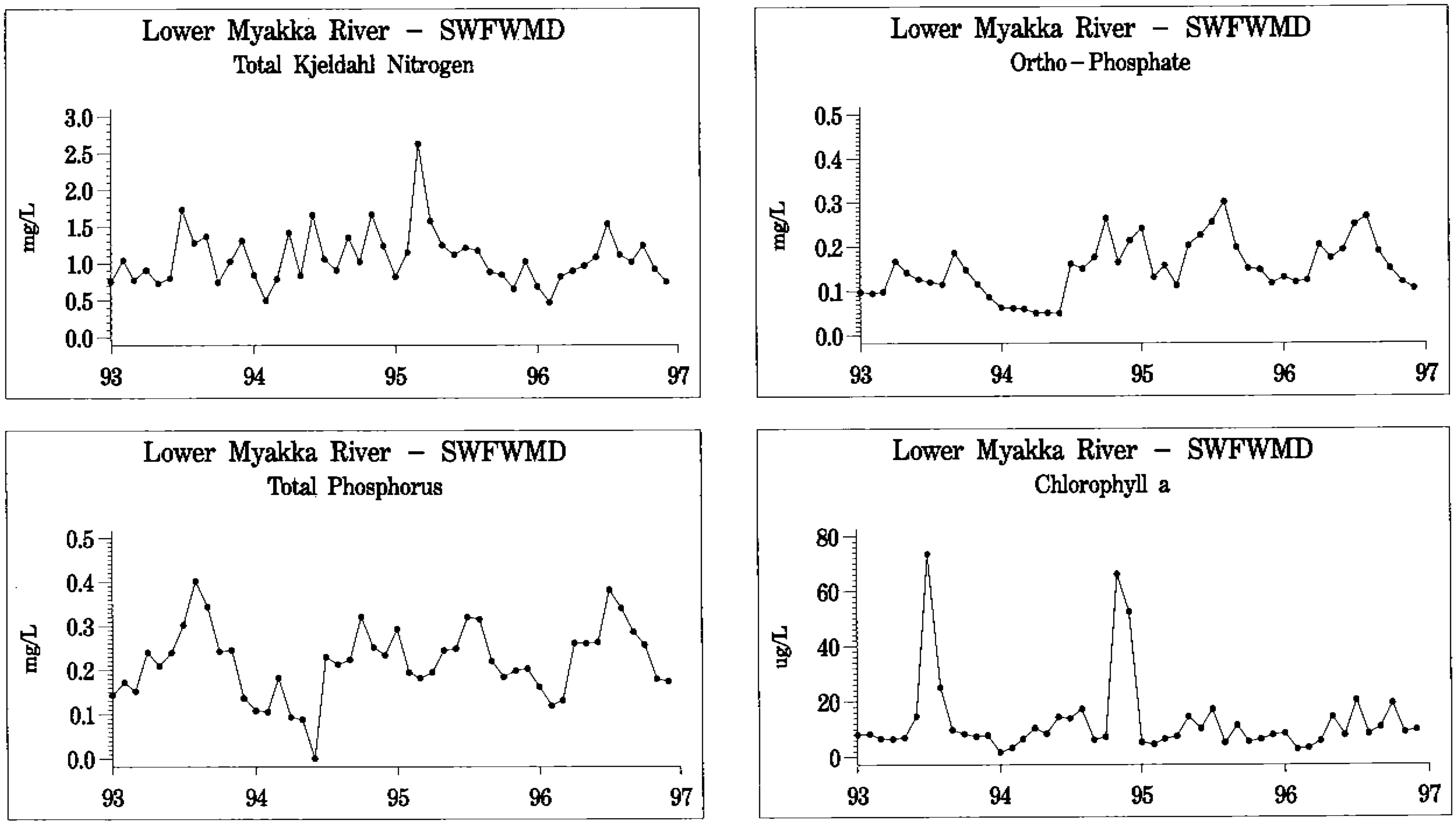


Figure 2-14. Time series graphs of water quality constituents in the Myakka River Basin (SWFWMD stations).

2.2.2.3 USGS Data

Figures 2-15 and 2-16 present mean monthly water quality data collected in the Upper Myakka River between 1962 and 1996 by the USGS. The following describes the current and long-term water quality conditions by constituent in this portion of the river.

Conductivity - There has been a very marked increase in conductivity during the past 30 years in the Upper Myakka River (Figure 2-15). Such changes in other areas of Southwest Florida have generally been attributed to the increased use of groundwater for agricultural irrigation.

Chlorides - Chloride concentrations have typically been in the range of 10-25 mg/L (Figure 2-16). A consistent increase in the lower concentrations was observed, especially during the period of 1980 through 1995.

Color - Color in the Upper Myakka River, on an average basis, is in the upper 25th percentile of all Florida streams. No temporal trends in the color observed by USGS during the period of 1965 through 1995 were apparent (Figure 2-15).

Turbidity - There are insufficient data to indicate any long-term patterns in turbidity in the Upper Myakka River (Figure 2-15).

Nitrate + nitrite nitrogen - Except for a large number of samples collected between 1978 and 1982, insufficient data have been collected to clearly show any definitive patterns (Figure 2-16).

Total nitrogen - Only a limited number of values have been collected over the past thirty years (Figure 2-16). However, the data indicate that the Upper Myakka is near the 60th percentile total nitrogen concentrations in Florida streams (Friedemann and Hand, 1989).

Ortho-phosphate - There was a marked decline in the Upper Myakka River during the 1960's (Figure 2-16). Since that time the observed range in concentrations has remained similar. These data clearly show that concentrations are much higher in this Upper Myakka than in the more tidally influenced areas measured by EQL and SWFWMD in the Lower Myakka River.

Total phosphorus (TP) - Few measurements were made during the 1960's when ortho-phosphate values were highest and it is difficult to determine if the increase during the 1980's is an artifact. The Upper Myakka River has TP concentrations near the 80th percentile for Florida freshwater streams (Friedemann and Hand, 1989).

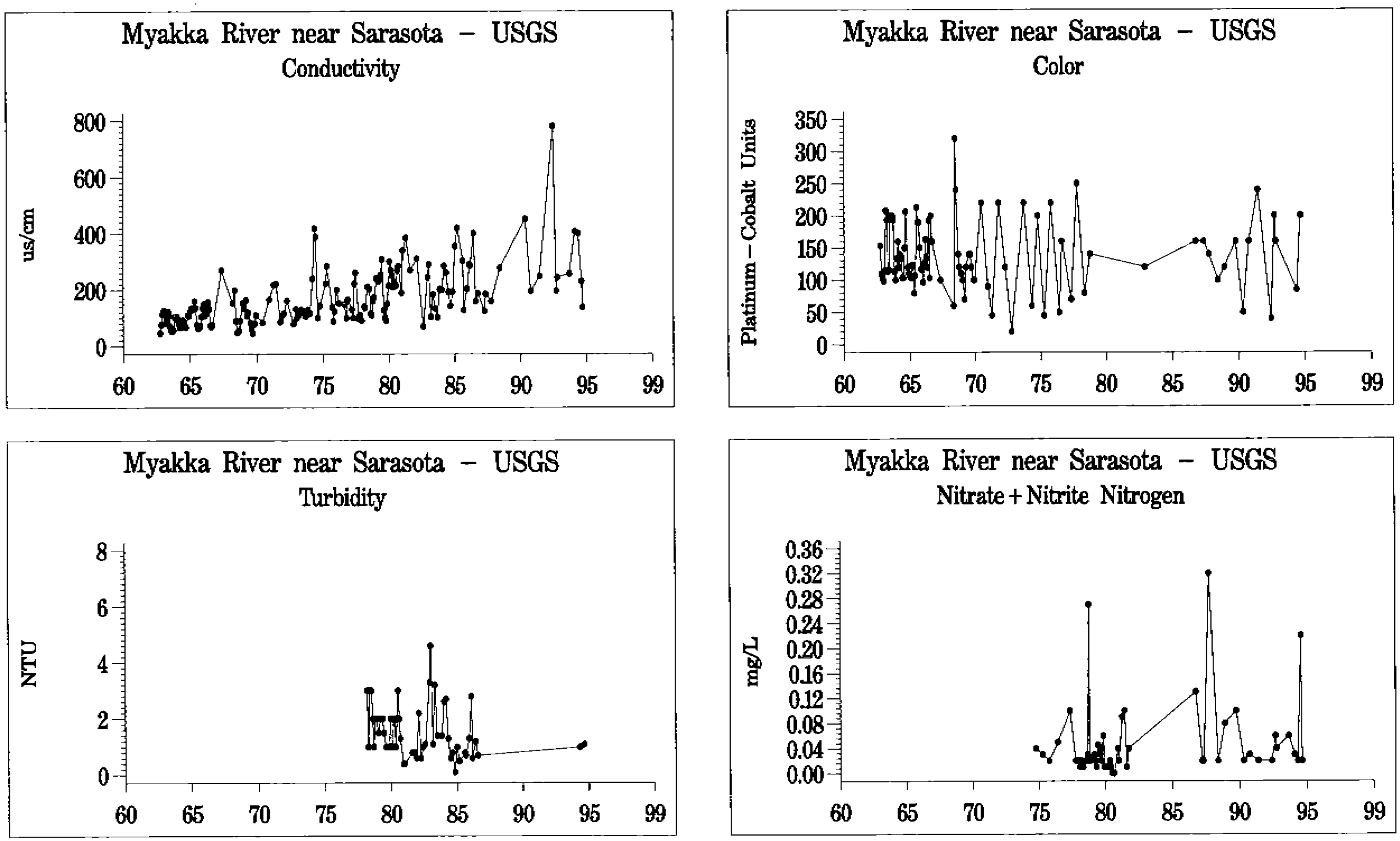


Figure 2-15. Time series graphs of water quality constituents in the Myakka River Basin (USGS stations).

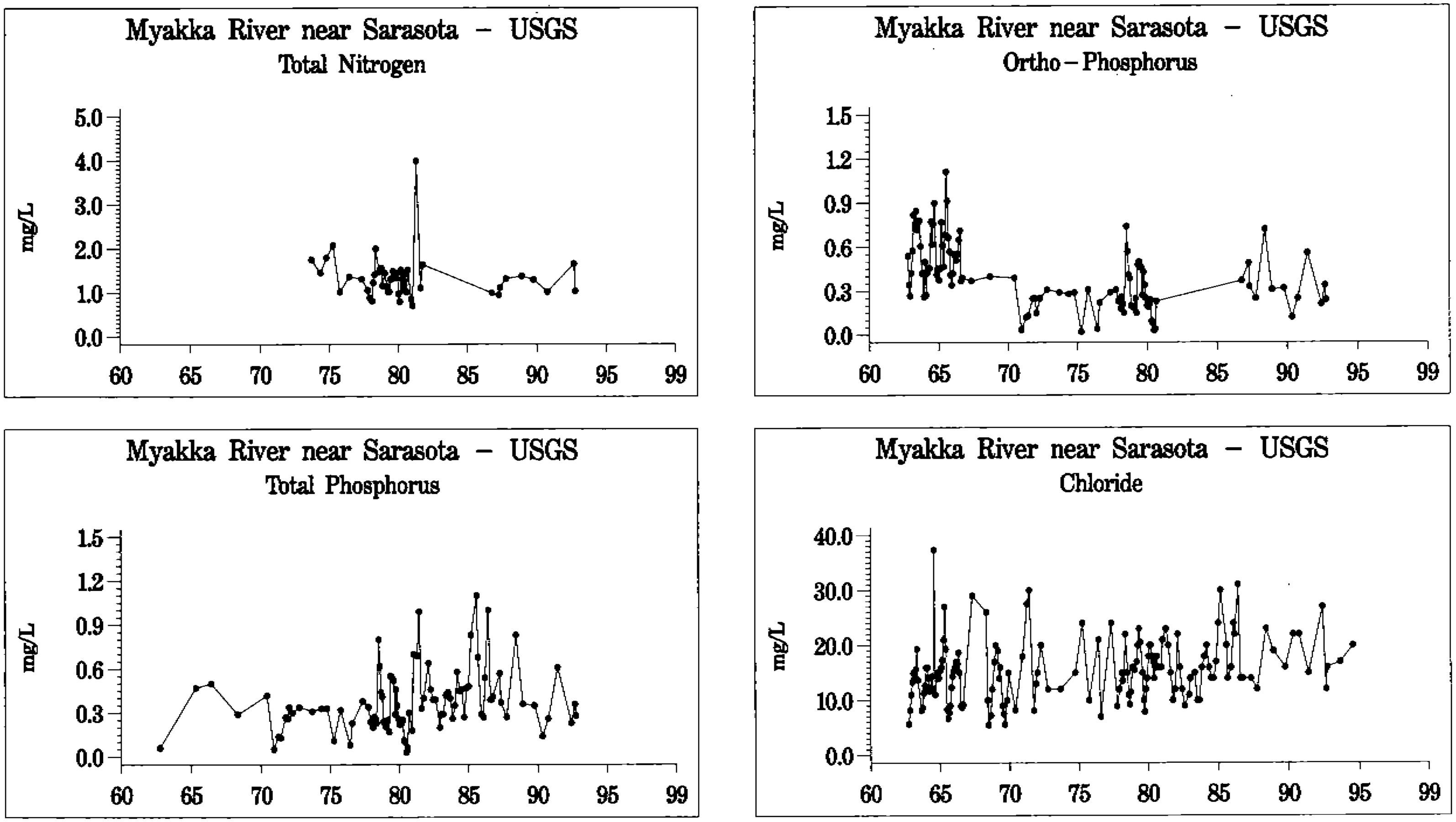


Figure 2-16. Time series graphs of water quality constituents in the Myakka River Basin (USGS stations).

2.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) was estimated for each subbasin by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to prioritize major basins and subbasins within the Charlotte Harbor NEP study area. Thus, the method development was focused on estimating relative loads in a consistent manner among major basins and subbasins to avoid biasing the evaluation. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

The detailed rainfall, SWFWMD 1990 land cover, and USDA soil data that were discussed earlier were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow was used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TSS, TN, and TP loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns.

Model calculations, data sources, and model coefficients used are described in Appendix D. Unless otherwise indicated, estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were defined as pasture, groves, feedlots, row and field crops and nursery, and undeveloped land uses were defined as range lands, barren lands, and upland forests.

2.3.1 Load Estimates for the Upper Myakka River Subbasin

The total estimated annual runoff discharge for this upper portion of the Myakka River drainage was 129 million cubic meters. The estimated annual pollutant loads were 418 tons of TN, 131 tons of TP, and 2,753 tons of TSS.

Agricultural runoff loads were estimated to be the most significant anthropogenic loads from runoff for the subbasin. Over one half of the 113,000 runoff contributing acres of the upper portion of the Myakka River drainage area has been developed as agricultural land (64,000 acres). Most of the remaining subbasin is in a relatively undeveloped state comprised of range land, upland forest, and wetlands. Thus, annual runoff from agricultural lands comprised over half (74 million cubic meters) of the total subbasin runoff, one half of the TN load (246 tons), three quarters of the TP load (75 tons), and nearly a third of the TSS load (1,102). Table 2-9 presents the loads from runoff by land use. Of the agricultural runoff sources, pasture lands were estimated to contribute the most (58 million cubic meters of runoff, 170 tons of TN, 52 tons of TP, 551 tons of TSS). The next highest contributing agricultural source was 2,600 acres of groves that contributed 3 million cubic feet of runoff, 6 tons of TN, 1 ton of TP, and 30 tons of TSS.

Urban lands were estimated to be a minor contributor to the total annual runoff and nonpoint source pollutant loads relative to the total agricultural loads. The 3,000 urban acres of mostly low density residential land contributed 6 million cubic meters of runoff, 11 tons of TN, 2 tons of TP, and 157 tons of TSS.

Table 2-9. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Upper Myakka River subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	7	2%	1	1%	67	2%	3,376,203	3%
Medium Density Residential	0	0%	0	0%	7	0%	184,584	0%
Commercial	0	0%	0	0%	7	0%	85,145	0%
Mining	2	1%	0	0%	65	2%	1,181,786	1%
Institutional,Transport., Util.	1	0%	0	0%	11	0%	870,034	1%
Range Lands	88	21%	44	34%	444	16%	30,787,147	24%
Barren Lands	2	1%	0	0%	18	1%	1,637,993	1%
Pasture	170	41%	52	40%	551	20%	58,248,364	45%
Groves	6	2%	1	1%	30	1%	2,737,249	2%
Feedlots	29	7%	6	4%	73	3%	1,333,547	1%
Nursery	0	0%	0	0%	4	0%	73,819	0%
Row and Field Crops	41	10%	17	13%	443	16%	11,622,669	9%
Upland Forests	71	17%	10	8%	1,033	38%	16,979,731	13%
TOTAL	418	100%	131	100%	2,753	100%	129,118,271	100%

2.3.2 Load Estimates for the Lower Coastal Myakka Subbasin

The total estimated annual runoff discharge for the lower portion of the Myakka River drainage was 213 million cubic meters from a contributing drainage area of 178,000 acres. This subbasin was the second largest subbasin of the study area, and it was estimated to have the second largest runoff load. The estimated annual pollutant loads were 671 tons of TN, 202 tons of TP, and 6,451 tons of TSS. One of the major differences in this basin in comparison with the others is that, although this subbasin is larger, it had approximately one half of the agricultural lands reported for the Myakka near Sarasota Subbasin.

Although only 18% of the contributing subbasin area, agricultural lands still comprised the majority of the anthropogenic loads from runoff. The 31,000 acres of agricultural lands contributed 35 million cubic meters of runoff per year, 104 tons of TN, 32 tons of TP, and 417 tons of TSS. Table 2-10 presents the loads from runoff by land use, based on 1990 land use maps. The most significant contributing agricultural land use was pasture (29,000 acres, 93 tons of TN, 28 tons of TP, 299 tons of TSS), and was followed by row and field crops (1,300 acres, 8 tons of TN, 3 tons of TP, and 90 tons of TSS).

Urban lands were less than one half of a percent (12,000 acres) of the total basin contributing area. They were estimated to contribute 26 million cubic feet of runoff, 51 tons of TN, 7 tons of TP, and 919 tons of TSS. Seventy-two percent of he loads were attributed to low, medium, and high density residential developments.

Table 2-10. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type with the Lower Coastal Myakka River subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	17	3%	3	1%	162	3%	8,088,021	4%
Medium Density Residential	12	2%	2	1%	181	3%	4,837,090	2%
High Density Residential	11	2%	2	1%	326	5%	4,583,835	2%
Commercial	2	0%	0	0%	98	2%	1,202,132	1%
Industrial	1	0%	0	0%	32	1%	305,819	0%
Mining	2	0%	0	0%	54	1%	977,311	1%
Institutional,Transport., Util.	7	1%	0	0%	67	1%	5,517,588	3%
Range Lands	251	37%	125	62%	1,264	20%	87,729,059	41%
Barren Lands	2	0%	0	0%	13	0%	1,168,303	1%
Pasture	93	14%	28	14%	299	5%	31,618,953	15%
Groves	3	0%	0	0%	12	0%	1,137,357	1%

Table 2-10. Continued.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Feedlots	1	0%	0	0%	1	0%	26,147	0%
Nursery	1	0%	0	0%	14	0%	226,931	0%
Row and Field Crops	8	1%	3	2%	90	1%	2,367,668	1%
Upland Forests	263	39%	37	19%	3,839	60%	63,102,286	30%
TOTAL	671	100%	203	100%	6,451	100%	212,888,499	100%

2.3.3 Point Source Inventory

This compilation of a point source inventory for the Myakka River Basin describes the numbers, locations, and discharge capacities of domestic and industrial point sources within the Myakka River Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin.

Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources. These databases can be found at the FDEP sites listed below.

ftp://ftp.dep.state.fl.us/pub/reports/gms80/domestic.exe
ftp://ftp.dep.state.fl.us/pub/reports/gms80/indust.exe.

The databases are in self-extracting ZIP files in a delimited format from the Wastewater Facility Regulation database. These databases contain point source information for the entire state of Florida, including the following:

facility identification number, whether it is NPDES, type, status, and name;
facility location, city, phone number, county, and district;
facility ownership (public or private), treatment process, and design capacity;
domestic wastewater class (domestic plants only), discharge to reuse, disposal,;
latitude and longitude, in degrees, minutes, and seconds; and
responsible authority, city manager, mayor, director, and authority's address.

Wastewater treatment plant discharges for those plants in the Myakka River Basin with greater than 1.0 MGD were previously described, using information from SWFWMD (1992). The following discussion utilizes only the FDEP databases. The FDEP databases give locations of point sources by latitude and longitude. The locations of the point sources were placed in a GIS coverage, which was then overlain with the basin boundary coverage, and each point source assigned to the corresponding major basin and subbasin (Figure 2-17). The FDEP databases included facility name,

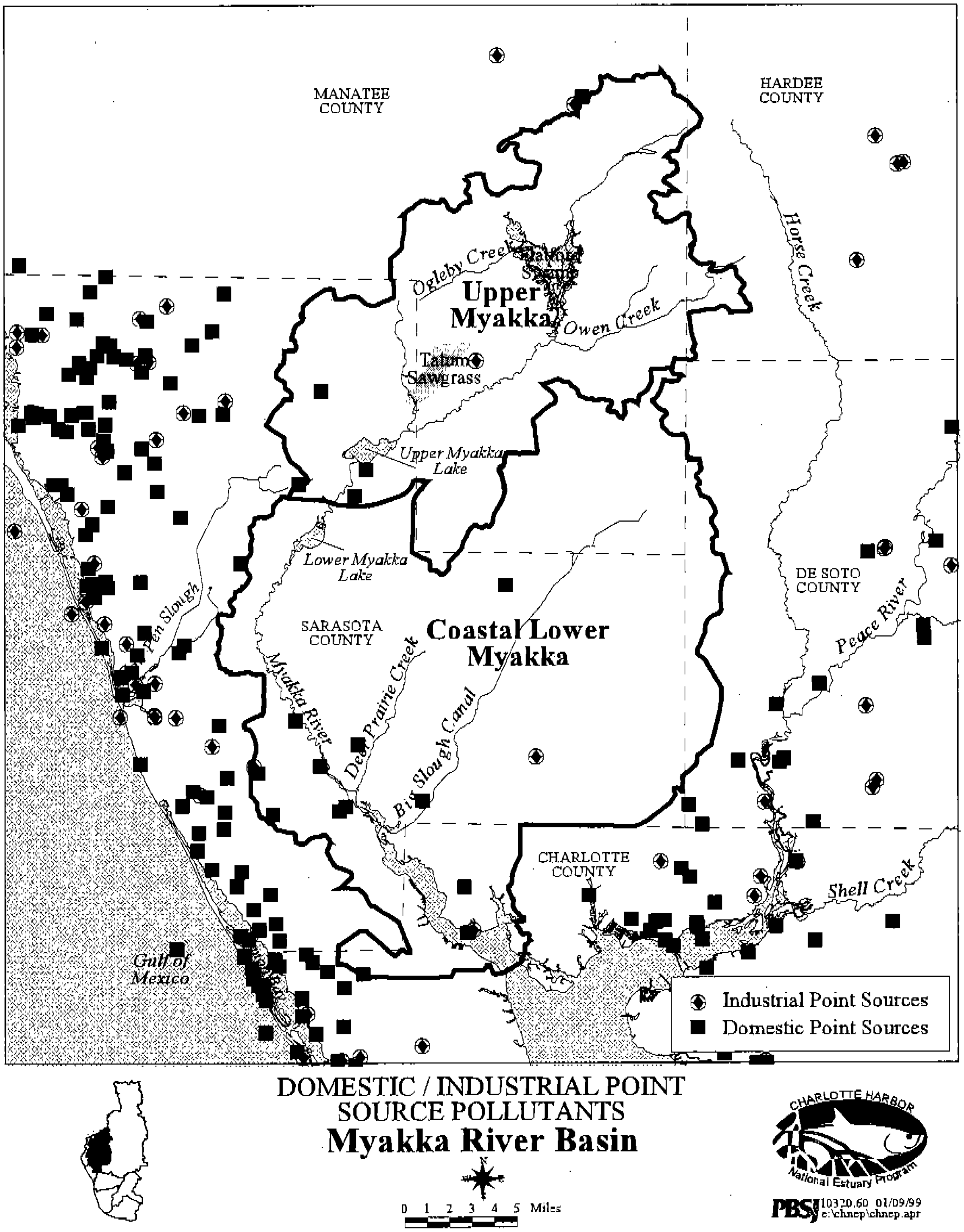


Figure 2-17. Location of domestic and industrial point sources in the Myakka River Basin.

county, discharge capacity, and receiving waterbody, with no corrections made in the course of this project to any of the descriptors in the database.

The Myakka River Basin contains 16 domestic point sources, with three of these found in the Upper Myakka Subbasin and the remaining 13 in the Coastal Lower Myakka Subbasin, as shown in Table 2-11. Most of the domestic point sources in the Myakka River Basin are found in Sarasota County (Tables 2-11).

Given the county descriptor in the FDEP database, the locations of several of the facilities are suspect, but the locations were assigned utilizing the database latitudes and longitudes for the facilities. Discharge capacities of the facilities range from 0.01 MGD to 1.1 MGD, with total discharge capacity for all plants in Table 2-10 of 2.58 MGD. Of this, 1.33 MGD is utilized for some form of reuse.

Industrial point sources are more evenly distributed within the subbasins of the Myakka River Basin, and within the counties of the basin (Table 2-12). Discharge capacities are not in the FDEP database for all but one of the facilities, which has a capacity of 1.2 MGD.

Table 2-11. Domestic point sources in the Myakka River Basin by subbasin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
Upper Myakka Subbasin			
OAK FORD WWTP	Sarasota	0.03	Spray Irrigation
MYAKKA RIVER ST. PARK 2	Sarasota	0.01	
MYAKKA RIVER ST. PARK 1	Sarasota	0.01	
Coastal Lower Myakka Subbasin			
PLANTATION WWTP	Sarasota	0.45	Part III Reuse
MANATEE COMMUNITY COLLEGE	Sarasota	0.01	
NORTH PORT WWTP	Sarasota	1.1	
VENICE CAMPGROUND WWTP	Sarasota	0.01	
HOURGLASS LAKES	Sarasota	0.02	
RAMBLERS REST RESORT WWTP	Sarasota	0.05	
MYAKKA MHC	Sarasota	0.01	
WEST PORT W. W. T. P.	Charlotte	0.33	Percolation Ponds/ Spray Irrigation
RIVERWOODS UTILITIES	Charlotte	0.5	Percolation Ponds/ Spray Irrigation
TARPON BAY CONDOMINIUMS	Charlotte	0.02	Drainfield
MYAKKA UTILITIES	Sarasota		Percolation Ponds/ Spray Irrigation

Table 2-12. Industrial point sources in the Myakka River Basin by subbasin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
Upper Myakka Subbasin			
PICCHIETTI'S FISH FARM	Manatee		Percolation Ponds
Nu-gulf wingate #002	Manatee		
Nu-gulf wingate #001	Manatee		
Coastal Lower Myakka Subbasin			
TAKE CARE CAR WASH	Charlotte		
F.P.L. TOLEDO BLADE SERVICE CENTER	Sarasota		
PLANTATION R/O WTP & DIW	Sarasota	1.2	

3. Peace River

This chapter presents a compilation and synthesis of information regarding the Peace River Basin portion of the Charlotte Harbor NEP area. The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

3.1 Physical Setting

The following sections provide a characterization of the Peace River Basin, a major tributary to Charlotte Harbor Estuary System (Figure 3-1). These sections include physiographic, topographic, geologic, hydrologic, and land use descriptions of the basin.

The Peace River Basin includes portions of eastern Sarasota, Manatee, and Hillsborough counties, parts of central and southern Polk County, most of Hardee and DeSoto counties, part of northern Charlotte County, and western portions of Highlands County. The basin has a drainage area of 2,350 square miles (Foose, 1986). The Peace River headwaters are a group of lakes in northern Polk County. The river then flows south for about 75 miles through Polk, Hardee, DeSoto, and Charlotte counties. The major tributaries of the Peace River include Peace, Saddle, Horse, Charlie, and Shell Creeks. The Peace River is divided into nine subbasins for this report:

- Peace River above Bartow,
- Peace River above Zolfo Springs,
- Peace River above Arcadia,
- Lower Peace River,
- Payne Creek,
- Charlie Creek,

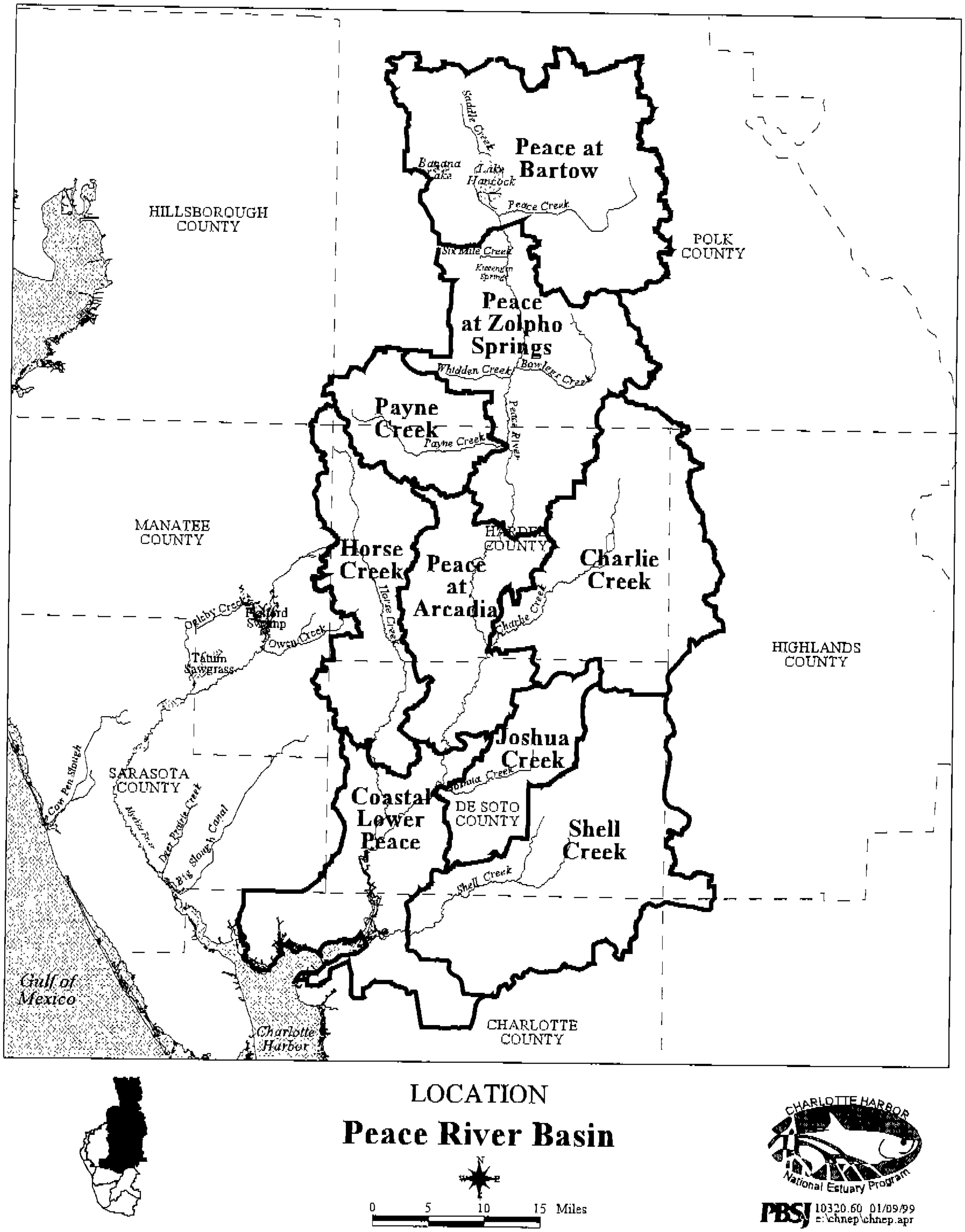


Figure 3-1. Location of Peace River Basin in the Charlotte Harbor NEP study area.

- Horse Creek,
- Joshua Creek, and
- Shell Creek.

3.1.1 Physiography

This section describes the topography, geology, soils, and land use in the Peace River Basin.

3.1.1.1 Topography

The Peace River flows from the physiographic provinces of the Polk Uplands southwest through the DeSoto Plain and in to the Gulf Coastal Lowlands where it enters Charlotte Harbor. The Polk Upland has gently rolling, sometimes hilly terrain and land-surface elevations range from over 200 feet above MSL near the headwaters to sea level at the mouth.

The Peace River drains the southern portion of Green Swamp, is a blackwater system and has high concentrations of organic acids originating in the swamp and surrounding forests. The river flows between the Polk Highlands to the east and the Central Highlands to the west. Occasionally, the river valley narrows and bluffs occur along the banks, most frequently between Zolfo Springs and Gardner in Hardee County. Low limestone bluffs are also located near Limestone Creek.

The DeSoto Plain occurs at about 60 to 85 feet above MSL, the boundary of which approximates the Sarasota-Manatee county line. Lakes are less common on the DeSoto Plain, a result of more recent karst topography and younger Wicomico Terrace surfaces. Although the DeSoto Plain is generally steep enough for a distinct drainage network, lands between river and creek valleys are relatively flat and support a variety of wetlands

The Peace River channel is well-defined at normal water level stages. Downstream from Arcadia, the floodplain widens and the channel braids. The marsh and swamp areas of the floodplain may reach a mile in width, smaller than those along the Myakka.

Many of the lakes in the headwaters area are linked by stems of canals, many of which have fixed or operable control structures. Some canals provide continual flow between lakes; in others, flow occurs only under high-water conditions.

3.1.1.2 Geology

The upstream portion of the Peace River is geologically similar to the Myakka River, described above. The Floridan aquifer system is the primary source of groundwater supply, although nearer the coast it is highly mineralized. In these areas, the surficial aquifer system and the intermediate

Hawthorn aquifer are the primary sources of groundwater supply. Historically, the upper portion of the Peace River Basin appears to have been an area of widespread upward leakage and artesian flow from the intermediate Hawthorn layer (Hammett, 1988).

3.1.1.3 Soils

The National Resource Conservation Service (NRCS) county soil reports and map provided most of the information discussed in this section. Within the Peace River Basin, flatwoods soils are the most dominant natural soil type. These are generally nearly level soils with 0 to 2% slopes, poorly drained, sandy, and have a high water table. They occur throughout the watershed predominantly as combinations of Myakka, Smyrna, and Immokalee soils series.

Patterns in HSG designations for the Peace River Basin are similar to those described for the Myakka River basin. Approximately 65% of the soils in the watershed are B soils (fairly well drained) (Tables 3-1 through 3-3 and Figure 3-2). Although many of these reflect the artificial drainage features in the basin, D soils comprise approximately 15% of the soils in the basin (poorly drained), while less than 9% are A (well-drained), and less than 12% are C (less well-drained).

Nearly 50% of Polk County in the northern portion of the Peace River Basin is underlain by upland soils. The Arents-Hydraquents-Neilhurst soils have been strip mined for phosphate or silica sands. Candler-Tavares-Apopka soils are characteristic of uplands and are moderately sloping, excessively to moderately well-drained, sandy, and underlain by loamy or clay material.

Table 3-1. Hydrologic Soil Types in the Peace River Basin: Peace at Bartow, Peace at Zolfo Springs, and Peace at Arcadia Subbasins.

Soil Type	Peace at Bartow		Peace at Zolfo Springs		Peace at Arcadia	
	Acres	%	Acres	%	Acres	%
A	78,869	31.8	39,985	20.2	3,357	2.6
B	74,847	30.2	73,249	37.0	95,718	74.7
C	33,899	13.7	23,553	11.9	9,628	7.5
D	60,130	24.3	61,024	30.8	19,480	15.2
TOTAL	247,745	100.0	197,810	100.0	128,184	100.0

The small distributary system near the mouth of the Peace River, in Charlotte County, also includes Peckish-Estero-Isles tidal and barrier island soils (poorly drained mucky fine sands). Low sandy ridges with 0-5% slopes occur near the mouth of the Peace River along Prairie Creek and are composed of Orsino-Daytona complex of well-drained marine sands. These soils are deep and moderately well-drained in thick beds of marine sands. At the mouth of the Peace River, there are Matlacha soils of mixed sands and shell and limestone fragments in altered areas immediately landward the sand flats.

Soils adjacent to the Peace River itself are generally of the Chobee series combined with another wetland soil type. This soil is deep, has nearly level slopes of 0-1%, is very poorly drained and occurs in depressions with high water tables. In Polk and DeSoto counties, Nittaw-Kaliga-Chobee and Bradenton-Felda-Chobee soil series occur, and include organic substrates of marshes and swamps on clayey marine sediments. In Hardee County, Bradenton-Felda-Myakka soils are similar, but occur on loamy marine sediments more characteristic of flatwoods, but not marshes and swamps.

Table 3-2. Hydrologic Soil Types in the Peace River Basin: Lower Peace, Payne Creek, and Charlie Creek Subbasins.

Soil Type	Lower Peace		Payne Creek		Charlie Creek	
	Acres	%	Acres	%	Acres	%
A	3,001	1.8	7,247	9.0	3,536	1.7
B	121,414	73.8	38,361	47.9	132,137	62.6
C	13,605	8.3	8,969	11.2	52,286	24.8
D	26,610	16.2	25,544	31.2	23,064	10.9
TOTAL	164,631	100.0	80,122	100.0	211,023	100.0

Table 3-3. Hydrologic Soil Types in the Peace River Basin: Horse Creek, Joshua Creek, and Shell Creek Subbasins.

Soil Type	Horse Creek		Joshua Creek		Shell Creek	
	Acres	%	Acres	%	Acres	%
A	1,205	0.9	205	0.3	1,920	0.8
B	113,489	83.6	67,654	87.4	194,880	83.1
C	10,039	7.4	2,879	3.7	13,881	5.9
D	11,044	8.1	6,661	8.6	23,729	10.1
TOTAL	135,777	100.0	77,398	100.0	234,410	100.0

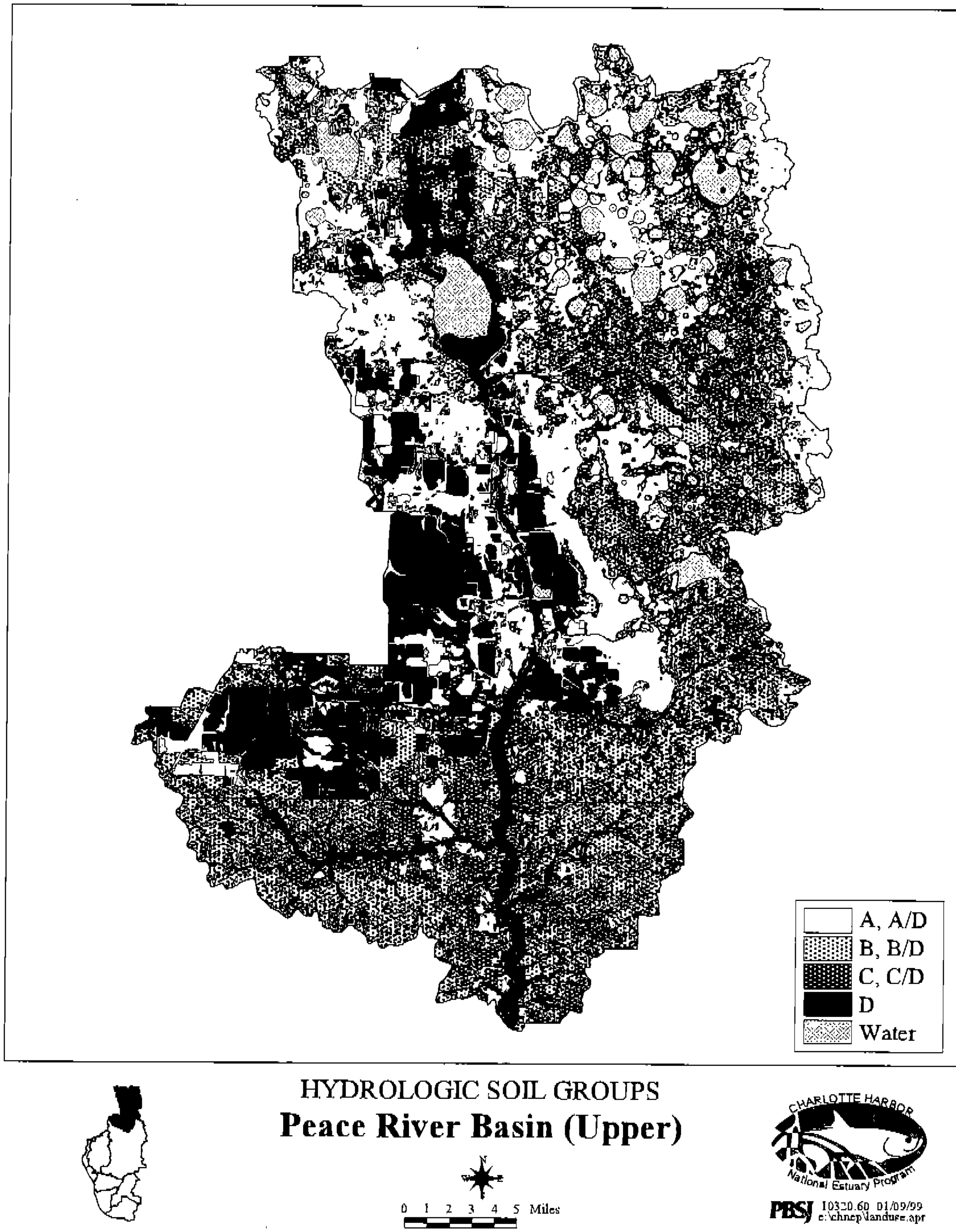


Figure 3-2. Hydrologic Soil Group designations for the Upper Peace River Basin.

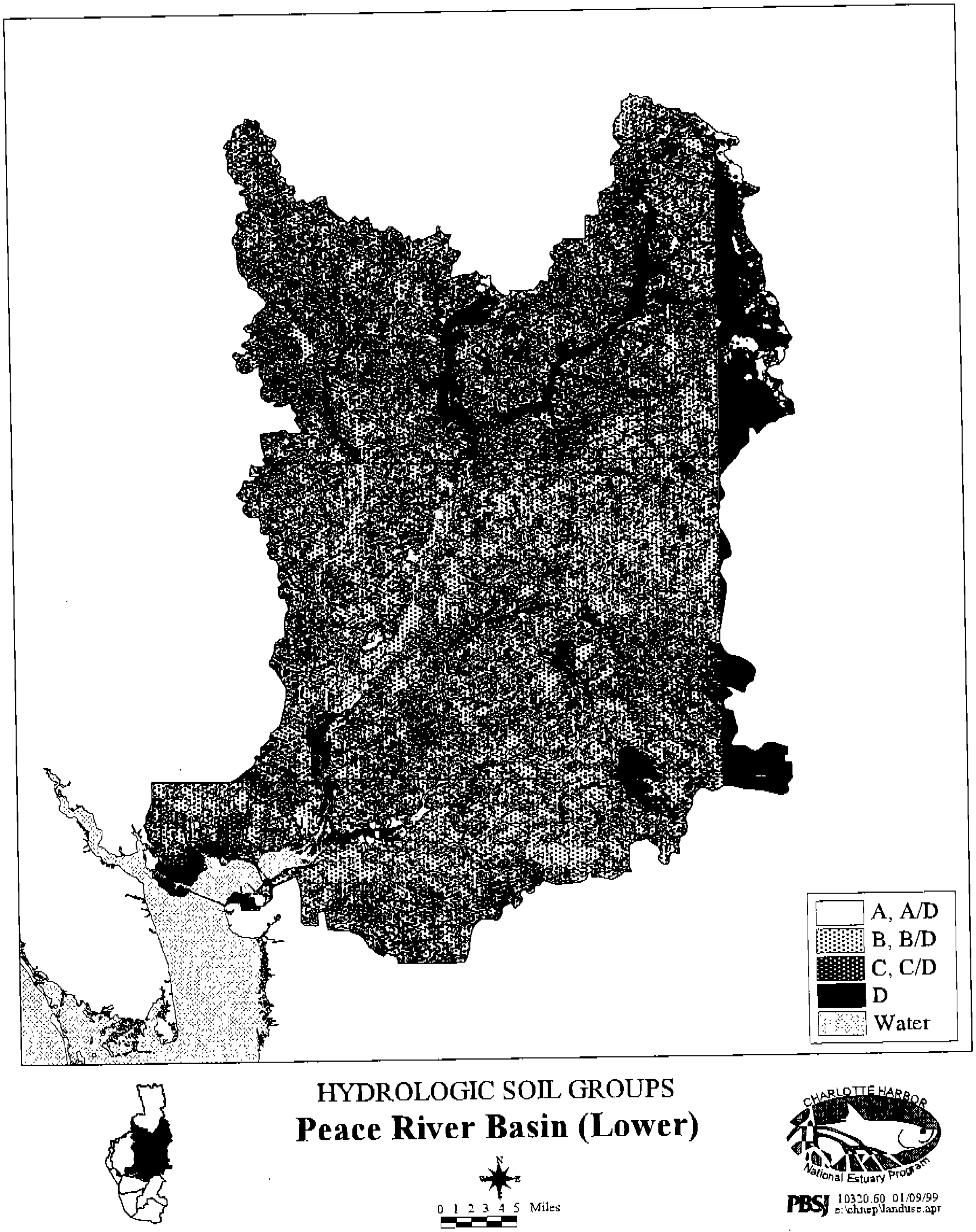


Figure 3-2. Hydrologic Soil Group designations for the Lower Peace River Basin.

3.1.2 Rainfall

Data from no fewer than four rain gages were used in calculating amounts of rainfall for each of the subbasins (Figure 3-3). Total annual precipitation and average monthly precipitation for the nine subbasins are presented in Figures 3-4 through 3-12.

Since 1970, the minimum average total annual precipitation has ranged from 32 inches (Lower Peace) to 38 inches (6 of the 9 subbasins). Maximum values ranged from 64 inches at the Peace at Bartow station in 1985 to 76 inches in the Joshua Creek subbasin in 1983. Maximum peaks consistently occurred in 1983.

Average monthly precipitation was highest for the wet season (summer) and lowest in the winter for all the basins. Rainfall was highest from June to September, and wet season monthly average values ranged from 5.6 to 8.2 inches. Average monthly rainfall values were lowest during November and ranged from 1.4 inches (Lower Peace) to 2 inches (Payne Creek), and average values did not exceed 3.4 inches through May. Two subbasins, Peace at Bartow and Peace at Zolfo Springs, had peak average monthly precipitation in July, compared with June for the other subbasins.

Analyses of the rainfall records conducted by Coastal Environmental (1996) indicated a rainfall deficit has occurred in all three Peace River subbasins above Arcadia. The estimated annual percent decline in rainfall ranged from 0.32%/year at Arcadia to 0.41%/year at Bartow.

3.1.3 Existing and Future Land Use

Land use data were obtained from SWFWMD, SFWMD, and the Southwest Florida Regional Planning Council (SWFRPC). Although other sources of data were available for various portions of the Charlotte Harbor NEP study area, these data sources provide a complete and consistent coverage for the entire study area.

The major urban areas in the Peace River Basin include Lakeland, Winter Haven, Bartow, Punta Gorda, Port Charlotte, and Arcadia. The river empties into the harbor at Port Charlotte, a part of the Charlotte Harbor Aquatic Preserve and Charlotte Harbor State Reserve, near Punta Gorda, Florida. Portions of the Peace River have been named Outstanding Florida Waters, designated as a Recreational Canoe Trail, and Payne Creek, a tributary to the Peace, has been designated a Special Feature Site. In addition, the Peace River corridor of the Charlotte Harbor Aquatic Preserve contains many recreation sites.

Existing and Future Land Use GIS Coverages for the Charlotte Harbor NEP Area are not always consistent in land use codes and coverages. Existing Land Use Coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SFWMD) land use data. Land Use data from

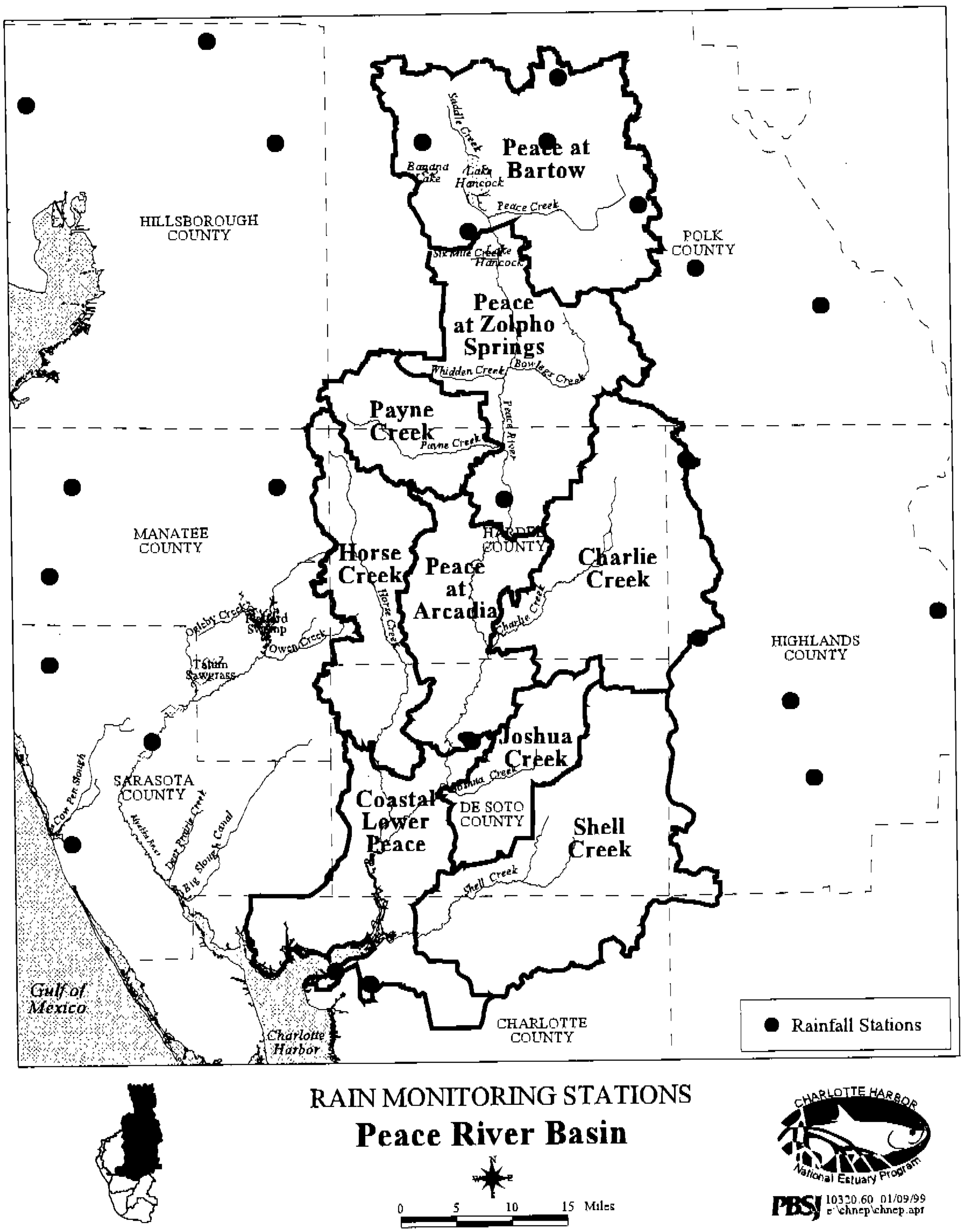
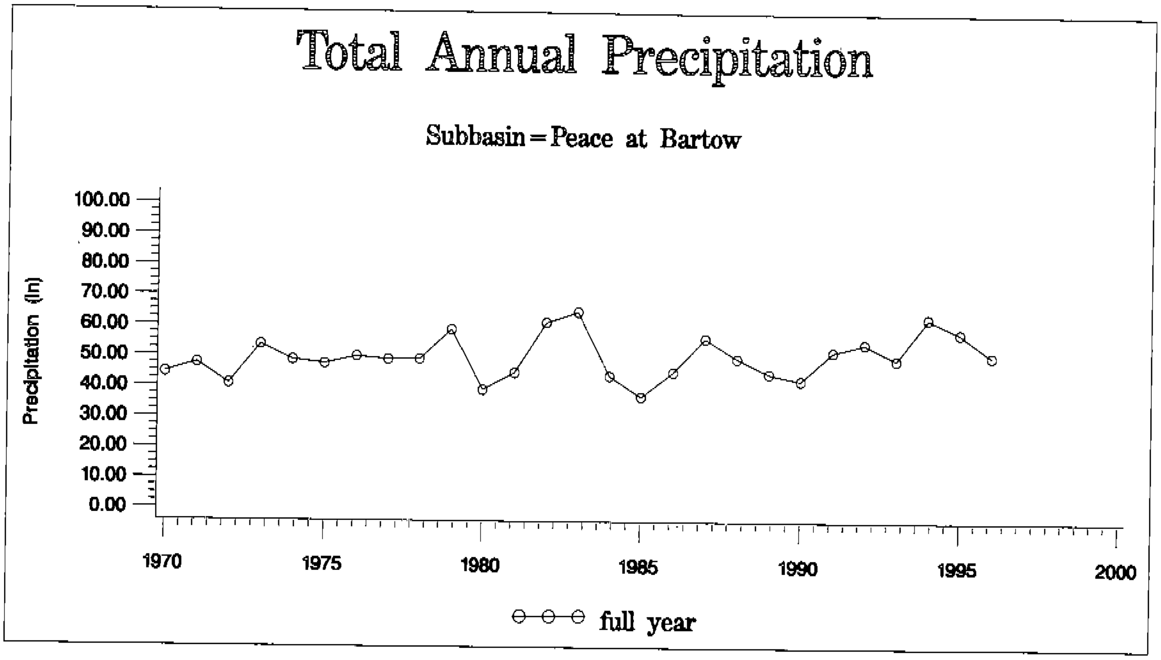


Figure 3-3. Rainfall monitoring stations in the Peace River Basin.



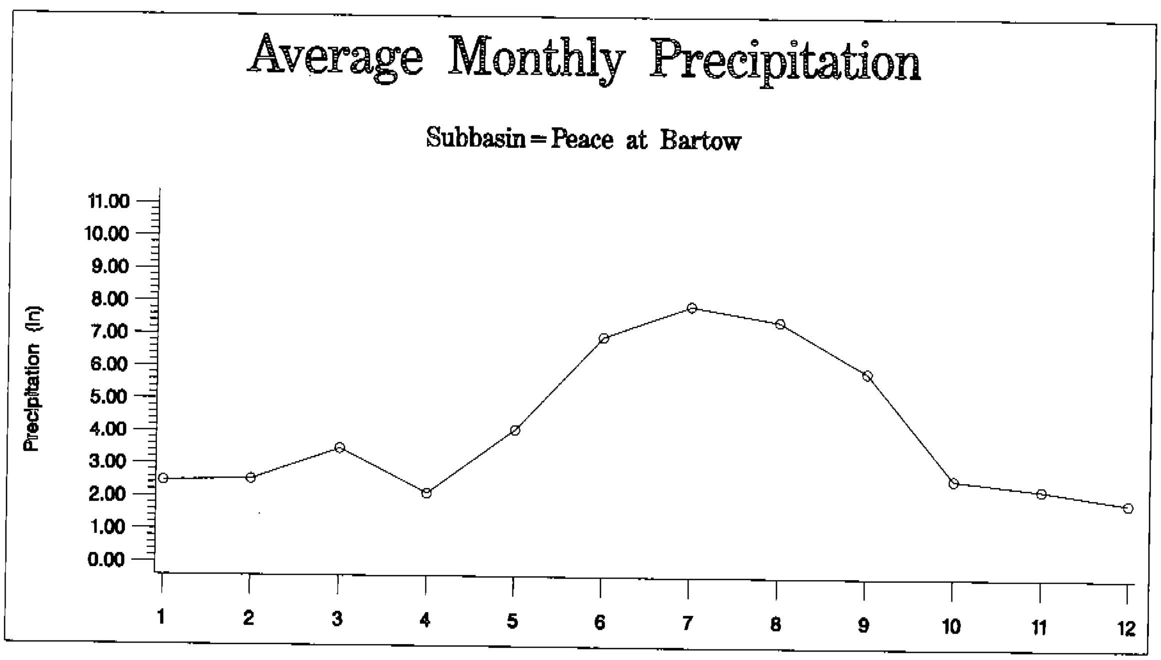
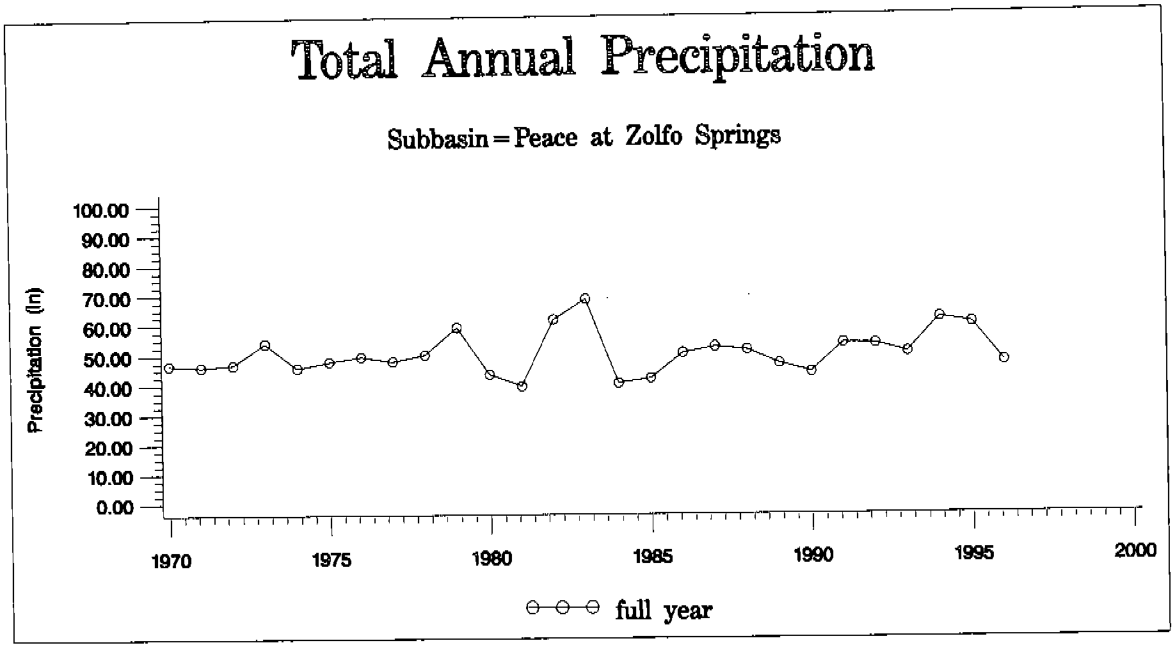


Figure 3-4. Total annual and average monthly precipitation in the Peace River above Bartow subbasin of the Peace River Basin.



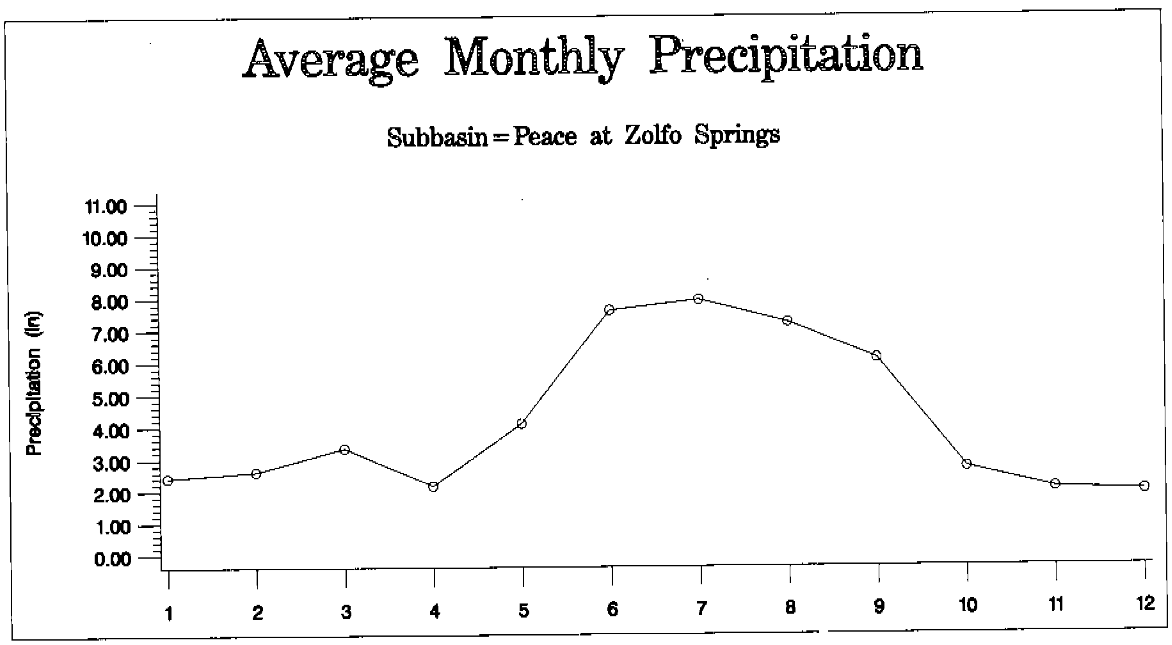
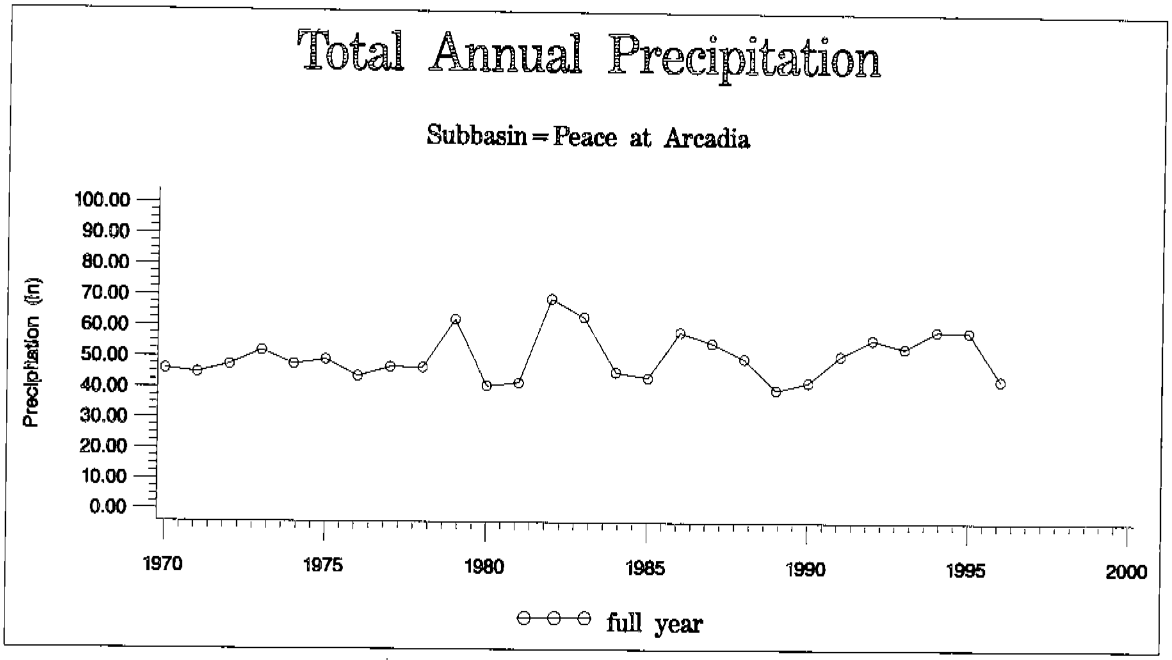


Figure 3-5. Total annual precipitation and average monthly precipitation for the Peace at Zolfo Springs subbasin.



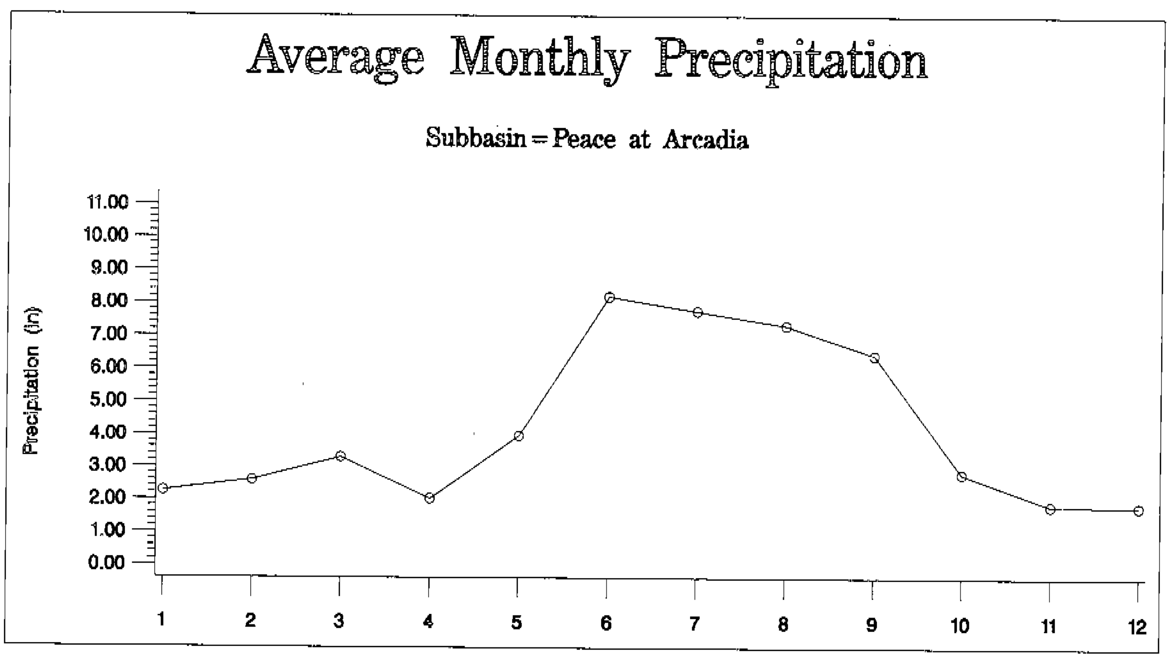
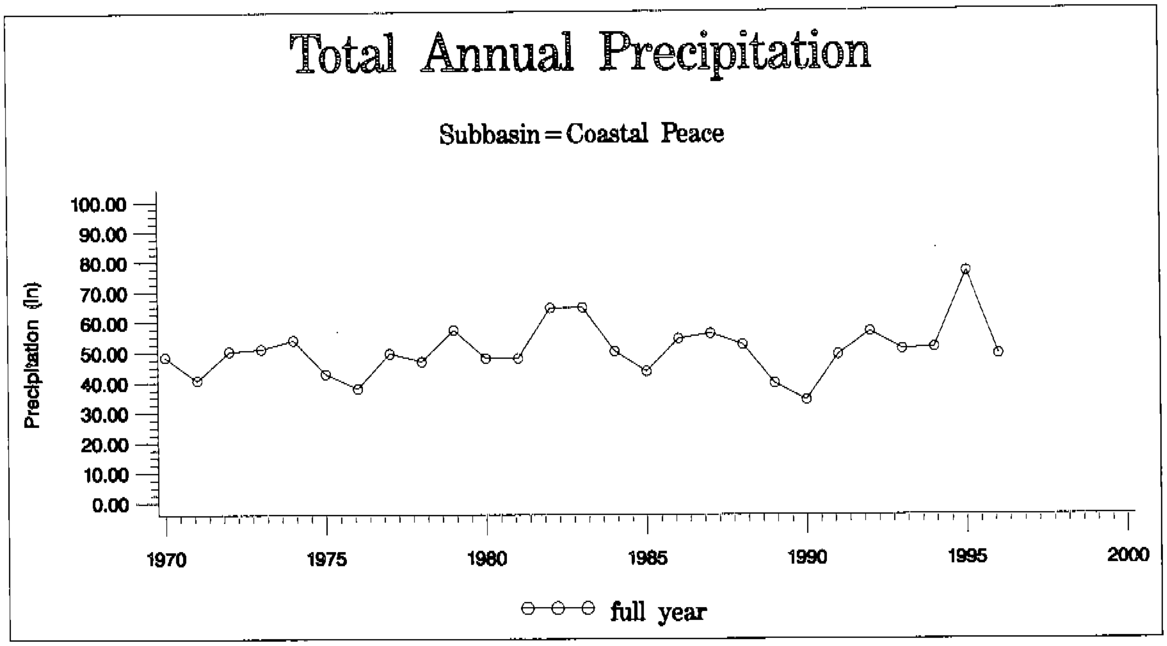


Figure 3-6. Total annual precipitation and average monthly precipitation for the Peace at Arcadia subbasin.



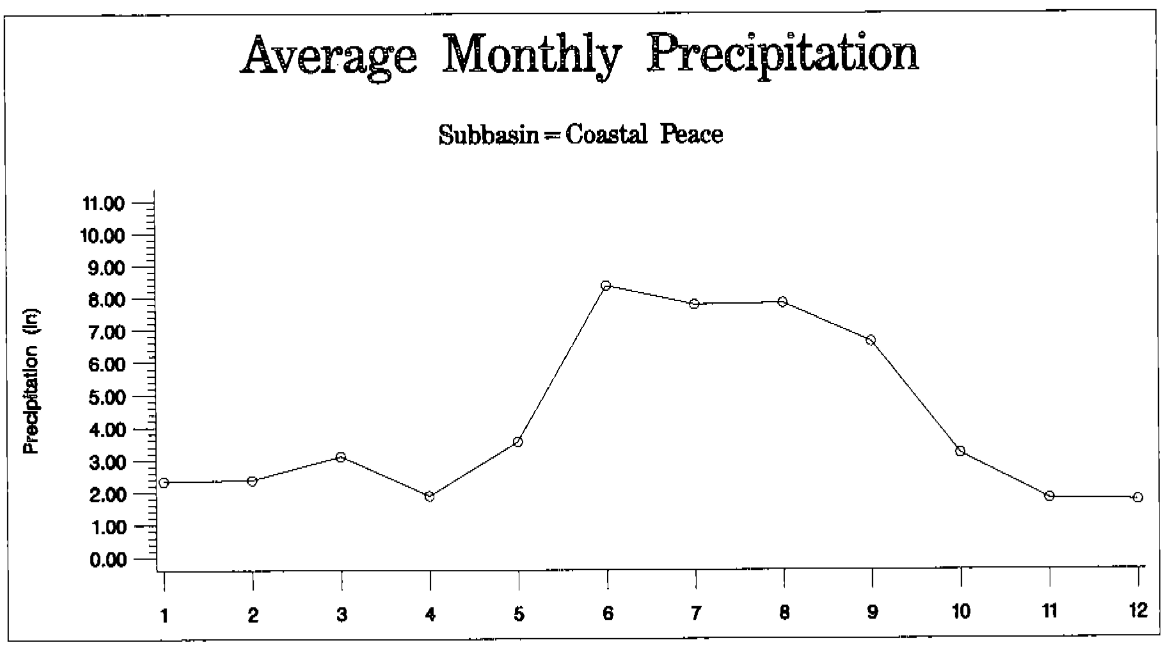
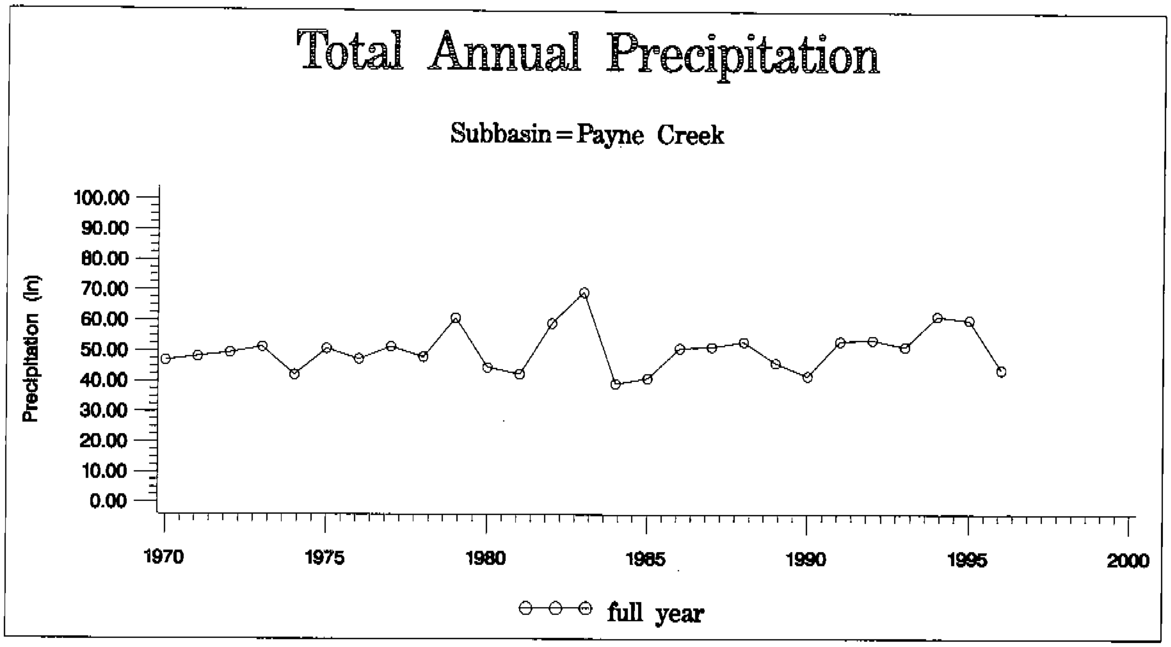


Figure 3-7. Total annual precipitation and average monthly precipitation for the Lower Peace subbasin.



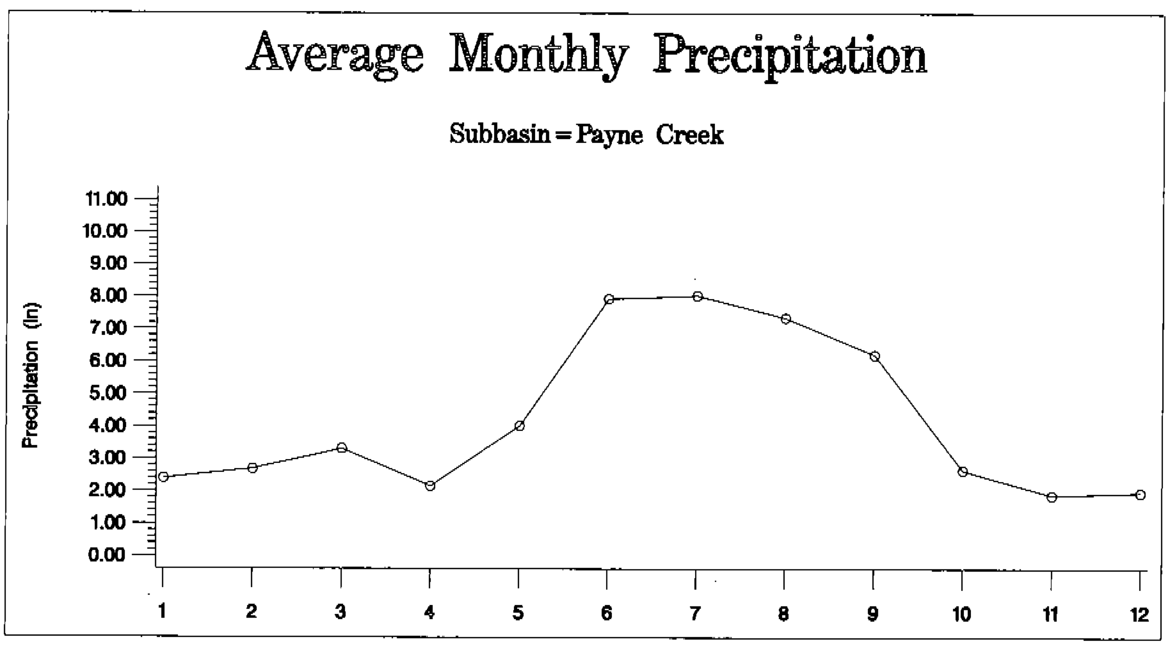
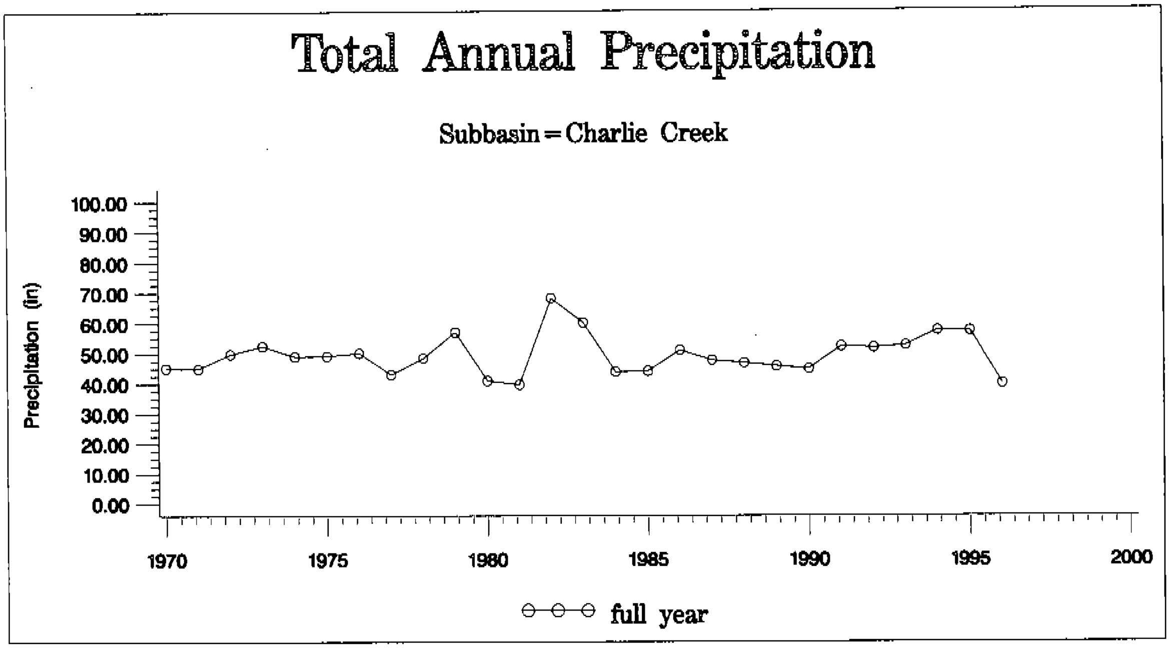


Figure 3-8. Total annual precipitation and average monthly precipitation for the Payne Creek subbasin.



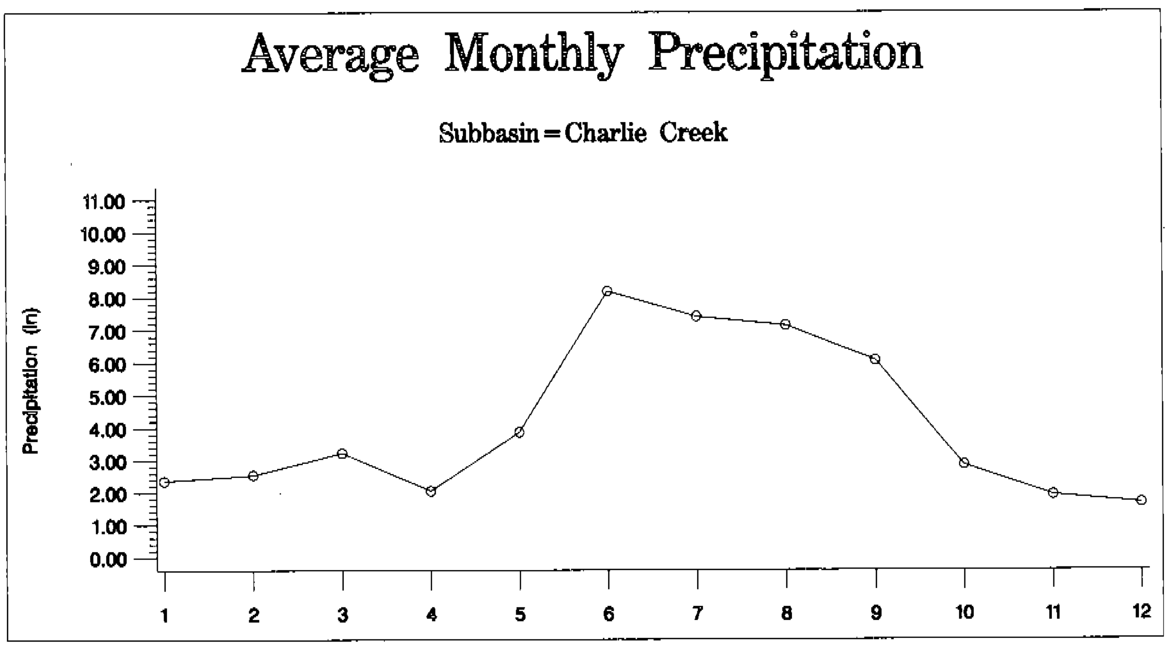
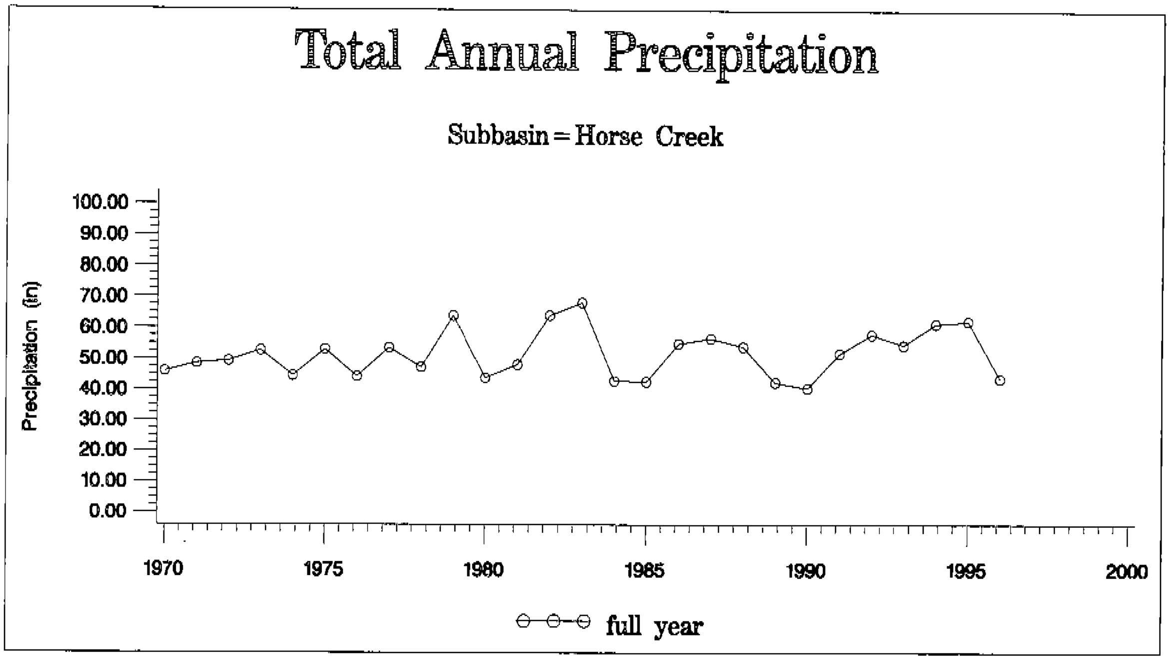


Figure 3-9. Total annual precipitation and average monthly precipitation for the Charlie Creek subbasin.



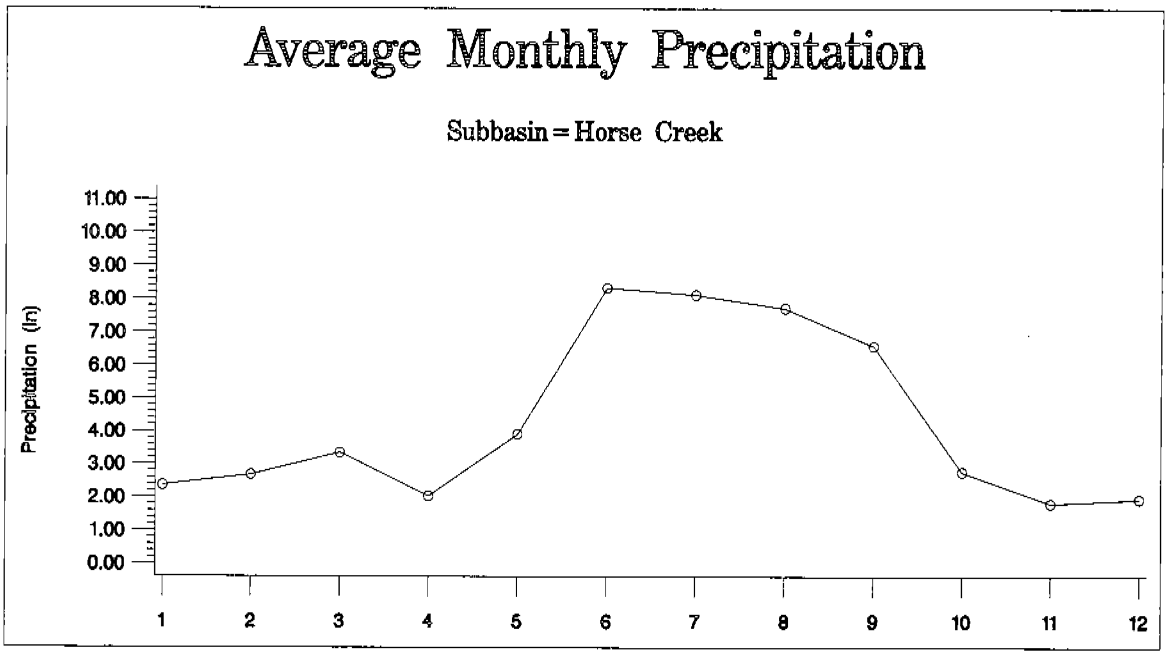
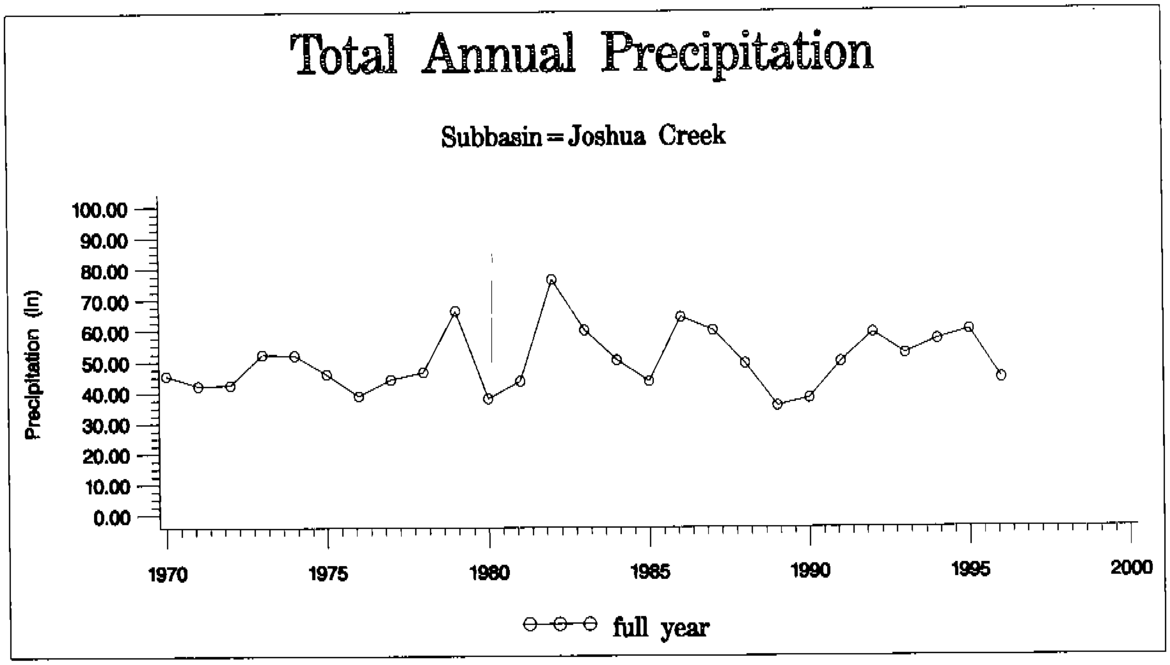


Figure 3-10. Total annual precipitation and average monthly precipitation for the Horse Creek subbasin.



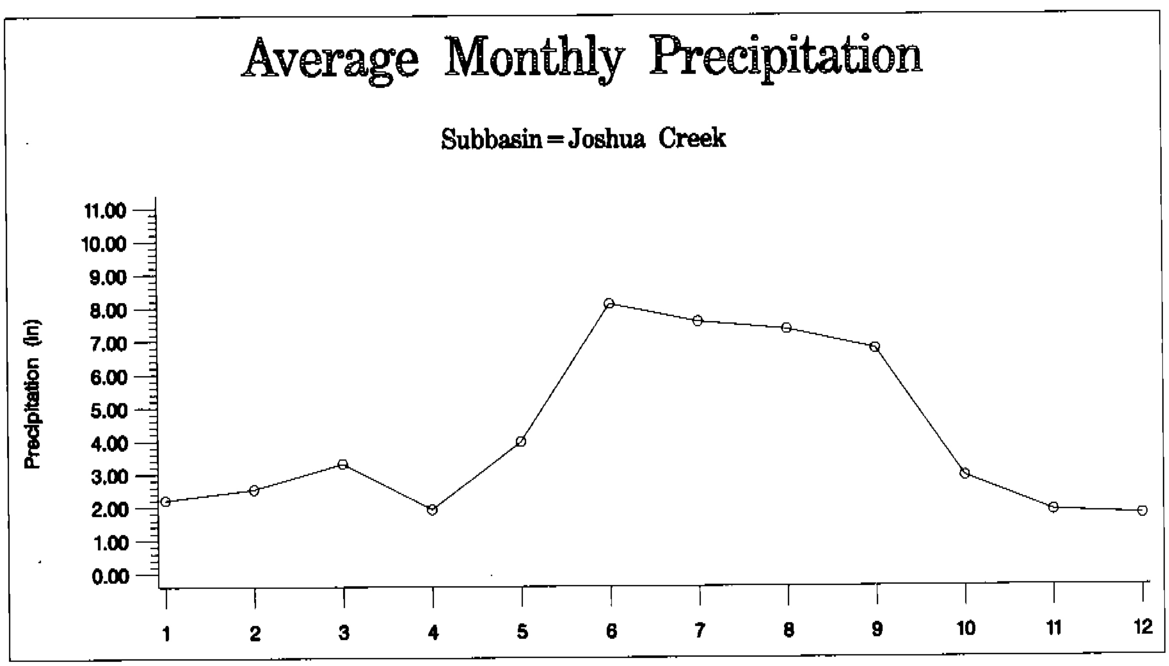
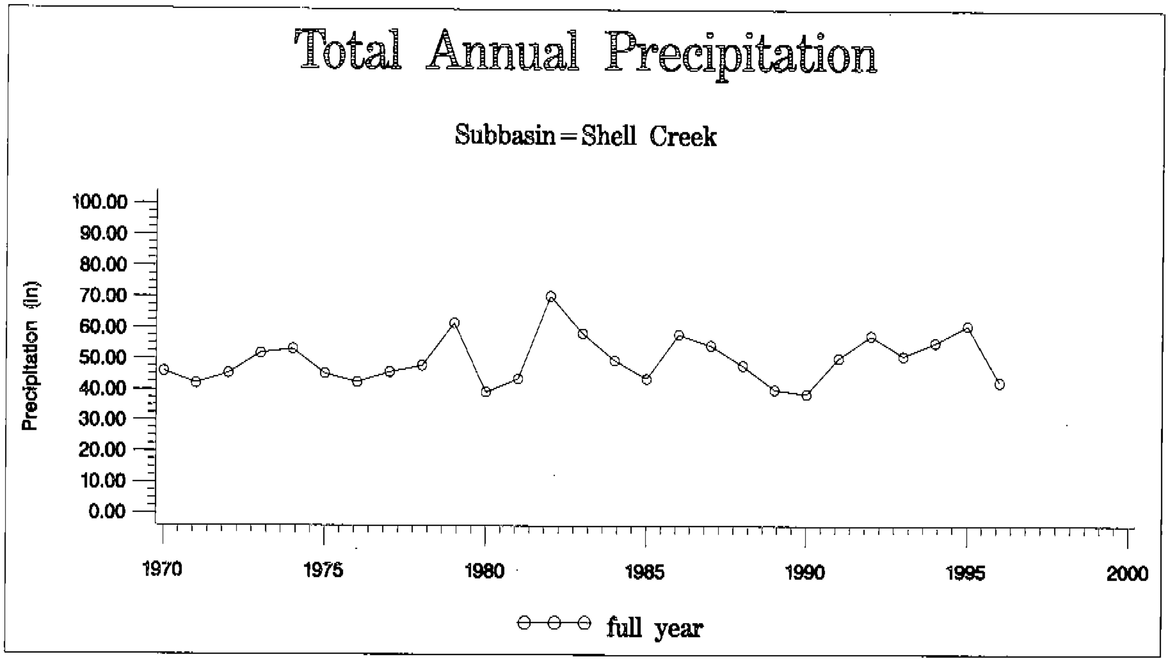


Figure 3-11. Total annual precipitation and average monthly precipitation for the Joshua Creek subbasin.



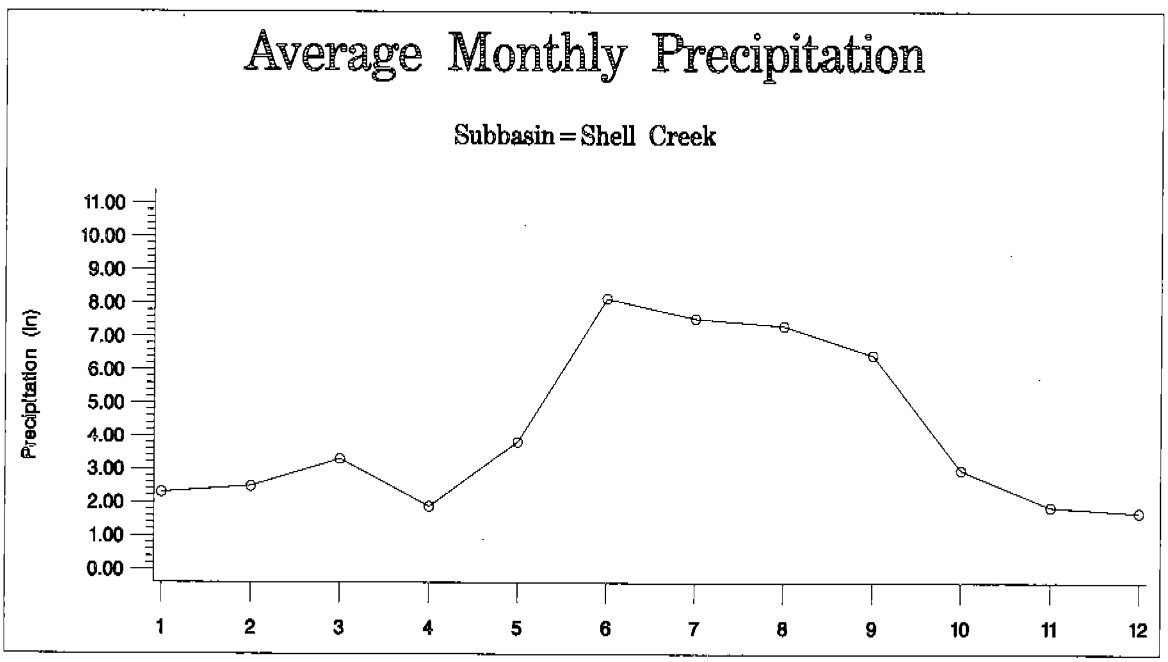


Figure 3-12. Total annual precipitation and average monthly precipitation for the Shell Creek subbasin.

SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We evaluated the two systems and developed a hybrid that is now in use for this project.

Future Land Use Coverages for the Charlotte Harbor NEP were developed by Southwest Florida Regional Planning Council (SWFRPC). SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions.

The FLUM uses a different and much simpler, land use classification system than either of the existing land use coverages and does not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). As a result, residential areas may increase tremendously under future scenarios because existing development is not taken into account. Direct comparisons between acreages of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category.

3.1.3.1 Existing Land Use/Cover

Existing land use in the Peace River Basin is presented in Figure 3-13 and Tables 3-4 through 3-6. Land use along the river is primarily agricultural and ranch, and phosphate has been mined for about 100 years. Both sides of the river have been mined in Polk County, and the industry is moving south into Hardee County. Zolfo Springs, Payne Creek, and Bartow subbasins in the upper portion of the Peace River Basin have existing mining land use acreages of 14.9%, 24.8%, and 5%, respectively.

There are three companies, CF Industries, Cargill Fertilizer, Inc., and IMC-Agrico Company, with active mining and reclamation activities in the Peace River Basin. An additional Phosphate Council company, U.S. Agri-Chemicals, no longer mines and is completing its reclamation activities. Mobil Mining and Minerals (Cargill) and Estech, Inc., mined in the past and are completing their reclamation obligations. The records for these companies indicate that 60,649 acres of land were mined in the Peace River Basin between July 1975 and December 1997 (reclamation became mandatory in 1975). Of these, nearly 35,000 acres (58%) have been reclaimed (contoured and revegetation) and an additional 5,423 acres (9%) have been contoured and are being revegetated.

Existing land use in the Peace River Basin is approximately 37% agriculture and 24% urban (Figure 3-13). Bartow is located near the headwaters of the river, and Fort Meade is north of Bowlegs Creek, in addition to Wachula, Zolfo Springs, and Arcadia. The headwaters of the Peace River and

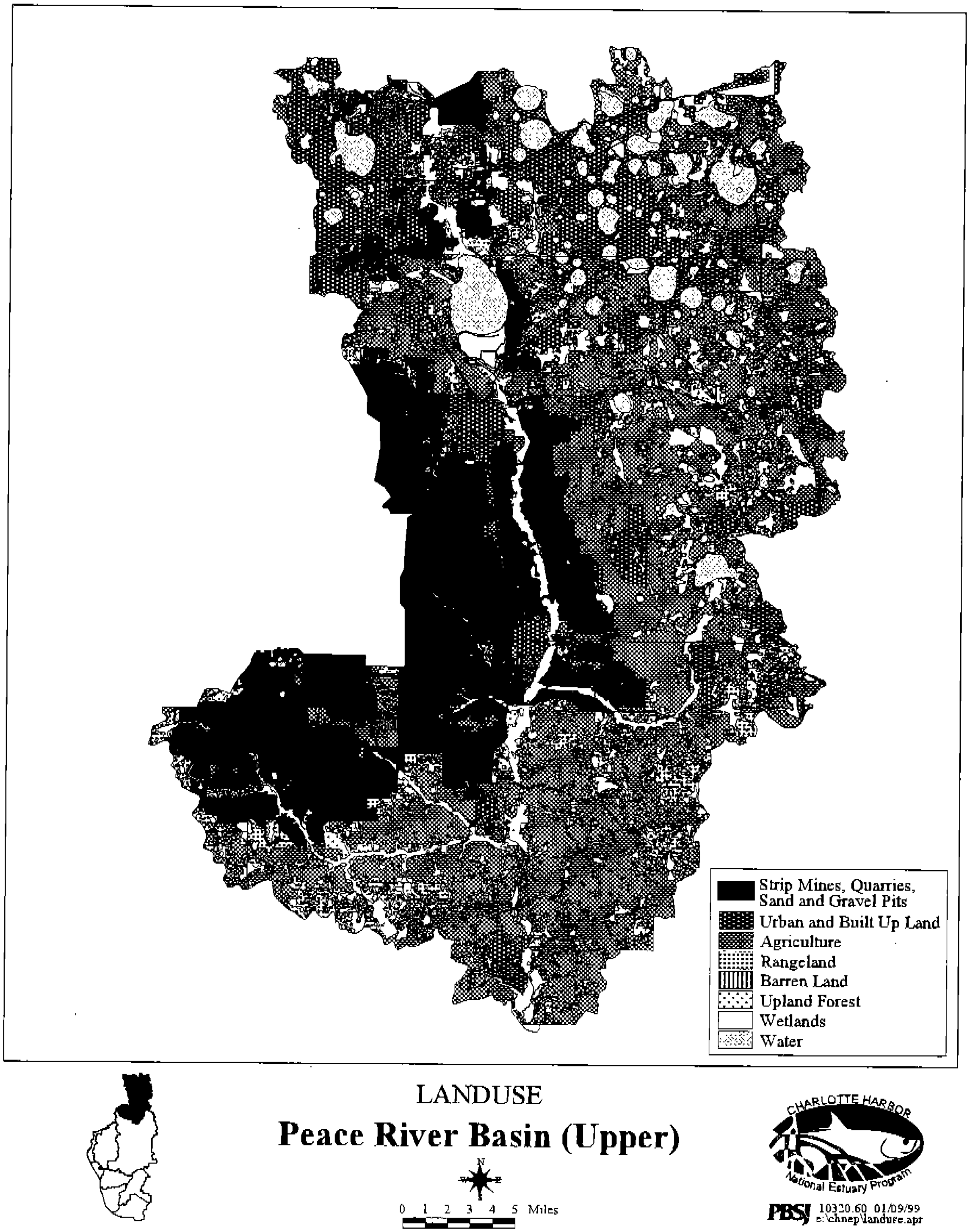


Figure 3-13a. Existing land use in the upper Peace River Basin (SWFWMD, 1988 and 1990).

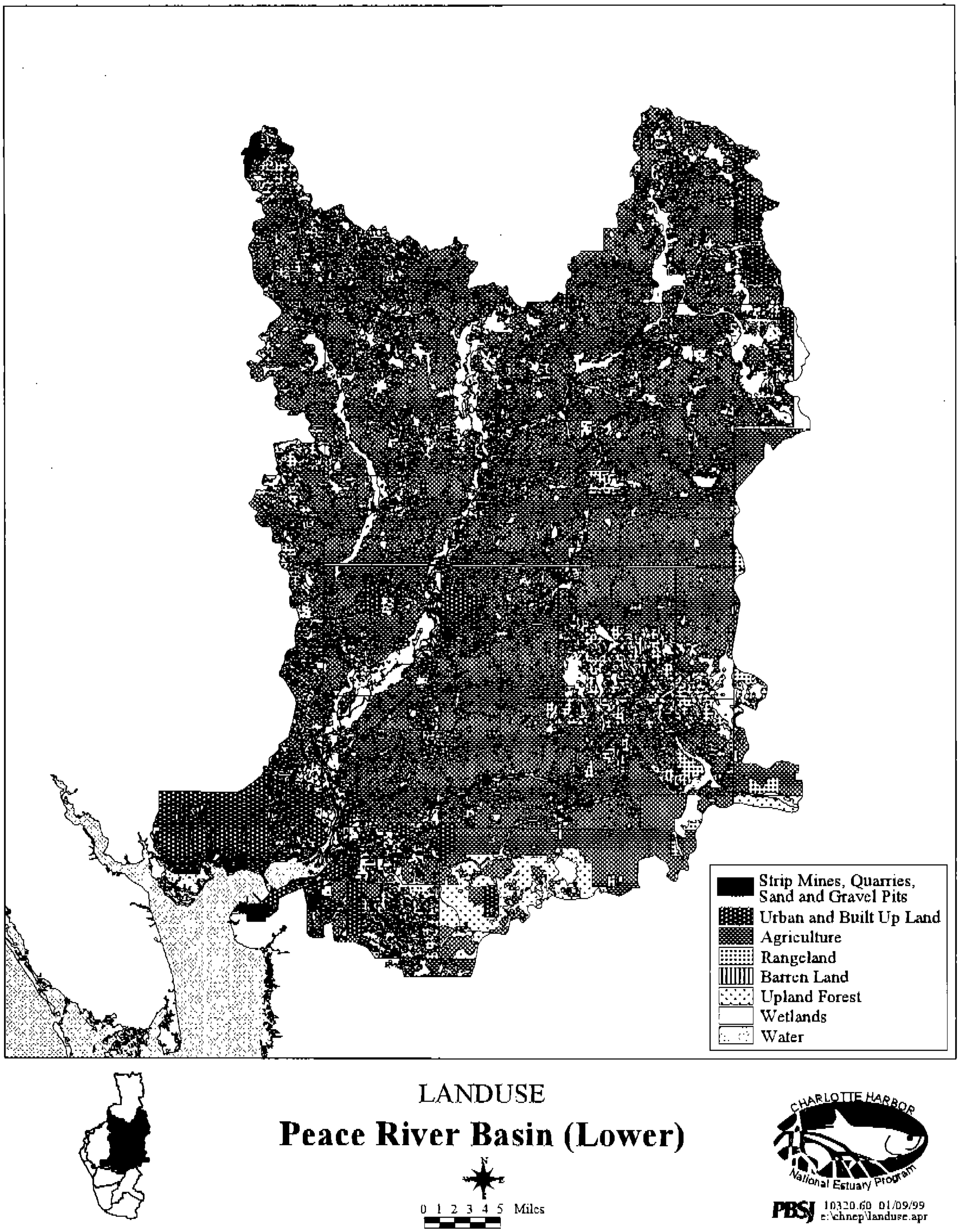


Figure 3-13b. Existing land use in the lower Peace River Basin (SWFWMD, 1988 and 1990).

Table 3-4. Current land use (1990)/cover in the Peace River Basin.

Land Use/Cover	Peace at Bartow		Peace at Zolfo Springs		Peace at Arcadia	
	Acres	%	Acres	%	Acres	%
Single Family Residential	7,221	2.9	2,852	1.4	1,425	1.1
Medium Density Residential	24,697	10.0	4,467	2.3	515	0.4
Multi-family Residential	4,958	2.0	214	0.1	30	0.0
Commercial	7,594	3.1	950	0.5	248	0.2
Industrial	3,166	1.3	182	0.1	23	0.0
Mining	20,619	8.3	65,498	33.1	0	0.0
Institutional	6,273	2.5	1,020	0.5	302	0.2
Range Lands	20,683	8.3	14,080	7.1	10,524	8.2
Barren Lands	898	0.4	90	0.0	16	0.0
Pasture	39,388	15.9	47,547	24.0	49,917	38.9
Groves	36,624	14.8	25,301	12.8	19,246	15.0
Feedlots	10	< 0.1	29	< 0.1	16	0.0
Nursery	436	0.2	135	0.1	159	0.1
Row and Field Crops	19	< 0.1	0	0.0	84	0.1
Upland Forested	10,966	4.4	7,433	3.8	17,077	13.3
Freshwater - Open Water	32,559	13.1	3,364	1.7	656	0.5
Saltwater - Open Water	0	0.0	0	0.0	0	0.0
Forested Freshwater Wetland	19,379	7.8	18,119	9.2	20,424	15.9
Saltwater Wetland	0	0.0	0	0.0	0	0.0
Non-forested Freshwater Wetland	11,908	4.8	6,520	3.3	7,524	5.9
Tidal Flats	350	0.1	11	< 0.1	0	0.0
TOTAL	247,745	100.0	197,810	100.0	128,184	100.0

Table 3-5. Current land use (1990)/cover in the Peace River Basin.

Land Use/Cover	Lower Peace		Payne Creek		Charlie Creek	
	Acres	%	Acres	%	Acres	%
Single Family Residential	6,888	4.2	204	0.3	3,354	1.6
Medium Density Residential	18,726	11.4	306	0.4	956	0.5
Multi-family Residential	1,237	0.8	53	0.1	88	< 0.1
Commercial	2,639	1.6	30	< 0.1	26	< 0.1
Industrial	240	0.1	20	< 0.1	19	< 0.1
Mining	630	0.4	36,987	46.2	0	0.0
Institutional	3,067	1.9	56	0.1	294	0.1
Range Lands	27,158	16.5	7,279	9.1	25,249	12.0
Barren Lands	500	0.3	5	< 0.1	25	< 0.1
Pasture	28,960	17.6	9,449	11.8	93,775	44.4
Groves	10,332	6.3	8,641	10.8	24,497	11.6
Feedlots	0	0.0	17	< 0.1	237	0.1
Nursery	26	< 0.1	6	< 0.1	204	0.1
Row and Field Crops	24	< 0.1	976	1.2	0	0.0
Upland Forested	27,075	16.4	5,926	7.4	22,502	10.7
Freshwater - Open Water	6,392	3.9	1,033	1.3	1,275	0.6
Saltwater - Open Water	477	0.3	0	0.0	0	0.0
Forested Freshwater Wetland	15,855	9.6	6,599	8.2	26,642	12.6
Saltwater Wetland	4,540	2.8	0	0.0	0	0.0
Non-forested Freshwater Wetland	9,863	6.0	2,534	3.2	11,880	5.6
Tidal Flats	2	< 0.1	0	0.0	0	0.0
TOTAL	164,631	100.0	80,122	100.0	211,023	100.0

Table 3-6. Current land use(1990)/cover in the Peace River Basin.

Land Use/Cover	Horse Creek		Joshua Creek		Shell Creek	
	Acres	%	Acres	%	Acres	%
Single Family Residential	1,646	1.2	1,131	1.5	3,004	1.3
Medium Density Residential	28	< 0.1	646	0.8	0	0.0
Multi-family Residential	0	0.0	37	< 0.1	86	< 0.1
Commercial	0	0.0	192	0.2	11	< 0.1
Industrial	9	< 0.1	7	< 0.1	0	0.0
Mining	1,922	1.4	0	0.0	26	< 0.1
Institutional	213	0.2	536	0.7	235	0.1
Range Lands	26,151	19.3	7,184	9.3	48,820	20.8
Barren Lands	11	< 0.1	76	0.1	254	0.1
Pasture	50,665	37.3	39,026	50.4	82,049	35.0
Groves	9,530	7.0	15,889	20.5	35,527	15.2
Feedlots	54	< 0.1	0	0.0	4	< 0.1
Nursery	42	< 0.1	79	0.1	9	< 0.1
Row and Field Crops	846	0.6	0	0.0	545	0.2
Upland Forested	19,860	14.6	4,343	5.6	25,552	10.9
Freshwater - Open Water	294	0.2	348	0.4	1,048	0.4
Saltwater - Open Water	0	0.0	0	0.0	6	< 0.1
Forested Freshwater Wetland	15,044	11.1	2,848	3.7	6,698	2.9
Saltwater Wetland	0	0.0	0	0.0	0	0.0
Non-forested Freshwater Wetland	9,461	7.0	5,056	6.5	30,537	13.0
Tidal Flats	0	0.0	0	0.0	0	0.0
TOTAL	135,777	100.0	77,398	100.0	234,410	100.0

the estuary in Charlotte County are highly developed and include the urbanized areas of the Peace River Shores, Harbour Heights, Punta Gorda, and Port Charlotte. Two railroads and 13 other bridges cross the river. Development along the Peace River in Hardee and DeSoto counties is limited.

Highest percentages of urban land uses among subbasins in the Peace River Basin are Lower Peace (20%), Zolfo Springs (38%), and Bartow (47%) subbasins. The urban land use can be attributed predominantly to medium density residential.

3.1.3.2 Future Land Use

The portion of the Peace River Basin within Charlotte County is expected to have the greatest increase in urban land uses as a result of coastal development, while the interior counties are expected to have smaller increases in urban development (Figure 3-14). One of the most conspicuous changes in future land use is the increase from 20% to 40% urban land use accounted for in the Lower Peace and from 3% to 28% in the Joshua Creek subbasin under future planning (Table 3-7 through 3-9). A small increase in agriculture also appears in future land use for the Lower Peace subbasin, although large increases in future agricultural land use occur in three additional subbasins.

The most conspicuous differences in existing and future land use in the Peace River Basin are exhibited for mining. Future land maps indicate large increases in mining land use in Zolfo Springs, Payne Creek, and Bartow subbasins. Future percentages of land use in Zolfo Springs, Payne Creek, and Bartow subbasins in the Peace River Basin include 50%, 92%, and 4% respectively of the acreage in mining.

3.1.4 Surface Water Hydrology and Water Management Practices

The primary flowway in this basin is the Peace River. Several major tributaries flow into the Peace River, with flows from Zolfo Springs, Payne Creek, Charlie Creek, Horse Creek, Joshua Creek, and Shell Creek contributing to the total flow of the river. The Peace River is a free-flowing river over its entire stretch, although two of its tributaries have regulated flow. A control structure (P-11) is found in its headwaters on Saddle Creek south of Lake Hancock, and a dam at the City of Punta Gorda's water supply reservoir on Shell Creek.

3.1.4.1 Surface Water Hydrology

Total monthly streamflow data were obtained from USGS monitoring records for the Peace River Basin and used to calculate existing streamflow inputs. Gaging stations are identified in Figure 3-15 for the Peace River Basin.

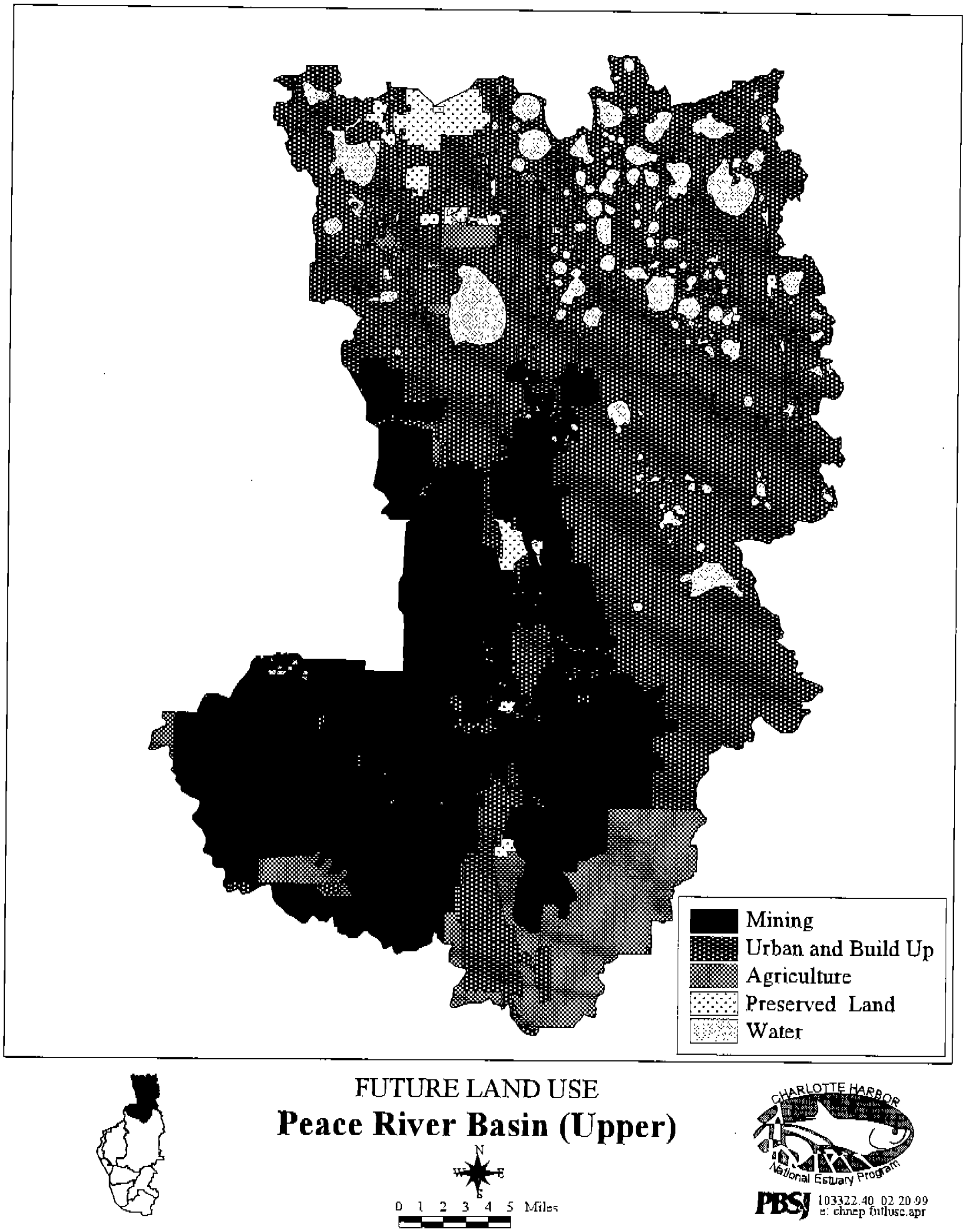


Figure 3-14. Future land use in the Upper Peace River Basin (SWRPC).

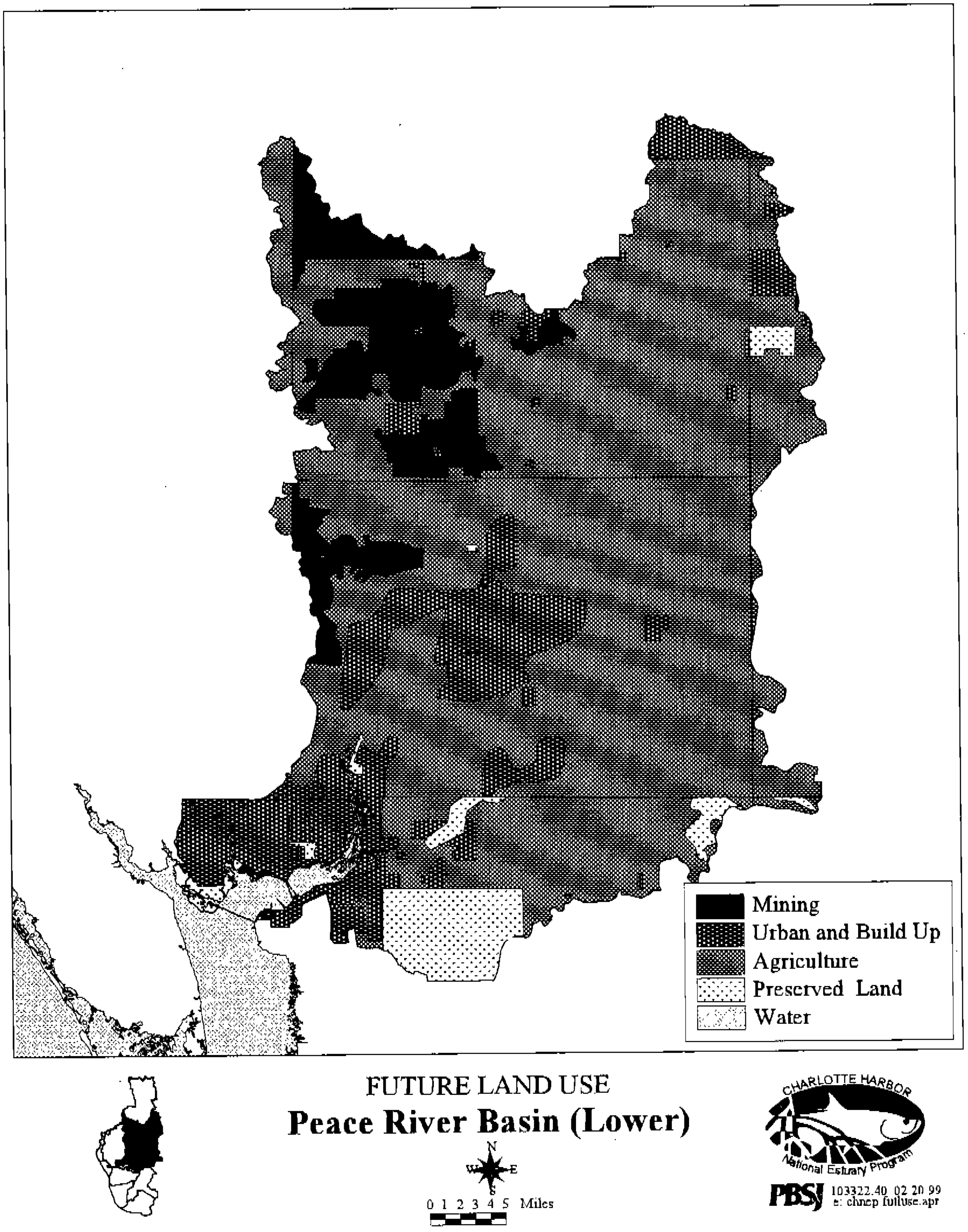


Figure 3-14. Future land use in the Lower Peace River Basin (SWRPC).

Table 3-7. Future land use (2010)/cover in the Peace River Basin.

Land Use/Cover	Peace at Bartow		Peace at Zolfo Springs		Peace at Arcadia	
	Acres	%	Acres	%	Acres	%
Single Family Residential	55,489	22	6,139	3	7,511	6
Multi-family Residential	4,747	2	3,194	2	142	0.1
Rural Residential	109,260	44	49,309	25	335	0.3
Commercial	22,281	9	6,222	3	3,236	3
Industrial	5,141	2	163	<0.1	0	0
Mining	9,881	4	98,449	50	38,676	30
Agricultural	0	0	30,656	15	78,084	61
Wetlands	31,281	13	1,912	1	0	0
Protected Resource	8,851	4	1,762	1	197	0.2
TOTAL	246,931	100	197,806	100	128,181	100

Table 3-8. Future land use (2010)/cover in the Peace River Basin.

Land Use/Cover	Lower Peace		Payne Creek		Charlie Creek	
	Acres	%	Acres	%	Acres	%
Single Family Residential	49,462	30	462	0.1	7,178	3.3
Multi-family Residential	6,249	4	463	0.1	119	0.1
Rural Residential	11,473	7	239	<0.1	8,720	4.1
Commercial	9,322	6	728	1	38	< 0.1
Industrial	2,355	1	0	0	228	0.1
Mining	4,452	3	73,524	93	0	0.0
Agricultural	55,712	34	3,282	4	194,041	90.7
Wetlands	1	< 0.1	289	0.4	0	0.0
Protected Resource	24,748	15	293	0.4	3,506	1.6
TOTAL	163,781	100.0	79,280	100.0	213,830	100.0

Table 3-9. Future land use (2010)/cover in the Peace River Basin.

Land Use/Cover	Horse Creek		Joshua Creek		Shell Creek	
	Acres	%	Acres	%	Acres	%
Single Family Residential	4,167	3.1	21,141	68.1	6,911	2.9
Multi-family Residential	0	0.0	0	0.0	179	< 0.1
Rural Residential	0	0.0	1,114	0.1	4,780	2.0
Commercial	669	0.5	2,459	3.2	1,444	0.6
Industrial	0	0.0	0	0.0	0	0.0
Mining	55,553	40.8	0	0.0	0	0.0
Agricultural	75,629	55.6	52,683	68.1	213,233	88.3
Wetlands	0	0.0	0	0.0	0	0.0
Protected Resource	0	0.0	0	0.0	14,884	6.2
TOTAL	136,018	100.0	77,397	100.0	241,462	100.0

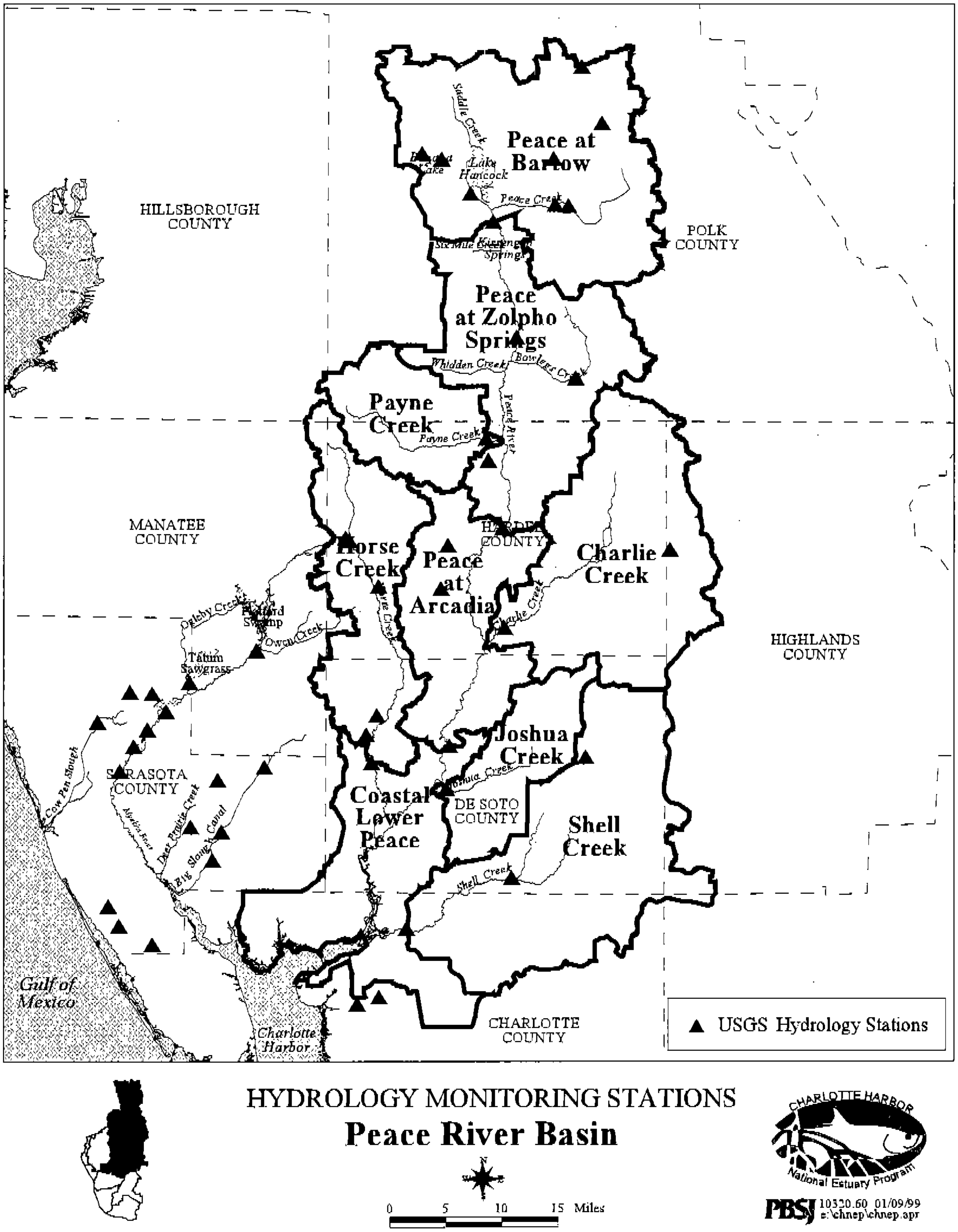


Figure 3-15. USGS water gaging stations in the Peace River Basin.

Total annual flow and average monthly flow are presented for eight stations in the basin, in order of increasing distance upstream from the mouth of the river (Figure 3-16 through 3-23). Total annual flows ranged from less than 1,000 to 10,000 cfs among the different stations. All stations exhibit large variation in discharges, but have seasonally characteristic patterns.

Maximum discharges occurred in September, near the end of the summer rainy season and are generally associated with hurricanes or tropical storms. Maximum September discharges are generally three to four times greater than the smaller peak discharges in May. Stream flows were lowest for December and May at all stations.

The three stations on the river channel have flows ranging from about 2500 cfs at Arcadia (downstream), to 1400 cfs at Zolfo Springs, to 450 cfs at Bartow (farthest upstream). The remaining five stations along tributaries ranged from about 220 cfs (Payne Creek) to nearly 700 cfs (Charlie Creek), reflecting the smaller drainage areas of the tributaries.

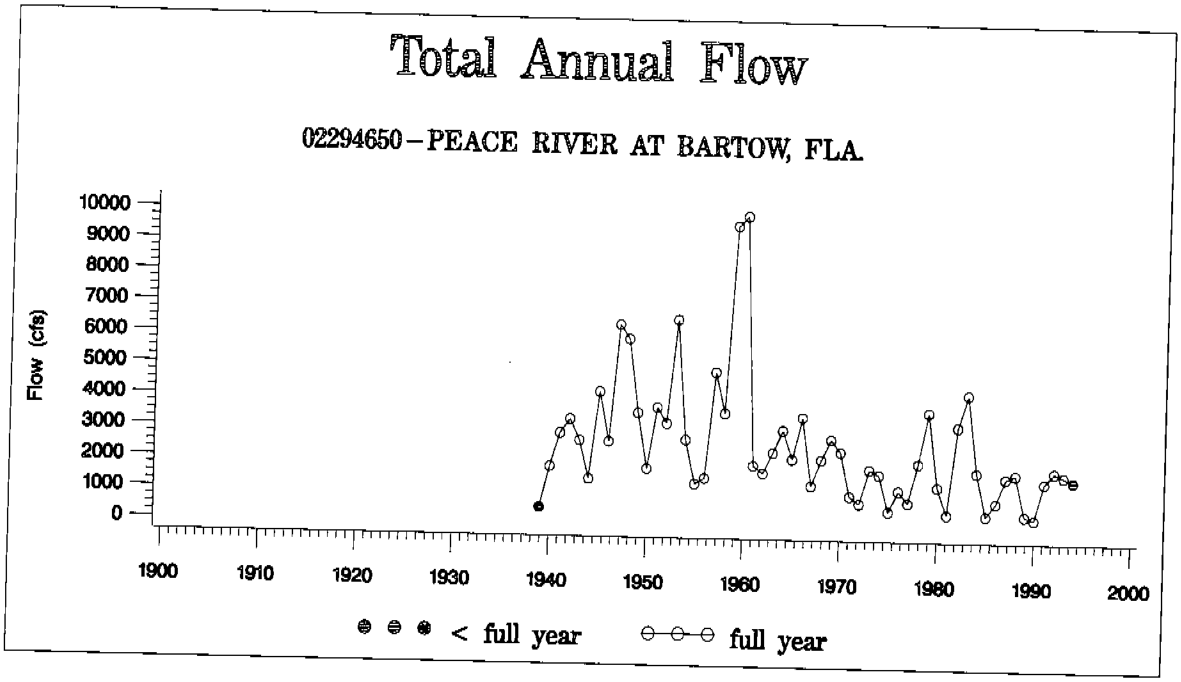
Deviations from general relationships between trends in rainfall and stream flow have been described by Hammett (1988) and Coastal Environmental (1994). A trend of decreasing wet season and dry season flows for the Peace River at Zolfo Springs, Bartow, and Arcadia cannot be attributed to rainfall trends alone, as it can for flows in other basins, and may be a result of declining artesian water levels of the Floridan Aquifer (Hammett, 1981). Results from Coastal Environmental indicate that the downward trends in flows ranged from a 1.32%/year decrease in flow in the Peace River at Arcadia to 2.53%/year in the Peace River at Bartow. The majority of the flow decline in the Peace River at Arcadia could be attributed to rainfall while factors other than rainfall contributed much more significantly in the Peace River at Bartow.

3.1.4.2 Urban Management Practices

Urbanized areas of the Peace River Basin are scattered throughout the basin and are associated with the cities of Lakeland, Winter Haven, and Bartow to the north, the smaller towns of Ft. Meade, Zolfo Springs, Wauchula, and Arcadia along the river, Avon Park to the east, Port Charlotte adjacent to Charlotte Harbor, and Punta Gorda in the Shell Creek subbasin. The discussion of urban management practices is divided into urban water uses and urban water discharges, including reuse.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. Discussion of water use is focused on facilities with an average permitted quantity greater than 0.5 million MGD. All water use information for those parts of the Charlotte Harbor NEP study area within the borders of the Southwest Florida Water Management District (SWFWMD), including the entire Peace River Basin, is from SWFWMD (1997) and SWFWMD (1992).



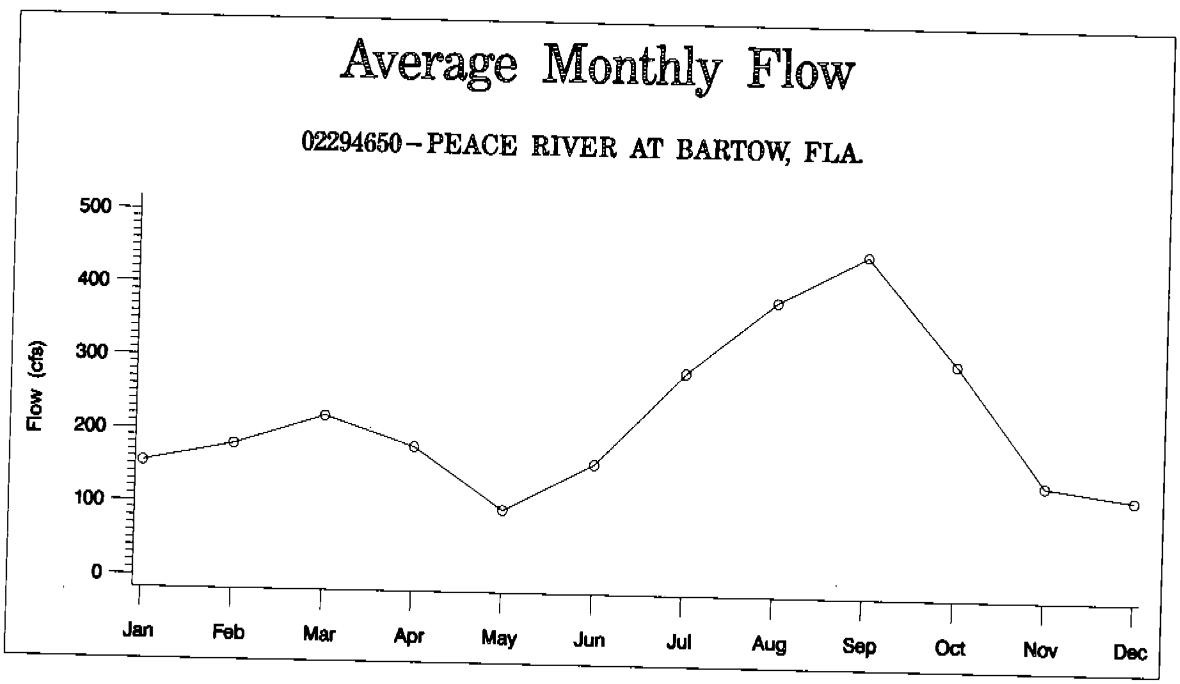
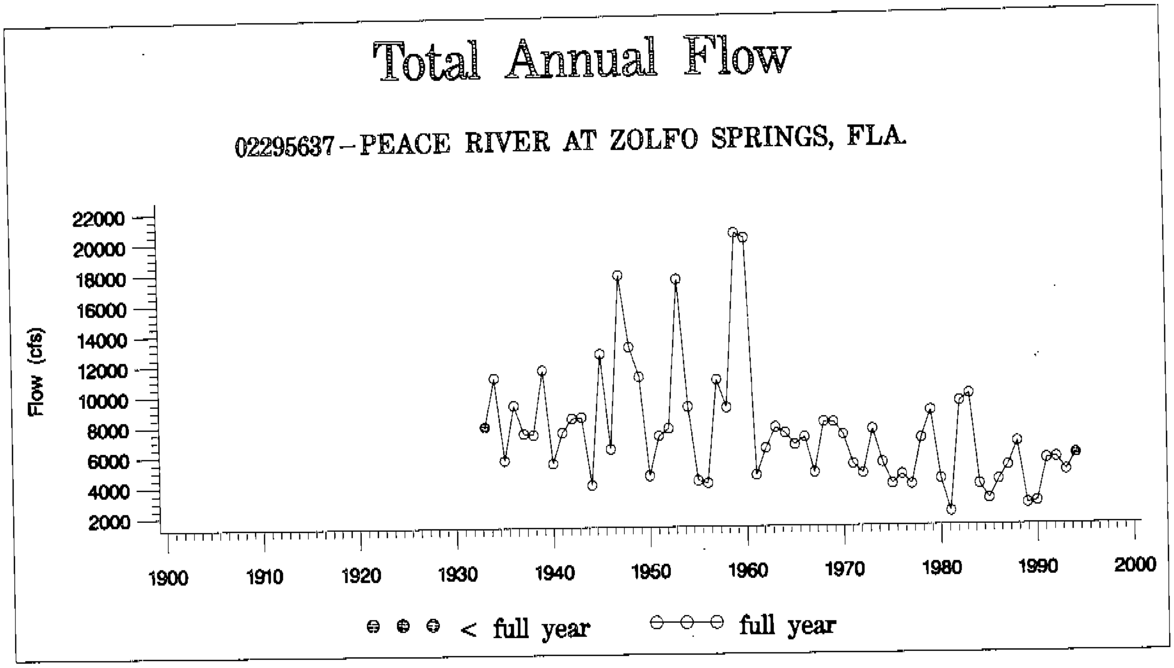


Figure 3-16. Plots of total annual flow and average monthly flow at station 02294650 in the Peace River Basin.



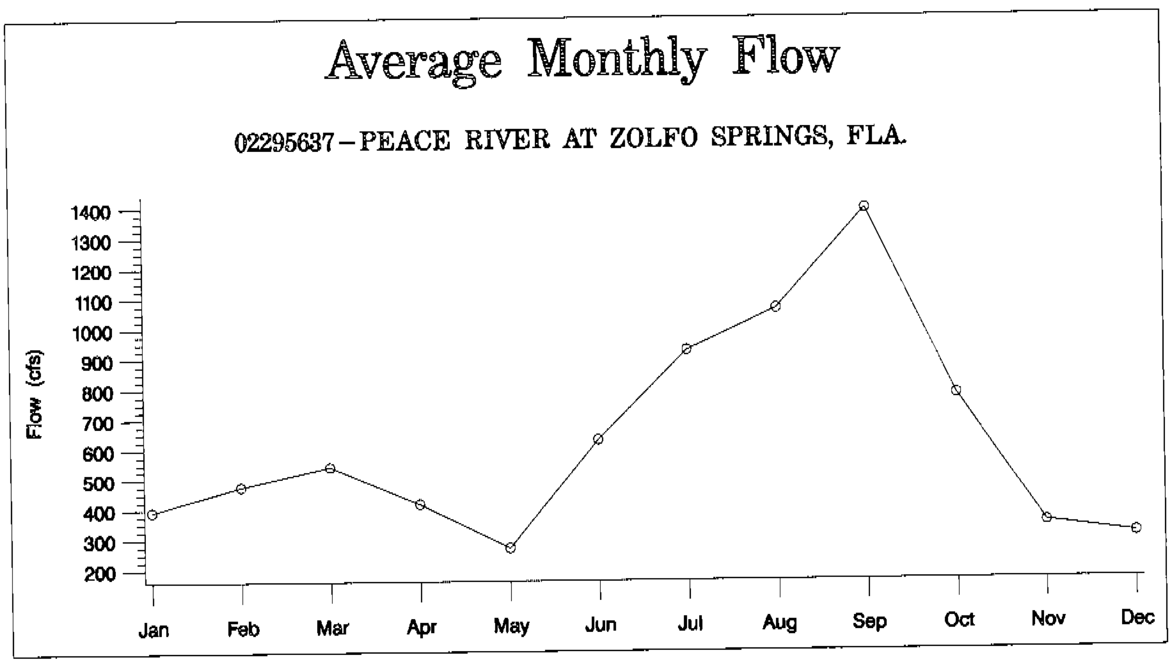
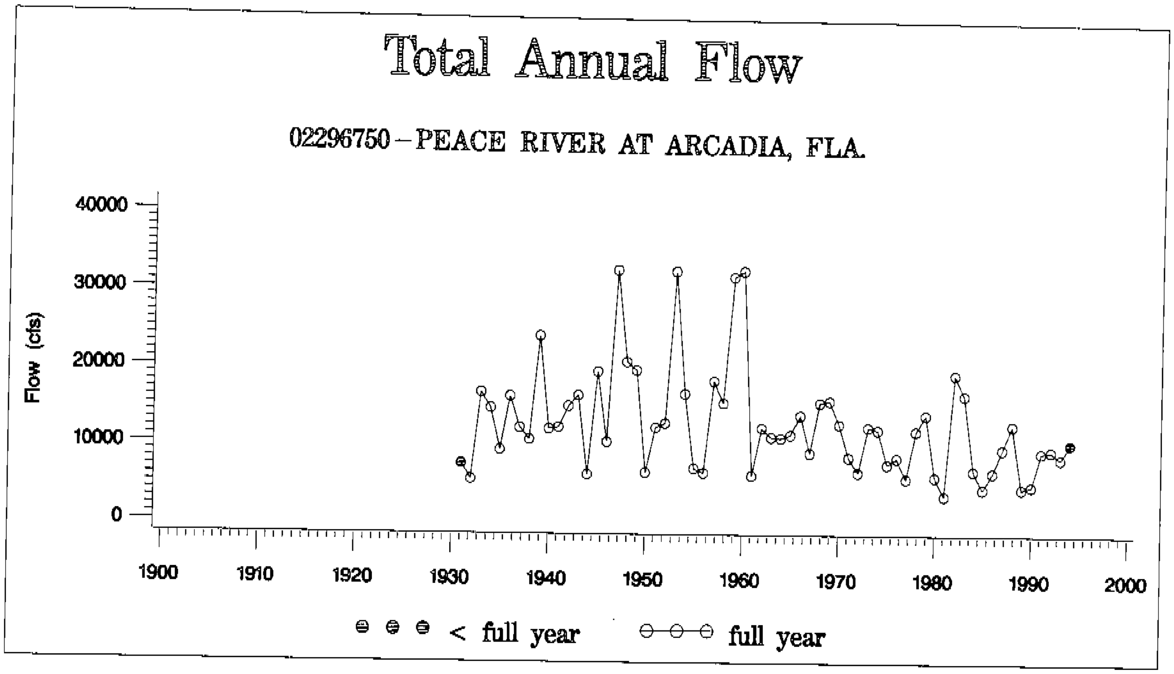


Figure 3-17. Plots of total annual flow and average monthly flow at station 02295637 in the Peace River Basin.



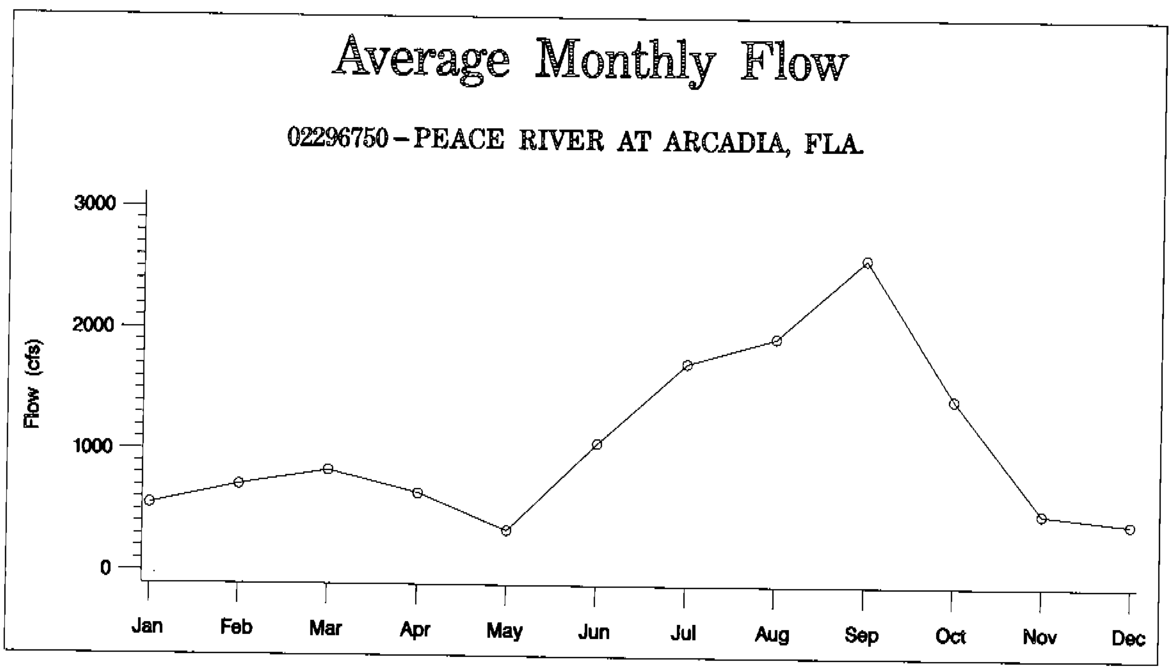
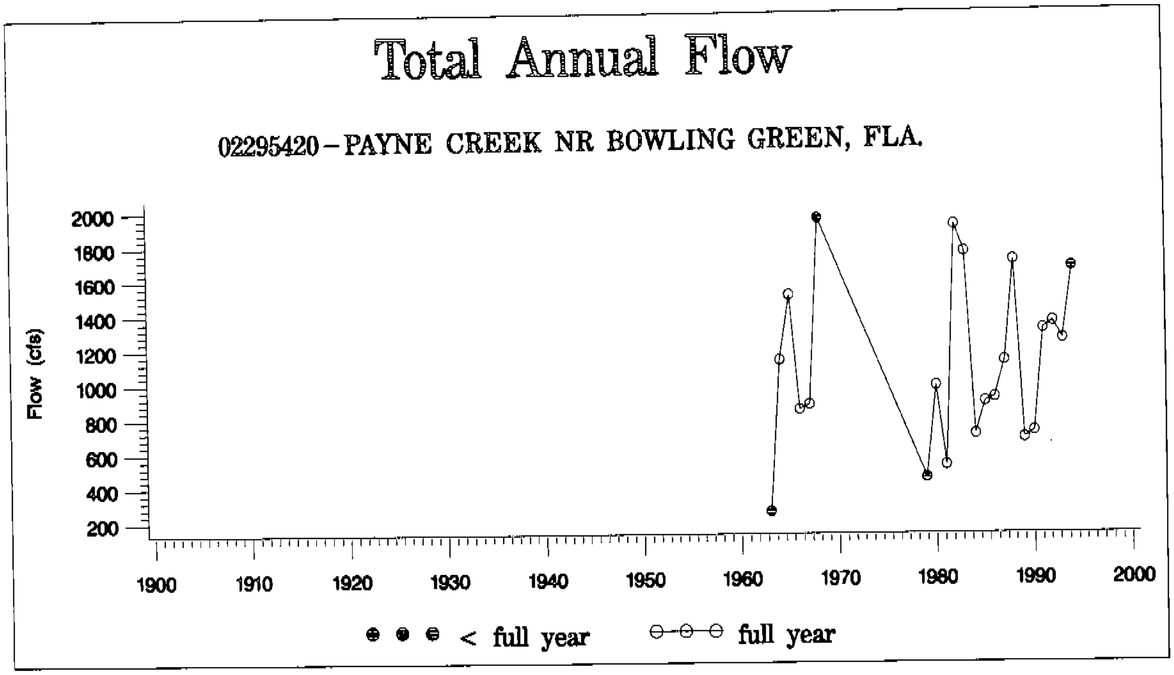


Figure 3-18. Plots of total annual flow and average monthly flow at station 02296750 in the Peace River Basin.



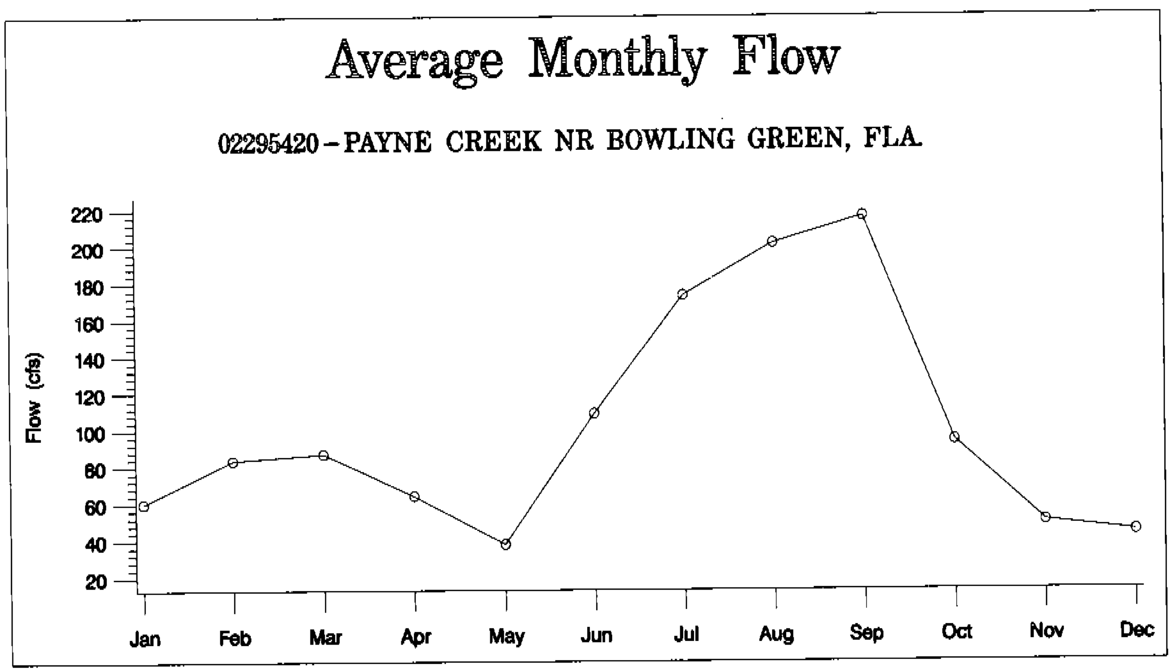
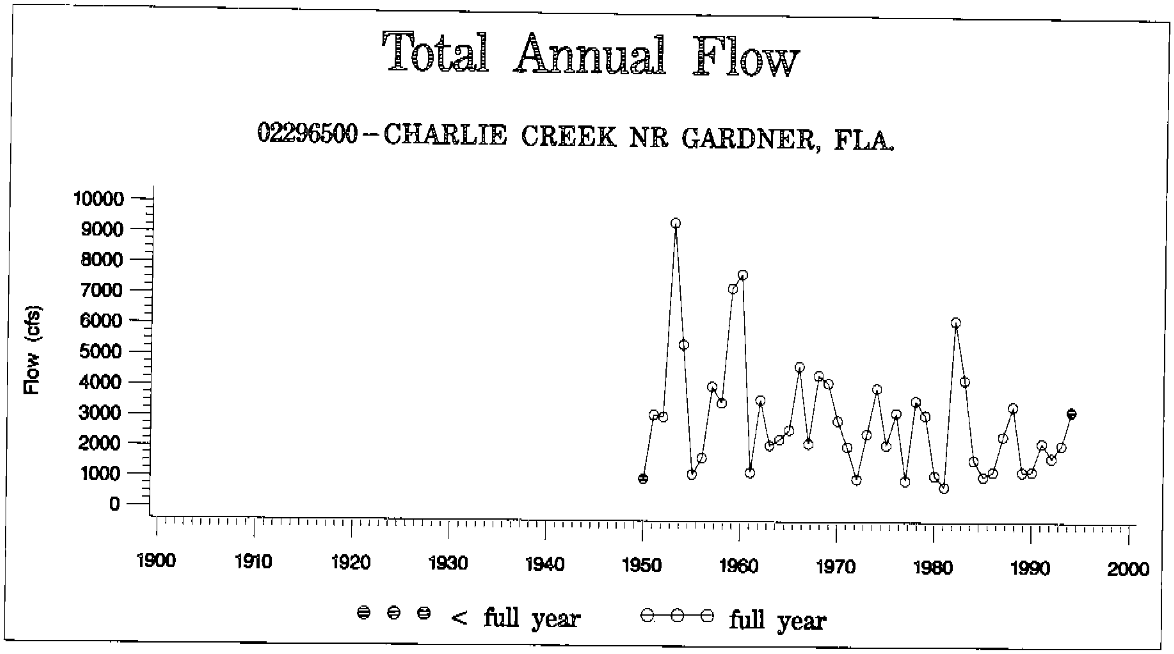


Figure 3-19. Plots of total annual flow and average monthly flow at station 02295420 in the Peace River Basin.



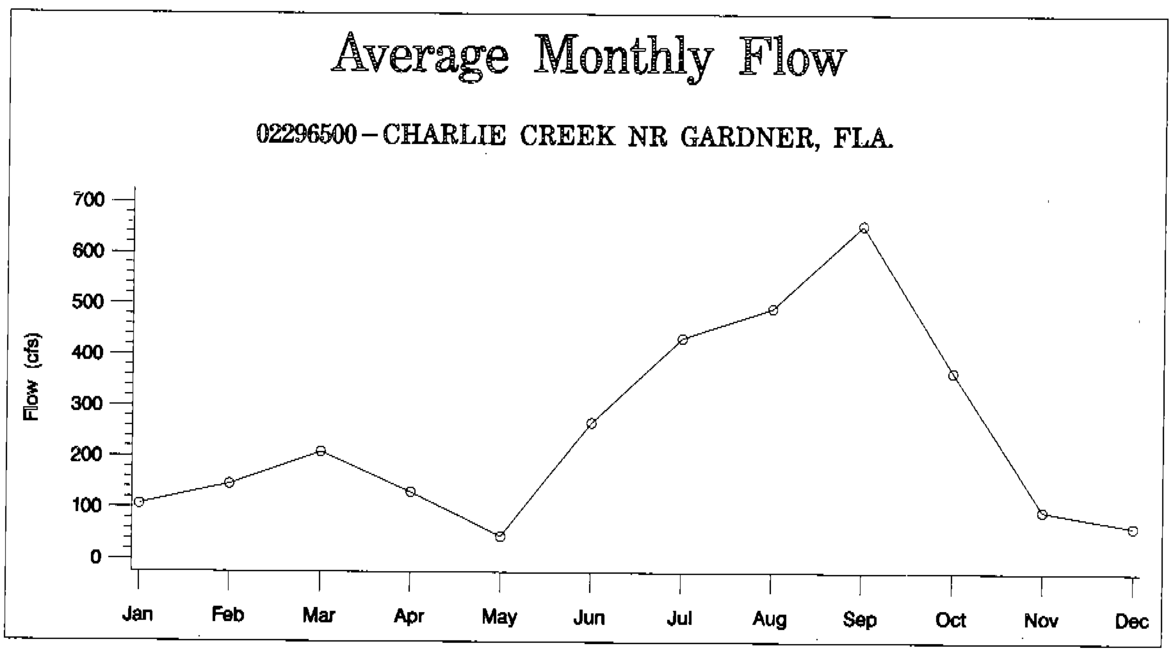
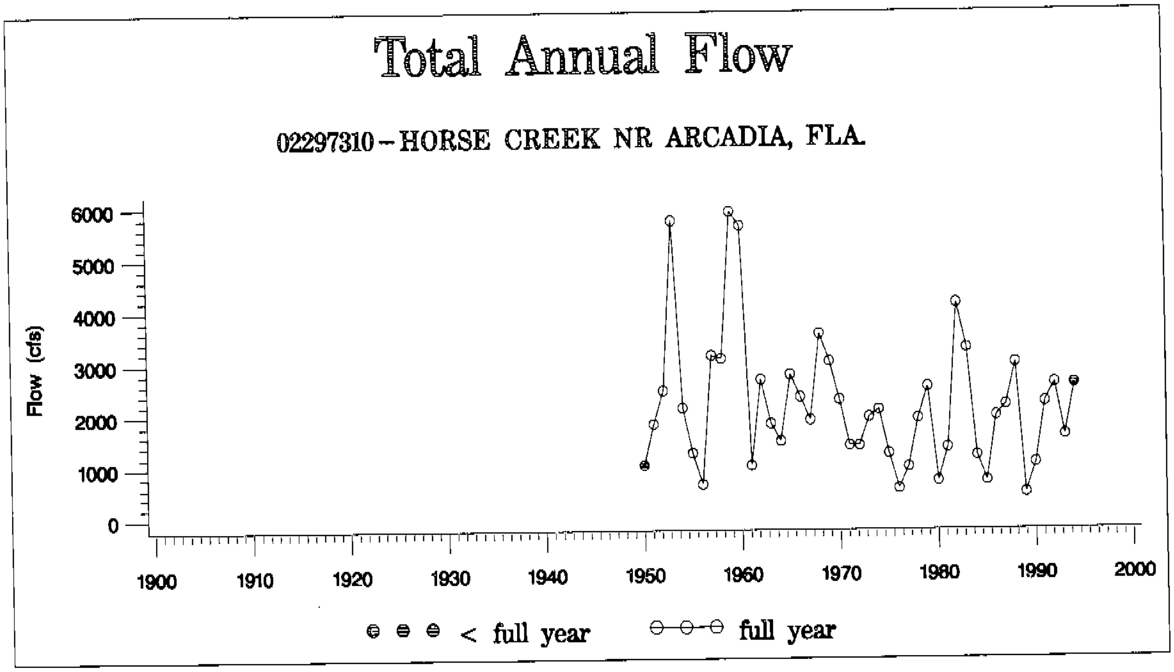


Figure 3-20. Plots of total annual flow and average monthly flow at station 02296500 in the Peace River Basin.



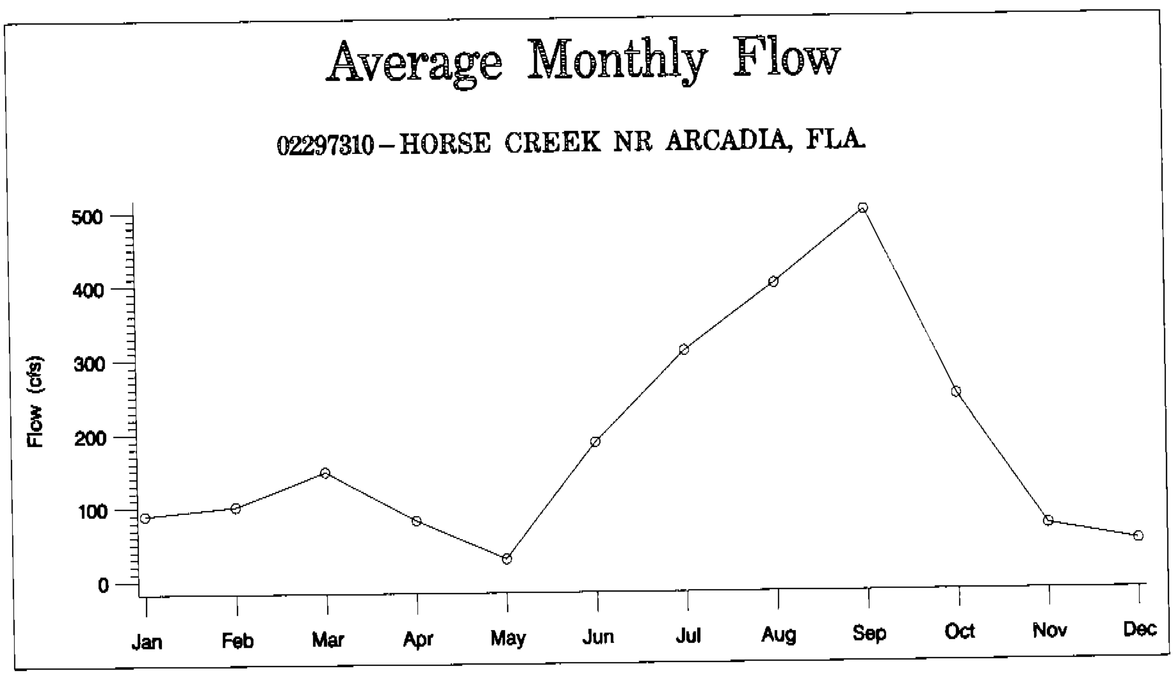
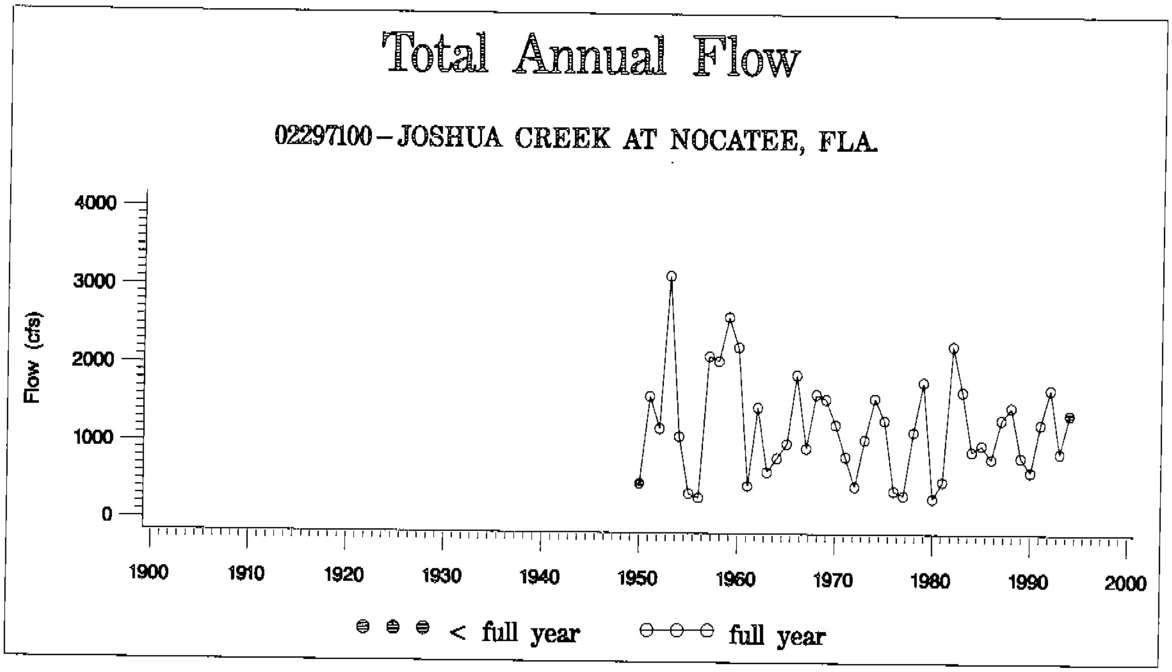


Figure 3-21. Plots of total annual flow and average monthly flow at station 02297310 in the Peace River Basin.



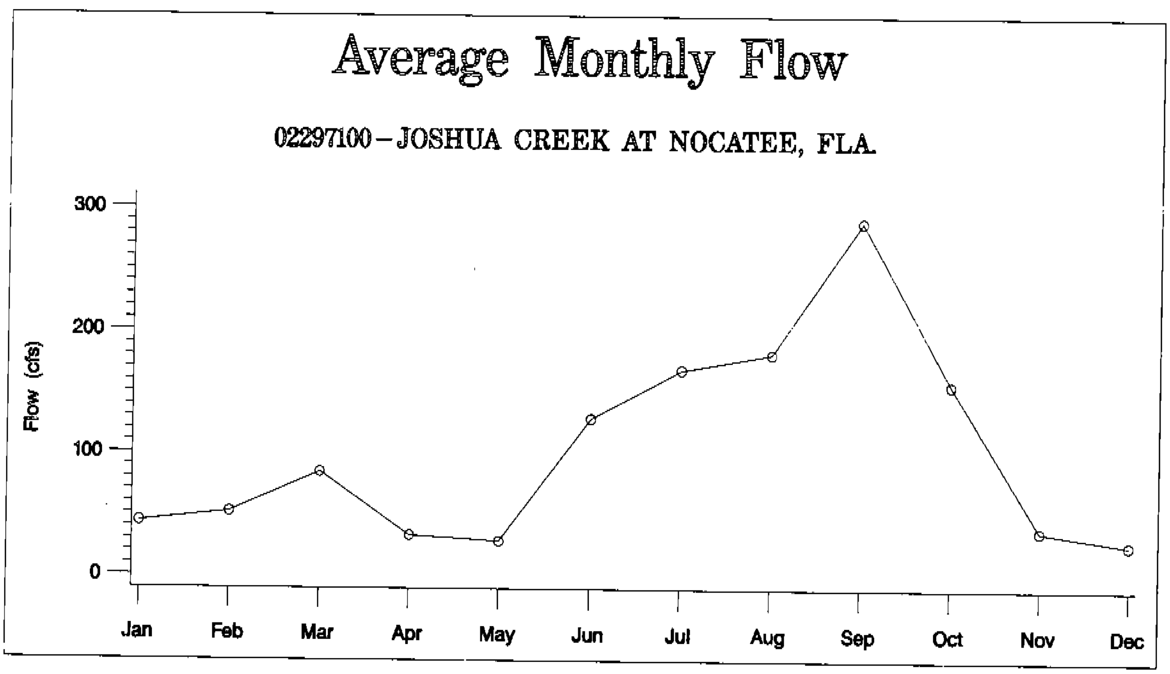
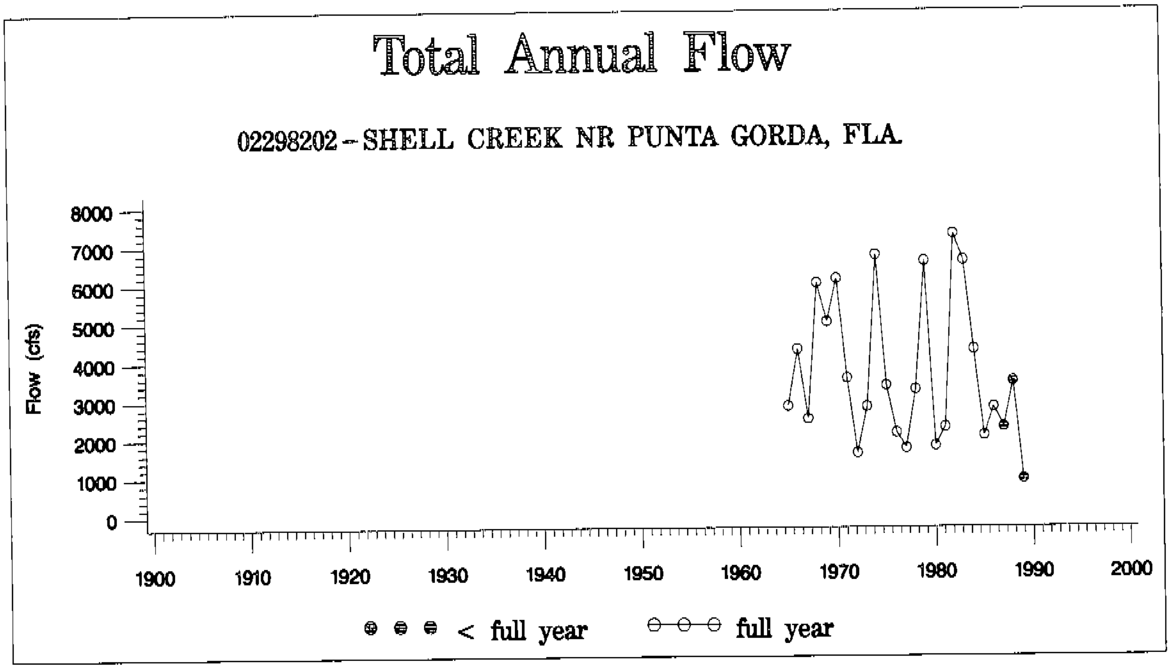


Figure 3-22. Plots of total annual flow and average monthly flow at station 02297100 in the Peace River Basin.



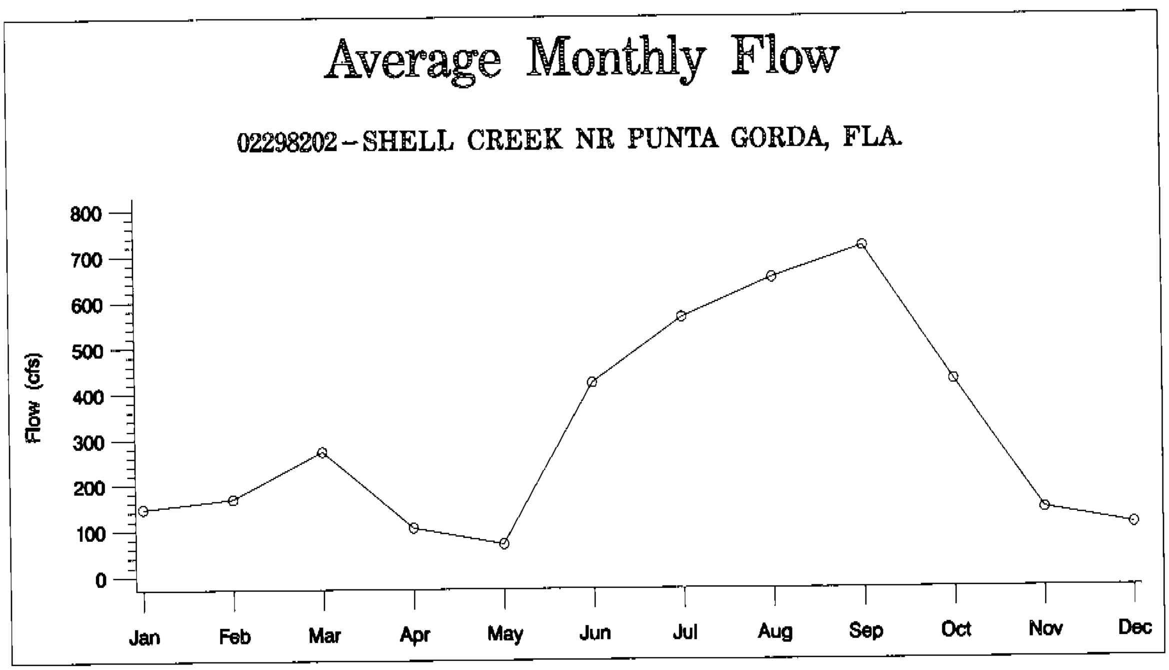


Figure 3-23. Plots of total annual flow and average monthly flow at station 02298202 in the Peace River Basin.

- Public Supply

Table 3-10 shows the public water supply facilities in the Peace River Basin with permitted withdrawals of more than 0.5 MGD, as well as the withdrawal sources for the facilities. A discussion of the populations served by each plant, withdrawal amounts, and withdrawal methods follows.

Table 3-10. Public water supply facilities in the Peace River Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
Charlotte Harbor Water Association	0.71	Intermediate aquifer
City of Punta Gorda	4.21	Shell Creek Reservoir
Peace River Treatment Facility	8.60	Peace River, ASR via Floridan aquifer
City of Arcadia	0.91	Intermediate aquifer
City of Wauchula	0.86	Floridan aquifer
Avon Park	2.40	Floridan aquifer
Bartow	3.45	Floridan aquifer
Bartow Airport	0.72	Floridan aquifer
Dundee	1.66	Floridan aquifer
Fort Meade	1.66	Floridan aquifer
Garden Grove Water Company	3.60	Floridan aquifer
Haines City	2.30	Floridan aquifer
Lake Alfred	0.89	Floridan aquifer
Lakeland	28.30	Floridan aquifer
PCBOCC* - South Lakeland	1.72	Floridan aquifer
Lake Wales	4.36	Floridan aquifer
PCBOCC* - Lake Wales	1.27	Floridan aquifer
Winter Haven	7.60	Floridan aquifer
PCBOCC* - Lake Garfield	1.30	Floridan aquifer
PCBOCC* - Auburndale	3.45	Floridan aquifer

* - Polk County Board of County Commissioners

The Charlotte Harbor Water Association, Inc., is a private utility water treatment plant on the northern side of the Peace River near the I-75 bridge crossing of the river, in Charlotte County. The plant withdraws via four wells from the Intermediate aquifer, with well depths of 450-565 feet. Permitted average daily groundwater withdrawals is 0.71 MGD. The Charlotte Harabor Water Association Inc. plant has an emergency connection with the PRMRWSA's Peace River Facility via a 6-inch diameter pipeline. This facility provided an estimated population of 5,256 with 0.37 MGD during 1990 (SWFWMD, 1992).

The City of Punta Gorda Municipal Water Treatment Facility, also in Charlotte County, withdraws from the Shell Creek Reservoir, an impoundment on Shell Creek created by Hendrickson Dam, just upstream of the conjunction of Myrtle Slough with the creek. Permitted average withdrawal is 4.22 MGD. The plant supplied an estimated population of 18,666 with 3.44 MGD during 1990 (SWFWMD, 1992).

The Port Charlotte/Murdock area obtains its potable water supply from the PRMRWSA through surface water withdrawals from the Peace River, and stores some of the water during the wet season via aquifer storage and recovery (ASR) in the Floridan aquifer and offstream surface reservoir for use during the dry season. The PRMRWSA is permitted to withdraw an average amount of 8.6 MGD from the Peace River. During 1990, the plant provided 8.05 MGD to an estimated 58,219 people (SWFWMD, 1992).

The City of Arcadia, in DeSoto County, operates a potable water treatment plant, with a permitted average withdrawal of 0.91 MGD. This withdrawal is via five wells from the Intermediate aquifer, with the wells ranging in depth from 255 to 350 feet deep, and having a total pumping capacity of 2.52 MGD. The City provided approximately 0.81 MGD to a population of 7,924 during 1988 (SWFWMD, 1992).

The City of Wauchula, in Hardee County, obtains its potable water supply from four wells from the Floridan aquifer. Well depths are 629-1152 feet, and the wells have a total pumping capacity of 5.07 MGD. The permitted average withdrawal is 0.86 MGD. During 1990, the City supplied approximately 4,419 people with withdrawals of 0.88 MGD (SWFWMD, 1992).

Avon Park, in Highlands County, has a municipal utility which withdraws via five wells from the Floridan aquifer, with a combined pumping capacity of 11.55 MGD, and maintains an additional well as a backup. Well depths are 900-1100 feet, with permitted average withdrawals of 2.4 MGD. This utility supplied an estimated population of 11,928 via average withdrawals of 1.68 MGD during 1990 (SWFWMD, 1992).

There are 14 potable water supply plants in the Polk County area within the Peace River Basin (SWFWMD, 1992). The Bartow municipal supply utilizes seven wells to withdraw a permitted average of 3.45 MGD from the Floridan aquifer, with well depths from 315-765 feet. The Bartow supply served an estimated population of 16,260 with approximately 2.65 MGD during 1990 (SWFWMD, 1992). The City of Bartow also operates a water supply system at the Bartow Airport, which serves the airport, the industrial park, and the subdivisions of Wheeler Heights, Gordon Heights, and Gate Road Park. The airport system is permitted to withdraw an average of 0.72 MGD from the Floridan aquifer, with five wells having a pumping capacity of 2.23 MGD and depths of 250-700 feet withdrawing from the aquifer. In 1990, the airport system served an estimated population of 2,287, whose total water use was an estimated 0.57 MGD (SWFWMD, 1992).

The Dundee municipal plant operates two wells withdrawing from the Floridan aquifer at depths of 614 and 755 feet, with permitted average withdrawals of 1.66 MGD. The Dundee plant provided service to an estimated population of 2,664, with a total water use of 0.58 MGD during 1990 (SWFWMD, 1992). The municipal supply for Fort Meade is permitted to withdraw an average of 1.66 MGD from its three wells into the Floridan aquifer, with the wells ranging in depth from 836 to 900 feet and having a pumping capacity of 6.10 MGD. This municipal plant provided an estimated population of 5,800 with an estimated water use of 0.98 MGD during 1990 (SWFWMD, 1992).

The Garden Grove Water Company is a private supplier which operates 14 wells withdrawing from the Floridan aquifer at depths of 348 to 772 feet. The wells have a total pumping capacity of 13.58 MGD, and the utility is permitted an average of 3.6 MGD. The Garden Grove supplier provided service for an estimated population of 20,598 with a total water use of 3.30 MGD during 1990 (SWFWMD, 1992). The Haines City municipal supply is permitted to withdraw an average of 2.30 MGD from the Floridan aquifer, with withdrawals via six wells which are 570-950 feet deep. Haines City supplied an estimated 11,340 people with a total water use of 2.27 MGD during 1990 (SWFWMD, 1992). The Lake Alfred municipal supply withdraws its permitted average of 0.89 MGD from the Floridan aquifer, utilizing three wells, about 400 feet deep, with a total pumping capacity of 4.32 MGD. Lake Alfred supplied an estimated population of 3,641 people with a water use of 0.59 MGD during 1990 (SWFWMD, 1992).

The Lakeland municipal supply is permitted to withdraw an average of 28.3 MGD from the Floridan aquifer. This supply is via 16 wells with depths of 550 to 1010 feet, with a total capacity of 53.71 MGD. The Lakeland plant provided service to an estimated population of 118,507 with an estimated water use of 24.4 MGD during 1990 (SWFWMD, 1992). The Polk County Board of County Commissioners operates the utility for South Lakeland. Permitted average withdrawals are 1.72 MGD, from six wells withdrawing from the Floridan aquifer. The wells have a total pumping capacity of 6.98 MGD, with depths of 315-760 feet. The South Lakeland utility supplied an estimate population of 11,900 with an estimated 1.4 MGD during 1990 (SWFWMD, 1992).

The Lake Wales municipal supply is permitted to withdraw an average of 4.36 MGD from the Floridan aquifer, and utilizes seven wells for this purpose. The wells range in depth from 850 to 1100 feet, and have a combined pumping capacity of 15.76 MGD. The Lake Wales municipal supply provided water to approximately 12,696 people with an estimate water use of 3.97 MGD during 1990 (SWFWMD, 1992). The Polk County Board of County Commissioners also operates a municipal supply facility at Lake Wales, with the facility permitted to withdraw an average of 1.27 MGD from the Floridan aquifer. Withdrawals are via serveral wells with a combined pumping capacity of 6.14

MGD, and depths of 545 to 1255 feet. This Lake Wales supply facility provided an estimated population of 4,000 with approximately 1.2 MGD during 1990 (SWFWMD, 1992).

The Winter Haven municipal supply operates 10 wells with a combined capacity of 20.18 MGD. These wells withdraw from the Floridan aquifer at depths between 593 and 816 feet to supply the permitted average of 7.6 MGD. In 1990, the facility supplied a population of approximately 30,011 with water use of 7.4 MGD (SWFWMD, 1992). The Polk County Board of County Commissioners operates water supply facilities at Lake Garfield and at Auburndale, in addition to those described earlier. The Lake Garfield facility is permitted to withdraw an average of 1.3 MGD via six wells from the Floridan aquifer, with the wells having depths of 552 to 700 feet and total capacity of 4.72 MGD. The Lake Garfield plant provided approximately 5,788 people with about 1.2 MGD during 1990 (SWFWMD, 1992). The Auburndale facility operates five wells, with depths of 600 to 650 feet, which withdraw the permitted average of 3.45 MGD from the Floridan aquifer. The wells have a maximum capacity of 11.52 MGD. This facility supplies the Dial Company, the Nakosa Company, the Florida Brewery, and the International Paper Company. During 1990, an estimated 13,118 people were provided with 2.28 MGD (SWFWMD, 1992).

In the early 1970's General Development Utilities began to actively search for a major regional water source for the projected population growth in a number of large communities in Southwest Florida under construction or planned by its parent company, General Development Corporation. These developments included the City of North Port in Sarasota County, Port Charlotte in Charlotte County, South Gulf Cove in Charlotte County, and two developments for which DRI's were later abandoned: Myakka Estates in Sarasota County and Villages of DeSoto in Desoto County. Population projections at the time for these developments made for the year 2020 exceeded a quarter million new residents in these planned communities. General Development Utilities goal was to establish a reliable and expandable source of potable water to supply this projected rapid population growth. After reviewing a number of potential alternative sources, and seeking the advice of numerous consultants including the staff from the University of Miami, it was determined that the site of the current water treatment facility on the Peace River in DeSoto County provided the greatest opportunity for a sustainable water supply for development within the three county area.

The first Consumptive Use Permit (CUP) for the facility was issued by SWFWMD in 1976. This permit mandated as a special condition that General Development Utilities undertake a Hydrobiological Monitoring Program to develop a data base which would allow for the assessment of potential impacts that freshwater withdrawals might have on biological communities in the Peace River downstream of the Plant and in upper Charlotte Harbor. Background monitoring began in 1976, construction of the facility was completed and withdrawals began in 1980. As part of the initial construction a small reservoir was dug and soon thereafter construction began on a series of aquifer storage recover wells (ASR). Adequate storage was identified as an important potential issue early in the initial evaluation and planning for the future facility. Unlike many other water treatment plants which utilize surface waters, there is no in-stream barrier in the Peace to impound water during the typically dry winter and spring months. In addition, SWFWMD mandated as an initial condition no withdrawals below certain low flows. As a result the Peace River Plant has always relied on off stream storage to maintain supplies during the dry season and/or drought conditions.

At the time of the first permit renewal in 1982 withdrawals comprised only a fraction of a percent of total flows. However, when the permit was renewed six years later, conditions had changed. Demands had started to increase, and southwest Florida was in the midst of one of the driest periods on record. General Development's consulting scientists and those from the District agreed that the existing withdrawal schedule caused the plant to rely too heavily on periods of low to moderate flows. As a result the withdrawal schedule was modified. A minimum criterion was established of no withdrawals when flows at Arcadia were below 100 cfs during spring months and 130 cfs the remainder of the year. Beyond that withdrawals could equal up to 10% of the daily flow at Arcadia, with a maximum not to exceed 22.0 MGD. This schedule increased minimum flows to the estuary, and allowed withdrawals to more closely follow the natural variability of the system.

In 1990 General Development Company filed for bankruptcy protection. Charlotte County took control of General Development Utilities facilities within Charlotte County, and ownership of the Peace River Water Treatment Plant was transferred to the public Peace River/Manasota Regional Water Supply Authority. The authority was formed and functions through agreements made among Manatee, Sarasota, Desoto and Charlotte Counties. With the Authority's ownership of the Peace River Water Treatment Facility, the Authority soon began plans to expand the plant and make it more of the regional supply originally envisioned by General Development Utilities. A further goal of the Authority has been to develop a series of interconnections among the member county's water supplies to reduce potential effects of natural disasters and other interruptions in supply. The Authority's plan to expand the Peace River Facility in Desoto County and interconnect it with Carlton Reserve Water Treatment Plant in Sarasota County is generally referred to as the "Peace River Option".

As currently envisioned, the Peace River Option is comprised of the following elements.

- Expand the current Water Treatment Facility on the Peace River fromm its current capacity of 12 mgd to 18 mgd.

- Construct a large number of new additional Aquifer Storage Recovery Wells in order to increase the storage capacity to meet expected increasing demands during the dry-season.

- Construct a 42 inch pipe from the Peace River Treatment Facility in DeSoto County to the Carlton Reserve Water Treatment Plant in Sarasota County.

The twenty-year Water Use Permit issued by SWFWMD in 1996, allows the Regional Water Supply Authority a set amount of water with a maximum annual average quantity of 32.7 mgd. The new permit increases the minimum flows as measured at Arcadia under which no withdrawals can occur to 130 cfs year round. Withdrawals can still not exceed 10% of the average daily flow at Arcadia.

What the Regional Water Supply Authority will be able to do is to withdraw, treat and store more water under high flows, with the removal of the 22 MGD upper cap, and an increase in plant capacity.

A number of concerns have been expressed with regard to the Peace River Option. Such concerns generally fall into three categories:

- Potential impacts which increased withdrawals may have on the biological communities of lower Peace River/Upper Charlotte Harbor.
- The precedent of inter-basin transfers of water.
- Effects this will have on future water supplies for projected growth in Charlotte County.

- Mining

Within the Peace River Basin mining land use covers 125,683 acres, or about 9% of the basin, as shown in the 1990 SWFWMD land use coverage. The preponderance of this land use (93%) is found in the Polk County portion of the basin and is associated with the phosphate mining activity in the region (Figure 3-16). The land use coverage also shows that mining occurs in portions of the basin within Charlotte, DeSoto, Hardee, Hillsborough, and Manatee counties. There are nine mining operations found within the Peace River Basin which have permitted average water uses of at least 0.5 MGD, with all withdrawals from groundwater sources (SWFWMD, 1997). Table 3-11 lists the mining operations, permitted average and maximum withdrawals, and withdrawal source for each mine.

Table 3-11. Mining operations water use in the Peace River Basin.

Company	Permitted Average Withdrawal (MGD)	Permitted Maximum Withdrawal (MGD)	Source
CF Industries, Inc.	7.73	10.30	Groundwater
Cargill Fertilizer, Inc.	12.00	15.00	Groundwater
E.R Jahna Industries, Inc.	5.75	9.12	Groundwater
Mobil Mining & Minerals Co.	16.40	19.00	Groundwater
Mobil Mining & Minerals Co.	1.36	----	Groundwater
Agrico Chemical Co.	9.00	12.00	Groundwater
Agrico Chemical Co.	13.80	17.28	Groundwater

Table 3-11. Mining operations water use in the Peace River Basin.			
George Coleman &Adrian R. Mining	1.20	----	Surface water
Lunter, Paul	1.73	1.73	Surface water
IMC-Agrico Co. & Farmland	23.30	27.00	Groundwater

CF Industries, Inc., operates a mining facility which had water use of 7.46 MGD in 1994, with a permitted average withdrawal of 7.73 MGD, and a permitted maximum withdrawal of 10.3 MGD. Cargill Fertilizer, Inc., has a mine with a permitted average withdrawal of 12.0 MGD and a permitted maximum withdrawal of 15.0 MGD, for which 1994 water use was 15.3 MGD. The E.R. Jahna Industries, Inc., mine used 3.91 MGD in 1994, of the permitted average withdrawal of 5.75 MGD and a permitted maximum withdrawal of 9.12 MGD (SWFWMD, 1997).

Mobil Mining and Minerals Company has two mining operations in the basin. One operation had a 1994 water use of 11.51 MGD, with a permitted average withdrawal of 16.4 MGD and a permitted maximum withdrawal of 19.0 MGD. The other Mobil Mining and Minerals Company mining operation had a 1994 water use of 1.36 MGD, which was also the permitted average quantity (SWFWMD, 1997).

U.S. Agri-Chemicals also has two mining operations in the basin. One of these has a permitted average of 9.0 MGD, a permitted maximum of 12.0 MGD, and used 8.98 MGD in 1994. The other Agrico Chemical Company operation used 13.77 MGD in 1994, of a permitted average withdrawal of 13.80 MGD and a permitted maximum withdrawal of 17.28 MGD (SWFWMD, 1997). IMC Agrico Company has a mine in the Peace River Basin, which in 1994 utilized 0.52 MGD, its permitted average withdrawal. The permitted maximum withdrawal for this operation is 0.73 MGD. IMC-Agrico Company & Farmland also operates a mine in the basin, which used its permitted average withdrawal, 23.3 MGD, in 1994, and has a permitted maximum withdrawal of 27.0 MGD (SWFWMD, 1997).

The George Coleman & Adrian R. Mining operation near the Charlotte/DeSoto County line has a permitted average withdrawal of 1.197 MGD from surface water, all of which was utilized in 1994. On the southeastern side of the Peace River in Charlotte County is the Paul Lunter mining operation, which has a permitted average maximum withdrawal of 1.73 MGD, and withdrew the entire permitted quantity from surface water in 1994 (SWFWMD, 1997).

- Industrial

Industrial land use in the Peace River Basin totals 3,614 acres. This is only about 0.3% of the basin area, with 91% of the industrial land uses found in Polk County (Figure 3-13). Industrial land uses are also found within the basin in Charlotte, DeSoto, and Hardee counties. A total of 19 industrial operations with permitted water use greater than 0.5 MGD are in the Peace River Basin (SWFWMD, 1997), as shown in Table 3-12.

Table 3-12. Industrial facilities water use in the Peace River Basin.

Company	Permitted Average Withdrawal (MGD)	Permitted Maximum Withdrawal (MGD)	1994 Use (MGD)	Source
IMC-Agrico Co.	9.32	18.60	6.84	Groundwater
IMC-Agrico Co. (South Pierce).	2.33	8.16	2.33	Groundwater
Central Florida Power Ltd.	1.70	----	1.70	Groundwater
U.S. Agri-Chemicals Corp.	6.50	7.52	8.58	Groundwater
Farmland Hydro Ltd.	9.50	15.00	5.5	Groundwater
Polk Power Partners Ltd.	0.76	----	0.76	Groundwater
Kaplan Industries, Inc.	1.00	----	0.51	Groundwater
CF Industries, Inc.	7.88	18.50	7.80	Groundwater
Cargill Fertilizer, Inc.	5.20	----	5.16	Groundwater
Orange Cogeneration Ltd.	0.66	----	0.66	Groundwater
City of Lakeland Power Plant	3.00	4.36	2.90	Groundwater
Auburndale Power Partners	1.80	----	1.80	Groundwater
Florida Distillers Co.	1.31	----	1.31	Groundwater
City of Lakeland	172.87	270.72	0.80	Surface water
Ridge Generating Station Ltd.	11.34	----	11.34	Groundwater
SFE Citrus	1.00	3.00	1.00	Groundwater
Coca-Cola Foods (Auburndale)	3.81	----	3.81	Groundwater

- Recreational

Golf courses and landscape (parks, medians, attractions, cemeteries, and other green areas) water use locations are not identified in SWFWMD (1997), so that no basin-specific water use may be associated with these land uses. However, the document does provide water use by county for golf courses and landscape for that portion of the county within the SWFWMD. Portions of Charlotte County within the SWFWMD had water use associated with golf courses for 1994 of 2.9 MGD, and landscape water use for the same time period was 0.5 MGD, for a total recreational use of 3.4 MGD for the county. In DeSoto County, golf course water use was 0.6 MGD in 1994, and landscape water use was 0.1 MGD, totaling 0.7 MGD for the county. Hardee County golf courses and landscape water usages were 0.2 MGD and 0.1 MGD, respectively, for a total of 0.3 MGD during 1994. For that portion of Highlands County within the SWFWMD, golf course and landscape water usages in 1994 were 2.1 MGD and 0.3 MGD, totaling 2.4 MGD. Hillsborough County water use by golf courses was 9.6 MGD in 1994, while landscape water use for the county was 3.0 MGD, totaling 12.6 MGD for recreational uses. Manatee County golf courses used 3.0 MGD for irrigation, and landscape water use in the same county was 0.1 MGD, for a total recreational water use of 3.1 MGD. For the portion of Polk County within the SWFWMD, 1994 golf course use was 6.7 MGD, and landscape use was 4.1 MGD, giving a total recreational use of 10.8 MGD. Sarasota County golf course use was 7.9 MGD, and landscape use was 0.4 MGD, for a total of 8.3 MGD in 1994 (SWFWMD, 1997).

Water Discharge and Reuse

There are 15 major domestic waste water treatment plants in the Peace River Basin associated with the urbanized areas in the basin (Zarbock et al., 1995). The Auburndale North Plant WWTP discharges to surface waters near Bartow, and has other surface discharge as well. The City of Bartow WWTP utilizes its effluent for industrial reuse. The City of Lake Alfred WWTP discharge is used for spray irrigation, as are the effluents from the two City of Winter Haven discharges and that from the City of Lake Wales WWTP. The City of Ft. Meade WWTP discharges to percolation ponds. The cities of Bowling Green and Wauchula WWTPs discharge to surface waters. The Charlotte County facilities of South Port and East Port WWTPs send effluent to percolation ponds and for use in spray irrigation, with the East Port facility also utilizing deep well injection for part of its effluent disposal. Rampart Utilities WWTP discharges to percolation ponds, and the City of Punta Gorda WWTP effluent is sprayed over a spray field which drains to Myrtle Slough. The City of Arcadia WWTP utilizes surface discharge for its effluent (Zarbock et al., 1995).

3.1.4.3 Agricultural Management Practices

The Peace River drains a largely agricultural area (43% of the basin), with the Peace River Basin containing approximately 1,477,000 acres (2,308 square miles). The 1990 agricultural land use area within Manatee and Sarasota counties was estimated by SWFWMD (1994) as shown in Tables 3-13 and 3-14. Estimates of irrigated acreages for each of these crops and water use were also reported. Only a small portion of Hillsborough County is within the Peace River Basin, with this portion of the basin containing only 115 acres of agricultural land uses, all pasture.

Table 3-13. 1990 estimated crop acreages, irrigation types, and water use in Manatee County.

Crop	Acreage	Irrigation Type -Acreage		Water Use (MGD)
Agronomic	2,000	Seepage	2,000	2.1

Table 3-13. 1990 estimated crop acreages, irrigation types, and water use in Manatee County.

Crop	Acreage	Irrigation Type -Acreage		Water Use (MGD)
Row/Field Crops	24,200	Low volume Seepage	2,800 20,900	77.0
Citrus	19,300	Overhead Low Volume Seepage	965 13,510 965	18.5
Nursery	2,175	Overhead Low Volume Seepage	975 100 1,100	14.6
Sod	3,200	Overhead Low volume	2,200 1,000	6.4
Irrigated Pasture	1,450	Seepage	1,450	2.4
TOTALS	52,325	Overhead Low Volume Seepage	4,140 17,410 26,415	121.0

Table 3-14. 1990 estimated crop acreages, irrigation types, and water use in Sarasota County.

Crop	Acreage	Irrigation Type -	Acreage	Water Use (MGD)
Agronomic	200	Seepage	200	0.2
Row/Field Crops	3,100	Seepage	3,100	9.1
Citrus	1,800	Low Volume Seepage	1,530 180	3.2
Nursery	220	Overhead	220	1.5
Sod	5,000	Seepage	5,000	10.0
Irrigated Pasture	555	Seepage	555	0.9
TOTALS	10,875	Low Volume Seepage	1,530 9,035	24.9

Estimates for major crop acreages, irrigation types, and water use requirements for 1990 for Charlotte County are shown in Table 3-15. Similar estimates for DeSoto, Hardee, Polk, and Highlands counties are shown in Tables 3-16 through 3-19. Total 1990 agricultural acreage from these estimates for Charlotte County was 13,565 acres, with an associated estimated water use of 22.6 MGD. Total estimated 1990 agricultural acreage for DeSoto County was 74,350 acres, with an associated estimated water use of 119.9 MGD. Estimated agricultural acreage in 1990 for Hardee County was 59,000 acres, with an estimated water use of 82.3 MGD. Total 1990 agricultural acreage from these estimates for Highlands County was 56,356 acres, with an associated estimated water use of 76.1 MGD. Estimated 1990 agricultural acreage for Polk County was 94,221 acres, with an associated estimated water use of 104.2 MGD. In all, the counties partially within the Peace River Basin contained an estimated 1990 agricultural acreage of 360,692 acres, with an estimated water use of 551.0 MGD.

Table 3-15. 1990 estimated crop acreages, irrigation types, and water use in Charlotte County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Row/Field Crops	1,500	Seepage 1,500	4.4
Citrus	10,500	Low Volume 8,925 Seepage 1,050	13.6
Nursery	215	Overhead 215	1.4
Sod	1,200	Seepage 1,200	2.9
Irrigated Pasture	150	Seepage 150	0.3
Totals	13,565	Overhead 215 Low Volume 8,925 Seepage 3,900	22.6

Table 3-16. 1990 estimated crop acreages, irrigation types, and water use in DeSoto County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Row/Field Crops	5,500	Seepage 5,500	16.0

Table 3-16. 1990 estimated crop acreages, irrigation types, and water use in DeSoto County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Citrus	57,500	Overhead Low Volume Seepage	2,875 40,250 11,500	76.2
Nursery	150	Overhead	150	1.0
Sod	10,000	Overhead	10,000	24.6
Irrigated Pasture	1,200	Seepage	1,200	2.1
Totals	74,350	Overhead Low Volume Seepage	13,025 40,250 18,200	119.9

Table 3-17. 1990 estimated crop acreages, irrigation types, and water use in Hardee County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Row/Field Crops	7,050	Seepage	7,050	20.7
Citrus	51,000	Overhead Low Volume Seepage	5,100 38,250 2,550	58.9
Nursery	150	Overhead	150	1.0
Sod	500	Seepage	500	1.2
Irrigated Pasture	300	Seepage	300	0.5
Totals	59,000	Overhead Low Volume Seepage	5,250 38,250 10,400	82.3

Table 3-18. 1990 estimated crop acreages, irrigation types, and water use in Highlands County.

Crop	Acreage	Irrigation Type -	Acreage	Water Use (MGD)
Agronomic	1,750	Seepage	1,750	1.8
Citrus	33,121	Overhead Low Volume	8,280 24,841	70.7
Nursery	485	Overhead Low Volume	388 97	3.2
Irrigated Pasture	21,000	Seepage	21,000	0.4
Totals	56,356	Overhead Low Volume Seepage	8,668 24,938 21,000	76.1

Table 3-19. 1990 estimated crop acreages, irrigation types, and water use in Polk County.

Crop	Acreage	Irrigation Type -	Acreage	Water Use (MGD)
Agronomic	10,465	None		0.0
Row/Field Crops	859	Overhead Seepage	799 60	2.7
Citrus	80,000	Overhead Low Volume	12,800 55,200	127.4
Nursery	947	Overhead Low Volume	710 237	6.3
Sod	1,750	Overhead	1,600	3.5
Irrigated Pasture	200	Overhead	200	0.3
Totals	94,221	Overhead Low Volume	16,109 55,437	140.2

3.2 Water Quality Conditions

Current and previous water quality data gathered in the Peace River Basin are presented and examined in this section. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

3.2.1 Data Sources

Data from four sources were used to examine current and long-term water quality in the Peace River Basin. These sources include:

EQL long-term monthly data collected between 1975 and 1996 in the Lower Peace River Basin. One or more monitoring stations were used to characterize each of the following areas:

- Lower Peace River Estuary - Peace River from U.S. 41 Bridge upstream to area of Lettuce Lake
- Lower Peace River - Peace from Lettuce Lake to Horse Creek
- Shell Creek above the Dam
- Shell Creek below the Dam
- Horse Creek at SR 70
- Peace River at Arcadia;

monthly data which have been gathered in the Lower Peace River Estuary since 1993 by SWFWMD in Alligator Bay, Marker 7, at the US 41 Bridge and approximately one mile upstream of Shell Point; and

the following long-term USGS data gathered throughout the Peace River Basin are discussed in this section:

- Horse Creek near Arcadia (02297310)
- Peace River at Arcadia (02296750)
- Peace River at Zolfo Springs (02295637)
- Peace River at Bartow (02294650)

Data for the following additional USGS stations are presented in Appendix C:

- Shell Creek near Punta Gorda (02298202)
- Prairie Creek near Port Ogden (02298123)
- Horse Creek near Myakka Head (02297155)
- Joshua Creek at Nocatee (02297100)
- Payne Creek near Bowling Green (02295420)

- Peace River at Fort Meade (02294898)
- Charlie Creek near Gardner (02296500).

Data gathered by Polk County at four locations in Lake Hancock and two sites in Peace Creek Canal are also presented in Appendix C. The locations of the water quality monitoring sites from all four data sources are presented in Figure 3-24.

3.2.2 Data Analyses

The EQL and SWFWMD monitoring data were typically collected on a monthly basis. Water quality data were collected by the USGS approximately monthly in the early portion of the data record but less frequently in recent years. The data analysis approach included:

- visual examination of time series plots of monthly mean values, and

- statistical tests for significant trends in mean annual water quality conditions using methods developed by Coastal Environmental (1996) for the Florida Department of Environmental Protection using seasonally weighted yearly averages. Depending on the distribution of the sampling frequency, the procedure examines for either trends over the entire sampling period or differences between periods within the data record, depending upon the continuity and length of the data record. A detailed description of the methodology used for defining trends is contained in Appendix C.

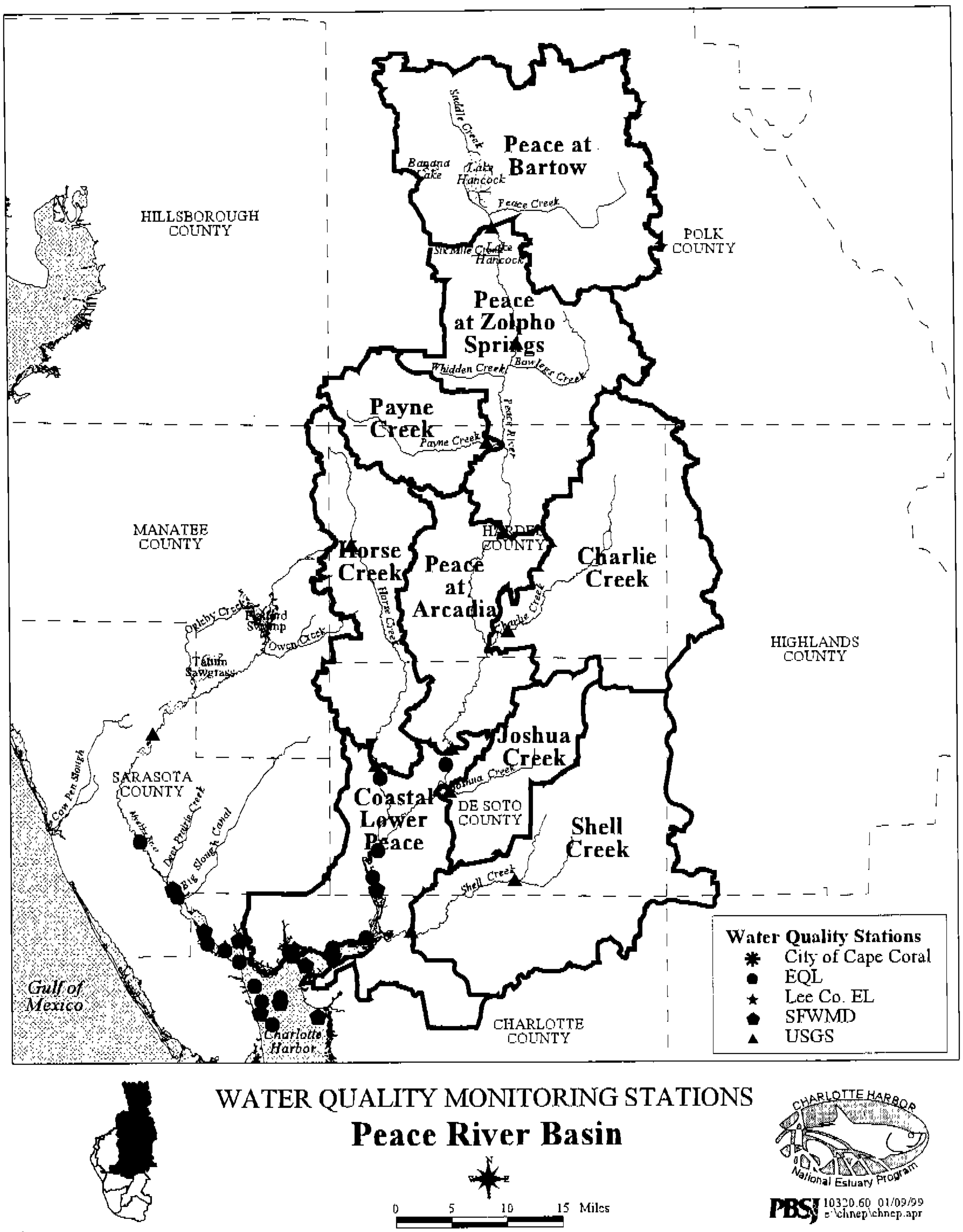


Figure 3-24. Location of water quality sampling sites in the Peace River Basin (EQL stations).

3.2.2.1 EQL Data

Figures 3-25 through 3-36 present mean monthly water quality data collected in the Lower Peace River Basin between 1975 and 1996. The following describes the current and long-term water quality conditions by constituent. Summary results of statistical tests for long-term trends for each of these constituents are presented in Table 3-20.

Conductivity - Average salinities in the most estuarine portions of the river can fluctuate by as much as 25 ppt in a single year. During extended periods of low rainfall (e.g., 1990-1991) species in the lowest areas of the Peace River are exposed to dramatically different salinity regimes than they are during very wet years (e.g., 1994-1995). However, when a very dry spring follows after a dryer than normal summer wet-season (e.g., 1985-1986), brackish water can extend upstream nearly to Horse Creek. Even under very high flow conditions, the magnitude of stratification which is common in the Harbor is far less apparent in the lower river. No significant trends in conductivity were detected in either the Lower Peace River or the Peace River Estuary (Table 3-20).

Color - The Peace River and its tributaries are all characterized as being black water freshwater streams. During each summer wet-season, order of magnitude increases in color typically occur. One of the most noticeable results is that light penetration into the water column is extremely limited during a major portion of the year. As a result the growth of submerged aquatic vegetation is typically extremely limited. The very narrow photic zone can also result in phytoplankton populations which are dominated by species (such as blue-green algae) adapted to being able to stay very near the surface.

Turbidity - From 1976 through 1990 long-term increases in turbidity were observed in the Peace River at Arcadia, Horse Creek at SR 70, and the Lower Peace River (upstream of Lettuce Lake). Agricultural increases in many areas of the basin have been linked as potential causes of increases in other constituents such as nitrogen and chlorides, and increasing dry-season flows. This may also account for the observed increases in turbidity in some areas.

Nitrate + nitrite nitrogen - Inorganic nitrogen levels are generally high throughout the Peace River. Concentrations in Peace River at Arcadia indicate levels are typically above 0.5 mg/L and often exceed 1.5 mg/L. Concentrations in all areas of the Peace clearly show a marked seasonal effect. During periods of low flow and reduced color, biological uptake can reduce nitrogen concentrations to near detection limits throughout the Peace River. Typically, low concentrations are apparent over an extended period of time in the time series plots in several reaches of the river during

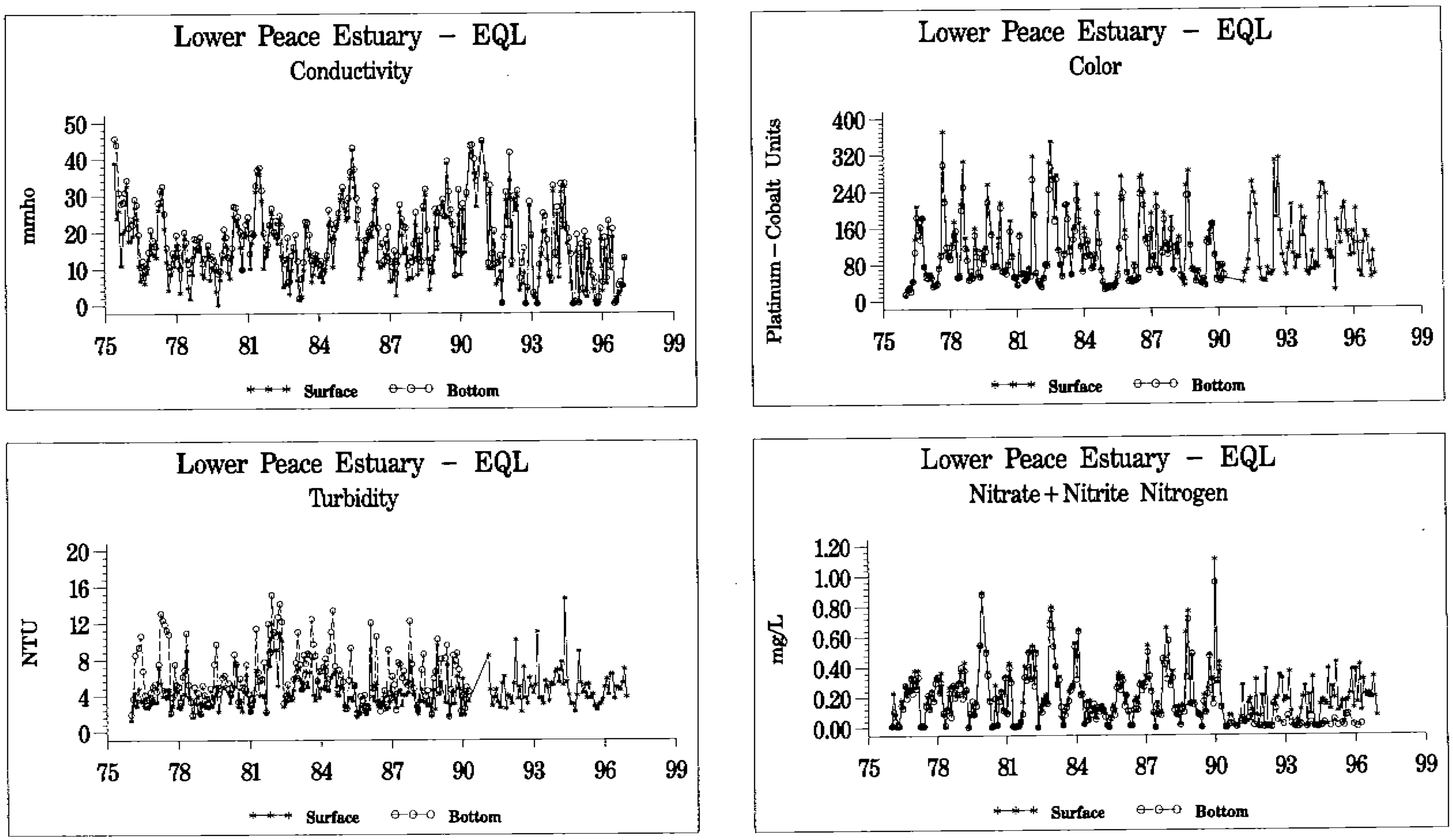
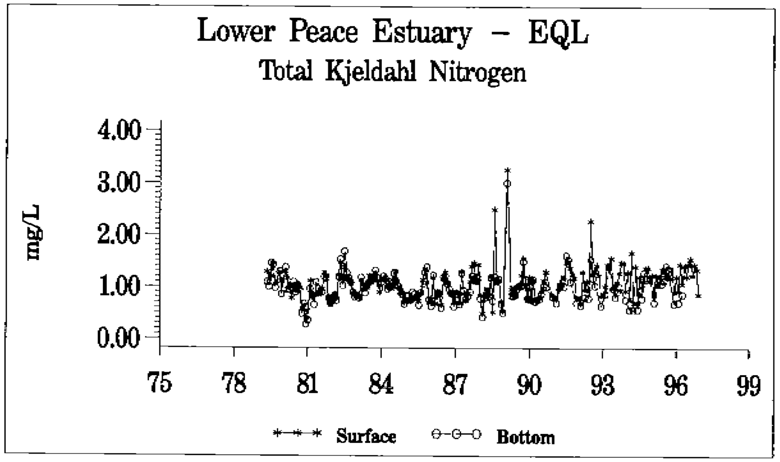
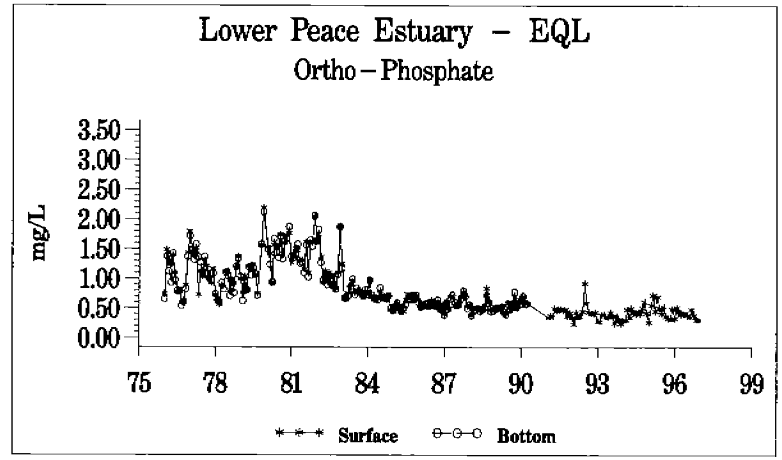
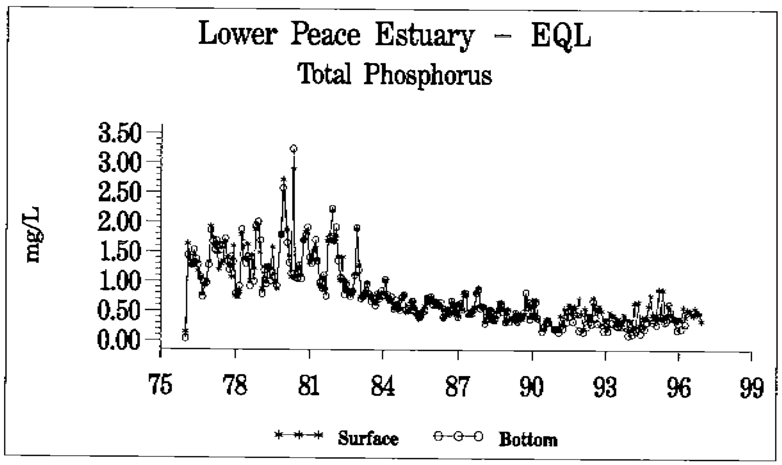


Figure 3-25. Time series graphs of water quality in the lower Peace estuary (EQL stations).







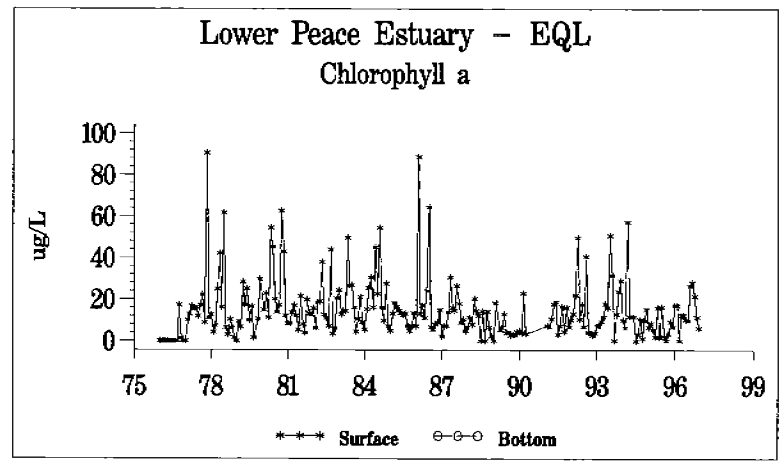
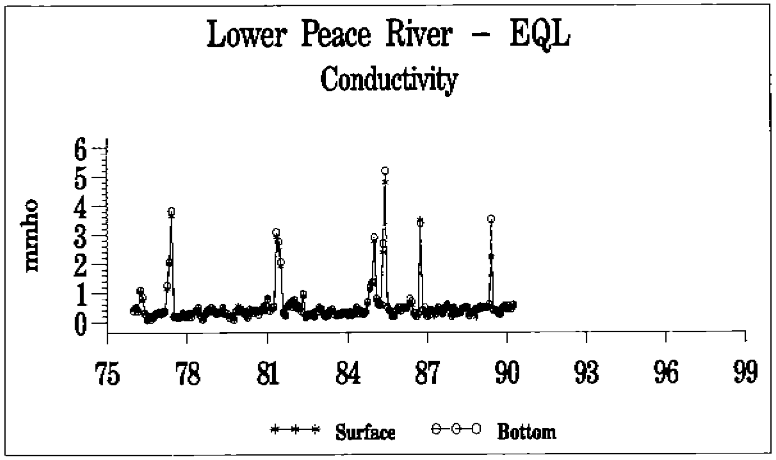
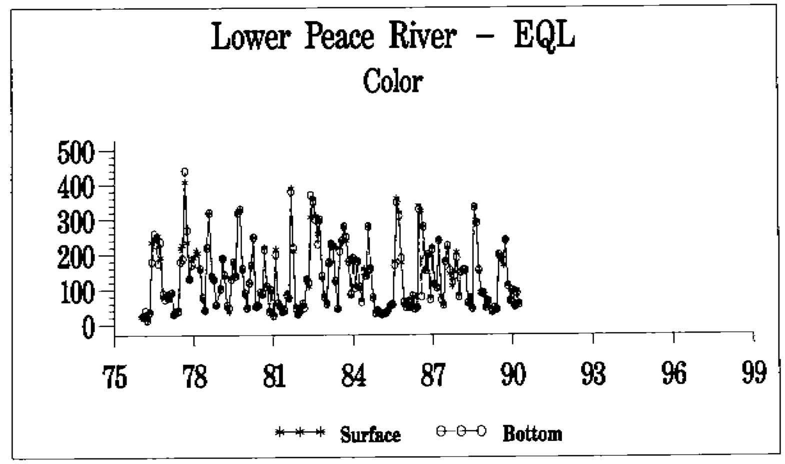
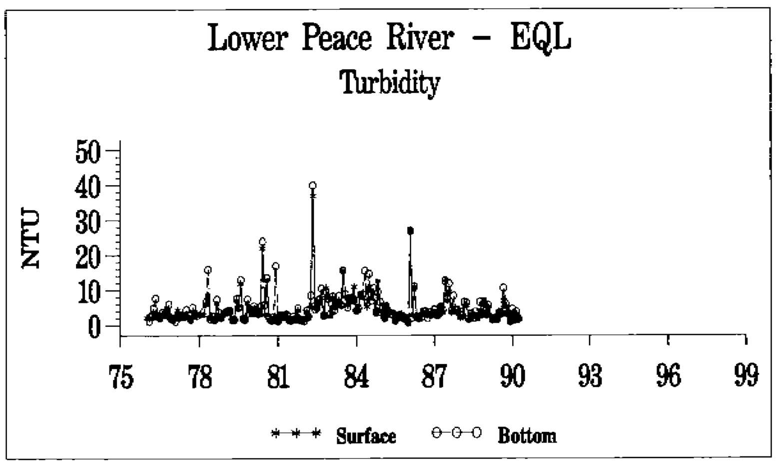


Figure 3-26. Time series graphs of water quality in the lower Peace estuary (EQL stations).







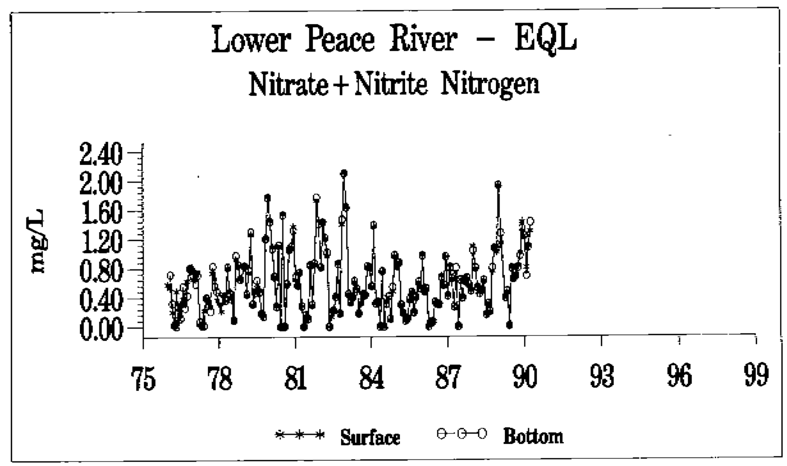


Figure 3-27. Time series graphs of water quality in the lower Peace estuary (EQL stations).

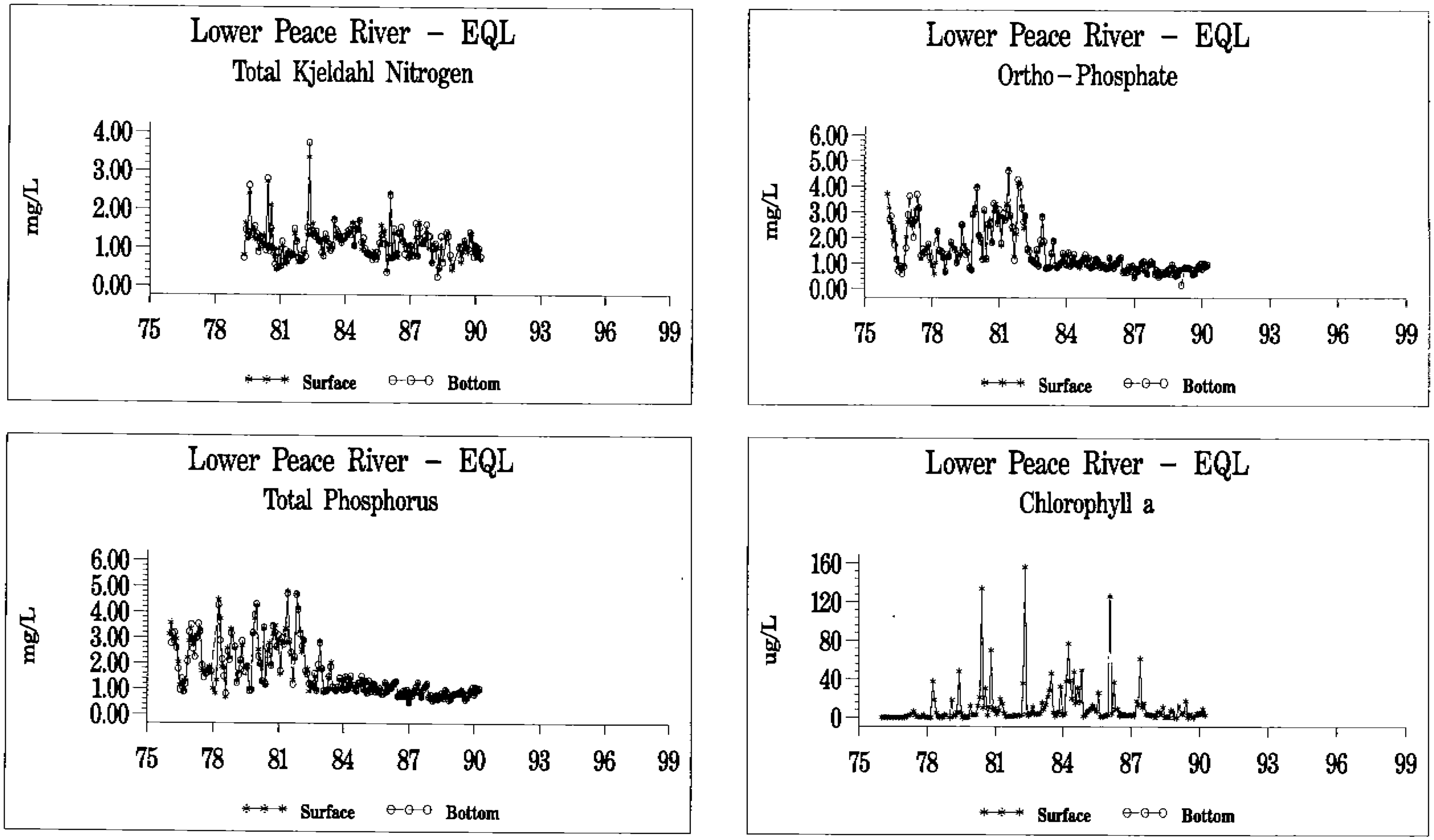


Figure 3-28. Time series graphs of water quality in the lower Peace estuary (EQL stations).

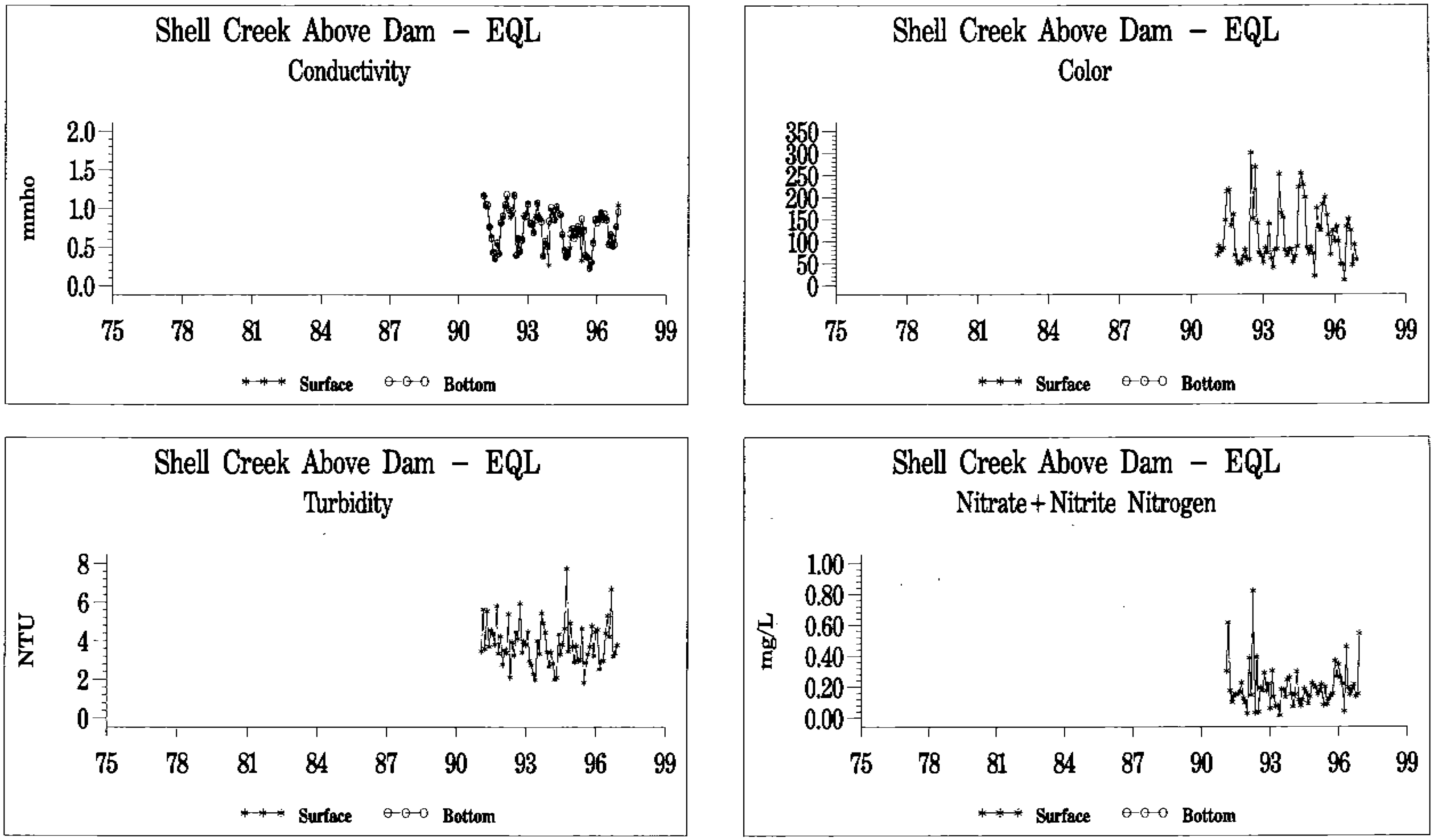


Figure 3-29. Time series graphs of water quality in the lower Peace estuary (EQL stations).

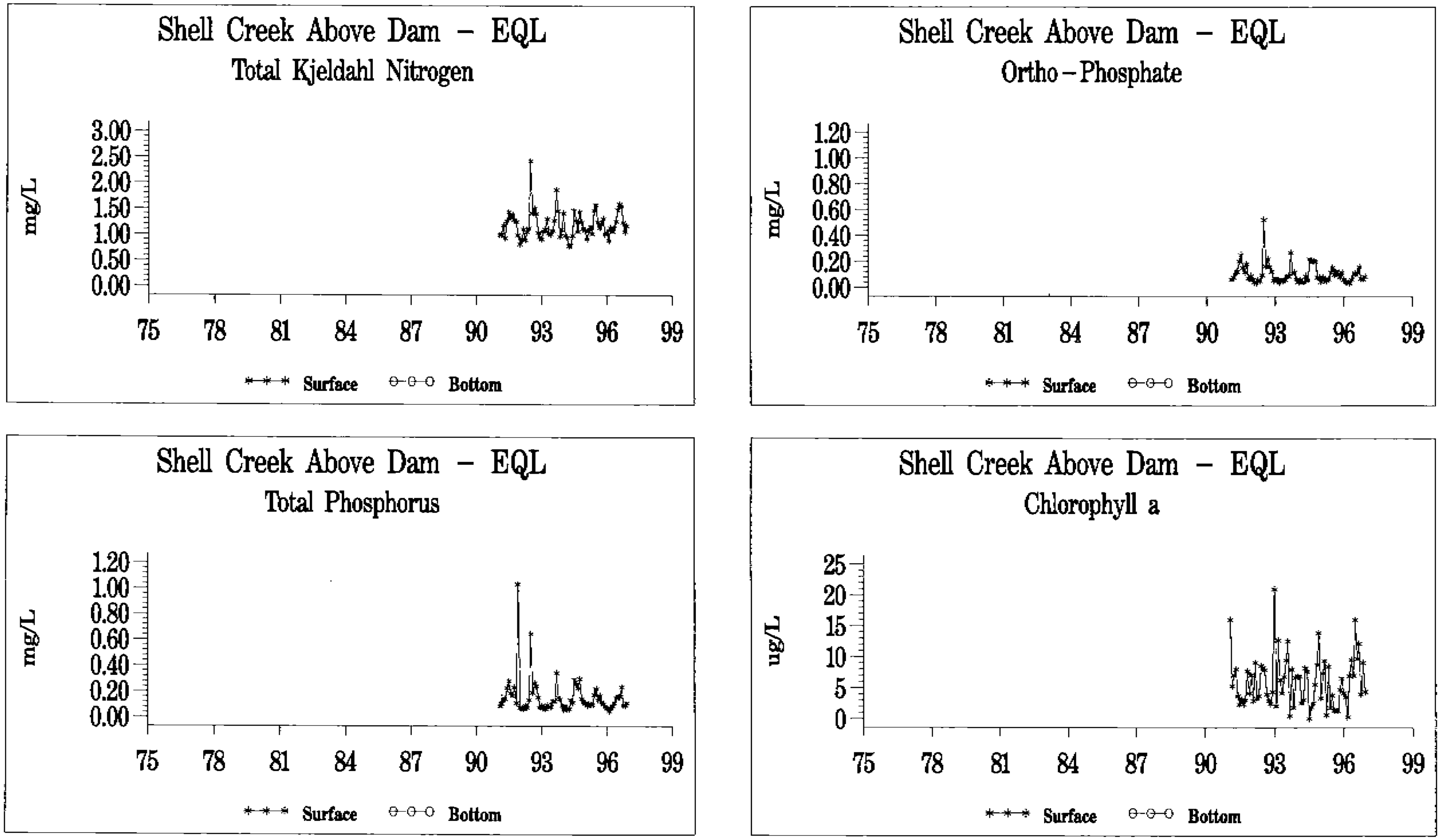


Figure 3-30. Time series graphs of water quality in the lower Peace estuary (EQL stations).

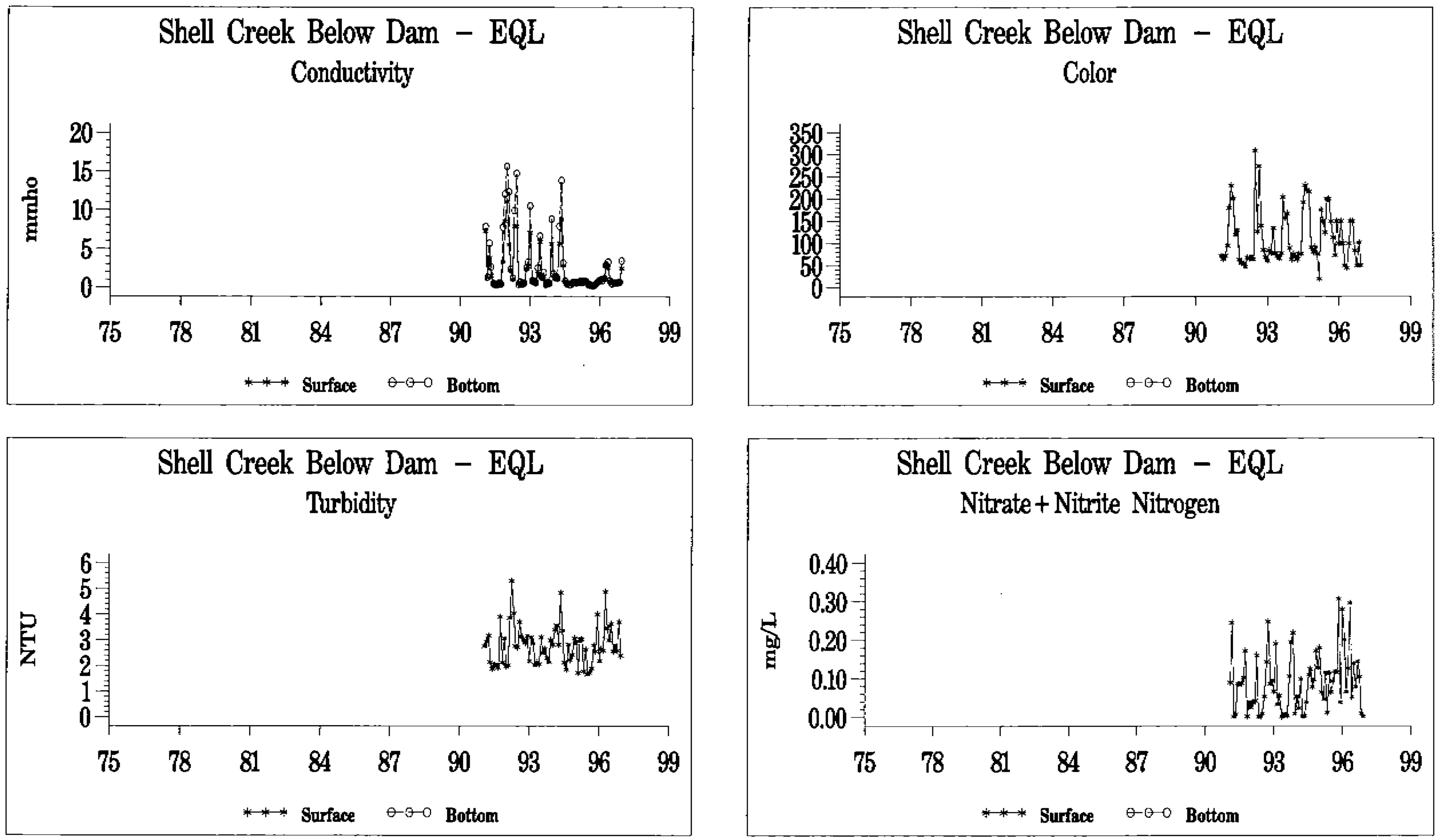
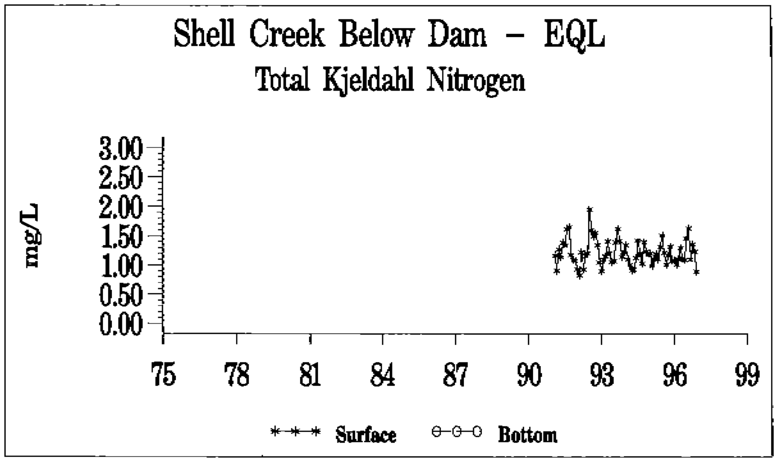
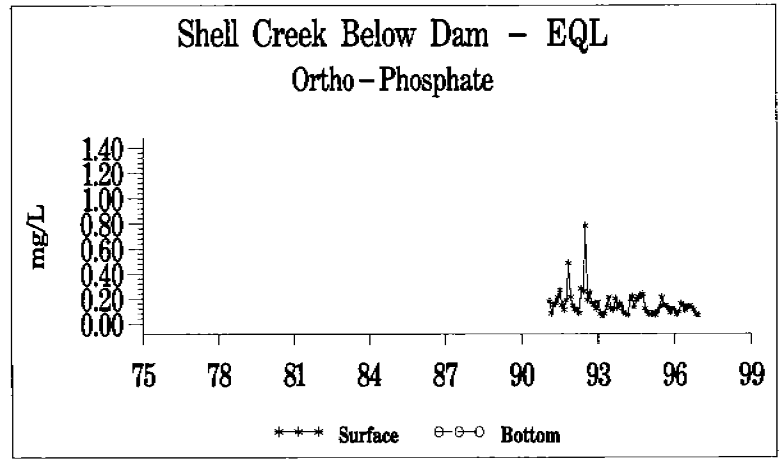
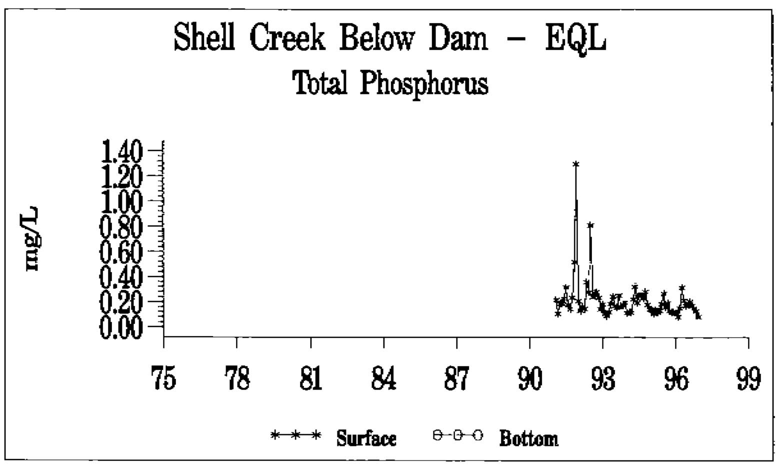


Figure 3-31. Time series graphs of water quality in the lower Peace estuary (EQL stations).







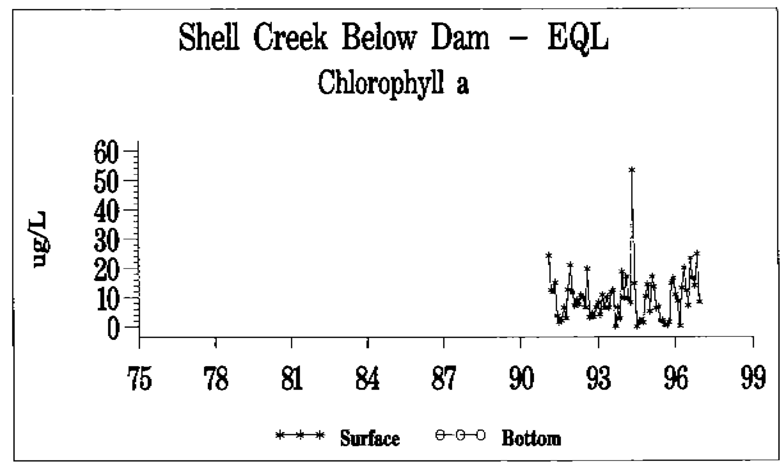


Figure 3-32. Time series graphs of water quality in the lower Peace estuary (EQL stations).

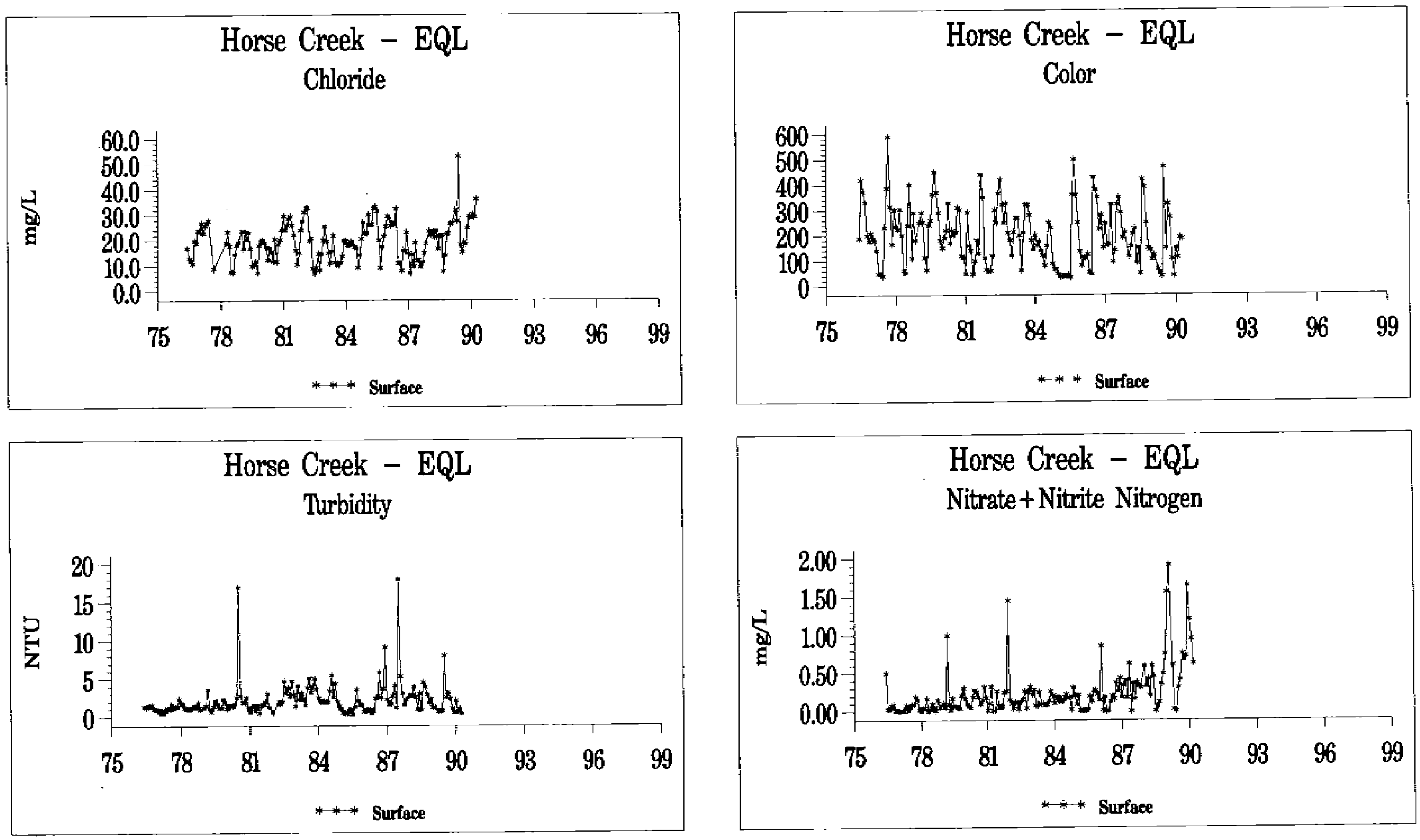


Figure 3-33. Time series graphs of water quality in the lower Peace estuary (EQL stations).

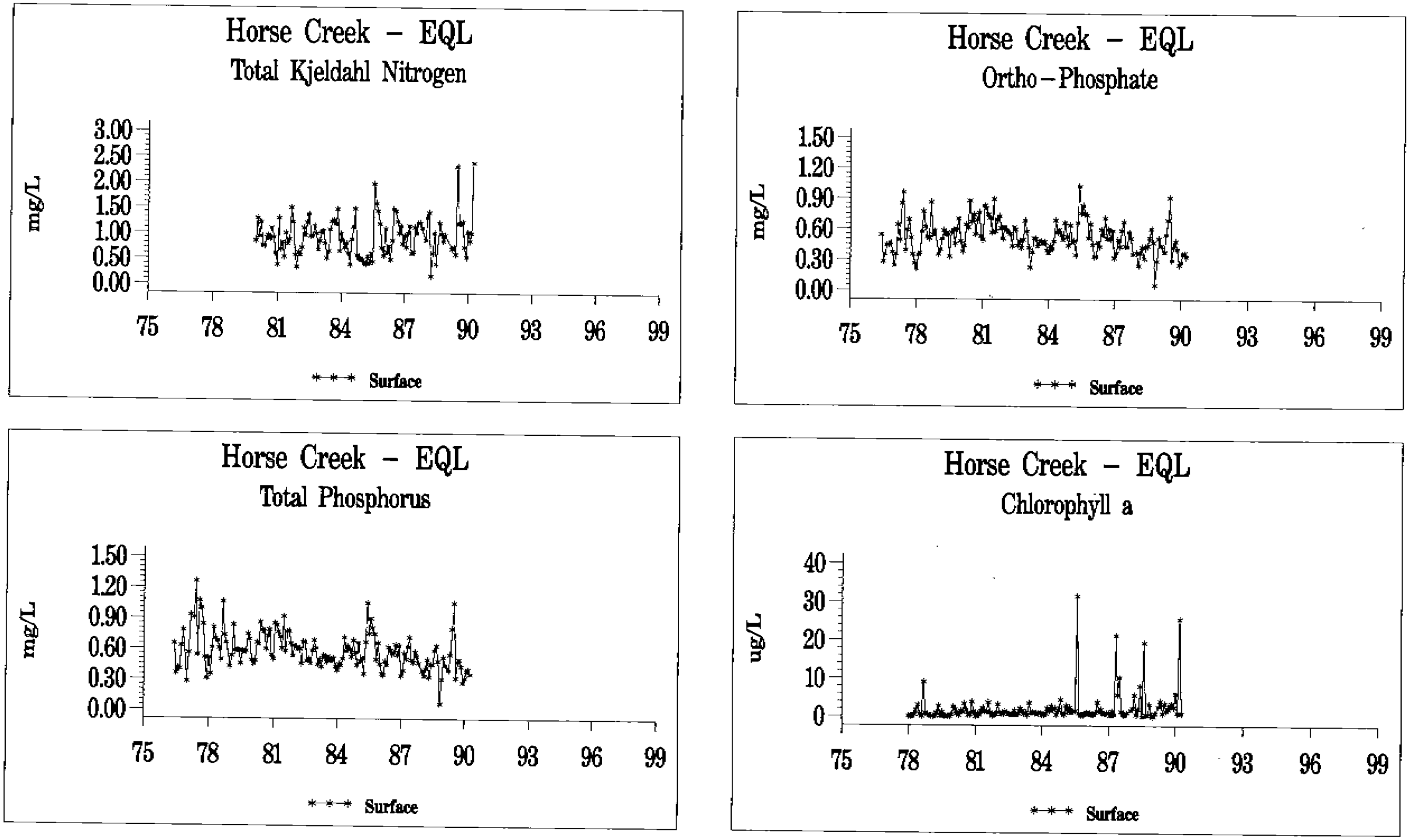


Figure 3-34. Time series graphs of water quality in the lower Peace estuary (EQL stations).

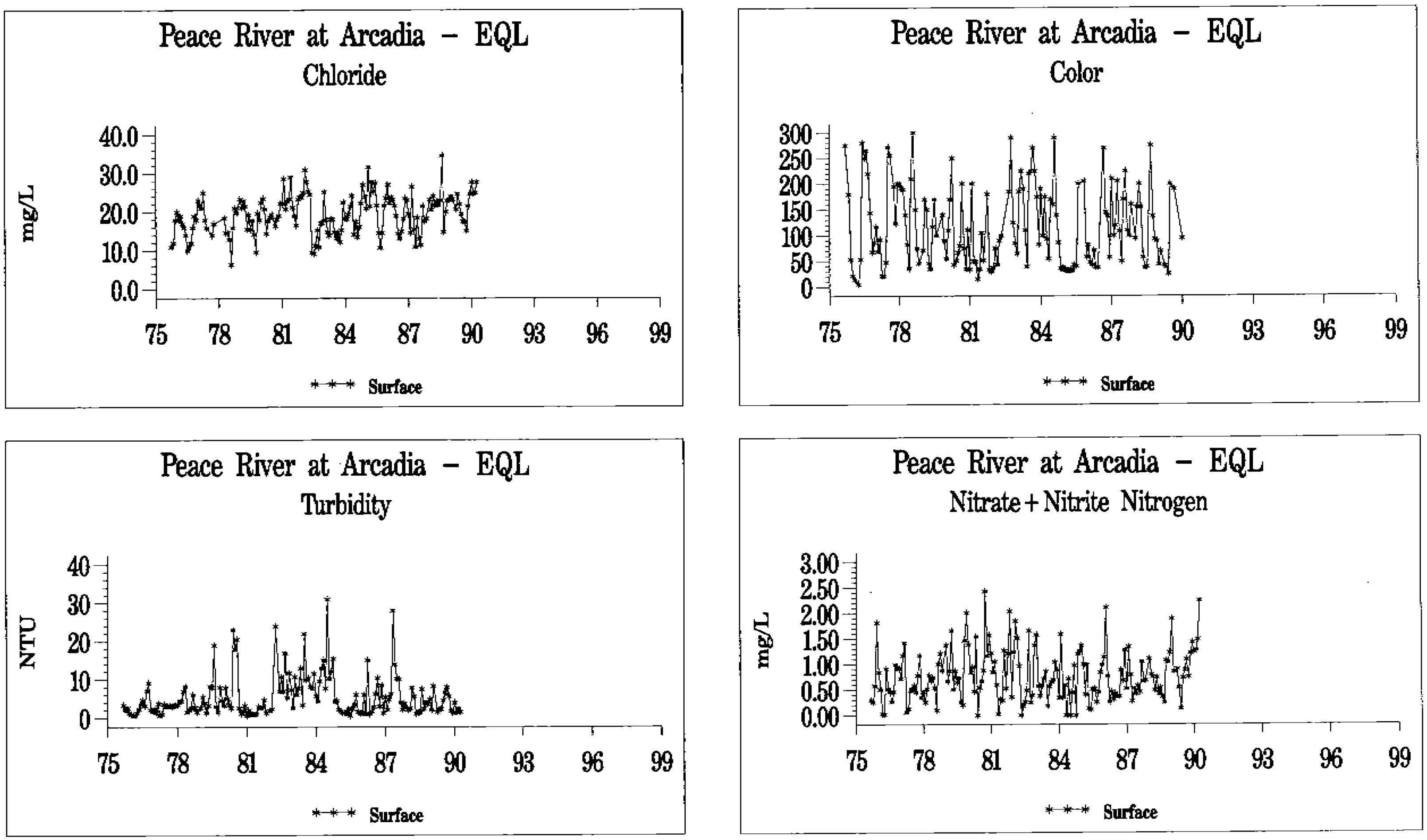


Figure 3-35. Time series graphs of water quality in the lower Peace estuary (EQL stations).

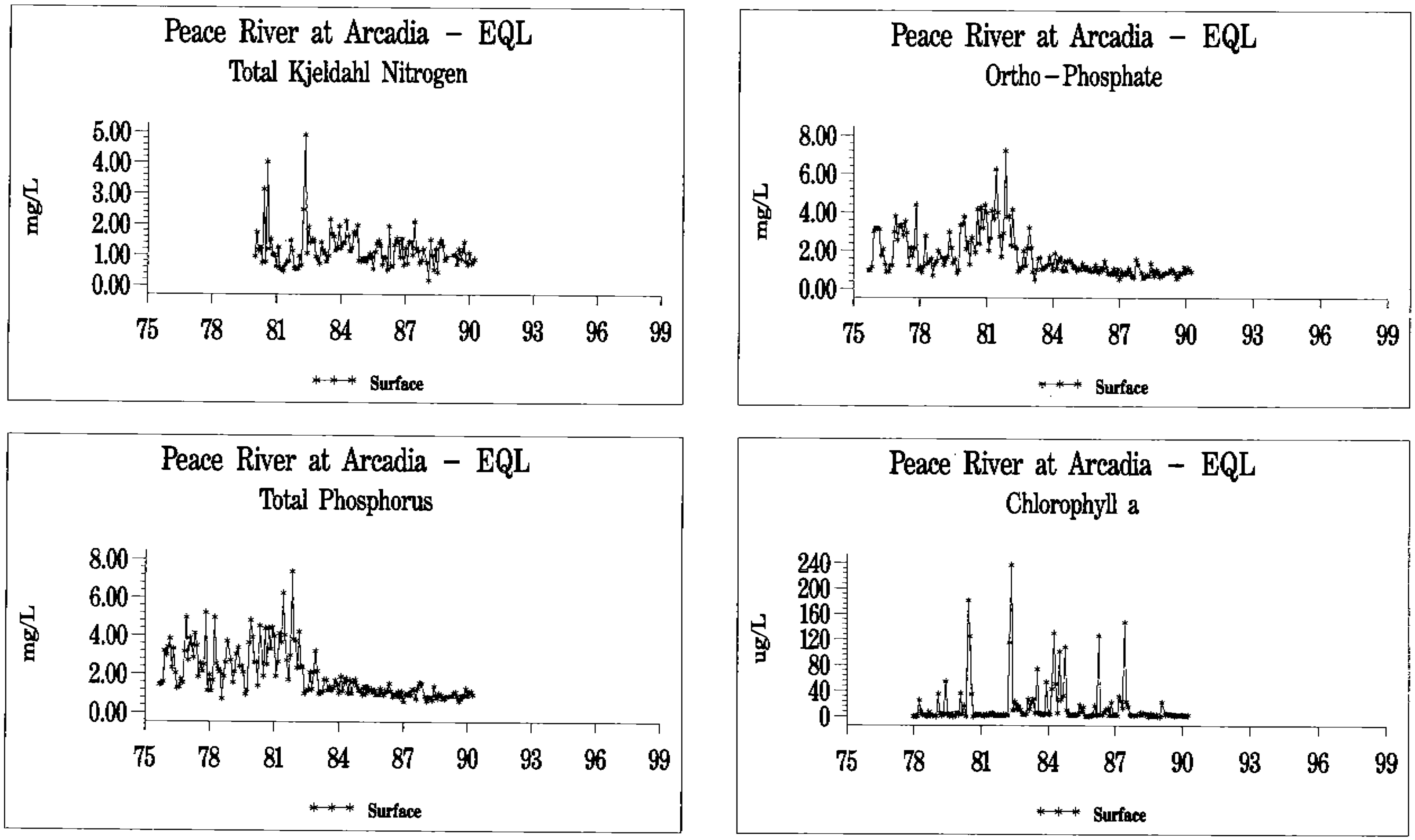


Figure 3-36. Time series graphs of water quality in the lower Peace estuary (EQL stations).

the drought conditions of the mid 1980's. Long-term statistically significant trends are evident in two areas. In Horse Creek nitrate+nitrite nitrogen concentrations increased dramatically at the same time that chlorides increased. Together these suggest the influences of increased agriculture in the area. In the lowest reaches of the Peace River there has been a significant decline in measured concentrations. Reductions in the most downstream portion of the Peace River are also apparent, especially since 1990.

Total Kjeldahl nitrogen - A very marked decline in the in the magnitude and frequency of peaks in the Peace River at Arcadia and in the Lower Peace River have occurred. It is possible that these apparent changes are related to improvements made by the City of Arcadia in its wastewater plant and method of disposal. Other patterns in the time series plots include an increasing frequency of high peaks on Horse Creek, and an apparent increase in the lowest reaches of the Peace River.

Ortho-phosphate & total phosphorus - Between 1976 and 1982 there where large peaks in both dissolved and total phosphorus concentrations observed throughout the Peace River. Since that time, the typical concentrations and the magnitude of annual variability have both declined. Concentrations in the Peace River have, in recent years, become much more similar to those observed in other freshwater streams in the basin such as Horse Creek or Shell Creek. Phosphorus concentrations in the Peace River typically are near the 90th percentile of all Florida streams, due to many factors including natural and anthropogenic influences.

Chlorophyll *a* - While chlorophyll concentrations in the Peace are usually below 20 g/L, very large algal blooms have been common in the Peace River. The magnitude of these blooms typically were greatest in upstream portions of the system. Given the likely contribution of phosphorus from natural sources these blooms may not be unusual. However, it is also apparent that anthropogenic influences may be important since marked declines in phosphorus concentrations have been observed in the upper Peace River during recent years which cannot easily be attributed to reductions in phosphorus supply from natural sources.

3.2.2.2 SWFWMD Data

Mean monthly water quality data collected by SWFWMD at two locations in the southern most portion of the Peace River between 1993 and 1996 are graphed in Figures 3-37 through 3-38.

Salinity - The Peace River Estuary has wide seasonal variations in salinity. During sustained high flows of the 1994 and 1995 summers, and briefly at the end of the 1996 summer, salinities were less than 0.5 ppt as far upstream as the U.S. 41 bridge.

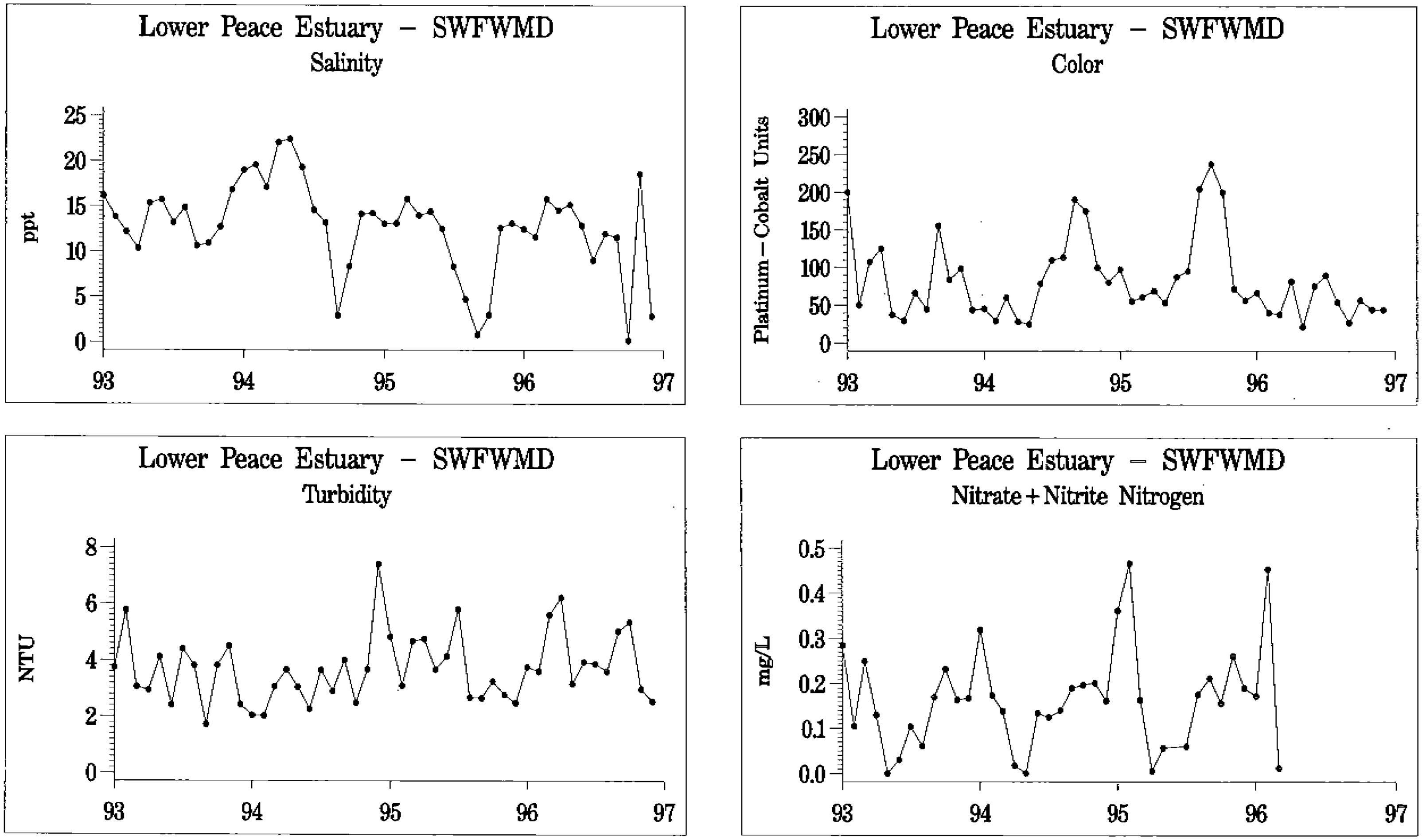


Figure 3-37. Time series graphs of water quality in the lower Peace estuary (SWFWMD stations).

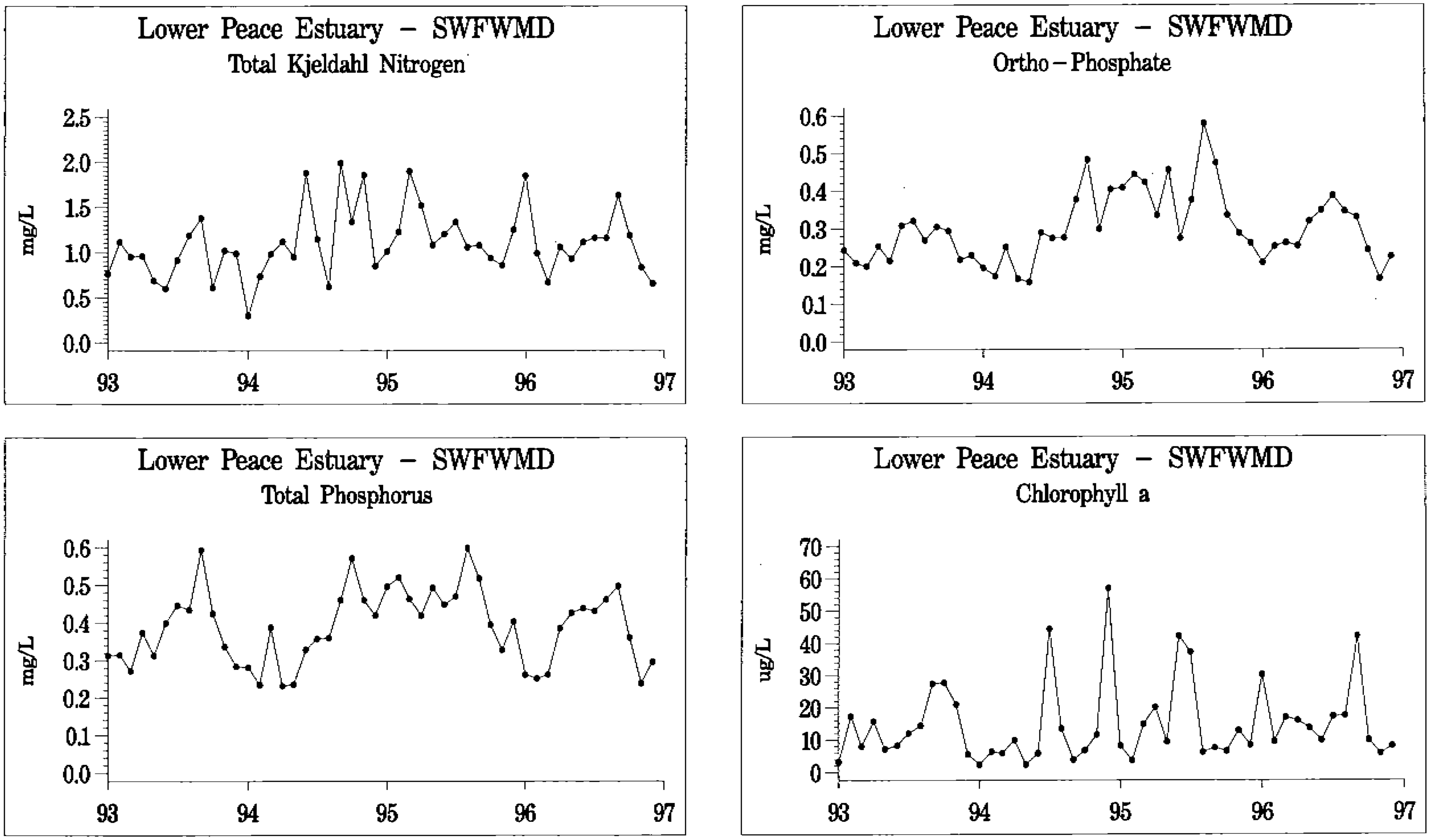


Figure 3-38. Time series graphs of water quality in the lower Peace estuary (SWFWMD stations).

Table 3-20. Summary of trend tests computed for water quality data from the Peace River Basin. ▲ - indicates increasing trend ($p < 0.05$); ▼ - indicates decreasing trend ($p < 0.05$); NS - indicates no significant trend; ID - insufficient data to detect trend.

Water Quality Constituent	Trend Test Result					
	Peace River Estuary	Shell Creek above Dam	Shell Creek below Dam	Lower Peace River	Horse Creek	Peace River at Arcadia
Conductivity (mmhos/cm)	NS	ID	ID	NS	ID	ID
Color (Pt-Co units)	NS	NS	NS	NS	NS	NS
Turbidity (NTU)	NS	NS	NS	▲	▲	▲
Nitrite-nitrate Nitrogen (mg/L)	▼	NS	NS	▲	▲	NS
Total Kjeldahl Nitrogen (mg/L)	▲	NS	NS	▼	NS	▼
Ortho-phosphate (mg/L)	▼	▼	▼	▼	▼	▼
Total Phosphorus (mg/L)	▼	NS	▼	▼	▼	▼
Chlorophyll *a* (µg/L)	NS	NS	NS	NS	▲	NS

Color - Peaks above 200 Pt-Co units were observed during each of the very wet periods in 1994 and 1995. These peaks however did not reach the magnitude of the peaks observed in the late 1970's and early 1980's under similarly high flows.

Turbidity - Values in the SWFWMD data fluctuated around 4 NTU and did not display the higher peaks observed by EQL during the same time period. The recent data collected by both groups does not show the consistently high peaks that were observed by EQL during the summer wet-seasons during the late 1970's and early 1980's.

Nitrate + nitrite nitrogen - These data clearly show the highest peaks occur during the winter months, and increase with the amount of freshwater flow during the preceding summer wet-season. As also shown by EQL data, the magnitude of these peaks in recent years have been less than those observed during the previous decade.

Total Kjeldahl nitrogen - Total Kjeldahl nitrogen increased during and after the two years of unusually high flows that occurred during 1994 and 1995.

Ortho-phosphate & total phosphorus - These data are very similar to those collected by EQL during the 1990's. Current concentrations are considerably lower than comparable measurements made between 1976 and 1990.

Chlorophyll *a* - Data collected by EQL and SWFWMD during the 1990's both show a decline in the magnitude of the chlorophyll peaks as compared to those by EQL before 1987.

3.2.3 USGS Data

Figures 3-39 through 3-46 present mean monthly water quality data collected in the Peace River between 1962 and 1996. The following describes the current and long-term water quality conditions by constituent. Variations in the frequency of sampling and numerous gaps prevented any statistical trend analysis of these data.

The most notable patterns in the USGS data for the Peace River are the decline in both phosphorus and nitrogen concentrations that have been observed from Bartow to Arcadia, with the declines being most dramatic in the upper portions of the river.

Specific conductance did not vary significantly from Peace River at Bartow to the Peace River at Arcadia. The data from the Peace River at Bartow clearly indicate a declining trend in conductance, especially in the higher conductance values.

3.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) were estimated for each subbasin by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to prioritize major basin or subbasins. Thus, the method development was focused on estimating relative loads in a consistent manner among subbasins to avoid biasing the subbasin prioritization.

The detailed rainfall, SWFWMD 1990 land cover, and USDA soil data that were discussed earlier were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was

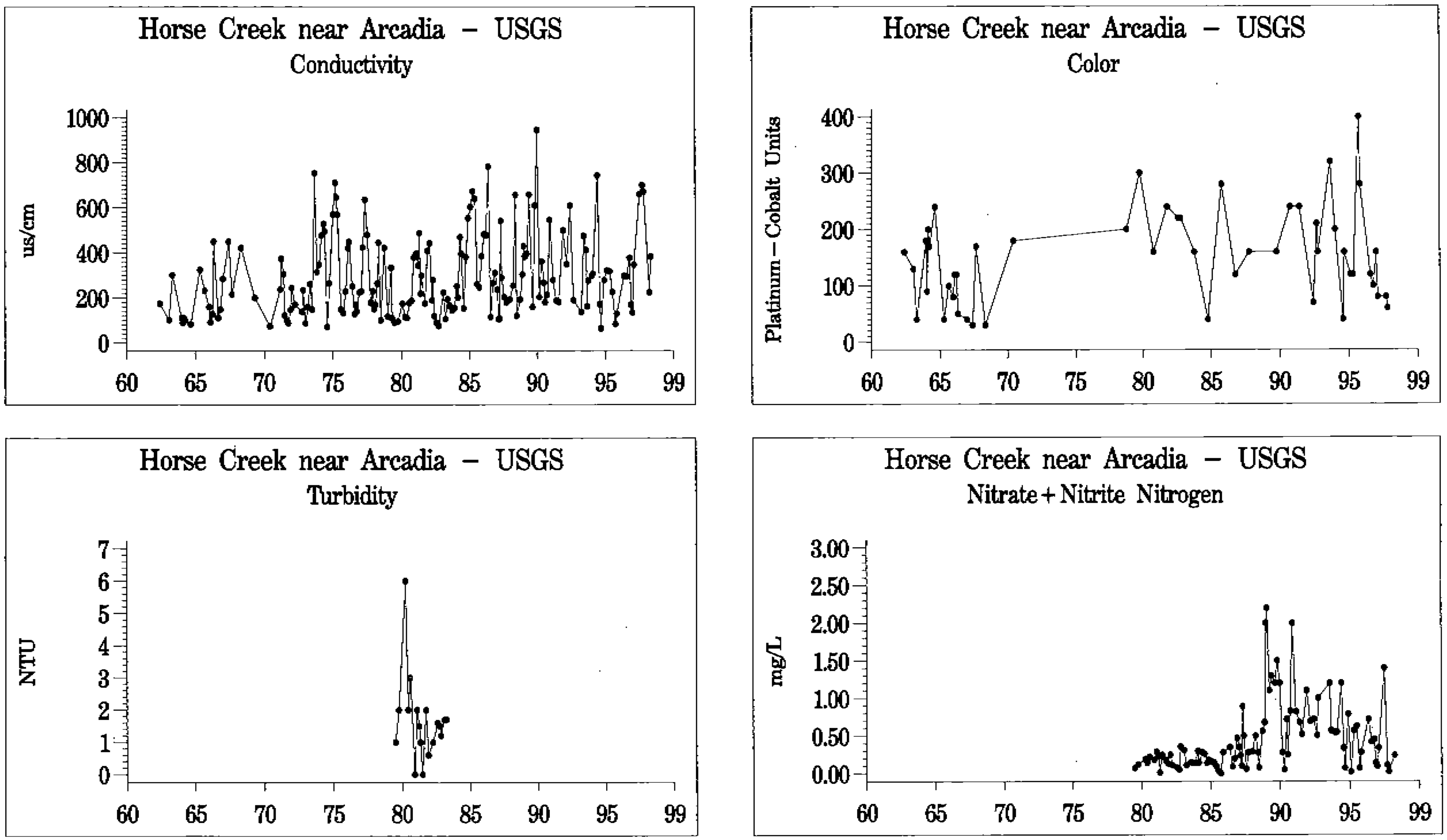


Figure 3.39 Time series graphs of water quality of Horse Creek near Arcadia (USGS Station).

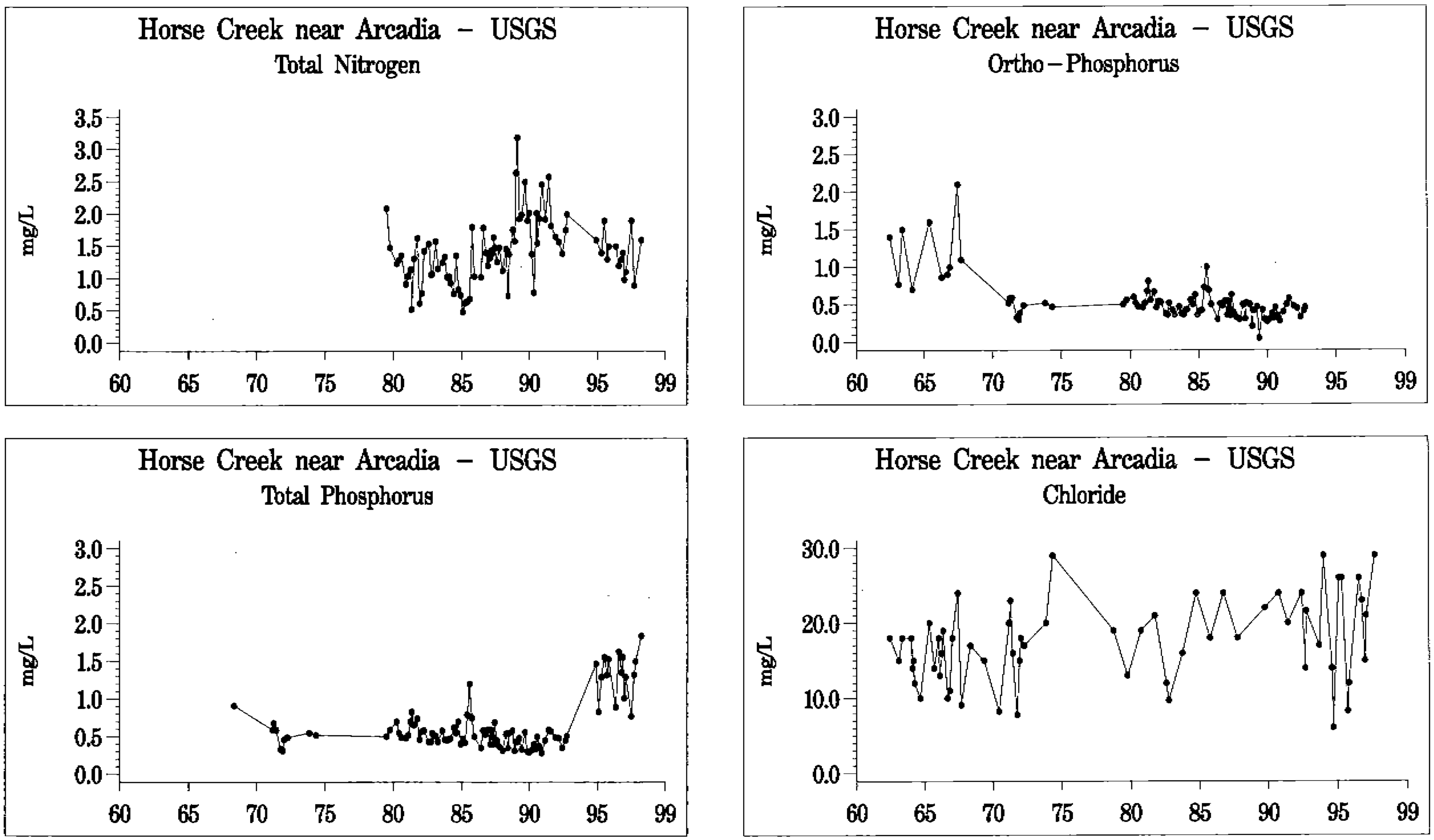


Figure 3.40 Time series graphs of water quality of Horse Creek near Arcadia (USGS Station).

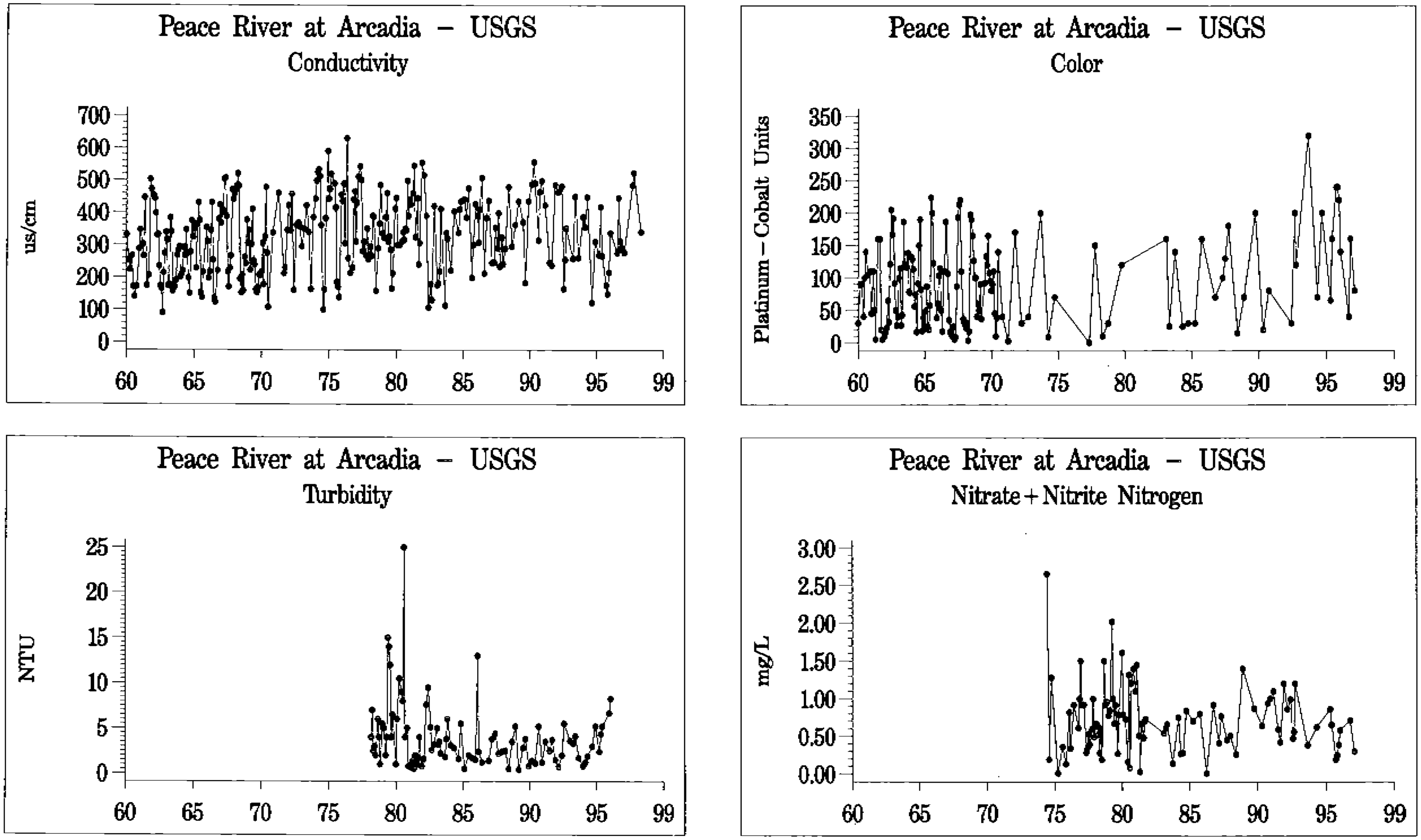


Figure 3.41 Time series graphs of water quality of Peace River at Arcadia (USGS Station).

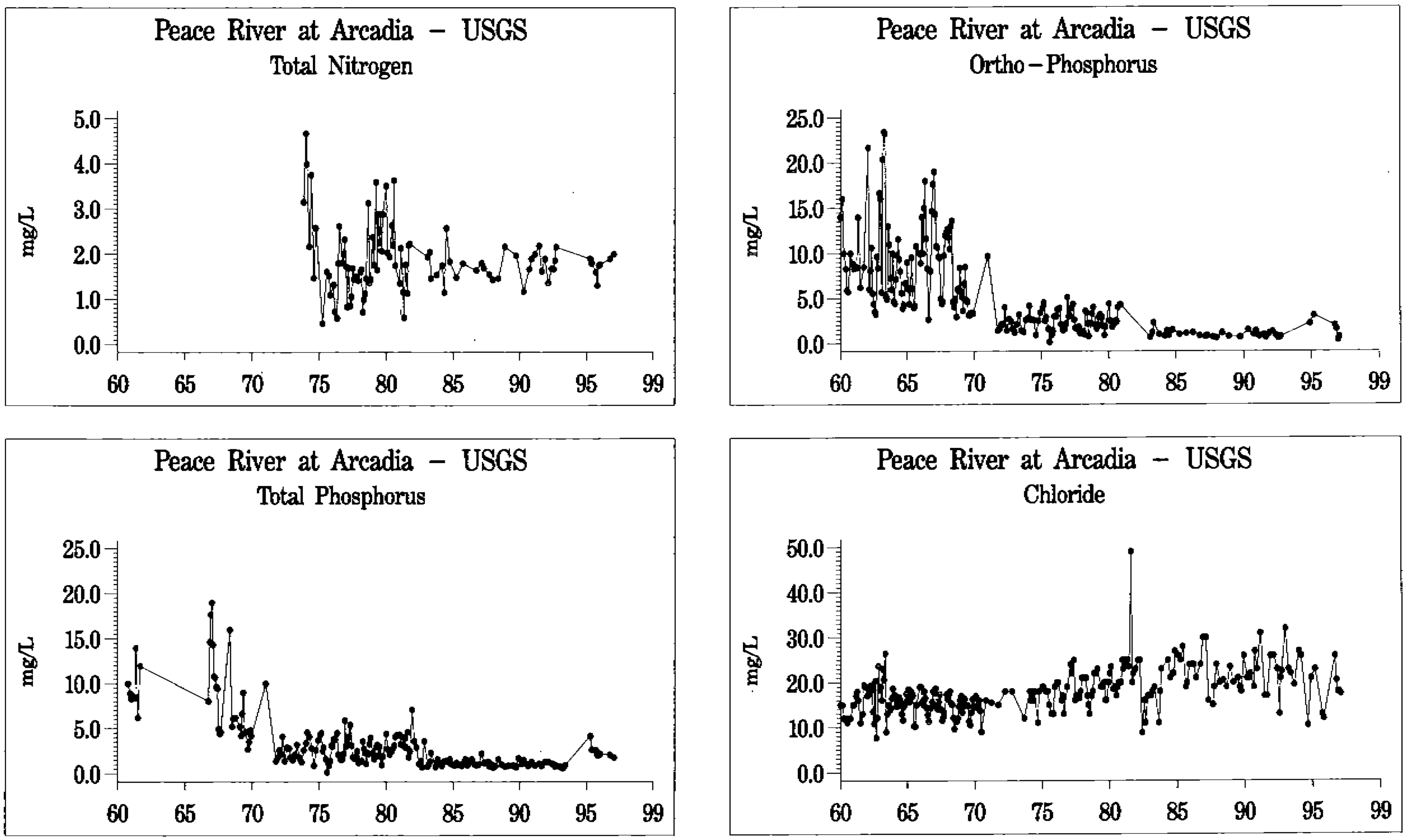


Figure 3.42 Time series graphs of water quality of Peace River at Arcadia (USGS Station).

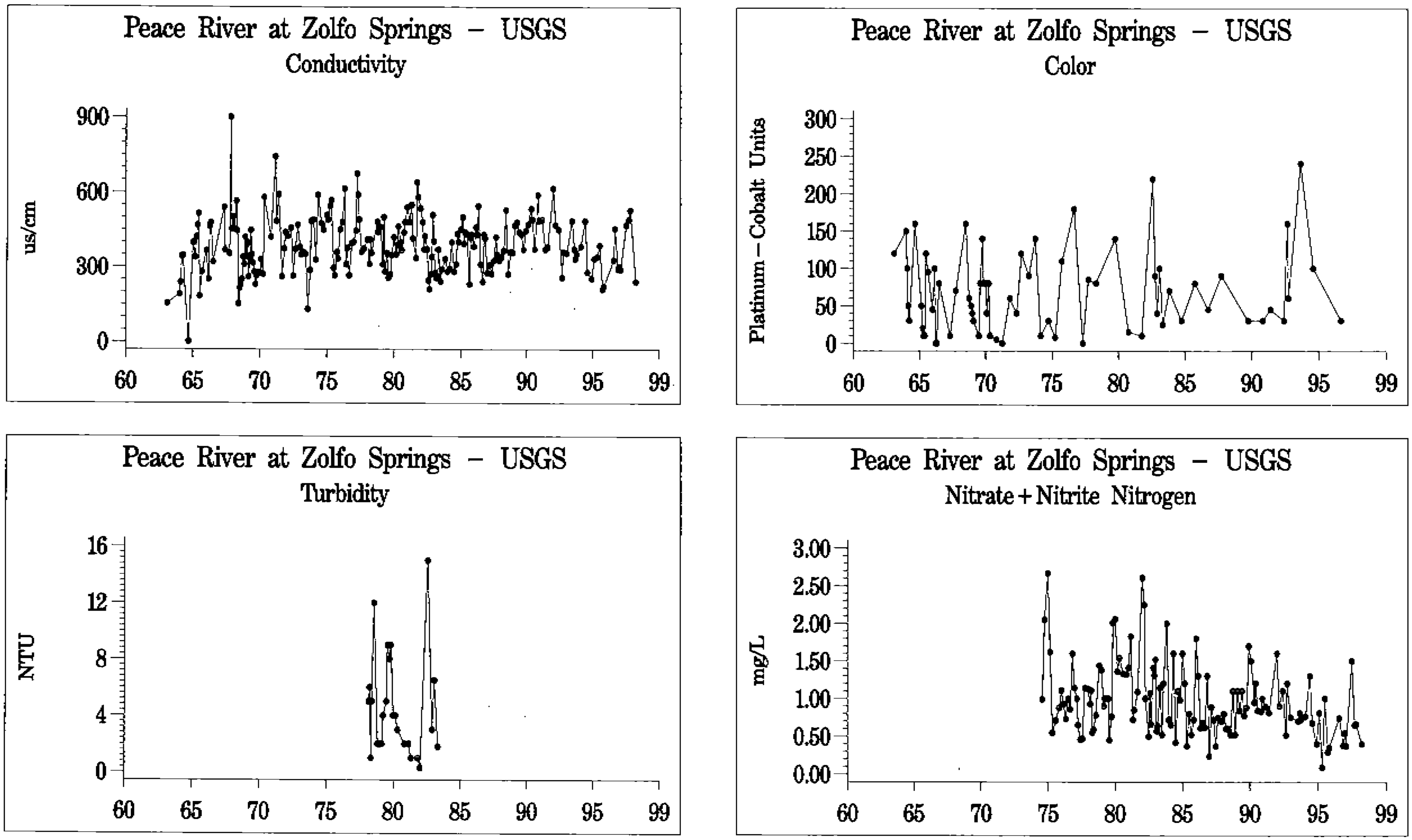


Figure 3.43 Time series graphs of water quality of Peace River at Zolfo Springs (USGS Station).

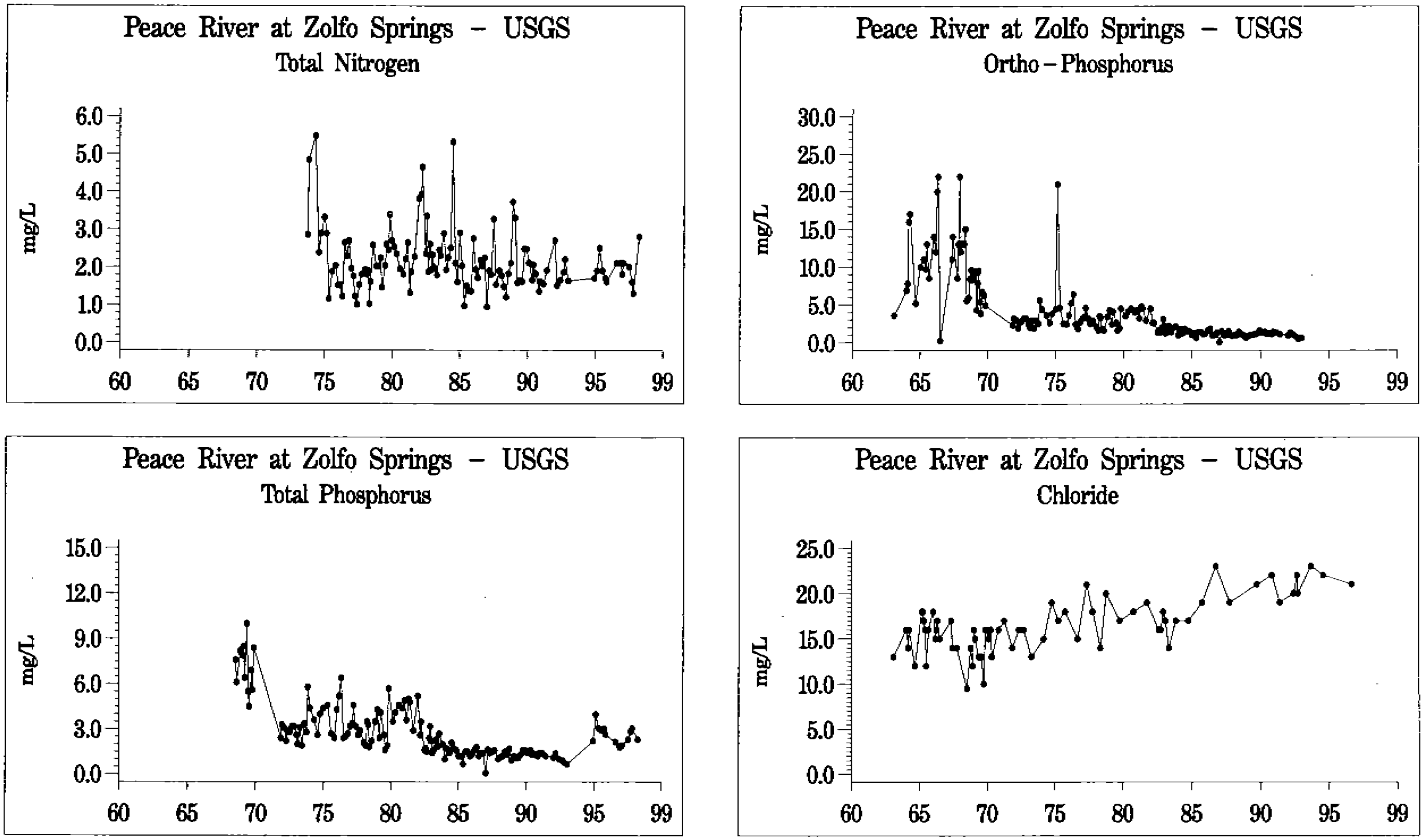


Figure 3.44 Time series graphs of water quality of Peace River at Zolfo Springs (USGS Station).

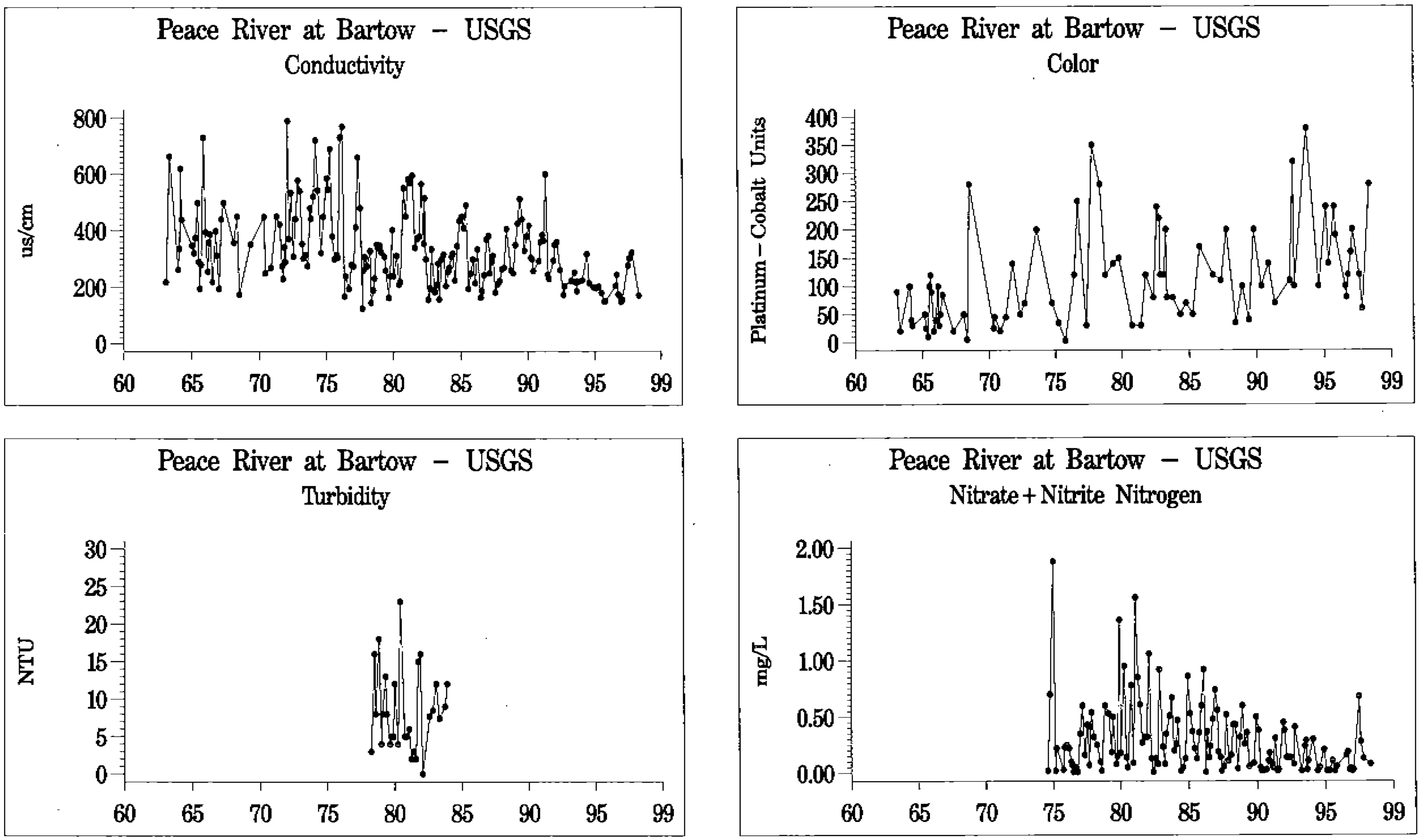


Figure 3.45 Time series graphs of water quality of Peace River at Bartow (USGS Station).

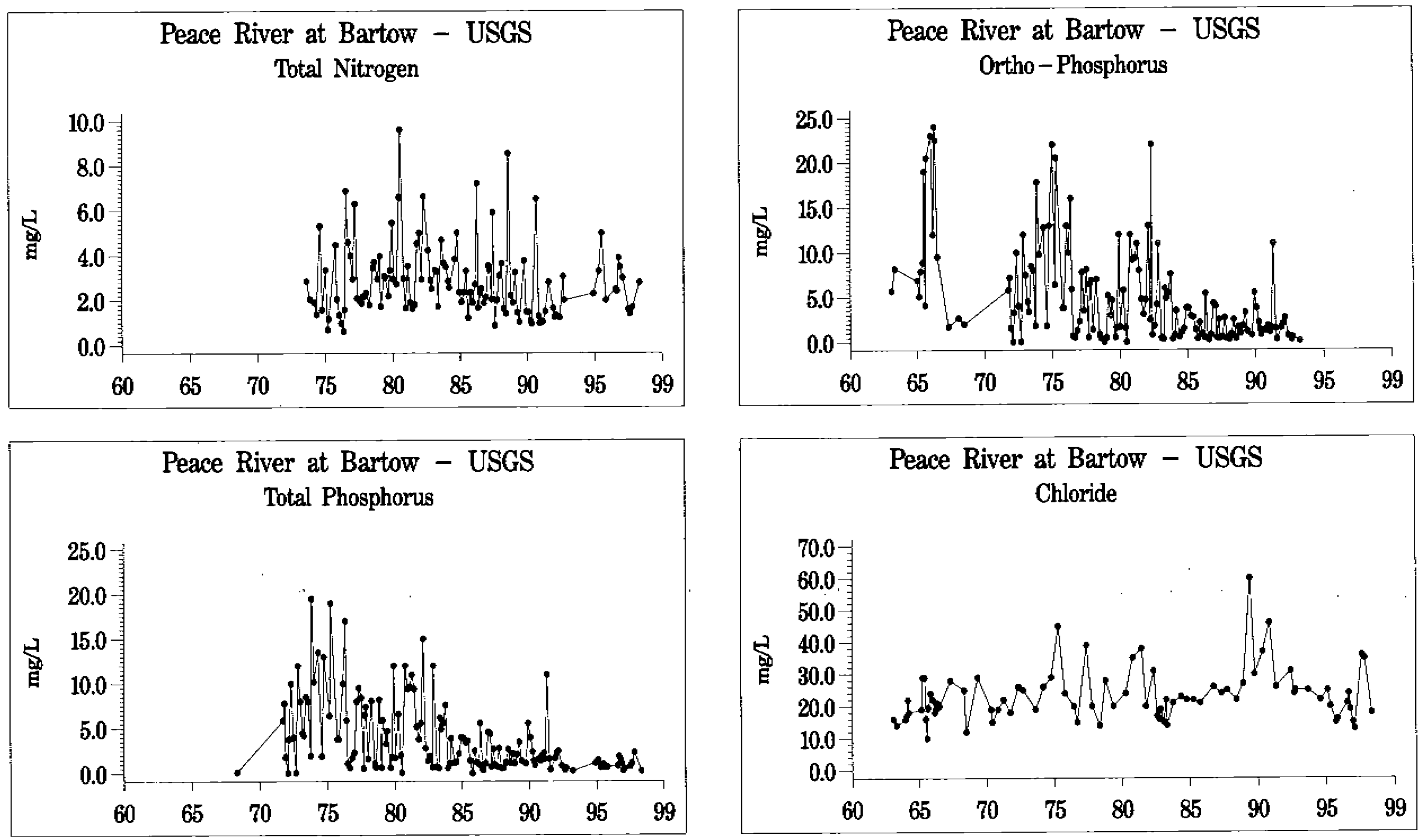


Figure 3.46 Time series graphs of water quality of Peace River at Bartow (USGS Station).

calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for South Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow was used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use pollutant concentration estimates specific to south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TN, TP, and TSS loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, feedlots, nursery, and field and row crops. Undeveloped land uses included range lands, barren lands, and upland forests.

3.3.1 Load Estimates for the Peace River at Bartow Subbasin

The Peace River at Bartow subbasin had the largest contributing area and the largest estimated hydrologic load of any of the Peace River subbasins. The estimated hydrologic load was also the largest for any of the subbasins in the Charlotte Harbor NEP study area. The total estimated annual runoff discharge for this subbasin was 260 million cubic meters. The estimated annual pollutant loads were 607 tons of TN, 126 tons of TP, and 10,184 tons of TSS. These pollutant loads represent approximately 10% of the total pollutant loads for the NEP study area. The total NEP study area loads were 6,807 tons of TN, 1,756 tons of TP, and 74,401 tons of TSS.

Nearly one half of the TP loads from runoff from this subbasin were from agricultural lands. The 76,000 acres of agricultural lands contributed 70 million cubic meters of runoff, 183 tons of TN, 45 tons of TP, and 740 tons of TSS. Almost all of these loads were estimated to come from pasture lands and groves. Table 3-21 presents the loads from runoff by land use.

The largest TN and TSS loads from runoff from this subbasin were from urban land uses. The 66,000 acres of runoff contributing urban lands were estimated to discharge 66 million cubic meters of runoff per year, 319 tons of TN, 47 tons of TP, and 8,476 tons of TSS. The largest loads were estimated to be from medium density residential and commercial land uses.

Table 3-21. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Peace River at Bartow subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	18	3%	3	2%	171	2%	8,547,425	3%
Medium Density Residential	106	17%	16	12%	1,597	16%	42,709,707	17%
High Density Residential	29	5%	5	4%	902	9%	12,697,666	5%
Commercial	61	10%	9	7%	2,445	24%	30,079,607	12%
Industrial	22	4%	4	3%	1,227	12%	11,873,901	5%
Mining	63	10%	9	8%	1,941	19%	35,085,900	14%
Institutional, Transport., Util.	21	3%	1	1%	193	2%	15,859,830	6%
Range Lands	56	9%	28	22%	280	3%	19,427,400	8%
Barren Lands	3	1%	0	0%	29	0%	2,591,311	1%
Pasture	114	19%	35	28%	368	4%	38,913,061	15%
Groves	67	11%	10	8%	327	3%	30,174,285	12%
Feedlots	1	0%	0	0%	2	0%	43,296	0%
Nursery	2	0%	0	0%	42	0%	692,196	0%
Row and Field Crops	0	0%	0	0%	1	0%	29,276	0%
Upland Forests	45	8%	6	5%	660	7%	10,845,032	4%
TOTAL	607	100%	126	100%	10,184	100%	259,569,894	100%

3.3.2 Load Estimates for the Peace River at Zolfo Springs Subbasin

The Peace River at Zolfo Springs Subbasin was estimated to have the second highest TSS load from runoff among the Peace River Subbasins. The total estimated annual runoff discharge for this subbasin was 173 million cubic meters. The total estimated annual pollutant loads from the subbasin were 414 tons of TN, 96 tons of TP, and 5,683 tons of TSS.

Nutrient and hydrologic loads due to anthropogenic runoff were predominantly agricultural. Lands in agricultural use contributed an estimated 189 tons of TN, 49 tons of TP, and 703 tons of TSS to the subbasin load from a total of 69,000 acres. Table 3-22 presents the loads from runoff by land use. Of these agricultural loads, most were associated with pasture and to a lesser extent with groves.

A very large portion (76%) of the total nonpoint source TSS load was attributed to urban land uses. The 36,000 acres of urban land uses contributed an estimated 153 tons of TN, 23 tons of TP, 4,318 tons of TSS, and 82 million cubic meters of runoff. The urban land use with the largest estimated TSS load was mining (3,566 tons).

Table 3-22. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Peace River at Zolfo Springs subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	7	2%	1	1%	67	1%	3,331,183	2%
Medium Density Residential	19	5%	3	3%	284	5%	7,600,201	4%
High Density Residential	1	0%	0	0%	35	1%	487,652	0%
Commercial	7	2%	1	1%	294	5%	3,621,596	2%
Industrial	1	0%	0	0%	46	1%	442,245	0%
Mining	116	28%	17	18%	3,566	63%	64,457,352	37%
Institutional, Transport., Util.	3	1%	0	0%	26	1%	2,134,574	1%
Range Lands	39	10%	20	21%	199	3%	13,803,044	8%
Barren Lands	0	0%	0	0%	3	0%	256,997	0%
Pasture	136	33%	41	43%	439	8%	46,392,533	27%
Groves	50	12%	7	7%	244	4%	22,485,519	13%
Feedlots	3	1%	1	1%	7	0%	129,857	0%
Nursery	0	0%	0	0%	13	0%	214,578	0%
Upland Forests	32	8%	5	5%	461	8%	7,577,329	4%
TOTAL	414	100%	96	100%	5,683	100%	172,934,660	100%

3.3.3 Load Estimates for the Payne Creek Subbasin

Payne Creek was estimated to have relatively low values of pollutant loads among the Peace River Basins. The total estimated annual runoff discharge for the Payne Creek drainage was 69 million cubic meters. The estimated annual pollutant loads were 163 tons of TN, 36 tons of TP, and 2,774 tons of TSS.

Agricultural lands contributed 19 million cubic meters of runoff, 50 tons of TN load, 13 tons of TP load, and 236 tons of TSS load per year. Table 3-23 presents the loads from runoff by land use. The primary agricultural lands were pasture and groves and to a lesser extent row and field crops.

Urban lands were estimated to contribute over 75% of the total TSS loads from runoff for all contributing lands in the subbasin. The 14,000 acres contributed 38 million cubic meters of runoff, 69 tons of TN, 10 tons of TP, and 2,086 tons of TSS per year. Mining was estimated to contribute 2,026 tons of TSS load per year, and was the single largest source of nonpoint source pollutants among urban land uses in the subbasin.

Table 3-23. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Payne Creek subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	1	0%	0	0%	5	0%	268,433	0%
Medium Density Residential	2	1%	0	1%	23	1%	621,201	1%
High Density Residential	0	0%	0	0%	11	0%	153,504	0%
Commercial	0	0%	0	0%	10	0%	126,098	0%
Industrial	0	0%	0	0%	8	0%	77,838	0%
Mining	66	40%	10	27%	2,026	73%	36,615,989	53%
Institutional, Transport., Util.	0	0%	0	0%	2	0%	148,755	0%
Range Lands	20	12%	10	28%	102	4%	7,058,288	10%
Barren Lands	0	0%	0	0%	0	0%	15,659	0%
Pasture	24	15%	7	20%	78	3%	8,229,742	12%
Groves	19	12%	3	8%	94	3%	8,650,283	13%
Feedlots	2	1%	0	1%	4	0%	76,334	0%
Nursery	0	0%	0	0%	1	0%	11,583	0%
Row and Field Crops	5	3%	2	6%	60	2%	1,563,766	2%
Upland Forests	24	15%	3	9%	350	13%	5,759,881	8%
TOTAL	163	100%	36	100%	2,774	100%	69,377,355	100%

3.3.4 Load Estimates for the Charlie Creek Subbasin

Although the watershed drainage area and hydrologic load were relatively moderate, the Charlie Creek Subbasin was estimated to have the second highest TP load among the Peace River Subbasins. The total estimated annual runoff discharge for this subbasin was 177 million cubic meters. The estimated annual pollutant loads were 541 tons of TN, 149 tons of TP, and 3,276 tons of TSS.

Agricultural lands were estimated to contribute the largest portions of the high nutrient loads. The extensive 119,000 acres of agricultural lands comprised over half of the subbasin area, and they contributed 119 million cubic meters of runoff, 349 tons of TN, 95 tons of TP, and 1,219 tons of TSS. Table 3-24 presents the loads from runoff by land use. The majority of the agricultural nonpoint source runoff and pollutant loads were from pasture and groves.

Urban lands were estimated to be a relatively minor source of nonpoint source pollutants for this subbasin. The 8,000 acres of urban lands were estimated to contribute 16 tons of TN, 2 tons of TP, and 209 tons of TSS. The urban land uses were almost entirely low and medium density residential.

Table 3-24. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type with the Charlie Creek subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	9	2%	1	1%	90	3%	4,523,370	3%
Medium Density Residential	5	1%	1	1%	74	2%	1,967,053	1%
High Density Residential	1	0%	0	0%	19	1%	261,732	0%
Commercial	0	0%	0	0%	8	0%	104,364	0%
Industrial	0	0%	0	0%	8	0%	79,363	0%
Institutional, Transport., Util.	1	0%	0	0%	10	0%	816,792	1%
Range Lands	75	14%	38	25%	380	12%	26,381,618	15%
Barren Lands	0	0%	0	0%	1	0%	74,180	0%
Pasture	271	50%	83	55%	877	27%	92,707,416	52%
Groves	54	10%	8	5%	266	8%	24,516,005	14%
Feedlots	22	4%	4	3%	57	2%	1,030,598	1%
Nursery	1	0%	0	0%	20	1%	330,110	0%
Upland Forests	100	19%	14	10%	1,466	45%	24,102,185	14%
TOTAL	541	100%	149	100%	3,276	100%	176,894,787	100%

3.3.5 Load Estimates for the Peace River at Arcadia Subbasin

The total estimated annual runoff discharge for this subbasin was 102 million cubic meters; nearly 70% of this hydrologic load was caused by pasture and groves. The estimated annual pollutant loads were 303 tons of TN, 78 tons of TP, and 2,099 tons of TSS.

The majority of the anthropogenic pollutant loads from runoff were considered to be from agricultural lands in this subbasin. The 69,000 acres of agricultural land were estimated to contribute 69 million cubic meters on runoff, 191 tons of TN, 51 tons of TP, and 705 tons of TSS. Table 3-25 presents the loads from runoff by land use. As illustrated in this table, almost all of the agricultural loads were attributed to pasture and groves.

Very little of the nonpoint source pollutant loads were likely contributed by urban land uses. The 2,500 acres of urban lands contributed an estimated 10 tons of TN, 1 ton of TP, and 181 tons of TSS to total subbasin loadings. No single land use within the Peace River at Arcadia Subbasin was dominant.

Table 3-25. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Peace River at Arcadia subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	4	1%	1	1%	36	2%	1,791,169	2%
Medium Density Residential	2	1%	0	1%	37	2%	987,810	1%
High Density Residential	0	0%	0	0%	6	0%	86,184	0%
Commercial	2	1%	0	0%	83	4%	1,018,046	1%
Industrial	0	0%	0	0%	9	0%	90,584	0%
Institutional, Transport., Util.	1	0%	0	0%	10	1%	801,686	1%
Range Lands	30	10%	15	19%	151	7%	10,444,253	10%
Barren Lands	0	0%	0	0%	1	0%	46,006	0%
Pasture	145	48%	44	57%	469	22%	49,598,132	49%
Groves	43	14%	6	8%	212	10%	19,526,827	19%
Feedlots	2	1%	0	0%	4	0%	70,734	0%
Nursery	1	0%	0	0%	16	1%	258,714	0%
Row and Field Crops	0	0%	0	0%	5	0%	134,020	0%
Upland Forests	73	24%	10	13%	1,062	51%	17,464,427	17%
TOTAL	303	100%	78	100%	2,099	100%	102,318,593	100%

3.3.6 Load Estimates for the Horse Creek Subbasin

The Horse Creek drainage was among the smallest subbasins of the Peace River subbasins. The total estimated annual runoff discharge for this subbasin was 116 million cubic meters. The estimated annual pollutant loads were 356 tons of TN, 104 tons of TP, and 2,502 tons of TSS.

Approximately one half of the subbasin area was defined as agricultural land use (61,000 acres). These agricultural lands contributed an estimated 63 million cubic meters of runoff or approximately one third of the subbasin annual total. The estimated annual pollutant loads from this runoff were 184 tons of TN, 52 tons of TP, and 669 tons of TSS. Table 3-26 presents the loads from runoff by land use. Similar to the other subbasins of the Peace River, these agricultural loads were primarily attributed to pasture and groves.

Less than 3000 acres of urban land use were reported for this subbasin. These lands contributed 5 million cubic meters of runoff, 9 tons of TN, 1 ton of TP, and 179 tons of TSS annually. They were comprised of mostly low density residential lands, and to a lesser extent mining.

Table 3-26. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Horse Creek subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	4	1%	1	1%	42	2%	2,120,910	2%
Medium Density Residential	0	0%	0	0%	2	0%	53,707	0%
Industrial	0	0%	0	0%	4	0%	36,977	0%
Mining	4	1%	1	1%	123	5%	2,227,604	2%
Institutional, Transport., Util.	1	0%	0	0%	7	0%	589,911	1%
Range Lands	76	21%	38	37%	383	15%	26,575,821	23%
Barren Lands	0	0%	0	0%	0	0%	33,365	0%
Pasture	151	42%	46	44%	488	20%	51,597,876	45%
Groves	23	6%	3	3%	110	4%	10,139,402	9%
Feedlots	5	2%	1	1%	14	1%	247,099	0%
Nursery	0	0%	0	0%	4	0%	68,888	0%
Row and Field Crops	5	1%	2	2%	54	2%	1,409,203	1%
Upland Forests	87	24%	12	12%	1,271	51%	20,892,344	18%
TOTAL	356	100%	104	100%	2,502	100%	115,993,108	100%

3.3.7 Load Estimates for the Joshua Creek Subbasin

Joshua Creek was estimated to have relatively low values of pollutant loads compared with the other Peace River Basins. The total estimated annual runoff discharge for this subbasin was 71 million cubic meters. The estimated annual pollutant loads were 196 tons of TN, 53 tons of TP, and 1,078 tons of TSS.

Loads from agricultural land use dominated the relatively low load estimates for this drainage area. The agricultural lands contributed 54 million cubic meters of runoff per year. The pollutant loads for agricultural lands were estimated to be 147 tons of TN, 39 tons of TP, and 541 tons of TSS. Table 3-27 presents the loads from runoff by land use. The agricultural runoff loads were primarily attributed to pasture and grove land uses.

A small amount of urban land use (2,500 acres) was reported for the Joshua Creek subbasin. The estimated annual runoff loads from these lands were 3 million cubic meters of runoff, 10 tons of TN, 1 ton of TP, and 166 tons of TSS. The urban land uses were primarily low density and medium density residential.

Table 3-27. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Joshua Creek subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	3	2%	0	1%	28	3%	1,422,937	2%
Medium Density Residential	3	2%	0	1%	46	4%	1,218,693	2%
High Density Residential	0	0%	0	0%	7	1%	102,397	0%
Commercial	2	1%	0	0%	65	6%	802,020	1%
Industrial	0	0%	0	0%	3	0%	26,626	0%
Institutional, Transport., Util.	2	1%	0	0%	17	2%	1,415,974	2%
Range Lands	20	10%	10	19%	103	10%	7,116,174	10%
Barren Lands	0	0%	0	0%	3	0%	234,504	0%
Pasture	112	57%	34	64%	362	34%	38,277,420	54%
Groves	35	18%	5	9%	171	16%	15,817,541	22%
Nursery	0	0%	0	0%	8	1%	128,148	0%
Upland Forests	18	9%	3	5%	265	25%	4,363,953	6%
TOTAL	196	100%	53	100%	1,078	100%	70,926,388	100%

3.3.8 Load Estimates for the Shell Creek Subbasin

Although the Shell Creek drainage area was not among the largest in the NEP study area, it was estimated to contribute the second highest TP load from among all of the subbasins. It was the also the second largest of the Peace River subbasins, and contributed the highest nutrient loads among the Peace River subbasins. The total estimated annual runoff discharge for this subbasin was 193 million cubic meters. The estimated annual pollutant loads were 565 tons of TN, 168 tons of TP, and 3,472 tons of TSS.

Most (60%) of the notably high TP loads from runoff were attributed to agricultural land uses. The total 188,000 acres of agricultural lands were estimated to contribute 115 million cubic meters of runoff, 315 tons of TN load, 84 tons of TP load, and 1,166 tons of TSS load. Table 3-28 presents the loads from runoff by land use. The agricultural land uses included 82,000 acres of pasture and 36,000 acres of groves.

Very little urban land use (3,000 acres) was reported for this subbasin. Almost all of this land use was low density residential. These urban lands contributed a total of 5 million cubic meters of runoff, 9 tons of TN, 1 ton of TP, and 102 tons of TSS on an annual basis. Only 1% of the reported high TP loads from this basin were attributed to urban land uses.

Table 3-28. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Shell Creek subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	8	1%	1	1%	72	2%	3,621,300	2%
High Density Residential	1	0%	1	0%	16	1%	221,278	0%
Commercial	0	0%	0	0%	3	0%	42,497	0%
Mining	0	0%	0	0%	4	0%	67,645	0%
Institutional, Transport., Util.	1	0%	0	0%	7	0%	603,630	0%
Range Lands	136	24%	68	41%	686	20%	47,635,446	25%
Barren Lands	1	0%	0	0%	8	0%	745,968	0%
Pasture	237	42%	72	43%	765	22%	80,826,682	42%
Groves	75	13%	11	6%	367	11%	33,874,399	18%
Feedlots	0	0%	0	0%	1	0%	16,620	0%
Nursery	0	0%	0	%0	1	%0	14,606	%0
Row and Field Crops	3	1%	1	1%	33	1%	857,280	0%
Upland Forests	103	18%	15	9%	1,508	%43	24,794,436	13%
TOTAL	565	100%	168	100%	3,472	100%	193,321,789	100%

3.3.9 Load Estimates for the Lower Peace River Subbasin

The Lower Peace River subbasin is the most downstream subbasin of the Peace River. The total estimated annual runoff discharge was 167 million cubic meters. The estimated annual pollutant loads were 458 tons of TN, 107 tons of TP, and 5,448 tons of TSS.

In contrast to the previously discussed Shell Creek Subbasin, urban lands were estimated to contribute the highest nonpoint source pollutant loads for the Lower Peace River Subbasin. The TSS loads from urban lands comprised 55% of the total TSS load for the subbasin. The 33,000 acres of urban lands in this subbasin contributed 71 million cubic meters of runoff, 155 tons of TN, 22 tons of TP, and 2,981 tons of TSS. Table 3-29 presents the loads from runoff by land use. As indicated by this table, this lower portion of the Peace River drainage was reported to have a notably high extent of commercial and medium density residential land uses.

Agricultural lands in this subbasin comprised more land area (39,000 acres) than did the urban lands. However the pollutant loads from these agricultural lands were estimated to be relatively less than those from urban lands (i.e., 100 tons of TN, 32 tons of TP, and 355 tons of TSS from 44 million cubic meters of runoff). These lands were reported to be primarily pasture and groves.

Table 3-29. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Lower Peace River subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	18	4%	3	3%	175	3%	8,775,664	5%
Medium Density Residential	91	20%	13	13%	1,379	25%	36,879,957	22%
High Density Residential	8	2%	1	1%	243	5%	3,415,348	2%
Commercial	22	5%	3	3%	889	16%	10,942,894	7%
Industrial	2	0%	0	0%	99	2%	954,036	1%
Mining	3	1%	0	0%	95	2%	1,714,821	1%
Institutional, Transport., Util.	11	2%	1	1%	102	2%	8,349,507	5%
Range Lands	79	17%	39	37%	397	7%	27,561,528	17%
Barren Lands	2	0%	0	0%	17	0%	1,520,219	1%
Pasture	85	19%	26	24%	274	5%	28,975,461	17%
Groves	23	5%	3	3%	114	2%	10,479,747	6%
Nursery	0	0%	0	0%	3	0%	42,000	0%
Row and Field Crops	0	0%	0	0%	1	0%	38,676	0%
Upland Forests	114	25%	16	15%	1,661	31%	27,306,326	16%
TOTAL	458	100%	107	100%	5,448	100%	166,956,184	100%

3.3.10 Pollution Source Inventory

The purpose of this compilation of a point source inventory for the Peace River Basin is to describe the numbers, locations, and discharge capacities of domestic and industrial point sources within the Peace River Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources, as discussed previously.

Wastewater treatment plant discharges for those plants in the Peace River Basin with greater than 1.0 MGD were previously described, using information from the SWFWMD (SWFWMD, 1992). The following discussion utilizes only the FDEP databases.

The Peace River Basin contains 166 domestic point sources and 196 industrial point sources (Figure 3-47). The distribution of these point sources by subbasin, as given later in Tables 3-30 and 3-31, is as follows:

Peace at Bartow - 88 domestic, 73 industrial,
Payne Creek - 4 domestic, 20 industrial,
Peace at Zolfo Springs - 17 domestic, 72 industrial,
Charlie Creek - 5 domestic, 6 industrial,
Peace at Arcadia - 7 domestic, 5 industrial,
Joshua Creek - 8 domestic, 3 industrial,
Horse Creek - 2 domestic, 0 industrial,
Shell Creek - 4 domestic, 6 industrial, and
Lower Peace - 30 domestic, 11 industrial.

The domestic point sources, according to the FDEP database, are distributed through the Peace River Basin with 95 in Polk County, 25 in DeSoto County, 22 in Charlotte County, 17 in Hardee County, three in Highlands County, and one in Manatee County, with three others listed as being in counties not within the Peace River Basin. The distribution of industrial point sources is: 160 in Polk County, 19 in Hardee County, 10 in DeSoto County, four in Charlotte County, one in Sarasota County, one in Glades County, and one assigned to a county not within the Peace River Basin.

Domestic point source discharge capacities are summed for each subbasin, as well as the amount of discharge which goes to reuse. Reuse in this context includes spray fields, percolation ponds, spray irrigation, plant recirculation, absorption fields, drainfields, and drainage ponds. Similarly, industrial point source discharges for each subbasin in the Peace River Basin are determined.

The Peace River at Bartow Subbasin contains domestic facilities with discharge capacities totaling 25.59 MGD. Of this, 0.11 MGD was listed as from plants with effluent utilized for reuse. Most of the facilities do not have a descriptor in the 'Receiving Waterbody' descriptor of the FDEP database, and four of the facilities in the Peace River at Bartow Subbasin do not have discharge capacities listed in the FDEP database (Table 3-30).

Industrial facilities in the Peace River at Bartow Subbasin only have discharge capacities listed for four of the 73 within the subbasin found in the FDEP database. However, 25 of the 73 are listed as having discharge utilized for reuse, with one listed as discharging to sanitary sewer and four as discharging to the Peace River. The remaining 43 industrial facilities in the Peace at Bartow Subbasin do not have a descriptor in the 'Receiving Waterbody' field of the FDEP database.

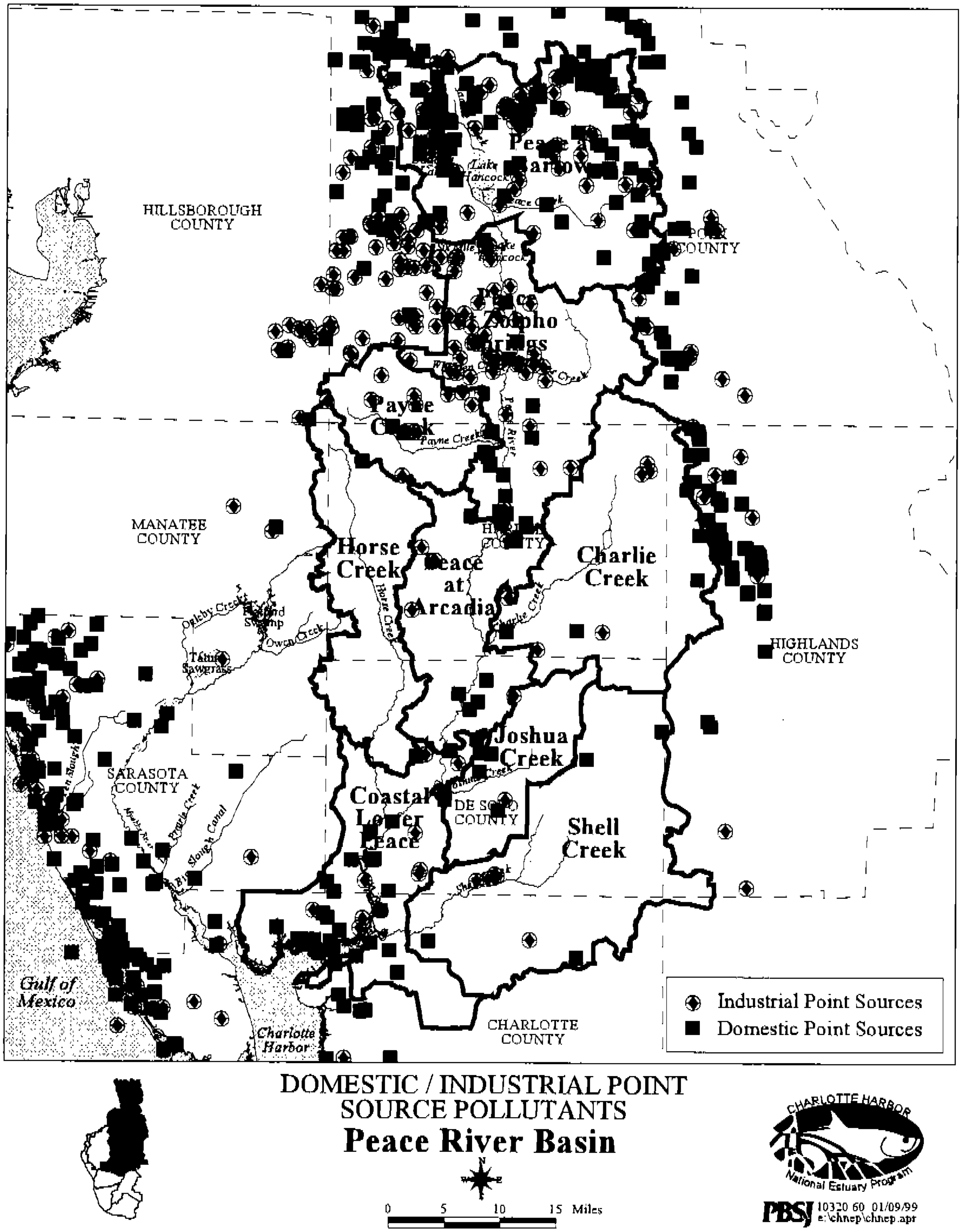


Figure 3-47. Location of industrial and domestic point sources of pollution in the Peace River Basin.

The Payne Creek Subbasin of the Peace River Basin contains domestic facilities with combined total discharge capacities of 0.25 MGD, all of which goes to reuse (Table 3-30). Industrial facilities in this subbasin have no discharge capacities listed in the FDEP database. Two of the facilities are listed with effluent utilized for reuse, and seven others are listed as discharging to Payne Creek. The remaining 11 have no receiving waterbody listed (Table 3-31).

The Peace River at Zolfo Springs Subbasin contains domestic point sources with a combined total discharge capacity of 4,006.75 MGD, mostly from one plant with 4,000 MGD discharge capacity. Of this total, 4,000.18 is for reuse. From the industrial point source database, there is a discharge capacity listed for only one of the plants. Four of the plants have discharge to reuse, and 19 of the facilities discharge to surface waters.

The Charlie Creek Subbasin domestic discharge capacities total 0.29 MGD, with 0.27 of this for reuse. Industrial facilities within the basin have discharge capacity listed for only one of the six in the subbasin, 0.14 MGD. Two of the six plants are listed as having reuse for their discharge.

The Peace River at Arcadia Subbasin has a total domestic discharge capacity of 0.21 MGD, 0.15 MGD of which is for reuse. Industrial point sources only have one discharge capacity listed of the five facilities listed in the basin, with the 0.29 MGD from this facility going to reuse.

The Joshua Creek Subbasin domestic point source discharge capacities total 0.46 MGD, with 0.37 MGD of this for reuse. No industrial point sources are in this subbasin.

In the Horse Creek Subbasin, total domestic point source discharge capacity is 0.03 MGD, with 0.02 MGD of this going to reuse. No industrial point sources are in this subbasin.

The Shell Creek Subbasin has a total domestic point source discharge capacity of 0.62 MGD, and 0.56 MGD of this goes to reuse. The discharge capacity from only one of the industrial point sources in this subbasin is listed, at 0.99 MGD. No receiving waterbody is given for any of the industrial point sources.

The Lower Peace Subbasin contains domestic point sources for which discharge capacities total 17.27 MGD. Total reuse is 15.17 MGD from the domestic point sources. Three of the 11 industrial point sources have discharge capacities listed, totaling 11.67 MGD, with two other facilities sending their discharge for reuse.

Table 3-30. Domestic point sources in the Peace River Basin.			
Facility Name	**County**	**Discharge Capacity (MGD)**	**Receiving Waterbody**
Subbasin: Peace River at Bartow			
AUBURNDALE ALLRED WWTP	Polk	1.4	
WINTER HAVEN #2 CITY OF	Polk	1.7	
LAKE WALES CITY OF NEW PLANT	Polk	1.9	
LAKELAND CITY OF	Polk	10.8	
PALM SHORES MOBILE VILLAGE	Polk	0.02	
MINERVA MHP WWTF	Polk	0.01	Spray field
GRIFFIN ELEMENTARY SCHOOL	Polk	0.01	
HERITAGE PLACE	Polk	0.06	
HERITAGE PLACE	Polk	0.06	
BOSWELL ELEM SCH	Polk	0.01	
COMBEEWOOD WWTP	Polk	0.06	
COMBEE ELEMENTARY SCHOOL	Polk	0.01	
TRAVISS VO-TECH WWTP	Polk	0.04	
OSCAR J POPE ELEMENTARY SCHOOL WWTP	Polk	0.01	
OSCAR J POPE ELEMENTARY SCHOOL WWTP	Polk	0.01	
PADGETT ESTATES	Polk	0.05	
PADGETT ESTATES	Polk	0.05	
WAVERLY WWTP	Polk	0.13	
CENTRAL REGIONAL WWTP	Polk	1.1	
LAKE ALFRED CITY OF	Polk	0.6	
NORTHSIDE WWTP	Polk	4	
ORCHID SPRINGS S/D	Polk	0.1	
GARDEN GROVE WATER CO CYPRESSWOOD	Polk	0.72	
TOWER MANOR MHP	Polk	0.03	
CAMP N AIRE CAMPGROUND	Polk	0.01	
TWIN FOUNTAINS MOBILE CONDOMINIUM S/D	Polk	0.04	
SEMINOLE FER. INC BARTOW CHEM. SE	Polk	0.02	
VILLAGE - LAKELAND THE	Polk	0.1	
SKYVIEW UTILITIES LTD	Polk	0.4	
LEISURE HOMES MHP	Polk	0.01	
ROYAL OAKS MH & TRAVEL RESORT	Polk	0.02	
LAKE MARIANNA ACRES MHP	Polk	0.06	
LAKE MARIANNA ACRES MHP	Polk	0.06	
JOHNS RESORT MOTEL & RESTAURANT	Polk	0.03	
LAKESIDE RANCH ESTATES WWTP	Polk	0.04	

Table 3-30. Domestic point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
COCA COLA FOOD DOMESTIC	Polk	0.03	
WINTER HAVEN MHP	Polk	0.04	
PLANTATION LANDINGS MHP	Polk	0.05	
HIGHLAND CITY PLAZA	Polk	0.02	Percolation Ponds
VANGUARD SCHOOL	Polk	0.03	
LAKE GIBSON ESTATES	Polk	0.1	
WAHNETA MHP	Polk	0.01	
LAKE REGION YACHT & COUNTRY CLUB	Polk	0.01	
SANLAN RANCH CAMPGROUND	Polk	0.06	
EVERGREEN MHP	Polk	0.03	
LAKE REGION MOBILE HOME VILLAGE	Polk	0.08	
BONNY SHORES MHP	Polk	0.03	
LINCOLN PARK MHP	Polk	0.01	
LAKE PARKER MHP	Polk	0.01	
TANGLEWOOD MHP	Polk	0.01	
LAKE BLUE MHP	Polk	0.02	
EATON PARK	Polk	0.02	
ANGLERS COVE WEST	Polk	0.07	
H&H LIQUID SLUDGE COMPOST FACILITY	Polk	.	
DELL LAKE VILLAGE MHP	Polk	0.04	
FOUR LAKES GOLF CLUB	Polk	0.07	Percolation Ponds
TIKI VILLAGE CAMPGROUND	Polk	0.02	
VALENCIA ESTATES MHP WWTP	Polk	0.02	
SUNSHINE REC. INC.(CYPRESS GDNS CG)	Polk	0.02	
PARADISE ISLAND RVP	Polk	0.01	
HOLIDAY TRAV-L-PARK	Polk	0.03	
WEST HAVEN HAMLET	Polk	0.01	
WINTERSET SHORES ESTATES	Polk	0.01	
SWEETWATER WEST	Polk	0.07	
LAKE MARIANNA SHORES	Polk	0.02	
VILLAGE WATER LTD	Polk	0.04	
TOWERWOOD	Polk	0.05	
CAREFREE RV COUNTRY CLUB	Polk	0.08	
TEN ROCKS MHP	Polk	0.01	
CENTRAL LEISURE LAKE MH & RV PARK	Polk	0.02	
ENCHANTED GROVE MH & RV PARK WWTP	Polk	0.02	
GARDEN MOBILE VILLAGE	Polk	0.01	

Table 3-30. Domestic point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
FAIRVIEW VILLAGE	Polk	0.01	
HIGHLAND APARTMENTS	Polk	0.03	
LAKE 'N' GOLF ESTATES	Polk	0.03	
SWISS VILLAGE MHP	Polk	0.14	
SWISS GOLF CLUB	Polk	0.18	
WOODLAND LAKES MHP	Polk	0.04	
ORANGE ACRES RANCH	Polk	0.04	
SANTA FE HIGH SCH	Polk	0.01	
GOOD LIFE RVP	Polk	0.07	
HAPPY DAYS MHP	Polk	0.05	
SWEETWATER EAST	Polk	0.07	
CITRUS RESEARCH CENTER WWTP SYSTEM	Polk	0.01	Percolation Ponds
WILSON ACRES S/D	Polk	0.06	
AUBURNDALE	Polk		Lake Lena Run - Peace River at Bartow
AUBURNDALE, NORTH	Polk		Lake Lena Run - Peace River at Bartow
CITY OF WINTER HAVEN #3	Polk		Spray Irrigation
Subbasin: Payne Creek			
C F INDUSTR. HARDEE PHOS. COMPLEX	Hardee	0	Plant Recirculation
WAGON WHEEL RV PARK	Hardee	0.03	Absorption Fields
HARDEE POWER STATION	Hardee	0.01	Percolation Ponds
HARDEE COUNTY CORRECTIONAL	Hardee	0.21	Spray Irrigation
Subbasin: Peace River at Zolfo Springs			
BOWLING GREEN STP	Hardee	0.32	
WAUCHULA STP	Hardee	1	
PINE CONE MHP	Hardee	0.02	Drainfield
PEACE RIVER HEIGHTS S/D	Hardee	0.04	Percolation Ponds
SOUTHERN OAKS WWTP	Hardee	0.01	Percolation Ponds
LITTLE CHARLIE CREEK RV PARK	Hardee	0.05	
LITTLE CHARLIE CREEK RV PARK	Hardee	0.05	
CRYSTAL LAKE MH & RV VILLAGE	Hardee	0.04	Percolation Ponds
PEACE RIVER RESORT	Hardee	0.03	Percolation Ponds/Spray Irrigation
ORANGE BLOSSOM RVP	Hardee	0.02	Percolation Ponds
FLORIDA SKP CO-OP, INC.	Hardee	0.02	Percolation Ponds
FORT MEADE CITY OF	Polk	1	

Table 3-30. Domestic point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
BARTOW CITY OF MAIN	Polk	4	
N-VIRO FT.MEADE FACILITY	Polk	.	
CARGILL FERTILIZER INC	Polk	4000	Plant Drainage Pond
HAMMOCK LAKE MHP	Polk	0.03	
LEE COUNTY INTERIM LIME STAB. FACIL	Lee	0.12	
Subbasin: Charlie Creek			
ORLANDO VACATION RESORT WWTF	Lake	0.04	Percolation Ponds
BROOKSIDE BLUFF R V RESORT	Hardee	0.05	Percolation Ponds
LAKE GLENADA CAMPING RESORT	Highlands	0.02	Percolation Ponds
HIGHLANDS UTILITY CO.	Highlands	0.16	Percolation Ponds
COUNTRY CLUB OF SEBRING	Highlands	0.02	
Subbasin: Peace River at Arcadia			
ZOLFO SPRINGS	Hardee	0.2	
CRAIGS TT & MP #2	DeSoto	0.04	Percolation Ponds
CROSS CREEK CC/RV RESORT WWTP	DeSoto	0.04	Percolation Ponds
LITTLE WILLIES RV PARK	DeSoto	0.04	Percolation Ponds
CADIA SPRINGS RV PARK	DeSoto	0.04	
BRIARCREST SUBDIVISION	Lee	0.03	Absorption Fields
City of Arcadia	DeSoto		Peace River
Subbasin: Joshua Creek			
NOCATEE ELEM SCH	DeSoto	0.02	Drainfield
SUNRISE MHP	DeSoto	0.02	Percolation Ponds
BIG TREE OF ARCADIA	DeSoto	0.04	Percolation Ponds
ARCADIA VILLAGE #1	DeSoto	0.03	
ARCADIA VILLAGE MHP PHASE II	DeSoto	0.09	Percolation Ponds
HERITAGE PLANTATION R V RESORT	DeSoto	0.04	
EDDIE'S PLANTATION RESTAURANT	DeSoto	0.02	
G PIERCE WOOD MEMORIAL HOSPITAL	DeSoto	0.2	Percolation Ponds
Subbasin: Horse Creek			
DESOTO VILLAGE	DeSoto	0.02	Percolation Ponds
IMC FOUR CORNERS MINE WWTP	Manatee	0.01	
Subbasin: Shell Creek			
DESOTO CORRECTIONAL INSTITUTION	DeSoto	0.5	Spray Irrigation
SUNLAKE TERRACE ESTATES MHP	Polk	0.06	
PARADISE PARK CONDOMINIUM	Charlotte	0.04	Percolation Ponds
SHELL CREEK PARK CAMPGROUND	Charlotte	0.02	Percolation Ponds

Table 3-30. Domestic point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
Subbasin: Lower Peace River			
WILLIAM TYSON WWTP	DeSoto	2	
PUNTA GORDA WASTEWATER MANAGEMENT SYSTEM	Charlotte	3.2	Spray Irr to SW
CHARLOTTE COUNTY UTILITIES-EASTPORT WWTP	Charlotte	10	Percolation Ponds/ Spray Irr/ Well
LETTUCE LAKE CAMPGROUND	DeSoto	0.03	Percolation Ponds
LETTUCE LAKE CAMPGROUND	DeSoto	0.03	Percolation Ponds
OAK HAVEN CAMPGROUND	DeSoto	0.01	Drainfield
OAKVIEW MHP	DeSoto	0.02	Percolation Ponds
KINGSWAY COUNTRY CLUB	DeSoto	0.01	Percolation Ponds
LAKE SUZY UTILITIES	DeSoto	0.05	Percolation Ponds
YOGI BEAR RIVER OAKS RV	DeSoto	0.03	
LIVE OAK R.V. RESORT	DeSoto	0.04	Percolation Ponds
DESOTO START CENTER	DeSoto	0	Spray Irrigation
SILVER LAKES	Polk	0.04	
MEADOW PARK ELEM SCHOOL	Charlotte	0.01	Percolation Ponds
EAST ELEMENTARY SCHOOL	Charlotte	0.01	Percolation Ponds
SOUTH PORT W. W. T. P.	Charlotte	1.2	Percolation Ponds/ Spray Irr
SANDHILL PINES CONDOMINIUM	Charlotte	0.05	Drainfield
WESTCHESTER PARK	Charlotte	0.02	Drainfield
WESTCHESTER WOODS CONDOMINIUMS	Charlotte	0.03	
RIVERS EDGE	Charlotte	0.02	Percolation Ponds
LAZY LAGOON MOBILE PARK	Charlotte	0.02	Drainfield
SEA COVE MOTEL & APTS.	Charlotte	0	Drainfield
PALM & PINES, INC.	Charlotte	0.02	Drainfield
PALMETTO MHP	Charlotte	0.01	Percolation Ponds
HARBOUR INN MOTEL	Charlotte	0.01	Absorption Fields
CHARLOTTE TOWNE APTS	Charlotte	0.01	Drainfield
MARY-LU MOBILE HOME PARK	Charlotte	0.02	Drainfield/Pond
RAMPART UTILITIES	Charlotte	0.31	Percolation Ponds/ Spray Irr
HARBOR VIEW TRAILER PARK	Charlotte	0.02	Percolation Ponds
EDGEWATER MANOR CONDO	Charlotte	0.01	Drainfield
RIVER FOREST VILLAGE	Charlotte	0.04	Percolation Ponds

Table 3-31. Industrial point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
Subbasin: Peace River at Bartow			
FORMER HART MART NO. 6	Polk	.	
MAJIK MARKET #51019	Polk	.	
ARISTECH CHEMICAL CORP	Polk	.	
BARTOW MINIG CORP	Polk	.	
CHALET SUZANNE FOODS INC	Polk	.	Spray field
POLK NURSERY (JERSEY RD FACILITY)	Polk	.	None -Recycled
BUCHANAN INDUSTRIES	Polk	.	
CONSOLIDATED STAINLESS, INC.	Polk	.	Sanitary Sewer
UNIVERSAL FOREST PRODUCTS, INC.	Polk	.	
SUNPURE LTD.	Polk	.	Percolation Pond/Spray Irrigation
CENTRAL PONTIAC	Polk	.	None -Recycled
FRUITBUD JUICE CORPORATION	Polk	.	Flood Irrigation
BRUNGART EQUIPMENT CO., INC.	Polk	.	None -Recycled
RIDGE FERTILIZER	Polk	.	
BROWNING-FERRIS INDUSTRIES	Polk	.	None -Recycled
MACASPHALT A DIV. OF APAC FL, INC	Polk	.	
PARA-MARINE, INC	Polk	.	None -Recycled
EWELL INDUSTRIES,INC.	Polk	.	
PAUL CITRUS INC	Polk	.	None -Recycled
AUBURNDALE POWER PARTNERS, L.P.	Polk	.	None -Recycled
MIRACLE TOYOTA	Polk	.	None -Recycled
MOBIL OIL CORP SS# 02-GNV	Polk	.	
RIDGE GENERATING STATION, L.P.	Polk	.	None -Recycled
FLORIDA BREWERY, INC	Polk	.	
KEMIRON, INC	Polk	.	
FL. CYPRESS GARDENS, INC.	Polk	.	
VIGORO IND.,INC.-KAISER/ESTECH DIV.	Polk	.	
RIDGE VO-TECH FIRE TRAIN. FACILITY	Polk	.	None -Recycled
W.G.ROE & SON,INC.	Polk	.	Percolation Ponds
OAKLEY TRANSPORT, INC.	Polk	.	
MITCO WATER LABORATORIES INC.	Polk	.	
GROWERS FERTILIZER CORPORATION	Polk	.	Retention Pond
FMC CORPORATION	Polk	.	
CUTRALE CITRUS JUICES (FORMERLY COCA COLA)	Polk	2	Spray field

Table 3-31. Industrial point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
INDIAN RIVER TRANSPORT, INC.	Polk	.	Spray Irrigation
RIDGE LUMBER	Polk	.	
CUTRALE CITRUS JUICES (FORMERLY COCA COLA)	Polk	.	
SUNBELT FOREST PRODUCTS	Polk	.	
W.R. GRACE BARTOW BEAR BR #8-E/004	Polk	.	
ARISTECH CHEMICAL CORPORATION	Polk	.	Spray field
B. C. COOK LAKELAND	Polk	.	
BOX USA GROUP, INC.	Polk	0	
LYKES PASCO - LAKE HAMILTON PACKING	Polk	7	Spray field
GOLDEN GEM LAKE GARFIELD	Polk	.	
JUICE BOWL PRODUCTS INC	Polk	.	
HYDROCHEM INDUSTRIAL SERVICES	Polk	.	
ASHTON FOODS - WINTER HAVEN PLANT	Polk	.	Spray field
DUNDEE CITRUS GROWERS ASSOCIATION	Polk	.	
CUTRALE CITRUS JUICES (FORMERLY COCA COLA)	Polk	.	
BORDO CITRUS PRODUCTS, INC.	Polk	.	
MID-FLORIDA FREEZER (AKA ALLSUN PUR	Polk	.	Spray Irrigation
POLK NURSERY COMPANY, INC.	Polk	.	
ARR-MAZ PRODUCTS, INC.	Polk	.	
FLORIDA DISTILLERS CO.-LAKE ALFRED	Polk	.	
LAKELAND MCINTOSH PLANT	Polk	.	
LAKELAND LARSON MEMORIAL PLANT	Polk	.	
FLORIDA DISTILLERS CO.-AUBURNDALE	Polk	2.6	
SFE CITRUS PROCESSORS	Polk	2.1	
U.S. AGRI-CHEMICALS COMPANY: BARTOW CHEMICAL PLANT	Polk	.	
THE WILLIAMS COMPANY, INC-SADDLE CR	Polk	.	
IMC AGRICO SADDLE CREEK MINE #01	Polk		Outfall #01 - Peace River at Bartow
BORDO CITRUS #001	Polk		Spray Irrigation
CARGILL CITRO AM. FROSTPROOF PUMP STATION	Polk		Spray Irrigation
COCA-COLA AUBURNDALE	Polk		Outfall #002 - Peace River at Bartow
FLORIDA DISTILLERS #001	Polk		Percolation Pond, Spray Irrigation

Table 3-31. Industrial point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
FLORIDA DISTILLERS SAMP PT 2 LAKE LENA RUN	Polk		Outfall #002 - Peace River at Bartow
FLORIDA DISTILLERS LAKE HAINES #3	Polk		Outfall #003 - Peace River at Bartow
FLORIDA DISTILLERS LAKE SWOOP	Polk		Percolation Pond
Subbasin: Payne Creek			
GARDINIER INC	Polk	.	
GARDINIER INC	Polk	.	
PAYNE CREEK MINE/AGRICO CHEM CO	Polk	.	
GARDINIER, INC. - FT. MEADE	Polk	.	
CF INDUSTRIES HARDEE COMPLEX II	Hardee	.	
CF INDUSTRIES, INC. HARDEE COMPLEX I, NORTH PASTURE MINE)	Hardee	.	
IMC-AGRICO CO. - FT. GREEN MINE	Polk	.	
IMC-AGRICO CO. - PAYNE CREEK MINE	Polk	.	
CF Industries #003	Hardee		Outfall #003 - Payne Creek
IMC Agrico Chemical, Payne Creek #01	Polk		Outfall #01 - Payne Creek
IMC Agrico Chemical, Ft. Green #002	Polk		Outfall #002 - Payne Creek
IMC Agrico Chemical, Ft. Green #001	Polk		Outfall #001 - Payne Creek
Cargill Payne Creek #001	Polk		Spray Irrigation
CF Industries Payne Creek #001	Polk		Surface Disch., Spray Irrigation
CF Industries Payne Creek #003	Polk		Outfall #003 - Payne Creek
Cargill Ft. Meade Payne Creek #002	Polk		Outfall #02 - Payne Creek
Cargill, Ft. Meade, Bryants #001	Polk		Outfall #001 - Payne Creek
Subbasin: Peace River at Zolfo Springs			
MOBIL CHEM CO	Polk	.	
SWIFT CHEMICAL CO	Polk	.	
SWIFT CHEM CO	Polk	.	
SWIFT CHEMICAL CO SILVER CITY MINE	Polk	.	
MOBIL, FORT MEADE MINE	Polk	.	
MOBIL,FORT MEADE MINE	Polk	.	
ALCOA INC	Polk	.	

Table 3-31. Industrial point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
NORALYN MINE	Polk	.	
GARDINIER INC	Polk	.	
PALMETTO MINE/AGRICO CHEM CO	Polk	.	
TRI-COUNTY FERTILIZER COMPANY INC.	Polk	.	
SHERMAN UTILITY STRUCTURES, INC	Polk	.	
MULBERRY ETHANOL FACILITY	Polk	.	
ORANGE COGENERATION L.P.	Polk	.	
BROWNING - FERRIS INDUSTRIES	Polk	.	None -Recycled
TIGER BAY LIMITED PARTNERSHIP	Polk	.	None -Recycled
MULBERRY COGENERATION FACILITY	Polk	.	
PEMBROKE MATERIALS	Polk	.	Percolation Pond
STEDEM FORD ,INC.	Polk	.	
ESTECH,INC.-WATSON MINE SLURRY LINE	Polk	.	
ESTECH,INC.-WATSON MINE SLURRY LINE	Polk	.	
USS AGRI-CHEM ROCKLAND MCULLOUGH CR	Polk	.	
USS AGRI-CHEM ROCKLAND SETT AREA S7	Polk	.	
ORANGE-CO OF FLORIDA, INC./ BARTOW PLANT	Polk	.	
USS AGRI-CHEM ROCKLAND SETT AREA N9	Polk	.	
KAPLAN INDUSTRIES	Polk	.	
ESTECH,INC.-WATSON MINE SLURRY LINE	Polk	.	
U.S. AGRI-CHEMICALS; ROCKLAND MINE	Polk	.	
ALUMINUM CO. OF AMERICA - FT. MEADE	Polk	.	Sprayfield
KNIGHTS DAIRY	Hardee	.	
ROGER NICKERSON DAIRY	Hardee	.	
COUNTRY CLEAN CAR WASH	Hardee	.	
BOWLING GREEN ENTERPRISE	Hardee	.	
ESTECH, INC. - AGRICOLA PLANT	Polk	.	
CARGILL FERTILIZER INC SOUTH FORT MEADE MINE	Polk	.	
U.S. AGRI-CHEMICALS, INC.: FT. MEADE CHEMICAL PLANT	Polk	.	
BARTOW HOLDING COMPANY, INC. (FORMERLY CITRUS HILL)	Polk	0	
CARGILL FERTILIZER FT.MEADE MINE	Polk	.	
ESTECH, INC. - WATSON MINE	Polk	.	

Table 3-31. Industrial point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
MOBIL MINING & MINERALS COMPANY - FT. MEADE MINE	Polk	.	
IMC-AGRICO COMPANY - NORALYN/PHOSPHORIA/CLEAR SPRINGS MINE	Polk	.	
SFE Citrus Processors #002 (adams)	Polk		Outfall #002 - Peace River at Zolfo Springs
SFE Citrus Processors #001 (adams)	Polk		Outfall #001 - Peace River at Zolfo Springs
Mobile Mining #002	Polk		Outfall #002 - Peace River at Zolfo Springs
Mobile Mining Ft. Meade #003	Polk		Outfall #003 - Peace River at Zolfo Springs
Mobile Mining Ft. Meade 3-w Cut #008	Polk		Outfall #001 - Peace River at Zolfo Springs
Estech Silver City Mine Spillway #004	Polk		Outfall #004 - Peace River at Zolfo Springs
Estech Watson Mine #001	Polk		Outfall #001 - Peace River at Zolfo Springs
Estech Watson Mine #003	Polk		Outfall #003 - Peace River at Zolfo Springs
Estech Watson Mine #004	Polk		Outfall #004 - Peace River at Zolfo Springs
Cargill Whidden Creek #002	Polk		Outfall #002 - Peace River at Zolfo Springs
IMC #002	Polk		Outfall #002 - Peace River at Zolfo Springs
IMC Clear Springs #004	Polk		CS-8 SW flood outfall #004 Peace at Zolfo
US Ag Chem Rockland Mine #006	Polk		Outfall #006 - Peace River at Zolfo Springs
Mobile Mining Ft. Meade #001	Polk		Outfall - PR - Peace River at Zolfo Springs
US Agric Chem Rockland #001	Polk		Outfall #001 - Peace River at Zolfo Springs
US Agric Chem Rockland #007	Polk		Outfall #007 - Peace River at Zolfo Springs
Cargill, Ft. Meade, Zolfo Springs	Polk		Outfall #002 - Peace River at Zolfo Springs
IMC Noralyn #001	Polk		Outfall #001 - Peace River at Zolfo Springs

Table 3-31. Industrial point sources in the Peace River Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
IMC Noralyn #003	Polk		Outfall #003 - Peace River at Zolfo Springs
Subbasin: Charlie Creek			
DARBY BUICK, INC.	Sarasota	.	None -Recycled
V&W FARMS INC	Hardee	.	
CARLTON MELEAR AND SON DAIRY	Hardee	.	
ALL FLORIDA JUICE CORP.	Hardee	.	Spray field
FRED A. SMALL	Hardee	.	
V & W FARMS, INC.	Hardee	0.14	
Subbasin: Peace River at Arcadia			
ONA AGRICULTURAL & RESEARCH & ED.	Hardee	.	
MANCINI PACKING COMPANY	Hardee	0.29	Spray field
FLORIDA FENCE POST CO.	Hardee	.	
NU-GULF INDUSTRIES,INC	Hardee	.	
FARMLAND HYDRO L.P.-HICKORY CK MINE	Hardee	.	
Subbasin: Joshua Creek			
SOUTHWESTERN CATTLE AND PACKING CO	DeSoto	.	
JOHN OLDHAM & SON INC.	DeSoto	.	
Subbasin: Shell Creek			
WOODSON SHELL MINE	DeSoto	.	
QUAVE MINE SITE	DeSoto	.	
DAVIS & SONS SHELL MINE	DeSoto	.	
HERBERT AVE. SHELL MINE	DeSoto	.	
RUDY LIGHTSEY SHELL PIT	DeSoto	.	
CHARLOTTE COUNTY SHELL PIT	Charlotte	0.99	
Subbasin: Lower Peace River			
RUCKS MOOREHAVEN DAIRY	Glades	.	
FL NEUROLOGICAL REHAB INC.,(FINR)	Hardee	.	Evaporation Pond
DESOTO CANNING COMPANY	DeSoto	.	
PEACE RIVER CITRUS PRODUCTS, INC.	DeSoto	.	Spray field
MYAKKA COLD STORAGE	DeSoto	.	
RIVERS EDGE INC	Charlotte	0.02	
CHARLOTTE HARBOR WATER ASSOC	Charlotte	0.15	End of San Moreno Canal
CORONET INDUSTRIES, INC.	Hillsborough	.	
CARGILL FERTILIZER, INC. - BARTOW CHEMICAL PLANT	Polk	.	

4. Charlotte Harbor Proper

This chapter presents a compilation and synthesis of information regarding the Charlotte Harbor Proper Basin portion of the Charlotte Harbor NEP area (Figure 4-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

4.1 Physical Setting

Charlotte Harbor Proper is that portion of the Charlotte Harbor study area which drains directly to the harbor north of Pine Island Sound. The basin includes portions of southern Charlotte County and northwestern Lee county and receives inflow from the Peace and Myakka rivers from the northeast and northwest, respectively. Charlotte Harbor Proper includes the main open water portions of Charlotte Harbor north of Pine Island Sound and Matalacha Pass. The open waters and bays west of Boca Grande Pass along the northern end of Pine Island to the eastern side of the harbor lie along the southern boundary of the basin. The northeast areas of the basin include Gasparilla Sound, Bull Bay, and Turtle Bay at the southern end of Cape Haze. Along the eastern shore major features include Burnt Store, Pirate Harbor, and Alligator Creek.

At its northern end, Charlotte Harbor Proper ends (for the Peace River side) at the line between Punta Gorda and Hog Island used by the USGS to define the mouth of the Peace River. The mouth of the Myakka River and the end of the Harbor Proper (for the Myakka side) is at the north end of Hog Island. During low tributary flows, tidal waters travel several miles upstream into the Peace River, while during high flows, freshwater flows into the harbor, particularly along the west bank between Hog Island and Cape Haze.

4.1.1 Physiography

These sections include physiographic, topographic, geologic, land use, and hydrologic descriptions of the basin.

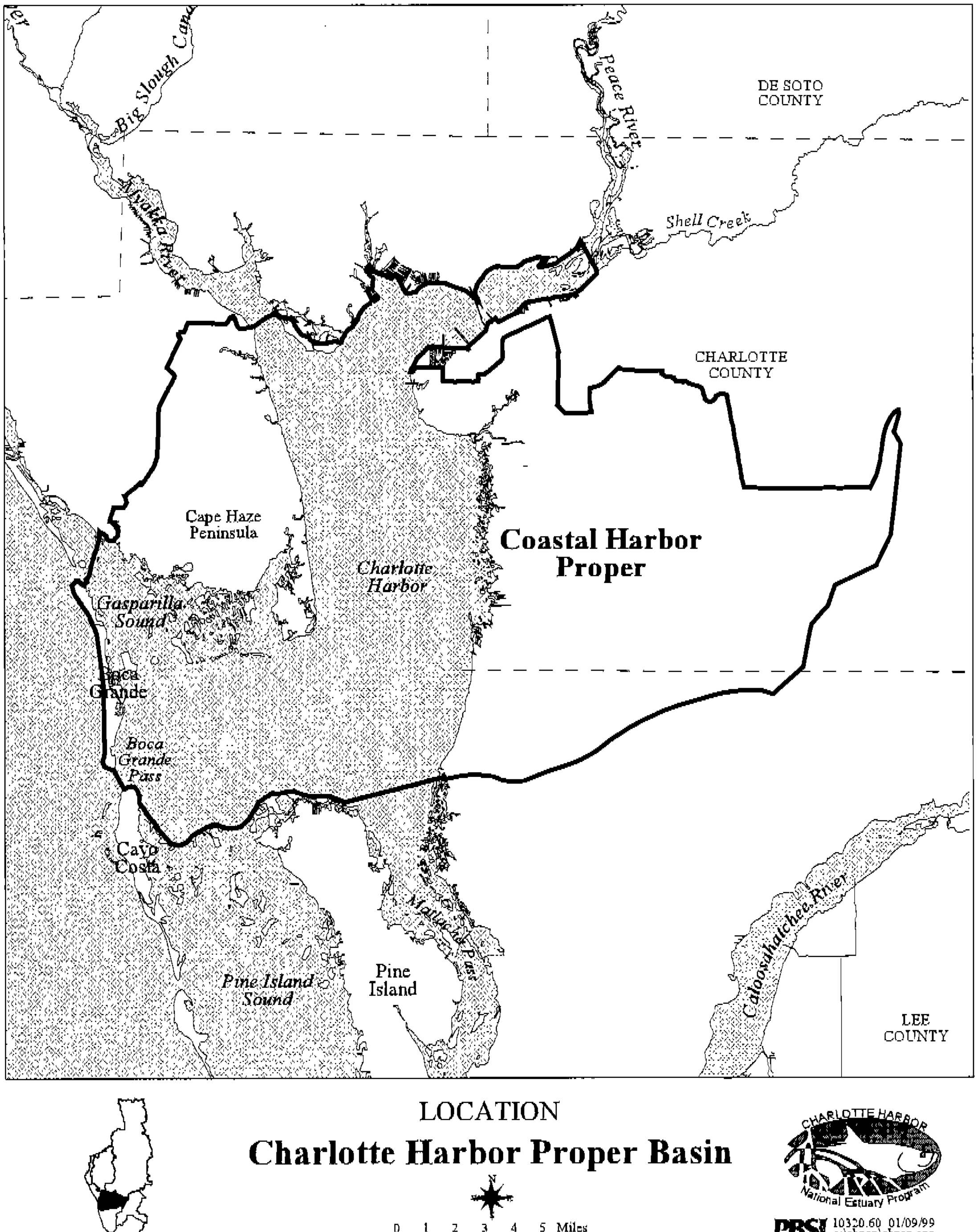


Figure 4-1. Location of Charlotte Harbor Proper Basin in the Charlotte Harbor NEP study area.

4.1.1.1 Topography

Because of its coastal nature, the Charlotte Harbor Basin rises in elevation from the coast west through Charlotte County and a small portion in northeastern Lee County. The area lies entirely within the Pamlico Terrace and less than 25 feet in elevation. The topography near the harbor is low and any changes in elevation are gradual. The City of Punta Gorda on the harbor's northern shore averages about 6 feet in elevation, the 5 foot contour line is only 1,000-1,200 feet upstream of the mouth of the river, and the 10 foot contour is nearly 1.5 miles upstream. Elevations are no higher than 25 feet above MSL in the western portion of the basin.

4.1.1.2 Geology

The Charlotte Harbor system formed approximately 5,000 years ago with the deposition of sediments in a series of deltaic formations over a Miocene limestone bedrock. The extensive mangrove forests along the coast originated following the submergence of low-lying coastal portions during the geologically recent rise in sea level. The Charlotte Harbor Proper Basin lies entirely within the Gulf Coastal Lowlands physiographic province which is generally bounded on the east by uplands and intermittently along the Gulf of Mexico by coastal lagoons and barrier chains. The lowlands are separated from the DeSoto Plain by marine terraces that developed on the south side of the Peace River Valley. The transition from upland to shoreline occurs over a broad, gently southwestward sloping plain composed of depositional sediments of marine origin. These sediments generally parallel the coastline, an arrangement which indicates their marine origin.

The surficial aquifer ranges in thickness from about 25 feet in northern Lee County to 100 feet in northern Charlotte County and Sarasota County near the harbor. The unconfined aquifer is comprised mainly of sand, clay sand, shell, and marl. Fill material with organic material is also found in areas of coastal dredge operations. There is very little, if any, natural aquifer recharge in this basin.

4.1.1.3 Soils

Holocene deposits of mangrove peat up to 15 feet thick overlie Miocene to Pleistocene marine limestones, marls, and sands. The Charlotte Harbor Proper Basin, like the other basins in the Charlotte Harbor NEP study area, are predominantly soils characteristic of flatwoods and sloughs, with some variation in coastal soils. Flatwoods soils include Wabasso-Pineda-Boca, Immokalee-Myakka, and Hallandale-Wabasso-Boca. These soils are nearly level, poorly drained, shallow to deep sandy soils, with loamy subsoils. The Immokalee-Myakka complex has slopes from 0-2%, while the others generally range 0-1%. Hallandale soil associations have limestone within 20 inches of the surface, while Boca soils have limestone within 20-40 inches of the soil surface, and limestone is at least 80 inches below the surface in Pineda soils.

The Charlotte Harbor Proper Basin soils are composed of tidally influenced, poorly drained soils with slopes of 0-1%. The barrier islands are made up of Kesson-Wulfert-Canaveral soil complexes of very poorly to moderately well drained, sandy and mucky soils over marine sands and shells with organics in the Wulfert phase. Coastal and lower riverine soils are Peckish-Estero-Isles soils similar to barrier islands soils, but with greater muck content and more poorly drained over limestone.

There are also some low sandy eastern portions of the watershed along Alligator Creek made up of nearly level, moderately well drained and sandy Orsino-Daytona soils. In addition, artificially created Matlacha soils of shell and limestone fragments occur just interior to the coastal soils around the harbor.

Like the Myakka and Peace river basins, approximately 60% and 30% of the soils are classified as B and D, respectively, in the Charlotte Harbor Proper Basin (Table 4-1, Figure 4-2). Forty-three percent of the basin is in agriculture, and most of the basin soils are classified as B/D, again indicating drainage for agricultural use in many of the soils. Charlotte Harbor Proper exhibited the lowest acreage of well-drained soils when compared with other major basins.

Table 4-1. Hydrologic soil types in the Coastal Harbor Proper Basin.

Soil Type	Acres	%
A	558	0.5
B	75,245	62.9
C	8,514	7.1
D	35,279	29.5
TOTAL	119,596	100.0

4.1.2 Rainfall

Data from twenty-four rain gages were used in calculating rainfall trends for the basin (Figure 4-3). Graphs of total annual precipitation and average monthly precipitation for the Charlotte Harbor Proper Basin are presented in Figure 4-4. Since 1970, minimum average total annual precipitation has ranged from 30 inches in 1990 to a maximum of 80 inches in 1995. The largest rainfall peaks occurred in 1983 and 1995. A summary of rainfall data from this basin is presented in Appendix A.

Average monthly precipitation was highest for the wet season (summer) and lowest in the winter for all the basins. Rainfall was highest from June to September, with a peak of 8.2 inches in June and a minimum of 6.2 inches in September. Average monthly rainfall values were lowest during November (1.4 inches), and average values did not exceed 3 inches through May.

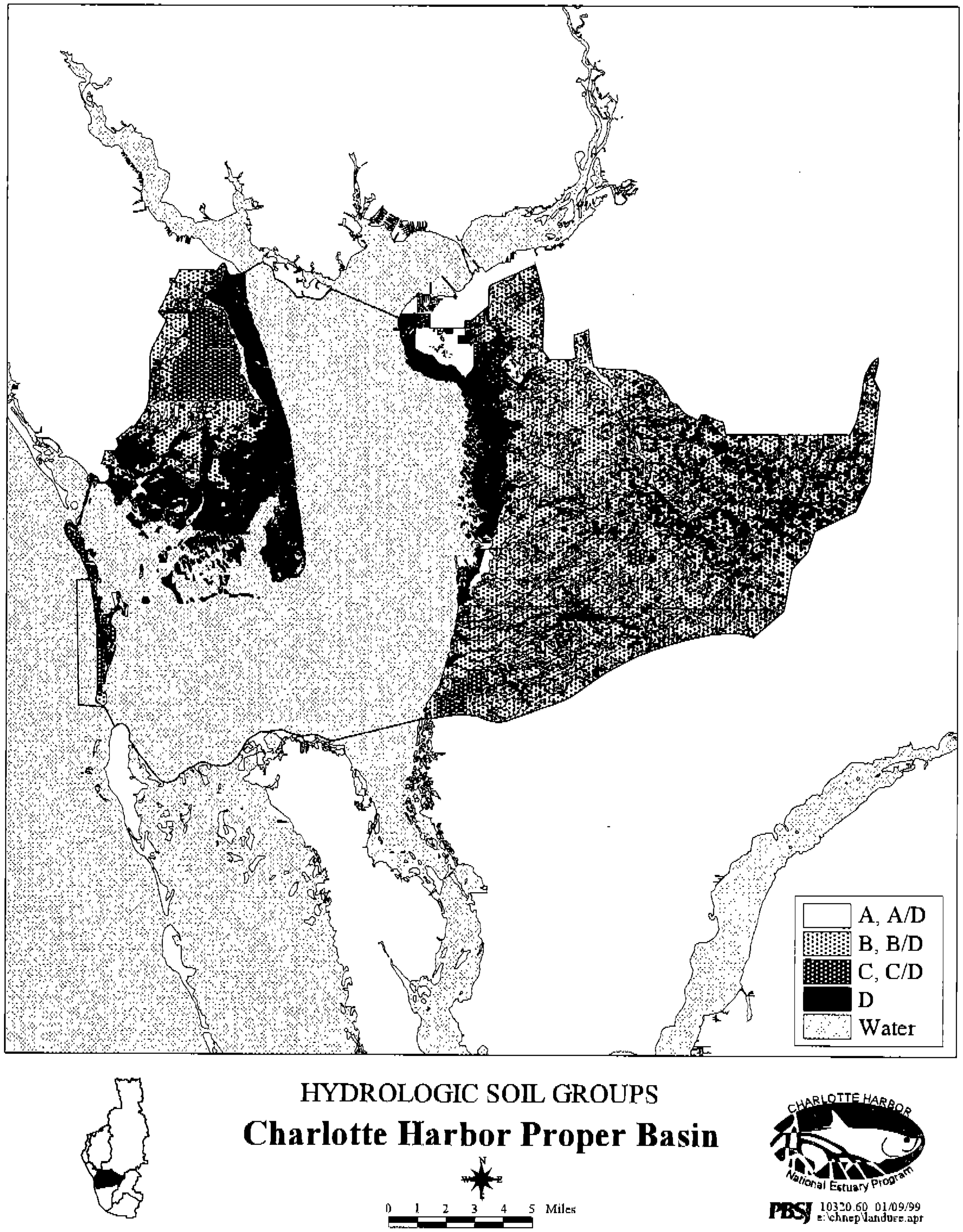


Figure 4-2. Hydrologic soil groups in the Charlotte Harbor Proper Basin.

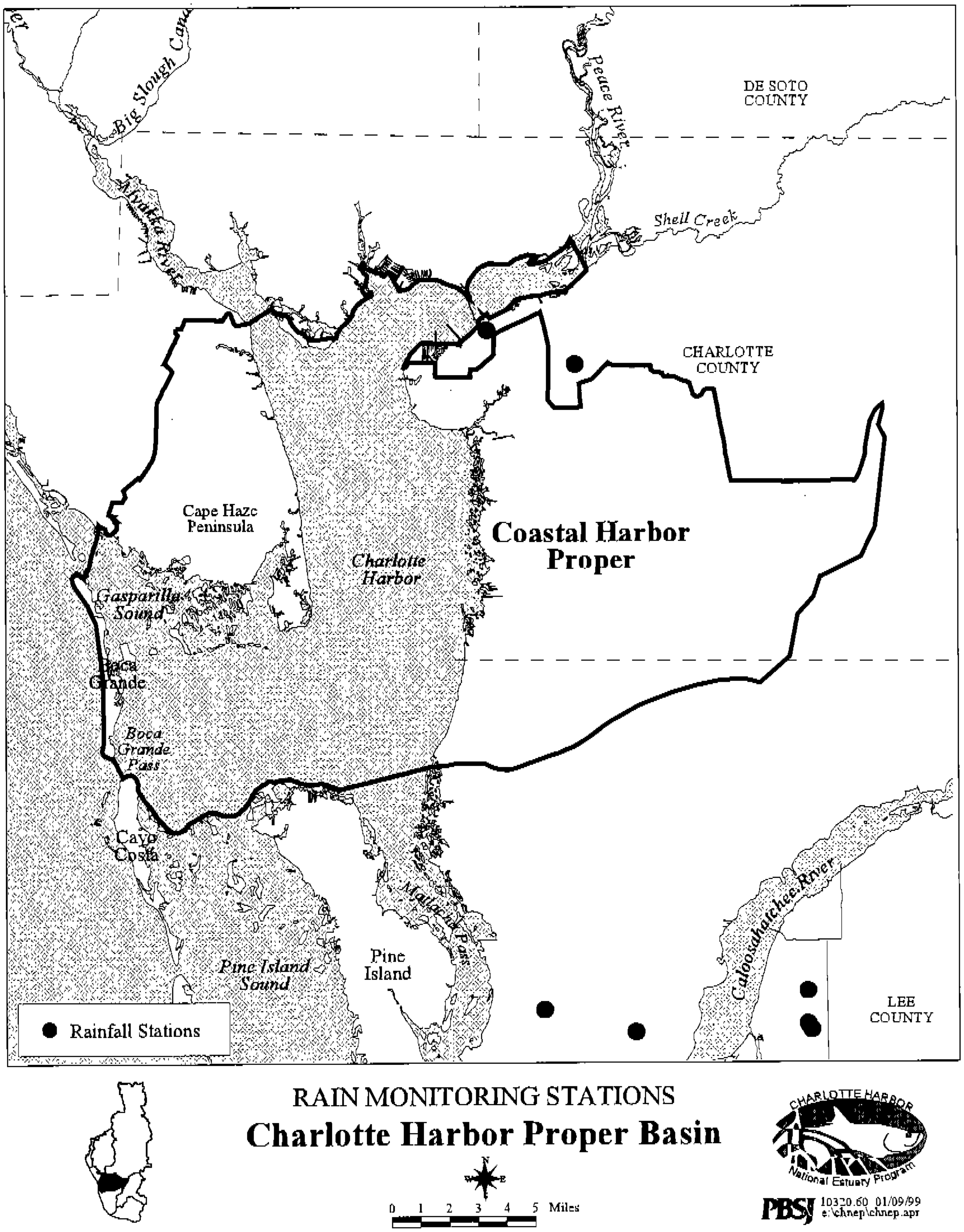
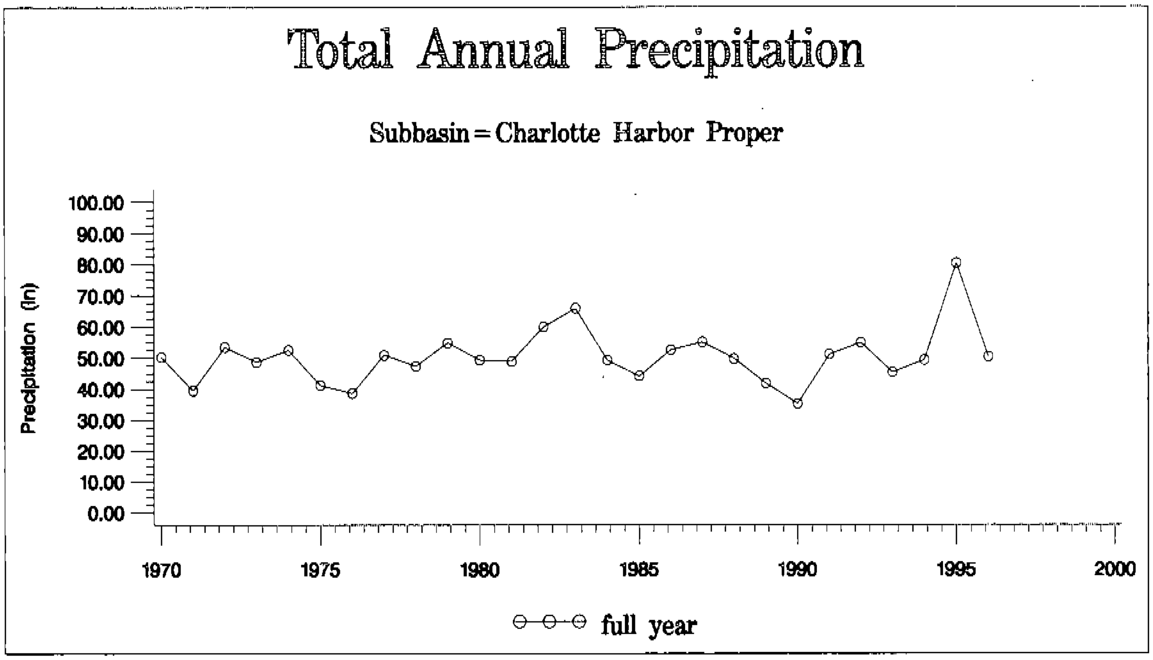


Figure 4-3. Rain station locations in the Charlotte Harbor Proper Basin.



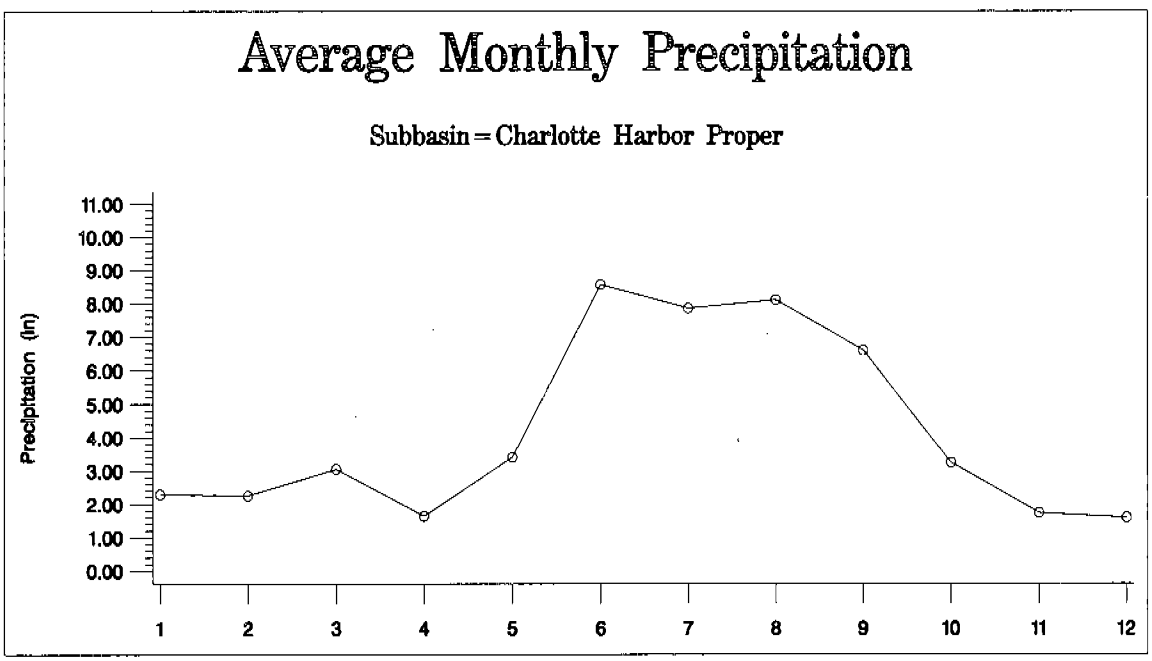


Figure 4-4. Total annual and monthly rainfall plots for the Charlotte Harbor Proper Basin.

4.1.3 Existing and Future Land Use

Land use data were obtained from SWFWMD, SFWMD, and the Southwest Florida Regional Planning Council (SWFRPC). Although other sources of data were available for various portions of the Charlotte Harbor NEP study area, these data sources provide a complete and consistent coverage for the entire study area.

Land use classification systems for existing and future land use GIS coverages for the Charlotte Harbor NEP area are not consistent. Existing Land Use Coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SWFWMD) land use data. Land Use data from SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We assigned new codes which make the SFWMD and SWFWMD land use classification systems comparable for this project.

Future Land Use Coverages for the Charlotte Harbor NEP were developed by Southwest Florida Regional Planning Council (SWFRPC). SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions.

The FLUMs use a different and much simpler land use classification system than either of the existing land use coverages and do not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). As a result, residential areas may increase tremendously under future scenarios because existing development is not taken into account. Direct comparisons between acreages of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category.

4.1.3.1 Existing Land Use

Unlike the Peace and Myakka Basins, where agriculture is the dominant land use, upland forests (19%), non-forested freshwater wetlands (20%), and salt marshes (15%) make up more than half of the land use acreage in the Charlotte Harbor Proper Basin (Table 4-2, Figure 4-5). Agricultural land uses comprise only 13.4% of this basin. Range lands constitute another 16% of the land use in the basin. Although Coastal Harbor Proper Basin is coastal and has a high potential for urban development, it currently includes only 6.9% urban land use.

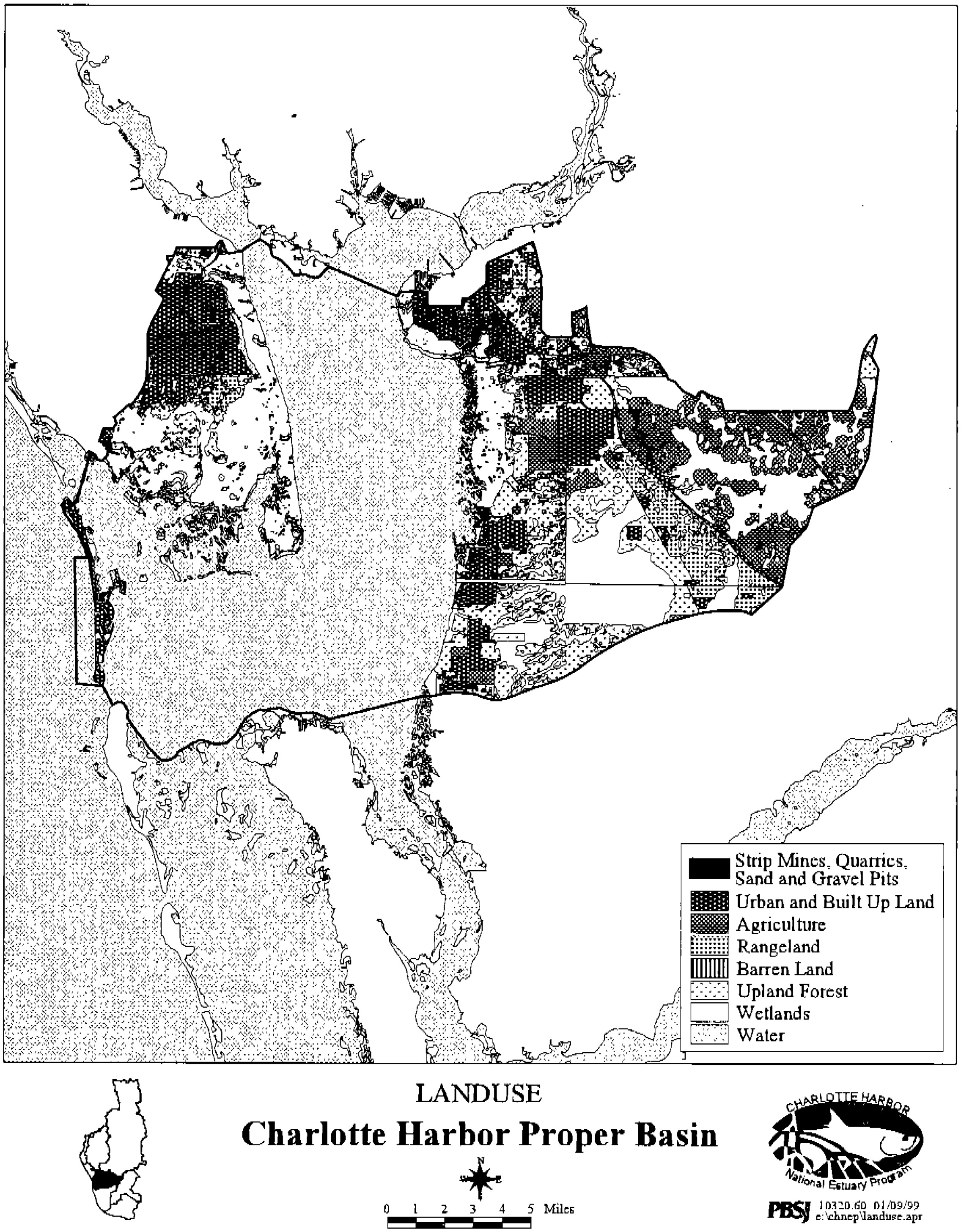


Figure 4-5. Existing land use map (SWFWMD, 1990; SFWMD, 1988) for the Charlotte Harbor Proper Basin.

Table 4-2. Current land use/cover in the Charlotte Harbor Proper Basin.

Land Use/Cover	Acres	%
Single Family Residential	3,305	2.8
Medium Density Residential	1,690	1.4
Multi-family Residential	1,332	1.1
Commercial	312	0.3
Industrial	290	0.2
Mining	333	0.3
Institutional	1,307	1.1
Range Lands	18,943	15.8
Barren Lands	453	0.4
Pasture	14,992	12.5
Groves	961	0.8
Feedlots	0	0.0
Nursery	0	0.0
Row and Field Crops	127	0.1
Upland Forested	23,036	19.3
Freshwater - Open Water	3131	2.6
Saltwater - Open Water	687	0.6
Forested Freshwater Wetland	6,429	5.4
Saltwater Wetland	18,028	15.1
Non-forested Freshwater Wetland	23,557	19.7
Tidal Flats	684	0.6
TOTAL	119,596	100.0

4.1.3.2 Future Land Use

Future projections include 29% urban land use in the Charlotte Harbor Proper Basin, and a small increase in agriculture to 16% (Table 4-3). The most substantial change, under a 100% build-out scenario, is conversion of non-urban and non-agriculture lands (e.g., range) to urban (Figure 4-6).

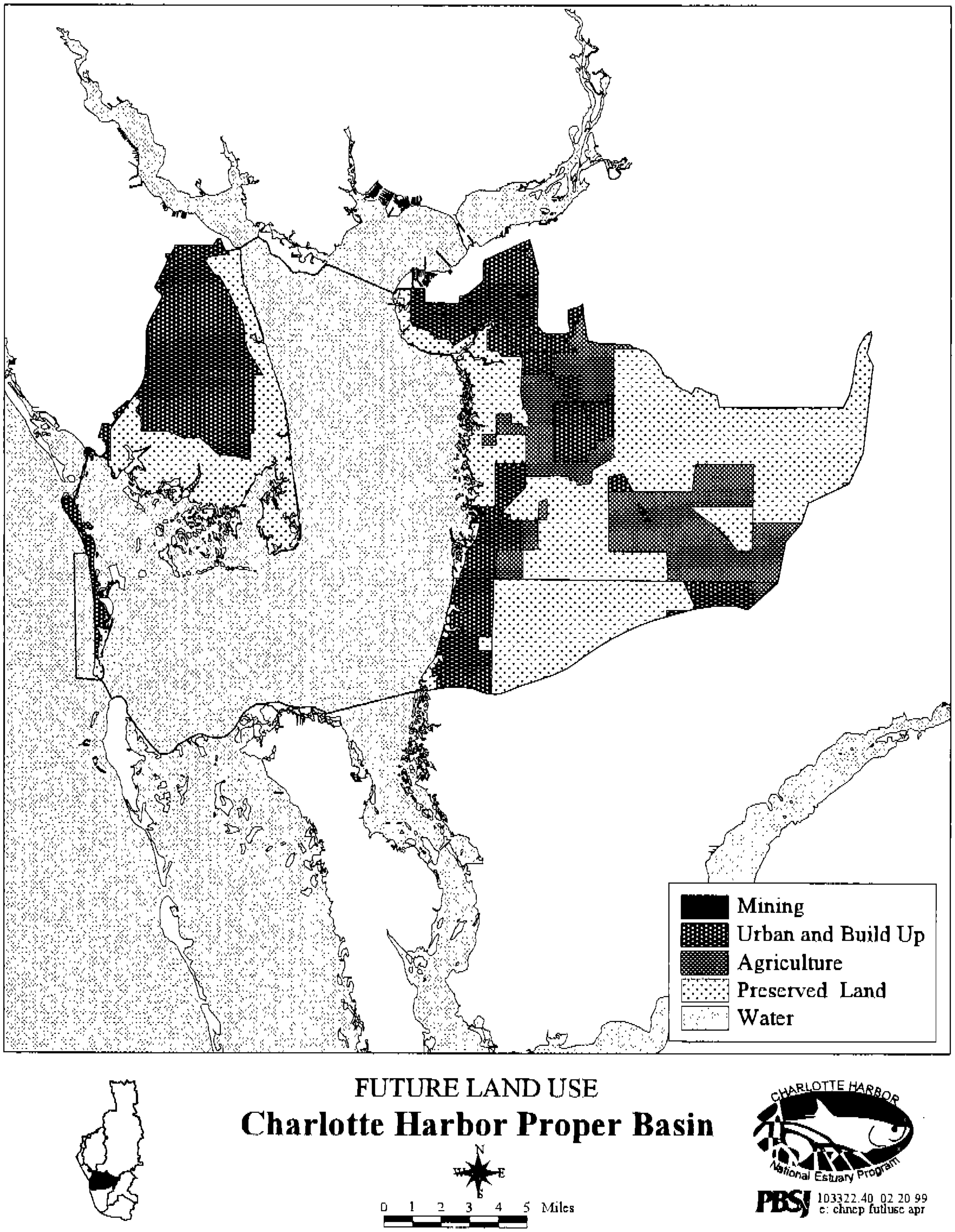


Figure 4-6. Future land use map (SWFRPC, 1990) for the Charlotte Harbor Proper Basin.

Table 4-3. Future land use/cover in the Charlotte Harbor Proper Basin.		
Land Use/Cover	**Acres**	**%**
Single Family Residential	28,674	23.3
Multi-family Residential	2,044	1.7
Rural Residential	829	0.7
Commercial	3,403	2.8
Industrial	1,295	1.1
Mining	0	0
Agricultural	19,533	15.9
Wetlands	0	0
Protected Resource	67,367	54.7
TOTAL	123,167	100

4.1.4 Surface Water Hydrology and Water Management Practices

The following sections describe the surface water hydrology and water management practices within the Charlotte Harbor Proper Basin.

4.1.4.1 Surface Water Hydrology

There are no streamflow gauges in the Coastal Harbor Proper Basin, reflecting the lack of major surface water conveyances outside of the Peace and Myakka rivers. Sheetflow and incident precipitation provide the other major freshwater inputs to this basin.

4.1.4.2 Urban Management Practices

The urbanized areas of the Charlotte Harbor Proper Basin are found along the coast of the harbor. Port Charlotte is on the northern shore, between the mouths of the Peace and Myakka rivers, and is partially within the Charlotte Harbor Proper Basin. Punta Gorda is on the southern bank of the Peace River near its mouth, and is also partially within the basin. Other urbanized areas are found along the western and eastern shores of the harbor, inland of the mangrove areas along the shores. The discussion of urban management practices is divided into urban water uses and urban water discharges, including reuse. The water uses and water discharges are tabulated in the following descriptions.

Water Use

Urban water uses include public water supply, industrial operations, and recreational uses. Discussion of water use is limited to facilities with an average permitted quantity greater than 0.5 MGD. Portions of the Charlotte Harbor Proper Basin lie within both water management districts. All water use information for those parts of the Charlotte Harbor NEP study area within the borders of the SWFWMD is from SWFWMD (1997) and SWFWMD (1992). Water use information for those parts of the Charlotte Harbor NEP study area within the borders of the SFWMD is from SFWMD (1994).

- Public Supply

The urban population of the basin is provided potable water by the City of Punta Gorda plant, Gasparilla Island Water Association, Rotunda West Utilities and Charlotte County Utilities.

- Mining

Mining land use within the Coastal Harbor Proper Basin accounts for only 71 acres of the basin, according to the 1990 SWFWMD and 1988 SFWMD land use coverages. This is only approximately 0.06% of the total area of the basin. Mining land use is found in both the Charlotte County and Lee County portions of the basin. Only one permitted mining venture with greater than 0.5 MGD water use is found in the basin, the Harper Bros., Inc. operation. This operation used 3.69 MGD in 1994, the permitted average withdrawal for the project, with withdrawals from surface waters. The permitted maximum withdrawal for this project is 6.48 MGD (SWFWMD, 1997).

- Industrial

The Coastal Harbor Proper Basin contains only 289 acres of industrial land use, which occupies about 0.2% of the basin. No industrial facilities with water uses greater than 0.5 MGD are found in the basin. However, the 1990 commercial and industrial self-supplied estimated water demand for Lee County was 31.3 MGD (SFWMD, 1994).

- Recreational

Golf courses and landscape (parks, medians, attractions, cemeteries, and other green areas) water use locations are not identified in SWFWMD (1997), so that no basin-specific water use may be associated with these land uses. The document does provide water use by county for golf courses and landscape for that portion of the county within the SWFWMD. Similarly, information on locations of water use within that area of the basin in the SFWMD is not given (SFWMD, 1994), but total water use for golf courses and landscape is given by county.

Within that portion of Charlotte County in the SWFWMD jurisdiction, golf course water use for 1994 was 2.9 MGD, and landscape water use was 0.5 MGD, totaling 3.4 MGD (SWFWMD, 1997). In the Lee County portion of the SFWMD jurisdiction, landscape demand for 1990 was 23.5 MGD, and golf course water use was 17.2 MGD, for a total demand of 40.7 MGD (SFWMD, 1994).

Water Discharge and Reuse

There are two major domestic waste water treatment plants in the Charlotte Harbor Proper Basin. The West Port Charlotte Utilities WWTP discharges to percolation ponds, with some of the effluent going to spray irrigation. The Burnt Store WWTP discharges to percolation ponds.

4.1.4.3 Agricultural Management Practices

Agricultural land use acreages for all major crops for 1990 in Charlotte County are shown in Table 4-4, as well as estimates of irrigated acreages for each of these crops and estimated water use. Lee County estimates for 1990 agricultural land use, irrigation type, and estimated water use are shown in Table 4-5 below (SFWMD, Vol. III, 1994). The portion of the Charlotte Harbor Proper Basin within Charlotte and Lee counties include approximately 101,000 acres and approximately 18,000 acres, respectively.

Table 4-4. 1990 estimated crop acreages, irrigation types, and water use in Charlotte County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Row/Field Crops	1,500	Seepage	1,500	4.4
Citrus	10,500	Low Volume Seepage	8,925 1,050	13.6
Nursery	215	Overhead	215	1.4
Sod	1,200	Seepage	1,200	2.9
Irrigated Pasture	150	Seepage	150	0.3
Totals	13,565	Overhead Low Volume Seepage	215 8,925 3,900	22.6

Table 4-5. 1990 estimated crop acreages, irrigation types, and water use in Lee County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Citrus	9,692	Overhead Seepage	4,846 4,846	28.5
Tropical Fruit	1,680	Seepage	1,512	4.8
Vegetables	9,785	Seepage	9,785	23.0
Nursery	606	Overhead	606	2.8
Sod	650	Seepage	650	3.0
Pasture	118,000	Cattle Watering		0.2
Totals	140,413	Overhead Seepage	5,452 16,793	62.3

4.2 Water Quality Conditions

Current and previous water quality data gathered in the Charlotte Harbor Proper are presented and examined in this section.

4.2.1 Data Sources

Data from two sources were used to examine current and long-term water quality in the Charlotte Harbor. These sources include:

- historic EQL long-term monthly data collected between 1975 and 1996, and
- data which have been gathered since 1992 by the SWFWMD at a series of locations previously sampled during the mid 1980's by the USGS.

The locations of these water quality monitoring sites are indicated in Figure 4-7.

4.2.2 Data Analysis

The EQL and SWFWMD monitoring data were typically collected on a monthly basis. The data analysis approach included:

- visual examination of time series plots of monthly mean values, and

- more formal statistical tests for significance of trends in mean annual water quality conditions employing methods developed by Coastal Environmental (1996) for the Florida Department of Environmental Protection. The procedure uses seasonally weighted yearly averages. Depending on the observed distribution of the sampling frequency, the procedure examines for either trends over the entire sampling period or differences between periods within the data record, depending upon the continuity and length of the data record. A detailed description of the methodology used for defining trends is contained in Appendix C.

4.2.2.1 EQL Data

The following describes the current and long-term water quality conditions by constituent. Figures 4-8 and 4-9 present mean monthly water quality data collected in Upper Charlotte Harbor by EQL. Summary results of statistical test for long-term trends for each of these constituents are presented in Table 4-6. Other data collected in lower portions of Charlotte Harbor Proper in the late 1970's and early 1980's are presented in Appendix C.

Conductivity clearly declines during high flow conditions. Not unexpectedly, the data demonstrate that the magnitude of and duration of these events are much greater in the upper than in the lower harbor areas. This same pattern is also evident with regard to stratification. However, during very high flow conditions, such as occurred in 1979, vertical salinity gradients can be found throughout the area, including the southern areas around Boca Grande. There was a statistically significant decline in mean annual conductivity (Table 4-6). Other statistically significant declines were detected in turbidity, and dissolved inorganic and total phosphorus concentrations, reflecting the declines observed in the Peace River over the same time period.

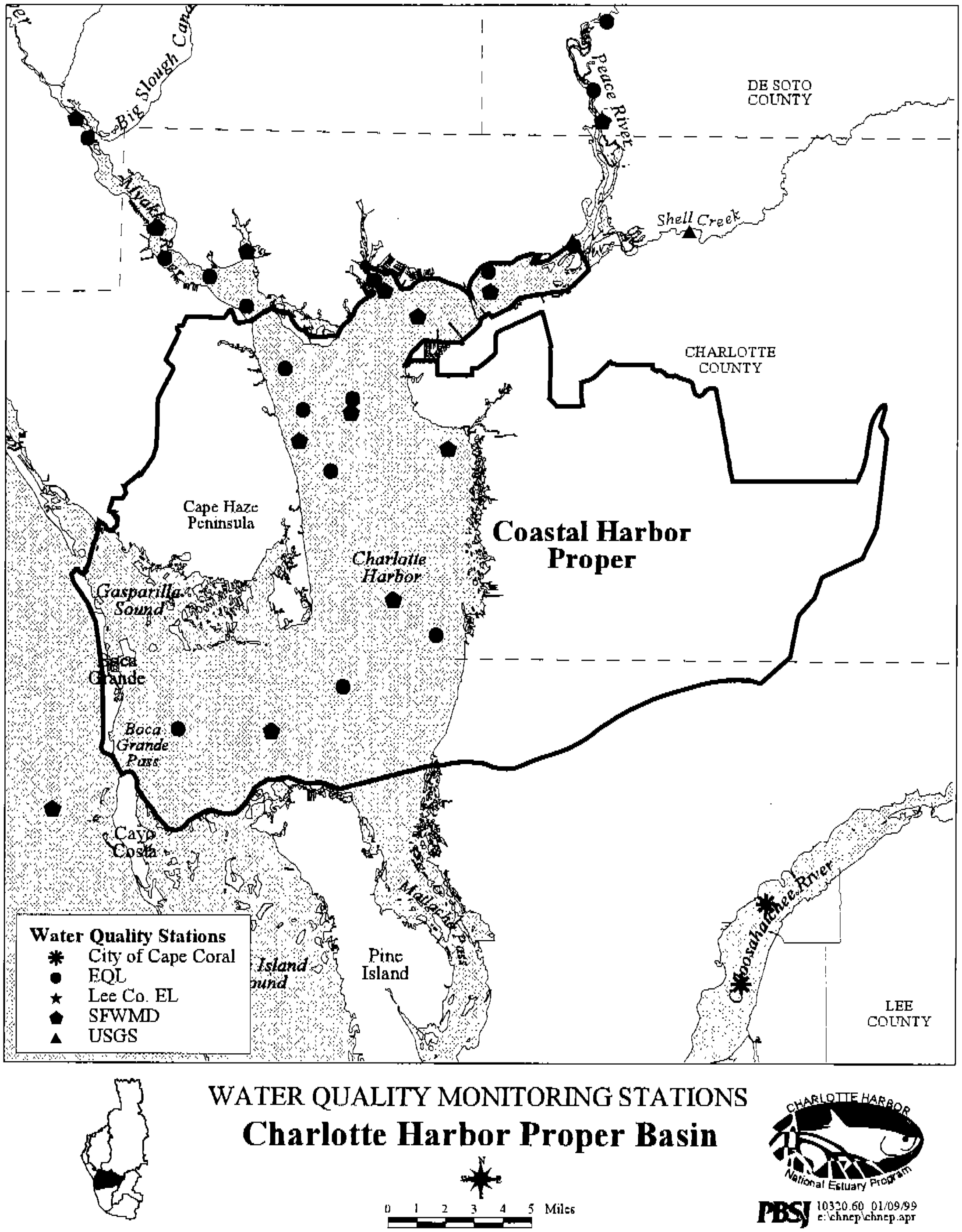


Figure 4-7. Location of water quality sampling sites in the Charlotte Harbor Proper Basin.

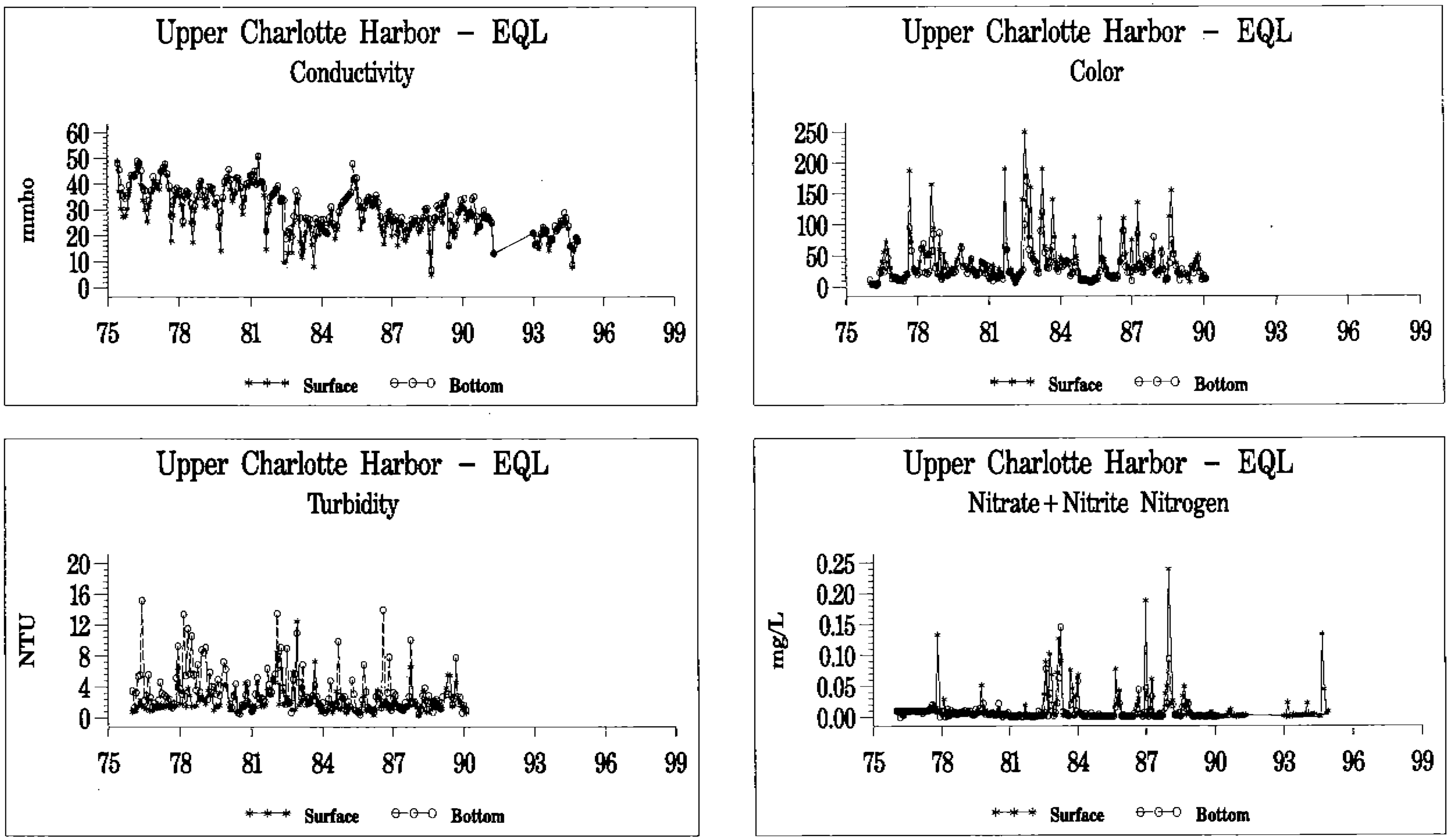


Figure 4-8. Time series graphs of water quality constituents measured in the Charlotte Harbor Proper Basin (EQL stations).

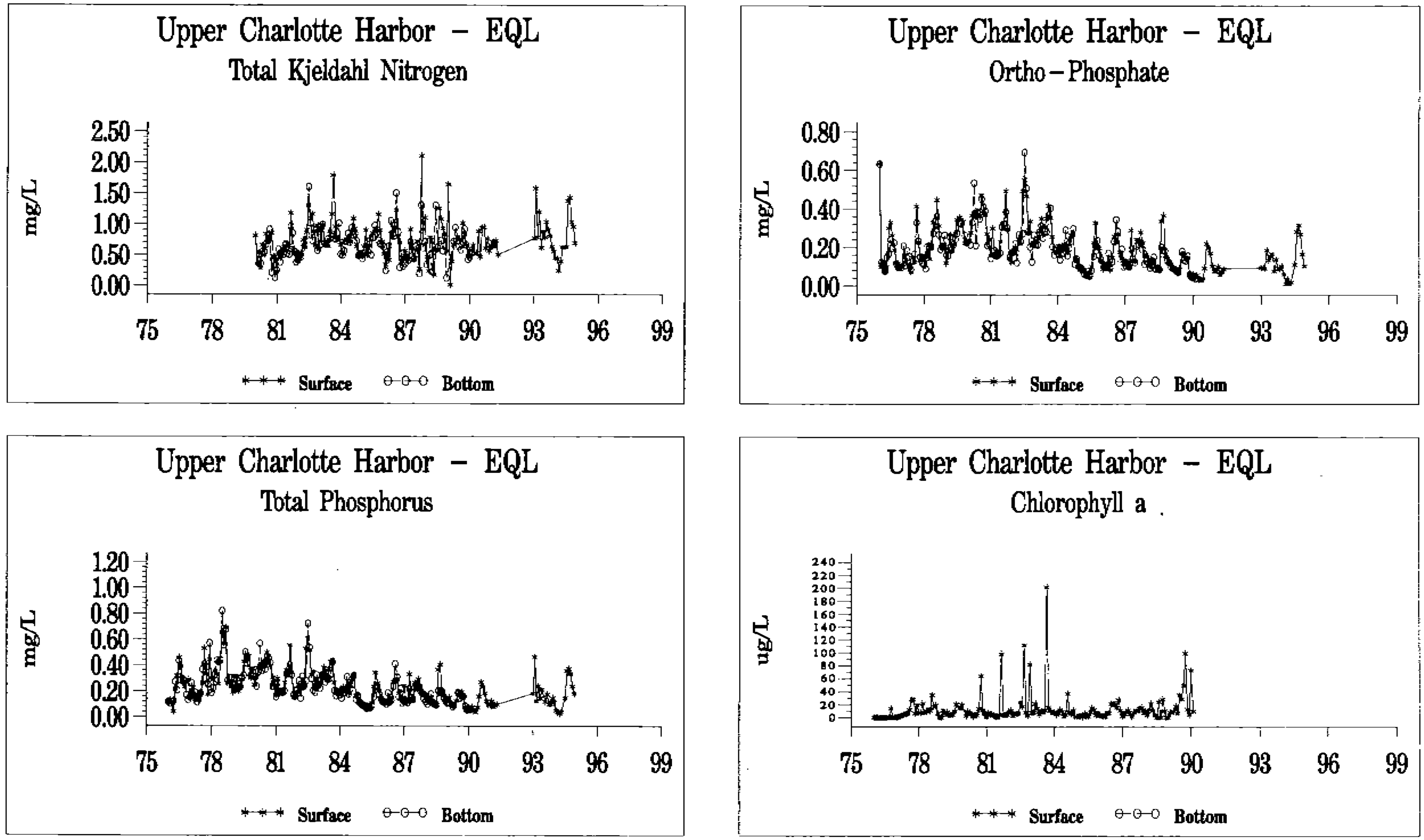


Figure 4-9. Time series graphs of water quality constituents measured in upper Charlotte Harbor Proper (EQL stations).

Table 4-6. Summary of trend tests computed for water quality data from Charlotte Harbor Proper. ▲ - indicates increasing trend ($p < 0.05$); ▼ - indicates decreasing trend ($p < 0.05$); NS - indicates no significant trend; ID - insufficient data to detect trend.

Water Quality Constituent	Trend Test Result
Conductivity (mmhos/cm)	▼
Color (Pt-Co units)	NS
Turbidity (NTU)	▼
Nitrate-nitrite Nitrogen (mg/L)	NS
Total Kjeldahl Nitrogen (mg/L)	NS
Ortho-phosphate (mg/L)	▼
Total Phosphorus (mg/L)	▼
Chlorophyll *a* (μg/L)	NS

4.2.2.2 SWFWMD Data

Figures 4-10 and 4-11 present mean monthly water quality data collected in Upper Charlotte Harbor between 1992 and 1996. Data collected in the lower portions of the harbor are included in Appendix C.

The recent data collected by SWFWMD agree very well with those collected by EQL in the Upper Charlotte Harbor area. In particular, the nitrogen, phosphorus, and chlorophyll concentrations are very similar in the two data records.

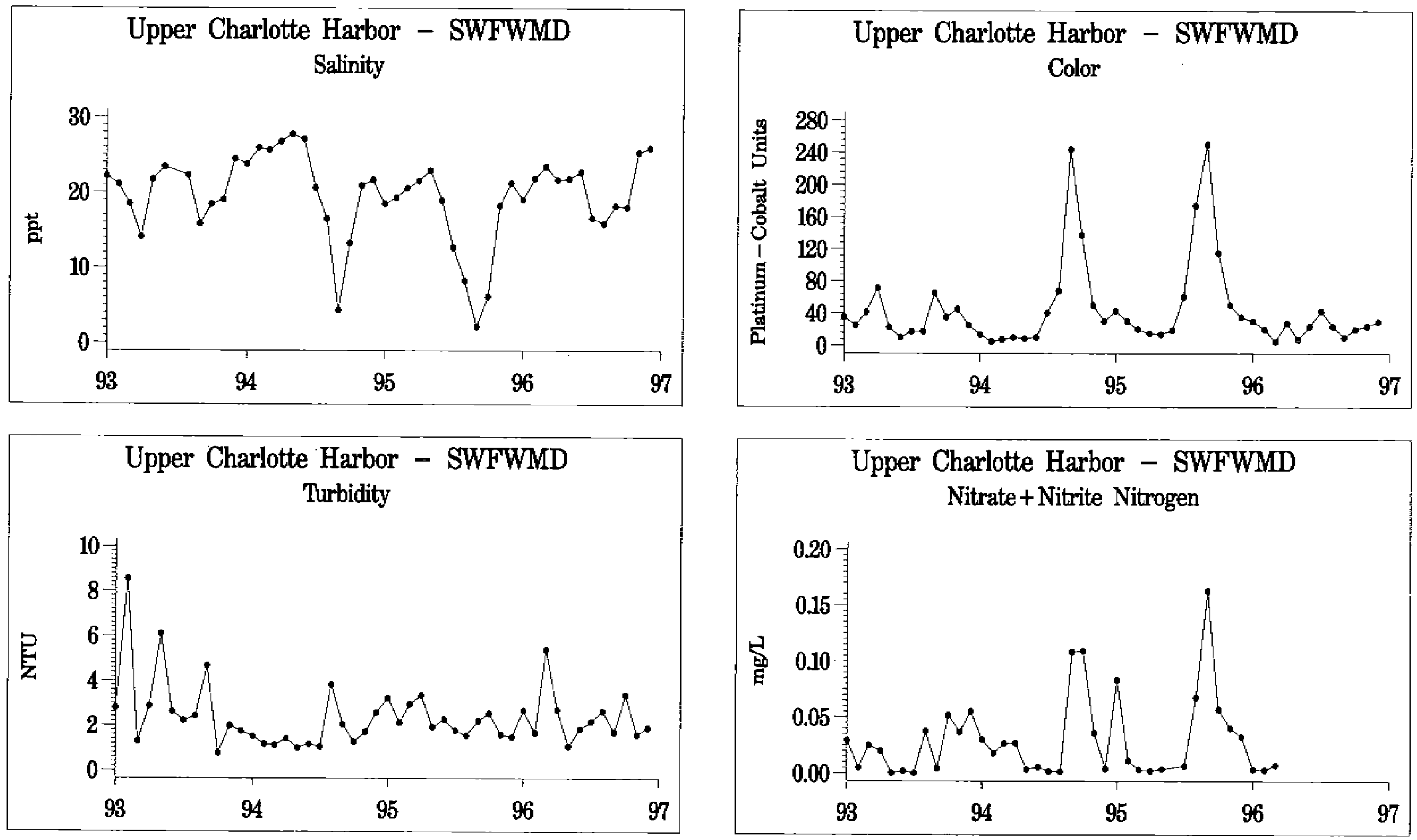


Figure 4-10. Time series graphs of water quality constituents measured in the Charlotte Harbor Proper Basin (SWFWMD stations).

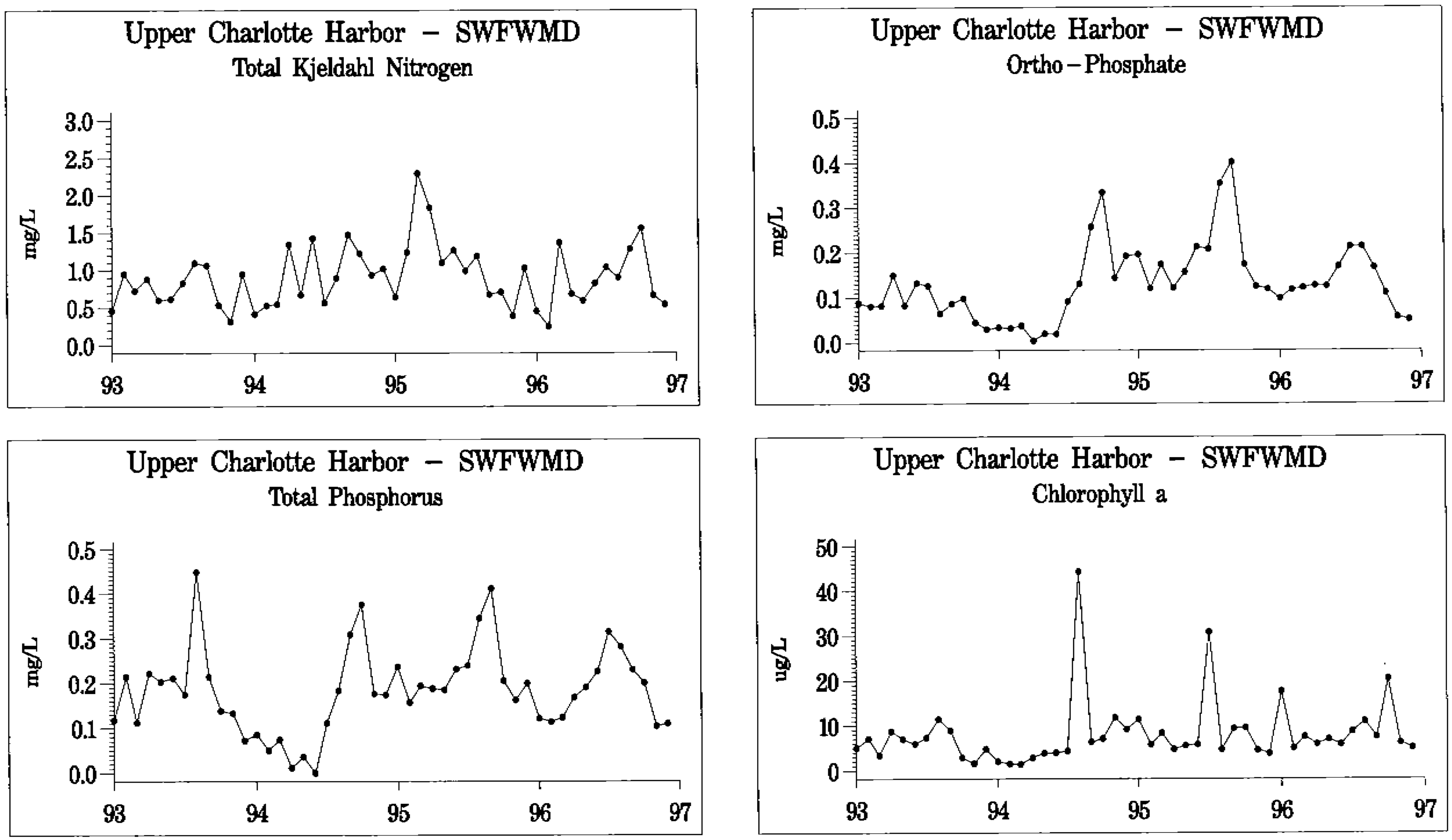


Figure 4-11. Time series graphs of water quality constituents measured in the Charlotte Harbor Proper Basin (SWFWMD stations).

4.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) were estimated for each subbasin by calculating nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to assign priority to major basins and subbasins. Thus, the method development was focused on estimating relative loads in a consistent manner among major basins and subbasins to avoid biasing the major basin and subbasin evaluation. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

The detailed rainfall, 1988 SFWMD land cover, SWFWMD 1990 land cover, and USDA soil data were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow was used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a basin or subbasin. Loadings were computed using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TN, TP and TSS loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, feedlots, row and field crops, and nursery. Undeveloped land uses were defined as range lands, barren lands, and upland forests.

4.3.1 Loading to the Charlotte Harbor Proper Basin

The total estimated annual runoff discharge for the Coastal Harbor Proper Basin was 80 million cubic meters. The estimated annual pollutant loads were 244 tons of TN, 63 tons of TP, and

2,719 tons of TSS. The total contributing area of the subbasin was 67,081 acres, and extended on both sides of Charlotte Harbor Proper.

The nonpoint source loads from this subbasin were primarily from undeveloped land uses. In total, the 42,000 acres of undeveloped land were estimated to have contributed 45 million cubic meters of runoff, 158 tons of TN, 43 tons of TP, and 1,739 tons of TSS. Table 4-7 presents the loads from runoff for this basin by land use. The undeveloped contributing uplands of this subbasin were primarily reported to be forest and rangeland.

Developed urban and agricultural lands were a lesser component of the nonpoint sources for runoff. The 16,000 acres of agricultural lands contributed 17 million cubic feet of runoff, 48 tons of TN, 14 tons of TP, and 165 tons of TSS per year. Most of the agricultural lands were reported to be pasture. The 8,000 acres of urban lands contributed 19 million cubic meters of runoff, 38 tons of TN, 6 tons of TP, and 814 tons of TSS per year. Most of the urban lands were reported to be residential.

Table 4-7. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Charlotte Harbor Proper Basin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	9	4%	1	2%	88	3%	4,411,046	6%
Medium Density Residential	8	3%	1	2%	125	5%	3,354,459	4%
High Density Residential	9	4%	2	3%	272	10%	3,825,866	5%
Commercial	3	1%	0	1%	106	4%	1,308,885	2%
Industrial	2	1%	0	1%	125	5%	1,210,539	2%
Mining	2	1%	0	0%	53	2%	958,046	1%
Institutional, Transport., Util.	5	2%	0	1%	45	2%	3,677,554	5%
Range Lands	58	24%	29	46%	291	11%	20,184,161	25%
Barren Lands	2	1%	0	0%	15	1%	1,380,073	2%
Pasture	45	19%	14	22%	147	5%	15,541,163	19%
Groves	2	1%	0	1%	10	0%	956,383	1%
Row and Field Crops	1	0%	0	1%	8	0%	208,986	0%
Upland Forests	98	40%	14	22%	1,433	53%	23,556,872	29%
TOTAL	244	100%	63	100%	2,719	100%	80,574,034	100%

4.3.2 Pollution Source Inventory

The purpose of this compilation of a point source inventory for the Charlotte Harbor Proper Basin is to describe the numbers, locations, and discharge capacities of domestic and industrial point sources within the Charlotte Harbor Proper Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources, as discussed previously.

Wastewater treatment plant discharges for those plants in the Charlotte Harbor Proper Basin with greater than 1.0 MGD within the SWFWMD were previously described, using information from the SWFWMD (SWFWMD, 1992), and those with greater than 0.5 MGD in the SFWMD (SFWMD, 1994). The following discussion uses only the FDEP databases, as previously described.

The FDEP databases list 14 domestic point sources and eight industrial point sources within the basin (Tables 4-8 and 4-9) (Figure 4-12). Two of the domestic point sources are in Lee County, and the remaining 12 are in Charlotte County. Two of the industrial point sources are also in Lee County, with the other six in Charlotte County.

Domestic point sources discharge capacities total 1.78 MGD, with 1.65 MGD of this sent to reuse. Two of the eight industrial point sources have no discharge capacities listed, with the others having a total discharge capacity of 0.32 MGD. Reuse accommodates 0.02 MGD of this, with another 0.04 MGD discharged to Alligator Creek.

Table 4-8. Domestic point sources in the Charlotte Harbor Proper Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
FAIRWAY WOODLANDS	Charlotte	0.13	Spray Irrigation
GULFVIEW RESORT	Charlotte	0.02	Percolation Ponds
BAY PALMS MOBILE HOME PARK	Charlotte	0.01	Percolation Ponds
TROPICAL PALMS OF FT MYERS LTD MHP	Charlotte	0.06	Percolation Ponds
CHARLOTTE BAY RESORT AND CLUB	Charlotte	0.02	Drainfield
CASA DEL MAR ESTATES MHP	Charlotte	0.1	Percolation Ponds
BURNT STORE WWTF	Charlotte	0.25	Percolation Ponds
BURNT STORE COLONY MOBILE HOME PARK	Charlotte	0.06	Drainfield
GASPARILLA MOBILE ESTATES	Charlotte	0.03	Percolation Ponds
SUN-N-SHADE FAMILY CAMPGROUND	Charlotte	0.02	Percolation/Drainfield
ALLIGATOR UTILITIES	Charlotte	0.06	Drainfield
ROTUNDA WEST UTILITIES CORP.	Charlotte	0.5	West Branch of Coral Creek
CHARLOTTE CORRECTIONAL INSTITUTION	Charlotte	0.18	Percolation Ponds
DEL VERA S.T.P.	Lee	0.13	
GASPARILLA IS WATER/DOMESTIC/ DIW	Lee	0.71	Spray Irrigation/ Well

Table 4-9. Industrial Point Sources in the Charlotte Harbor Proper Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
ROTONDA SPRINGS SHELL PIT	Charlotte		
HARBOR BRANCH OCEANOGRAPHIC INSTITUTE, INC.	Lee		
SOUTHERN STATES UTILITIES - BURNT STORE R/O	Charlotte	0.16	
SUNSET REALTY AQUACULTURE	Lee	0.1	
ALLIGATOR MOBILE HOME PARK	Charlotte	0.04	Alligator Creek
BURNT STORE COLONY - R/O PLANT	Charlotte	0.01	Drainfield
CASA DEL MAR MHP	Charlotte	0.01	Percolation Ponds
ZEMEL ROAD LANDFILL (CHARLOTTE COUNTY)	Charlotte	0	

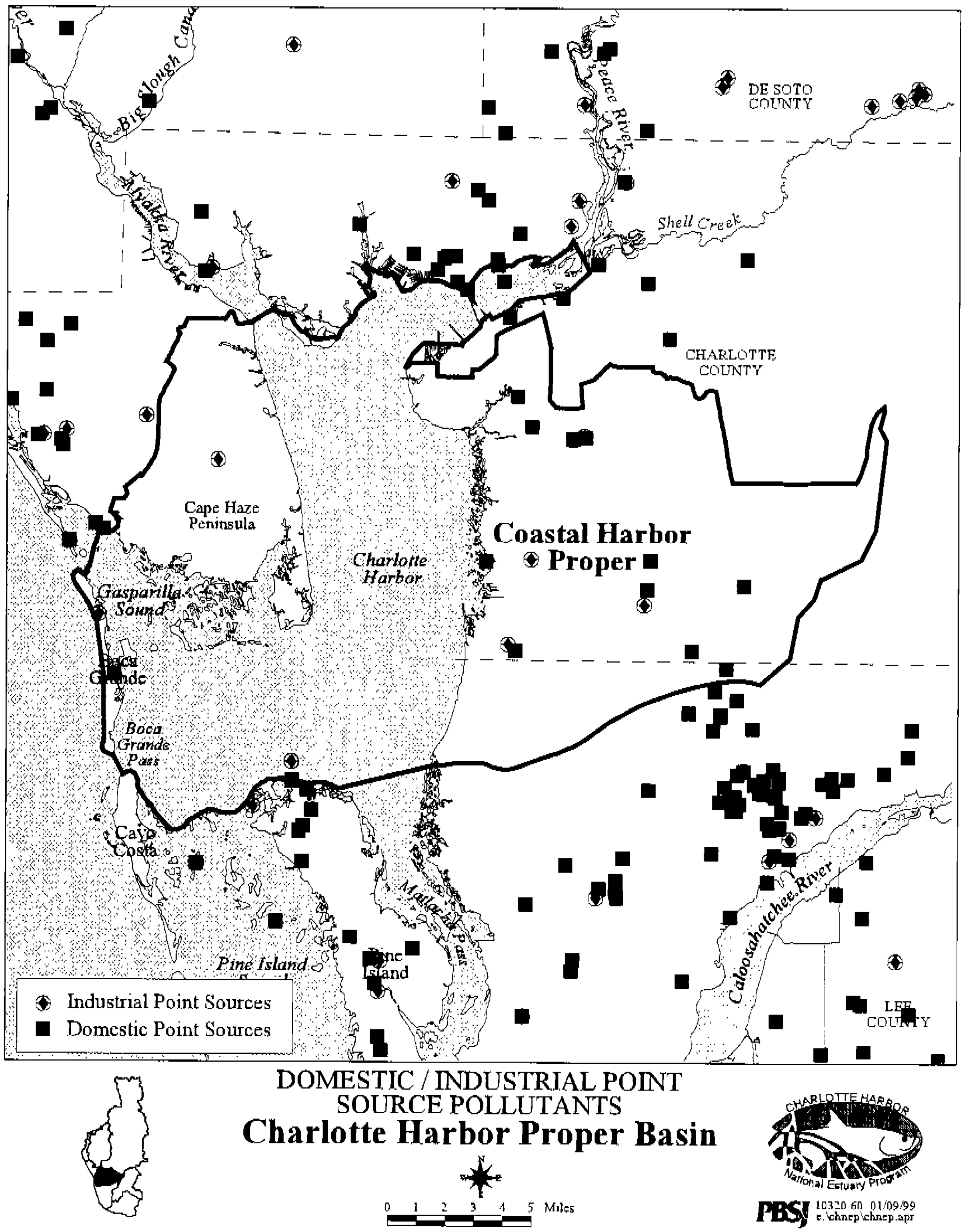


Figure 4-12. Location of domestic and industrial point sources in the Charlotte Harbor Proper Basin.

5. Lemon Bay Basin

This chapter presents a compilation and synthesis of information regarding the Lemon Bay Basin portion of the Charlotte Harbor NEP area (Figure 5-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

5.1 Physical Setting

The Lemon Bay Basin covers part of the northwestern portion of Charlotte County and stretches into the southwestern corner of Sarasota County, along the Gulf coast west of the Myakka River and Upper Charlotte Harbor. Several small creeks discharge to Lemon Bay, including Alligator Creek, Forked Creek, Gottfried Creek, Rock Creek, Oyster Creek, and Buck Creek. A small portion of the Lemon Bay Basin is drained to Gasparilla Sound by the east and west branches of Coral Creek. Just north of Gasparilla Sound, and drained by the West Branch of Coral Creek, is a large urban development, the Rotonda development. Northwest of this development along the shores of Lemon Bay lies Grove City, and Englewood is farther northwest, on the Charlotte/Sarasota county line.

5.1.1 Physiography

This section describes the topography, geology, soils, and land use in the Lemon Bay Basin.

5.1.1.1 Topography

Lemon Bay Basin elevations range from mean seal level along the Gulf coast and lower reaches of the Myakka River to a maximum of about 25 feet. On both the mainland and barrier islands, elevations are low, averaging about 7 feet above MSL with a maximum of less than 20 feet. Slopes are gentle throughout the adjacent land areas, even at the headwaters of the eastern tributary creeks. Slopes and elevations are lowest to the south, along Cape Haze and the mouth of Lemon Bay. Artificial alterations to natural shorelines and drainage patterns have been made through dredging

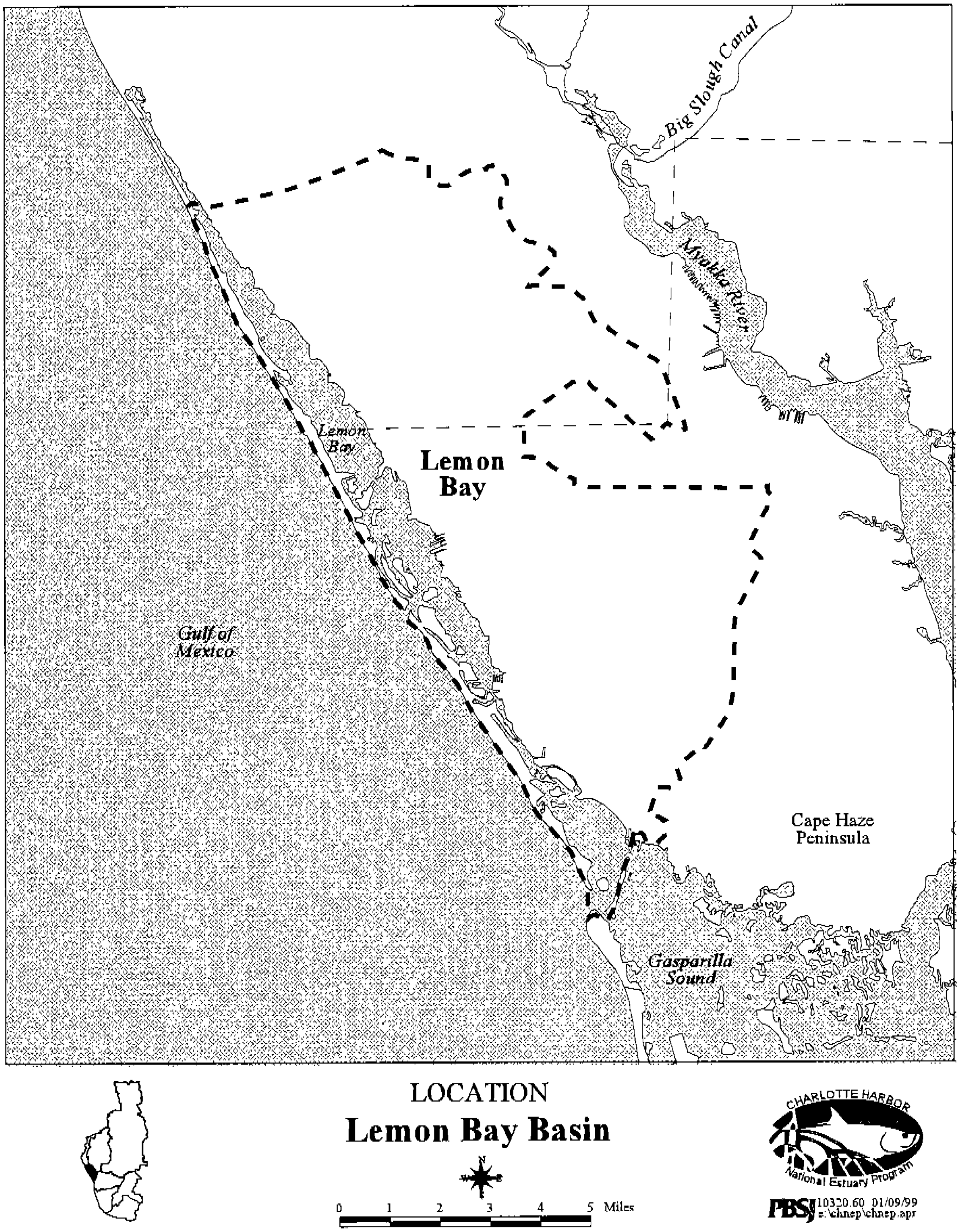


Figure 5-1. Location of the Lemon Bay Basin within the Charlotte Harbor NEP study area.

and filling activities. The City of Englewood lies above the 10 foot contour and most of the basin lies below the 10 foot contour.

5.1.1.2 Geology

The physical geography of the Lemon Bay Basin developed largely during the past one million years of geologic history. Local surface and subsurface geology, Pleistocene glaciations, and weathering have shaped topography, soils, and other physical features of the basin.

Except for the coast at Venice, the Gulf coast in Sarasota County consists of barrier islands, spits, and lagoons. The barrier islands formed during the last 4,000 years to 5,000 years, after sea level became reasonably stable, and they represent the latest changes to conditions during this period. Since the present sea level has stabilized, very little new sand has been added to the islands in this area and most sand lost through erosion is redeposited as spits at the ends of the islands, in lagoons, or in offshore areas.

Sediments at the surface in Sarasota County consist of quartz sand, consolidated and unconsolidated shell beds, clay, limestone, and dolomite. These sediments range in age from Oligocene (38 to 22.5 MYA) to Holocene (10,000 years ago to the present). The Oligocene Series occurs as Suwannee Limestone in Sarasota County and is generally below the surface. Parent materials consist of beds of sandy and clayey materials, which were transported and deposited by waters of the sea that covered the area a number of times during the Pleistocene period. During higher sea levels, the Mio-Pliocene sediments were eroded and redeposited or were reworked on the shallow sea bottom to form marine terraces.

Flooding during the recent Pleistocene resulted in deposition of a series of sediments in deltaic formations which began the in-filling of the existing estuary and formed the present barrier island chain which began as a spit of land at the north end near the present Gasparilla Island. River sediments and those of the littoral drift helped create a chain of barrier islands with Sanibel Island at the southern end. The five major barrier islands present today include Gasparilla, Cayo Costa, North Captiva, Captiva, and Sanibel. These islands have joined, separated, and changed shape over time (Herwitz, 1977).

The aquifer in the basin is generally artesian, comprised of Oldsmar and Lake City Limestones, Avalon Park Formation, and Ocala and Suwannee Limestone. These sediments lie beneath the impermeable rocks of the Hawthorn Group, which comprises the intermediate confining unit and aquifer system in the area. The surficial aquifer system is comprised primarily of Caloosahatchee and Tamiami Formations, and both ground- and surface water flow is generally east to west into the Gulf.

5.1.1.3 Soils

The barrier islands are made up of Kesson-Wulfert-Canaveral soil complexes made up of very poorly to moderately well drained, sandy and mucky soils over marine sands and shells with organics in the Wulfert phase. Small, artificially created soils of shell and limestone fragments occur on the interior portion of the watershed.

Although there is less acreage in agriculture in this basin, HSG-designated B soils (well drained) make up 65.7% of the soils in the Lemon Bay (Table 5-1, Figure 5-2). Poorly drained HSG designated D soils make up 18.9% D (poorly drained) soils, 14.5% are C soils, and 1% are A (very well drained) soils. The coastal basin consisting of Lemon Bay consists of nearly 90% flatwoods soils that are nearly level, poorly drained sandy soils over loamy subsoils. In both Sarasota and Charlotte counties Myakka-Eugallie and Myakka-Immokalee sand and fine sand combinations. Myakka-Holopaw-Pineda and Pomello-Myakka-Eugallie soils occur along the river and coast.

Table 5-1. Hydrologic soil types in the Lemon Bay Basin.

Soil Type	Acres	%
A	412	0.9
B	29,874	65.7
C	6,596	14.5
D	8,616	18.9
TOTAL	45,498	100.0

5.1.2 Rainfall

Data from a total of eight rainfall gages were used in calculating total annual rainfall since 1970 in the Lemon Bay Basin (Figure 5-3). Total annual precipitation and average monthly precipitation (Figure 5-4) were plotted for the basin. Minimum total annual precipitation ranged from approximately 34 inches of rain in 1980 to 82 inches of rain in 1995. Similar to other basins, peak annual precipitation occurred during 1983 and 1995.

Seasonal monthly precipitation was highest from June to September, and wet season average values ranged from 7.2 inches in September to 8.6 inches in August. Average monthly rainfall values were lowest during November (approximately 1.8 inches), and average values did not exceed 3.4 inches through May.

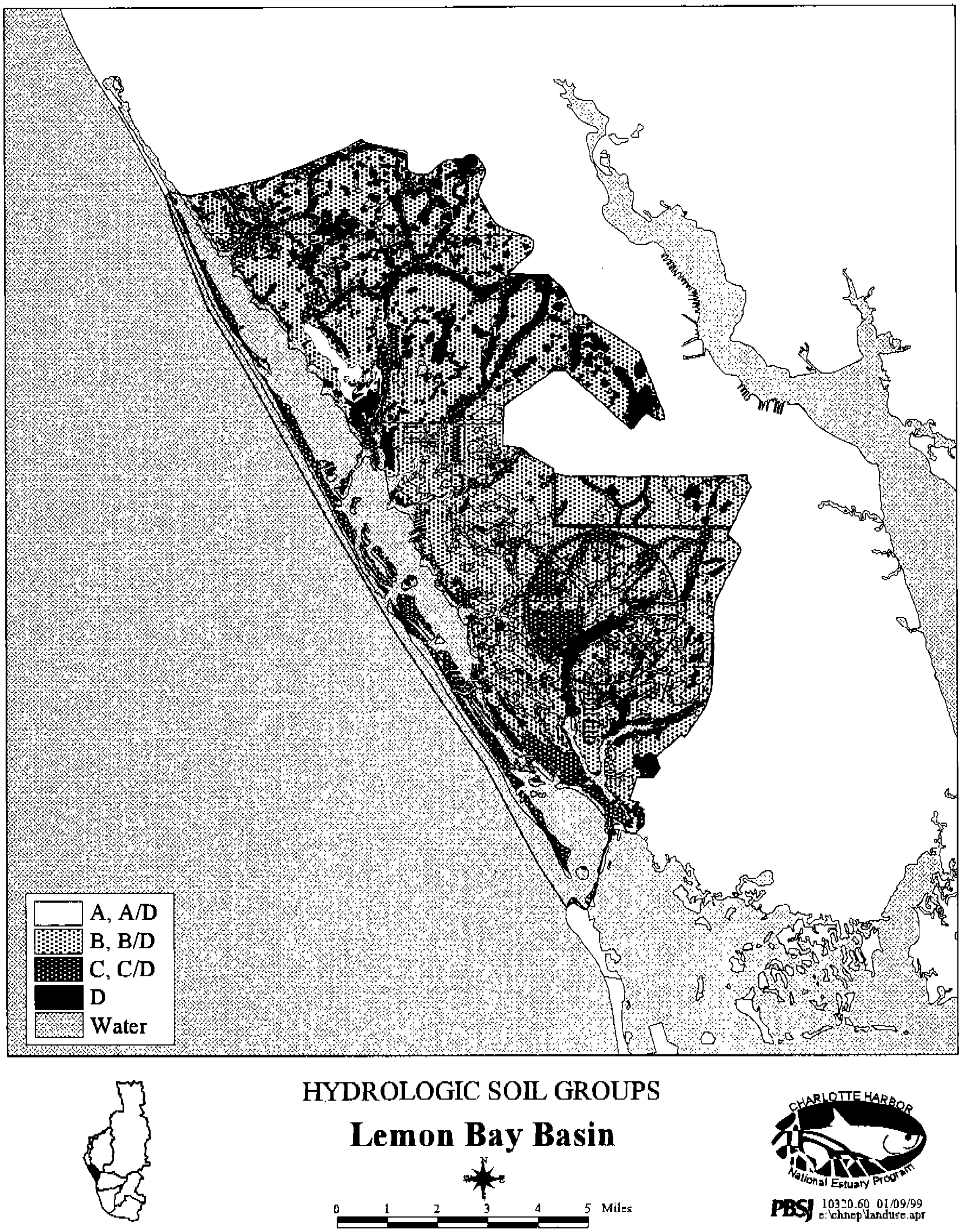


Figure 5-2. Hydrologic soil groups in the Lemon Bay Basin.

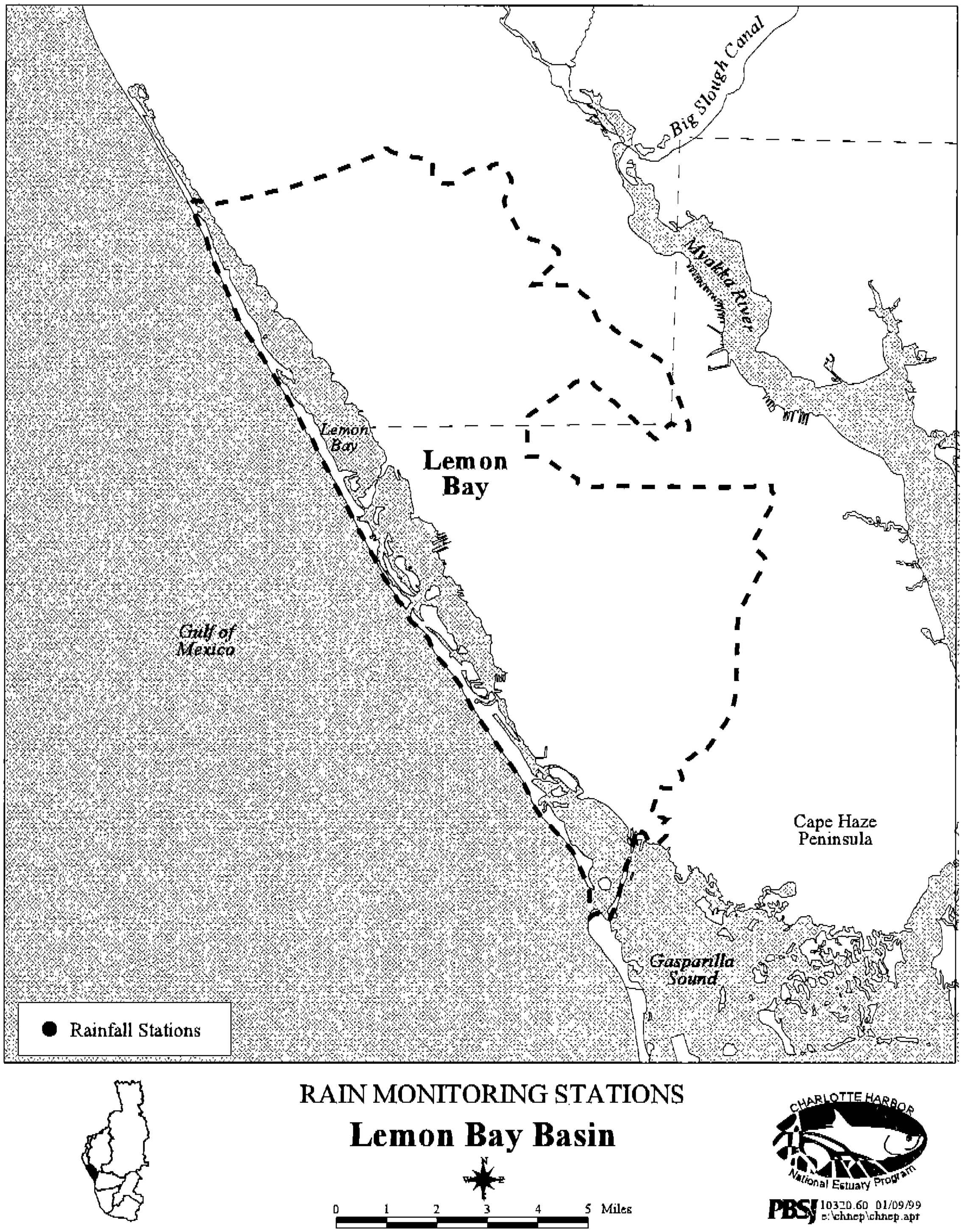
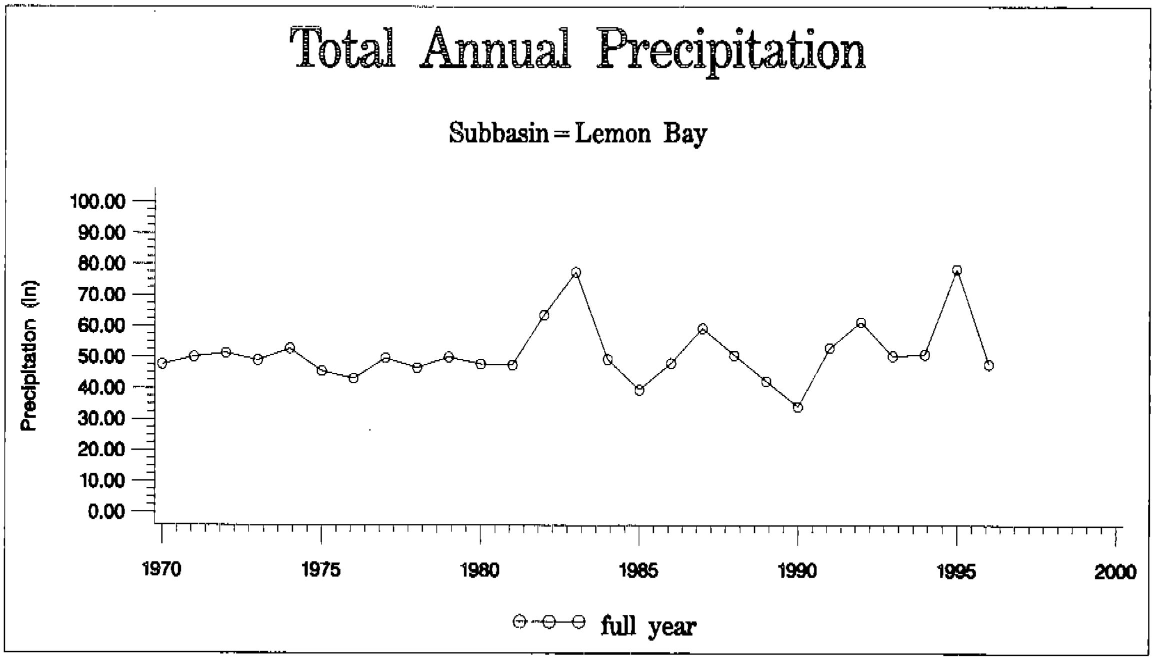


Figure 5-3. Rain station locations in the Lemon Bay Basin.



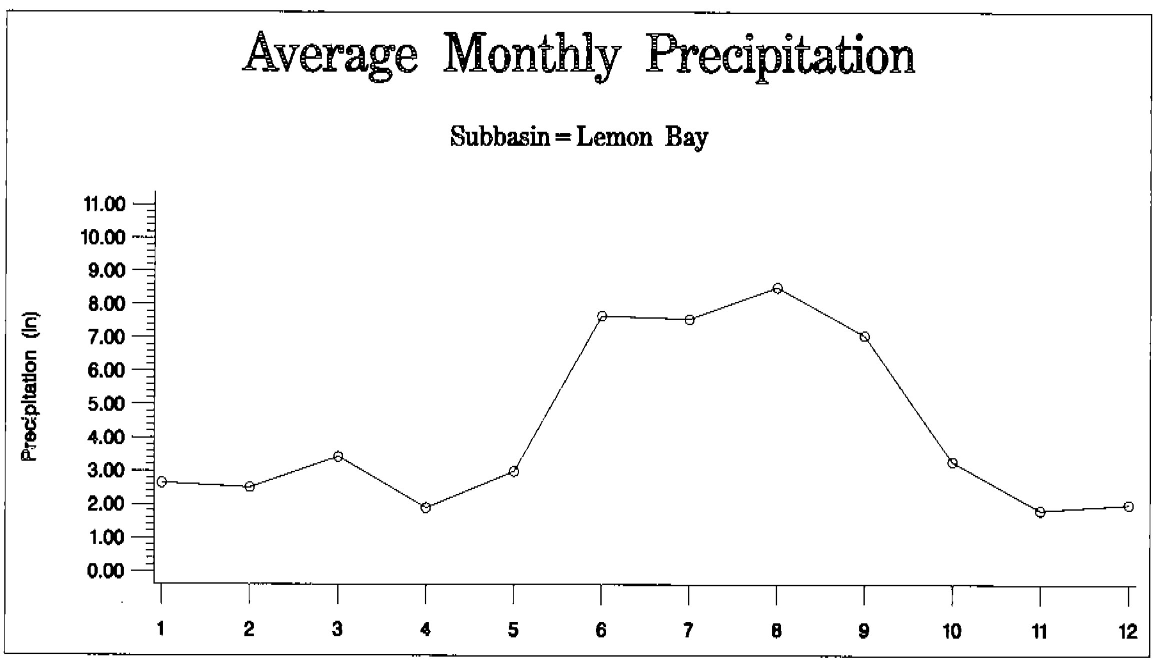


Figure 5-4. Total annual and monthly rainfall plots for the Lemon Bay Basin.

5.1.3 Existing and Future Land Use

Existing land use acreages for Lemon Bay Basin are presented in Table 5-2 and future land use acreages are presented in Table 5-3. Existing and future land use maps are presented in Figures 5-5 and 5-6, respectively.

Land use classification systems for existing and future land use GIS coverages for the Charlotte Harbor NEP area are not consistent. Existing Land Use Coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SWFWMD) land use data. Land Use data from SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We assigned new codes which make the SFWMD and SWFWMD land use classification systems comparable for this project.

Future Land Use Coverages for the Charlotte Harbor NEP were developed by Southwest Florida Regional Planning Council (SWFRPC). SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions.

The FLUM uses a different and much simpler, land use classification system than either of the existing land use coverages and does not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). As a result, residential areas may increase tremendously under future scenarios because existing development is not taken into account. Direct comparisons between acreages of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category.

5.1.3.1 Existing Land Use

Unlike the Peace River and Myakka River basins, the Lemon Bay Basin includes very little agricultural land use, and it contrasts with the Coastal Harbor Proper Basin in that it includes higher percentages of residential land use. Greatest acreages of land use occur for range lands (24%) and upland forests (20%), followed closely by residential land use (23%). These non-agricultural and non-urban land uses are the most likely to change under future land use scenarios.

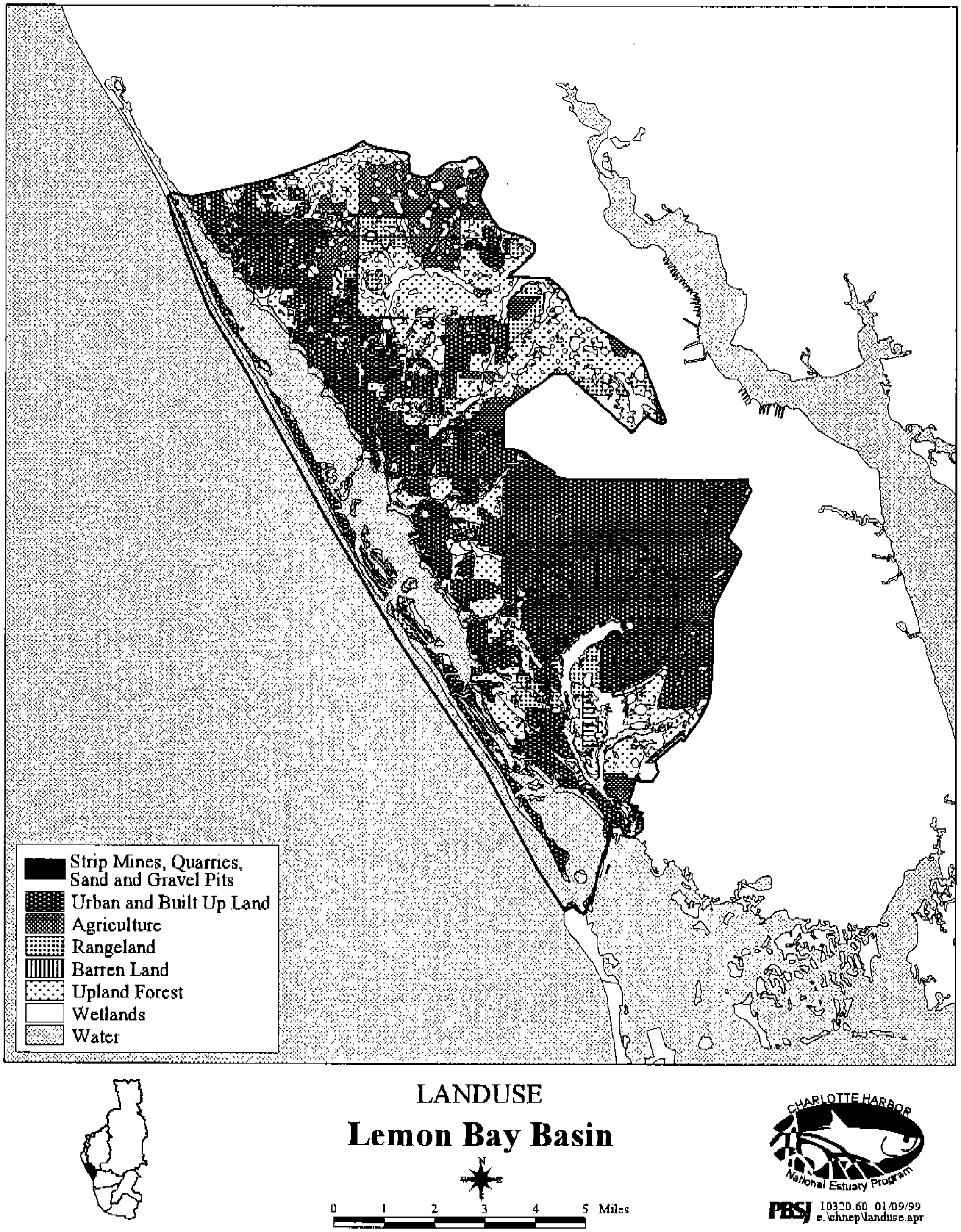


Figure 5-5. Existing land use map (SWFRPC, 1990) for the Lemon Bay Basin.

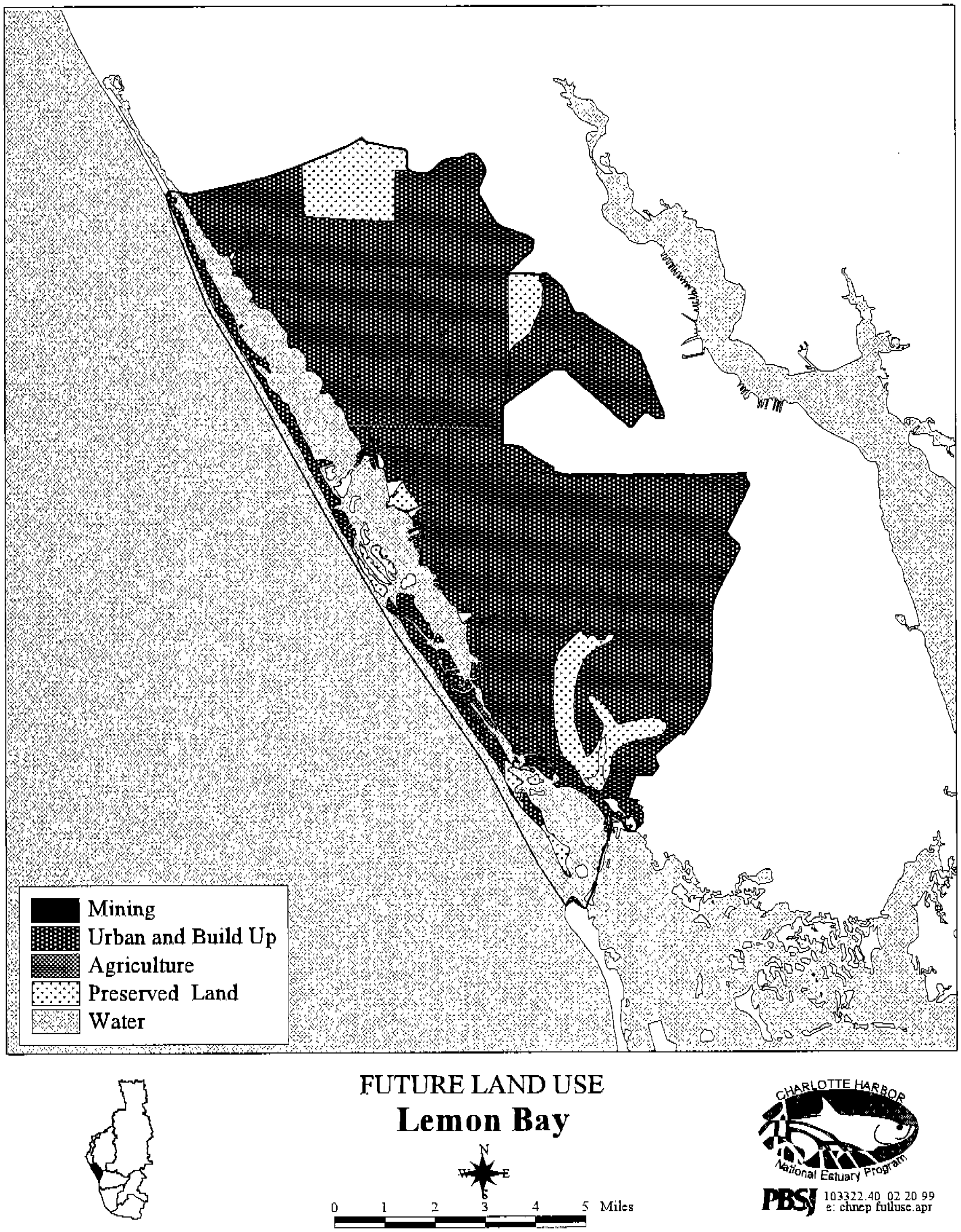


Figure 5-6. Future land use map (SWFRPC, 1990) for the Lemon Bay Basin.

Table 5-2. Current (1990) land use/cover in the Lemon Bay Basin.		
Land Use/Cover	**Acres**	**%**
Single Family Residential	3,247	7.1
Medium Density Residential	5,964	13.1
Multi-family Residential	1,217	2.7
Commercial	714	1.6
Industrial	154	0.3
Mining	286	0.6
Institutional	445	1.0
Range Lands	11,094	24.4
Barren Lands	81	0.2
Pasture	749	1.6
Groves	170	0.4
Feedlots	0	0.0
Nursery	16	< 0.1
Row and Field Crops	0	0.0
Upland Forested	9,286	20.4
Freshwater - Open Water	1,139	2.5
Saltwater - Open Water	6,274	13.8
Forested Freshwater Wetland	1,552	3.4
Saltwater Wetland	1,100	2.4
Non-forested Freshwater Wetland	1,989	4.4
Tidal Flats	21	< 0.1
TOTAL	45,498	100.0

5.1.3.2 Future Land Use

The largest change in land use in the basin is an increase in percent urban land use from 26% to 74%. Agricultural land use includes a small portion of the basin under either existing or future land use and changes very little under future land use planning (decreases from 2 to 1%). The largest land use in the FLUMs is residential, which comprises nearly 75% of the future land use in the basin. Protected Resources make up the next largest category, although this land use makes up only 10 of the future land use in the basin.

Table 5-3. Future (2010) land use/cover in the Lemon Bay Basin.

Land Use/Cover	Acres	%
Single Family Residential	28,618	64.2
Multi-family Residential	2,279	5.1
Rural Residential	6,408	14.4
Commercial	1,267	2.8
Industrial	993	2.2
Mining	0	0
Agricultural	519	1.2
Wetlands	0	0
Protected Resource	4,524	10.1
TOTAL	44,607	100.0

5.1.4 Surface Water Hydrology and Water Management Practices

There are no USGS streamflow gages in the Lemon Bay Basin. Several creeks, including Alligator Creek, Forked Creek, Gottfried Creek, Rock Creek, Oyster Creek, and Buck Creek, drain to the eastern shore of Lemon Bay and contribute small quantities of fresh water to the bay. Coral Creek discharges to Gasparilla Sound south of Lemon Bay. Tributary discharges correspond to rainfall.

The Lemon Bay Basin is that portion of the Charlotte Harbor Watershed west of the Charlotte Harbor Proper Basin, extending westward to the Gulf of Mexico, and including Manasota Key and Don Pedro Island. Within the Lemon Bay Basin, dominant land uses are range lands (24%), forested uplands (20%), open saltwater (14%), and medium density residential (13%) (Table 5-2). This basin includes portions of northwestern Charlotte County and southwestern Sarasota County.

5.1.4.1 Urban Management Practices

The urbanized areas of the Lemon Bay Basin are found along the Gulf Coast and in the southern portions of the basin. Englewood is on the Gulf Coast in the northern part of the basin, across Lemon Bay from Manasota Key, and Grove City is south of Englewood, opposite the southern end of Manasota Key. Further inland, east of Buck Creek and north of the east branch of Coral Creek, is the Rotonda development.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. Discussion of water use is limited to facilities with an average permitted quantity greater than 0.5 million gallons per day (MGD). All water use information for those parts of the Charlotte Harbor NEP study area within the borders of the Southwest Florida Water Management District (SWFWMD), including the entire Lemon Bay Basin, is from SWFWMD (1997) and SWFWMD (1992).

- Public Supply

Table 5-4 lists the public water supply facilities in the Lemon Bay Basin with permitted withdrawals of more than 0.5 MGD, as well as the withdrawal sources for the facilities. A discussion of the populations served by each plan, withdrawal amounts, and withdrawal methods follows.

Table 5-4. Public water supply facilities in the Lemon Bay Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
Gasparilla Island Water Assc., Inc.	1.70	Surficial, Intermediate aquifers, PRMRWSA
Rotonda West Utility Corp.	1.66	Surficial, Intermediate aquifers
Sarasota County Utility System	2.08	Sorrento Wellfield - Intermediate aquifer

The Gasparilla Island Water Association, Inc., is a private utility which operates 32 wells withdrawing from the surficial aquifer. The wells average 30 feet deep, and withdraw the permitted average of 0.43 MGD from the surficial aquifer. The utility also may purchase up to 1.4 MGD from the PRMRWSA. The Gasparilla Island Water Association also has four wells which withdraw from the Intermediate aquifer, producing a finished water capacity of 0.75 MGD. The total permitted average withdrawal for the utility is 1.7 MGD. During 1990, the utility served approximately 4,350 people with an average demand of 1.0 MGD. Of this, 0.87 MGD was from the utility's wellfields and 0.30 MGD was from the Peace River Facility (SWFWMD, 1992).

The Rotonda West Utility Corporation is a private utility serving the 23,000-acre Rotonda development. Its water supply system is via 29 wells from the surficial aquifer which average 30 feet deep, and via four wells from the Intermediate aquifer which average 145 feet deep. Permitted average withdrawals from both sources is 1.66 MGD, of which 0.35 MGD is from the surficial and

1.31 MGD is from the Intermediate aquifer. This facility provided potable water supply to a population of 4,808, with use of 0.52 MGD, during 1990 (SWFWMD, 1992).

The Sarasota County Utility System operates the Sorrento Wellfield. The Sorrento Wellfield was formerly privately owned, and is just west of US 41 between Sarasota and Venice. The three wells withdrawing from the wellfield are permitted for an average of 2.08 MGD, and average 350 feet deep. Withdrawals are from the Intermediate aquifer (SWFWMD, 1992).

- Mining

There are 286 acres of mining land use within the Lemon Bay Basin, making up approximately 0.6% of the basin. Two mining facilities are found within the basin which have water uses greater than 0.5 MGD. Table 5-5 lists the mining operations, their permitted average withdrawals, and withdrawal source.

The Handy Phio, Inc., mining operation used 1.40 MGD in 1994, almost twice its permitted maximum withdrawal, and nearly three times its permitted average withdrawal. The Ajax Paving Industries, Inc., mine used its entire permitted average withdrawal of 2.46 MGD in 1994, and has a permitted maximum withdrawal of 2.95 MGD (WUSE&P, 1997).

Table 5-5. Mining operations water use in the Lemon Bay Basin.

Company	Permitted Average Withdrawal (MGD)	Permitted Maximum Withdrawal (MGD)	Source
Handy Phio, Inc.	0.54	0.72	Surface water
Ajax Paving Industries, Inc.	2.46	2.95	Surface water

- Industrial

The Lemon Bay Basin contains only 154 acres of industrial land use, as determined from the 1990 SWFWMD land use coverage. No industrial water uses of greater than 0.5 MGD were found for this basin.

- Recreational

Recreational water use for Charlotte and Sarasota counties was previously described in the Myakka River Basin recreational water use section of this report.

Water Discharge and Reuse

There are no major domestic waste water treatment plants in the Lemon Bay Basin.

5.1.4.2 Agricultural Management Practices

Agricultural land use estimates for all major crops for 1990 in Charlotte County are listed in Table 5-6, as well as estimates of irrigated acreages for each of these crops and estimated water use. Sarasota County estimates for 1990 agricultural land use, irrigation type, and estimated water use are shown in Table 5-7.

Table 5-6. 1990 estimated crop acreages, irrigation types, and water use in Sarasota County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Agronomic	200	Seepage 200	0.2
Row/Field Crops	3,100	Seepage 3,100	9.1
Citrus	1,800	Low Volume 1,530 Seepage 180	3.2
Nursery	220	Overhead 220	1.5
Sod	5,000	Seepage 5,000	10.0
Irrigated Pasture	555	Seepage 555	0.9
TOTALS	10,875	Low Volume 1,530 Seepage 9,035	24.9

Table 5-7. 1990 estimated crop acreages, irrigation types, and water use in Charlotte County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Row/Field Crops	1,500	Seepage 1,500	4.4
Citrus	10,500	Low Volume 8,925 Seepage 1,050	13.6
Nursery	215	Overhead 215	1.4
Sod	1,200	Seepage 1,200	2.9

Table 5-7. 1990 estimated crop acreages, irrigation types, and water use in Charlotte County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Irrigated Pasture	150	Seepage	150	0.3
Totals	13,565	Overhead Low Volume Seepage	215 8,925 3,900	22.6

5.2 Water Quality Conditions

No comprehensive data bases were identified which allowed a comprehensive assessment of long-term and current water quality conditions either during the development of the "Compendium of Existing Information" or while compiling background data for this subsequent "Synthesis of Existing Information".

5.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) was estimated for each subbasin by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to prioritize major basins or subbasins. Thus, the method development was focused on estimating relative loads in a consistent manner among subbasins to avoid biasing the major basin or subbasin evaluation.

The detailed rainfall, 1988 SFWMD land cover, SWFWMD 1990 land cover, and USDA soil data were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow was used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of designated land use and soil within a subbasin. Loadings were calculated using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TSS, TN, and TP loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, feedlots, row and field crops and nursery. Undeveloped land uses were defined as range lands, barren lands, and upland forests.

5.3.1 Load Estimates for the Lemon Bay Basin

The total estimated annual runoff discharge for the Lemon Bay Basin was 48 million cubic meters from a contributing area of 33,000 acres. The estimated annual pollutant loads were 134 tons of TN, 32 tons of TP, and 1,926 tons of TSS.

The largest sources of pollutant loads from runoff were urban land uses. The 12,000 acres of urban land uses in the subbasin were estimated to contribute 57 tons of TN, 9 tons of TP, and 1,150 tons of TSS. Table 5-8 presents the loads from runoff by land use for this subbasin. Residential lands were the primary urban land uses and were dominated by medium density residential parcels.

There were very few agricultural lands within this subbasin (1,000 acres). These lands were estimated to contribute a total of 1 million cubic meters of runoff, 3 tons of TN, 1 ton of TP, and 11 tons of TSS per year. These agricultural lands were primarily comprised of pasture and grove lands.

Table 5-8. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Lemon Bay Basin.

Land Use Type	TN		TP		TSS		Hydrological Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	9	7%	1	4%	86	5%	4,322,976	9%
Medium Density Residential	29	22%	4	14%	440	23%	11,774,733	25%
High Density Residential	8	6%	1	5%	254	13%	3,576,918	7%
Commercial	6	5%	1	3%	247	13%	3,035,576	6%
Industrial	1	1%	0	1%	64	3%	618,042	1%
Mining	1	1%	0	1%	43	2%	785,015	2%
Institutional,Transport., Util.	2	1%	0	0%	15	1%	1,212,987	3%

Table 5-8. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Lemon Bay Basin.

Range Lands	33	25%	17	52%	169	9%	11,695,442	24%
Barren Lands	0	0%	0	0%	3	0%	256,962	1%
Pasture	2	2%	1	2%	7	0%	766,825	2%
Groves	0	0%	0	0%	2	0%	169,147	0%
Nursery	0	0%	0	0%	2	0%	28,512	0%
Upland Forests	41	31%	6	18%	595	31%	9,773,707	20%
TOTAL	134	100%	32	100%	1,926	100%	48,016,841	100%

5.3.2 Pollution Source Inventory

The purpose of this compilation of a point source inventory for the Lemon Bay Basin is to describe the numbers, locations, and discharge capacities of domestic and industrial point sources within the Lemon Bay Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources, as discussed previously.

Wastewater treatment plant discharges for those plants in the Lemon Bay Basin with greater than 1.0 MGD were previously described, using information from the SWFWMD (SWFWMD, 1992). The following discussion uses only the FDEP databases, as previously described.

The FDEP databases list 37 domestic point sources and five industrial point sources within the basin (Tables 5-9 and 5-10). Nine of the domestic point sources are in Sarasota County, 27 are in Charlotte County, and one is listed as being in a county not in the Lemon Bay Basin. The industrial point sources are all in Charlotte County (Figure 5-7).

Domestic point sources discharge capacities total 3.66 MGD, with 2.86 MGD of this sent to reuse. Industrial point sources have a total discharge capacity of 1.10 MGD, 0.02 MGD of which is used for reuse, 0.04 MGD is injected to wells, and 0.67 is discharge to the East Branch of Coral Creek.

Table 5-9. Domestic Point Sources in the Lemon Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
OAK GROVE MHP WWTP	Sarasota	0.02	
SHADY HAVEN TP	Sarasota	0.01	
DEER CREEK MHP	Sarasota	0.02	
ENGLEWOOD ISLES	Sarasota	0.4	
CARRIAGE HOUSE RESTAURANT	Sarasota	0.01	

Table 5-9. Domestic Point Sources in the Lemon Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
POLYNESIAN VILLAGE MHP	Sarasota	0.04	Drainfield
HOLIDAY VENTURES AT ENGLEWOOD	Sarasota	0.08	
ENGLEWOOD UTILITIES WWTP FKA FOXWOOD CONDOMINIUM	Sarasota	0.16	
TANGERINE WOODS	Sarasota	0.1	
SANDALHAVEN UTILITIES W. W. T. P.	Charlotte	0.15	Percolation Ponds
BAYVIEW EAST CONDO.	Charlotte	0.01	Drainfield
ENGLEWOOD BEACH PLACE CONDO	Charlotte	0.01	Drainfield
PELICAN LANDING	Charlotte	0.02	Drainfield
LANDINGS ON LEMON BAY	Charlotte	0.04	Drainfield
CASTAWAYS CONDOMINIUM	Charlotte	0.01	Drainfield
LA COQUINA CONDO	Charlotte	0.02	Drainfield
OYSTER CREEK MOBILE HOME PARK	Charlotte	0.01	Drainfield
EL GALEON MOTEL	Charlotte	0.03	Drainfield
HIDEAWAY BAY BEACH CLUB CONDO ASSOCIATION, INC.	Charlotte	0.02	Absorption Fields
FANTASY ISLAND II	Charlotte	0.01	Drainfield
WATERS EDGE CONDO	Charlotte	0.03	Percolation Ponds
ENGLEWOOD HEALTH CARE CENTER	Charlotte	0.01	Percolation Ponds
LEMON BAY BREEZES	Charlotte	0.03	Drainfield
HOUSE OF CHAN	Charlotte	0.01	Drainfield
ADMIRALTY VILLAS, INC.	Charlotte	0.01	Drainfield
PARK POINTE VILLAS W. W. T. P.	Charlotte	0.01	Absorption Fields
KNIGHT ISLAND UTILITIES W. W. T. P.	Charlotte	0.06	Drainfield
ROTONDA WEST WWTP (OLD PLANT)	Charlotte	0.63	Percolation Ponds/ Spray Irrigation
EBCO WASTEWATER INC	Charlotte	0.03	Percolation Ponds
TIKI APARTMENTS	Charlotte	0.01	Spray Irrigation
ENGLEWOOD WATER DISTRICT NORTH	Charlotte	0.38	Percolation Ponds
FOREST PARK CONDO	Charlotte	0.04	Percolation Ponds
INDIGO ISLES MHP OWNERS ASSOC INC	Charlotte	0.02	Percolation Ponds1
MERCURY MARINE	Charlotte	0.01	Drainfield
OAKWATER COVE CONDO	Charlotte	0.01	Drainfield
ENGLEWOOD WATER DISTRICT SOUTH	Charlotte	1.2	Spray Irrigation
SHADY ACRES TRAVEL PARK, #2	Lee	0.04	Retention Pond

Table 5-10. Industrial Point Sources in the Lemon Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
GASPARILLA ISLAND WATER ASSOC	Charlotte	0.67	East Branch, Coral Creek
GASPARILLA PINES RO WATER PLT	Charlotte	0.25	
LITTLE GASPARILLA UTILITY, INC.	Charlotte	0.04	Class V Wells
KNIGHT ISLAND UTILITIES, INC.	Charlotte	0.03	
BIZZY BUZZY'S COIN LAUNDRY	Charlotte	0.02	Drainfield

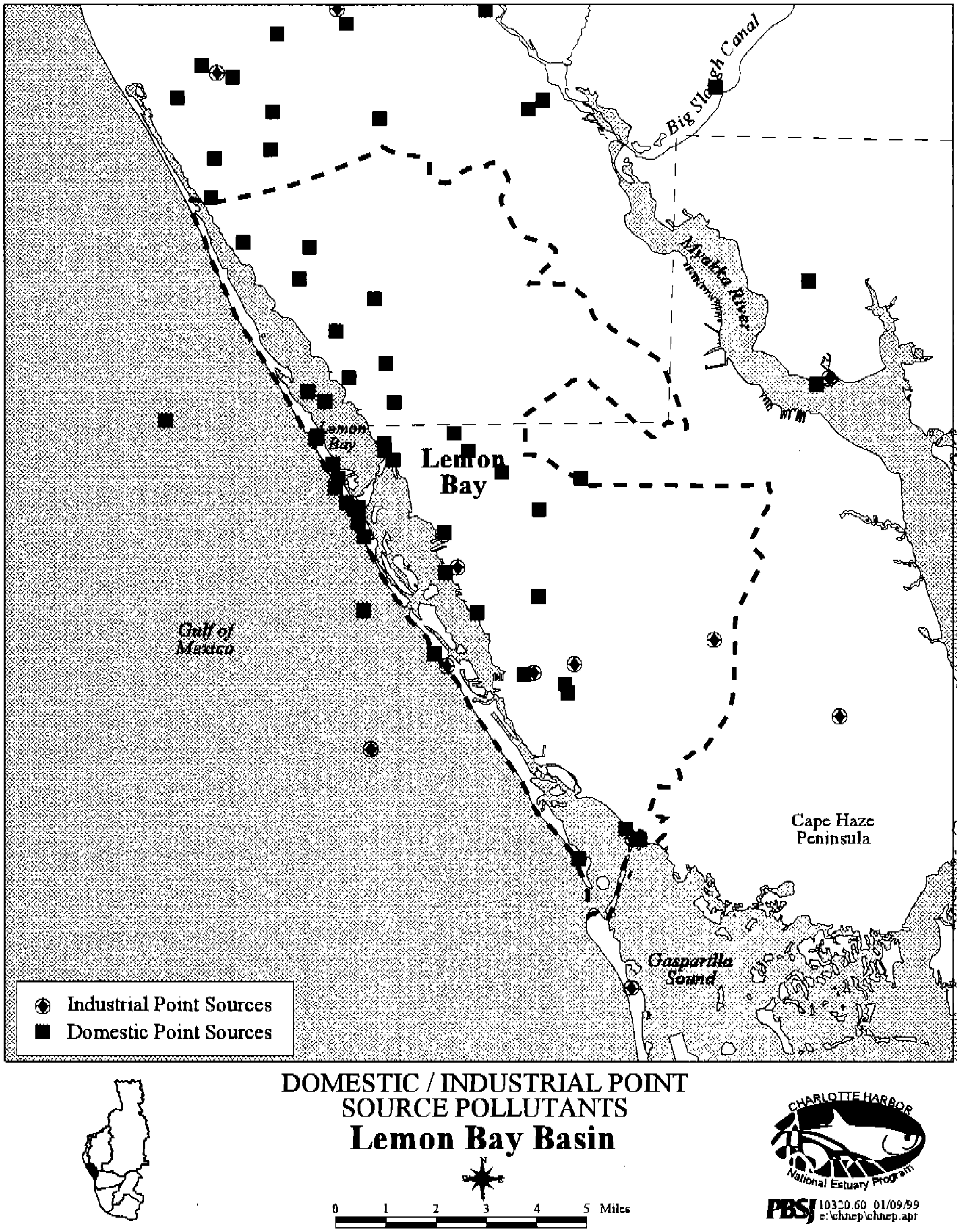


Figure 5-7. Location of domestic and industrial point sources in the Lemon Bay Basin.

6. Pine Island Sound/Matlacha Pass

This chapter presents a compilation and synthesis of information regarding the Pine Island Sound/Matlacha Pass Basin portion of the CHNEP area (Figure 6-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

6.1 Physical Setting

The Pine Island Sound/Matlacha Pass Basin comprises the southern portion of Charlotte Harbor, including the open waters and bay within Pine Island Sound, San Carlos Bay, and Matlacha Pass. This basin includes the series of coastal barrier islands of Cayo Costa, North Captiva, Captiva, and Sanibel. The central portion of the Pine Island Sound/Matlacha Pass Basin includes all of Pine Island and Little Pine Island. The eastern boundary of the basin includes those areas in the City of Cape Coral, northern Lee County and southern Charlotte County which drain into Matlacha Pass.

6.1.1 Physiography

This section describes the topography, geology, and land use in the Pine Island Sound/Matlacha Pass Basin.

6.1.1.1 Topography

The long, narrow basin has minor topographic relief, interrupted by canals. Topography in the Pine Island Sound/ Matlacha Pass basin ranges from sea level to no greater than 10 feet along the barrier islands and coastal mainland.

6.1.1.2 Geology

Pine Island is believed to be a remnant of the original mainland that was isolated by a southerly shift

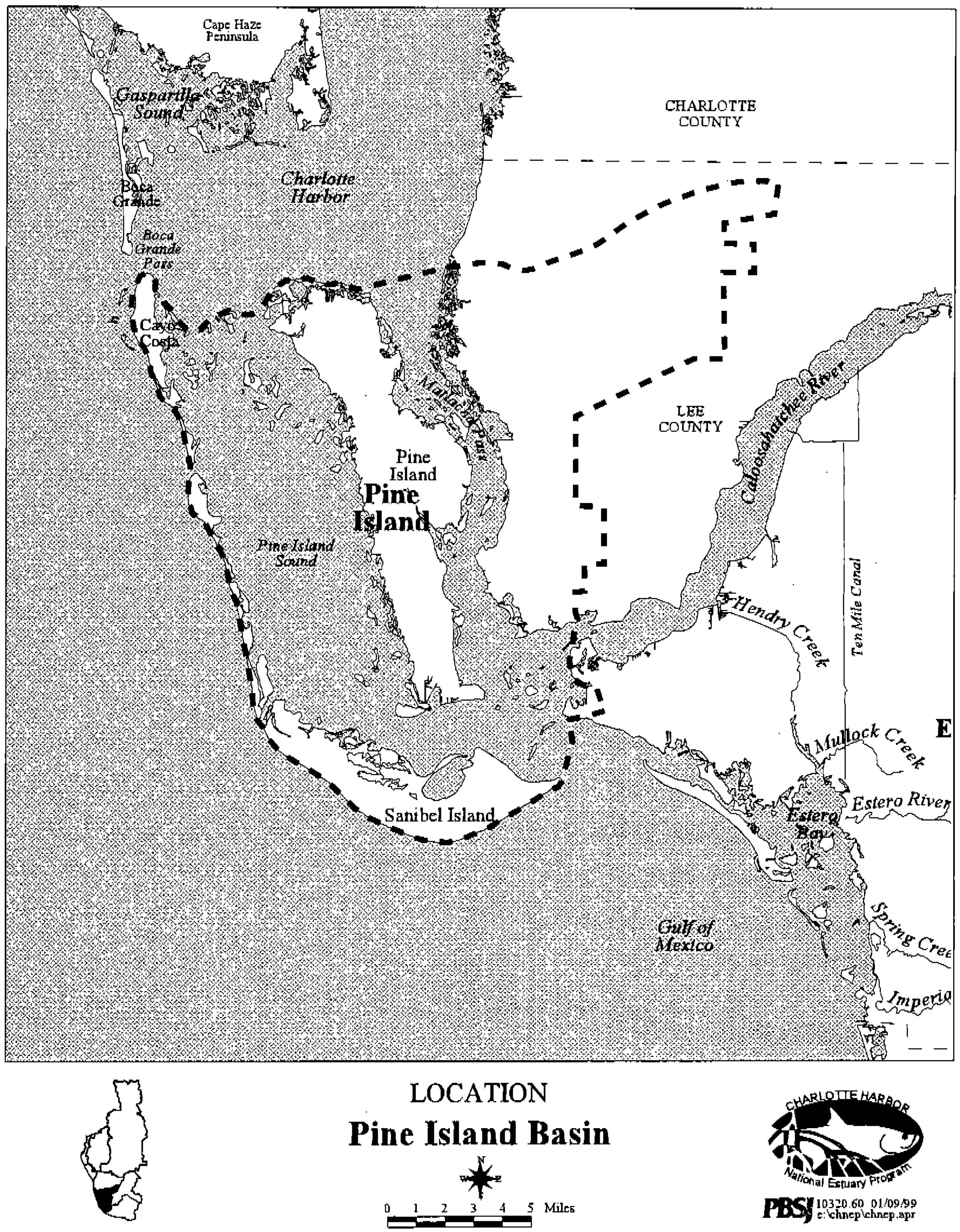


Figure 6-1. Location of the Pine Island/ Matlacha Pass Basin in the Charlotte Harbor NEP study area.

in the river flow. Then, as sediments built up at the present location of Little Pine Island and the evolving shape of Sanibel Island restricted water flow, the estuary broke through to the Gulf, creating a deep channel near the present Boca Grande Pass. This pass eventually shifted to its present position. Other passes have been opened and closed by storm events and other natural forces that are still acting on the system today. Both Cayo Costa and North Captiva Island have had new cuts through them in the early 1980's.

The parent materials underlying the islands and coastal mainland of the Pine Island Sound/Matlacha Pass basin consist of beds of sand and clay materials transported and deposited by sea waters during the Pleistocene period. During high sea levels, the Miocene-Pliocene sediments were eroded and redeposited or reworked on the shallow sea bottom to form marine terraces which now lie beneath the land.

The Pine Island Sound/Matlacha Pass basin includes Gulf Coastal Lowlands and Gulf Barrier Chain physiographic provinces. The Gulf Barrier Chain consists of a string of barrier islands from Long Key to Cape Romano. These islands likely formed as dune ridges and spits as sand from coastal headlands, rivers, and formerly emergent areas of the continental shelf was deposited. When sea level rise slowed approximately four to five thousand years ago, the sand was shaped into islands parallel with the shoreline by wind and water currents.

In contrast, Sanibel Island is believed to have formed from deltaic deposits composed primarily of mollusk shells. As sediments built up at Little Pine Island and the newly evolving Sanibel Island restricted water flow, the estuary opened to the Gulf, creating a deep channel near the present Boca Grande Pass. This pass eventually shifted to its present position as other passes presently do in response to storm events and other natural forces.

The mainland portion of the basin is in the Gulf Coastal Lowlands and is similar in geology to coastal Charlotte Harbor basin described earlier.

6.1.1.3 Soils

Soils within the Pine Island Sound/Matlacha Pass Basin include about 70% artificially created soils of shell and limestone fragments in the southeast portion of the watershed, contiguous with those same soils in the adjacent Charlotte Harbor basin. The interior of Pine Island is made up of flatwoods soils of the Immokalee-Myakka complex.

The tidal areas and barrier islands complexes of the basin are poorly to moderately well-drained soils over marine sands and shells. The flats along the perimeter of Pine Island are Peckish-Estero-Isles soils made up of mucky sands over limestone with 0-1% slopes. These soils are characteristic of marshes and swamps. The east side of Sanibel Island on the intercoastal waterway is composed of more organic and flooded Wulfert-Kesson-Captiva soils characteristic of mangrove swamps. In contrast, the Gulf Coast Sanibel Island and Captiva and Gasparilla islands include fine sand soils and ridges of the Canaveral-Captiva-Kesson series.

There are no soils designated as A (very well-drained) under the HSG classification system in the Pine Island Sound/Matlacha Pass Basin (Table 6-1 and Figure 6-2). Unlike the other basins, percentages of soils were more evenly distributed, and only 41.4% of the soils are classified in the B (well-drained) soils grouping, 30.5% in C (less well-drained), and 28.1% in D (poorly drained).

Table 6-1. Hydrologic soil types in the Pine Island/Matlacha Pass Basin.

Soil Type	Acres	%
A	0	0.0
B	36,338	41.4
C	26,815	30.5
D	24,694	28.1
TOTAL	87,848	100.0

6.1.2 Rainfall

The mean annual rainfall for 33 years of record is about 53 inches for this area. About 30% of summer days on the beaches include thunderstorms, compared with inland areas which have thunderstorms about 60% of the days. Regional long-term rainfall data were available from 16 rain gauges for calculating rainfall in Pine Island Sound/ Matlacha Pass basin (Figure 6-3). Evaporation and rainfall have been reported to be equal (Vishner and Hughes, 1969) in the basin and there are generally no recharge areas.

Total annual precipitation and average monthly precipitation (Figure 6-4) were plotted for the basin. In addition, total and average monthly precipitation were calculated for the entire basin. Appendix A presents a summary of the rainfall data from this basin.

Rainfall data are similar to other basins in the watershed. Minimum total annual precipitation (for years with twelve months data) ranged from approximately 32 inches of rain in 1964 to approximately 74 inches of rain in 1983.

Average monthly precipitation was highest during the summer months June to September and average rainy season monthly values ranged from 8.4 to 9.2 inches. Average monthly rainfall was lowest in November (approximately 2.4 inches), and average values did not exceed 3.8 inches through May.

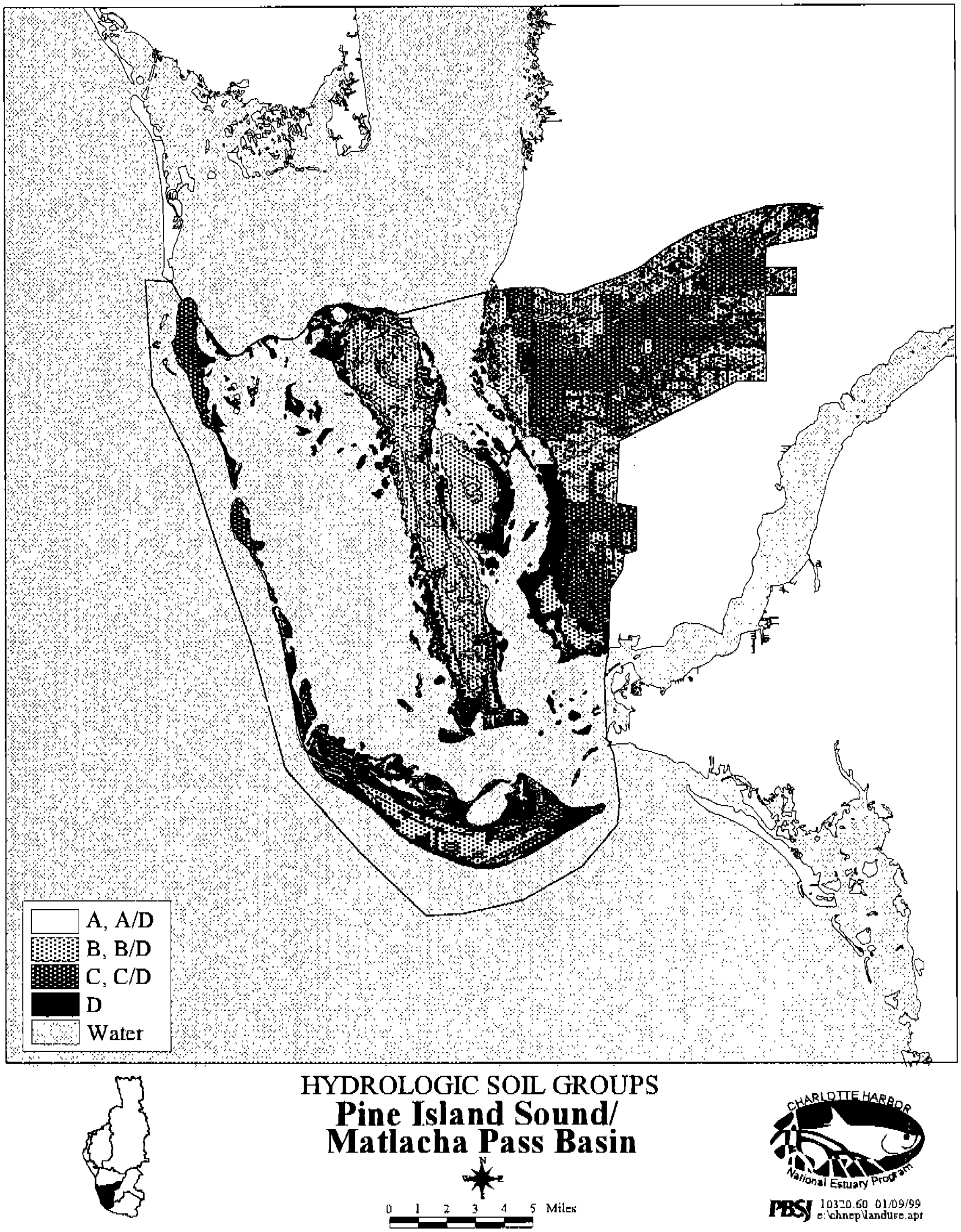


Figure 6-2. Hydrologic soil groups in the Pine Island/ Matlacha Pass Basin.

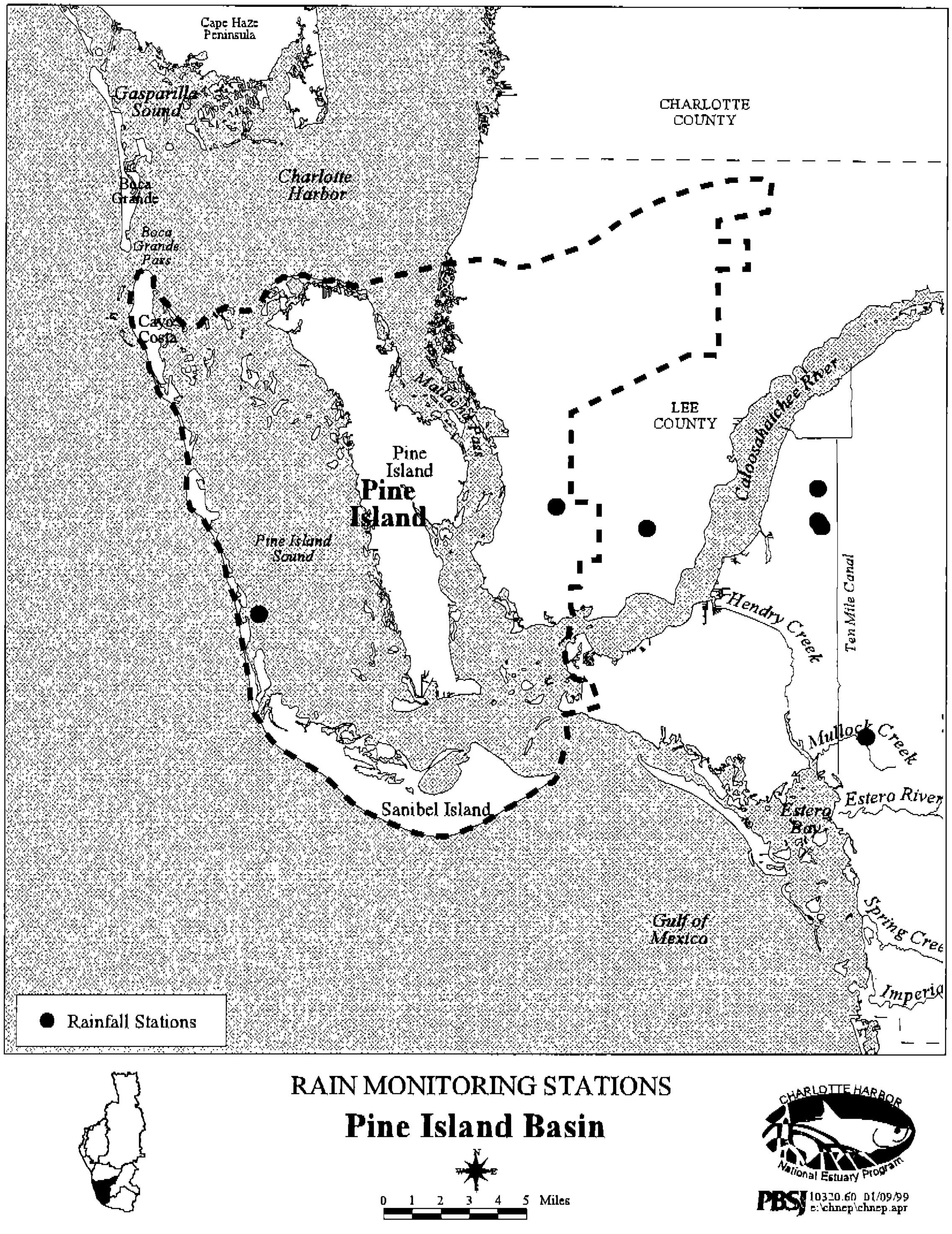
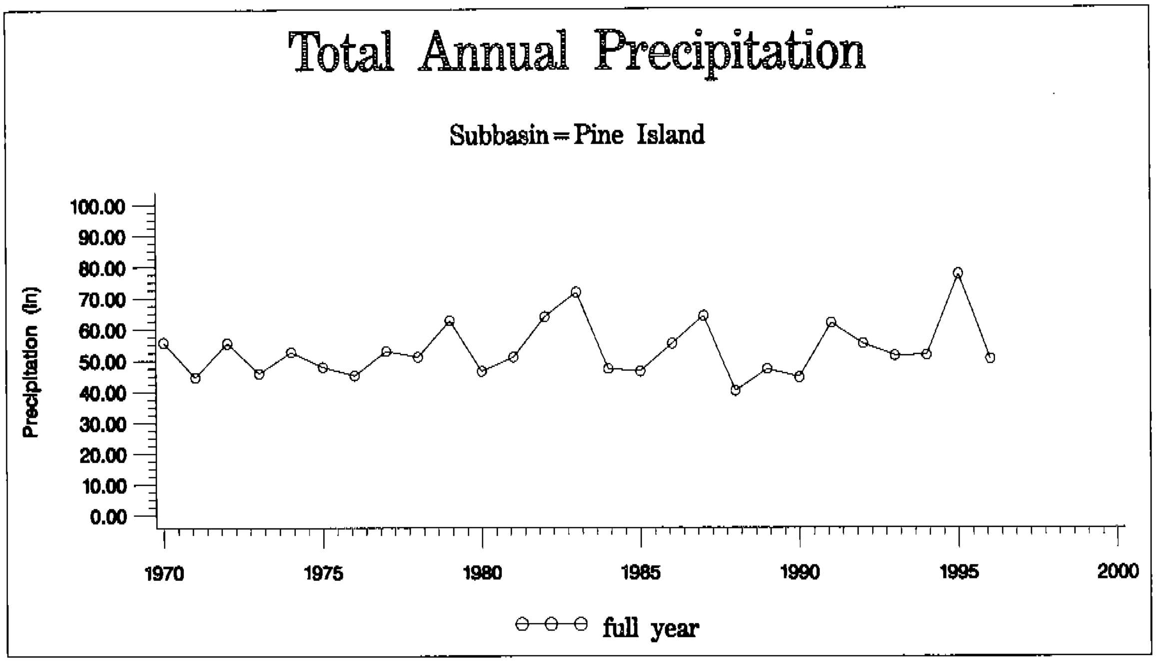


Figure 6-3. Rain station locations in the Pine Island/ Matlacha Pass Basin.



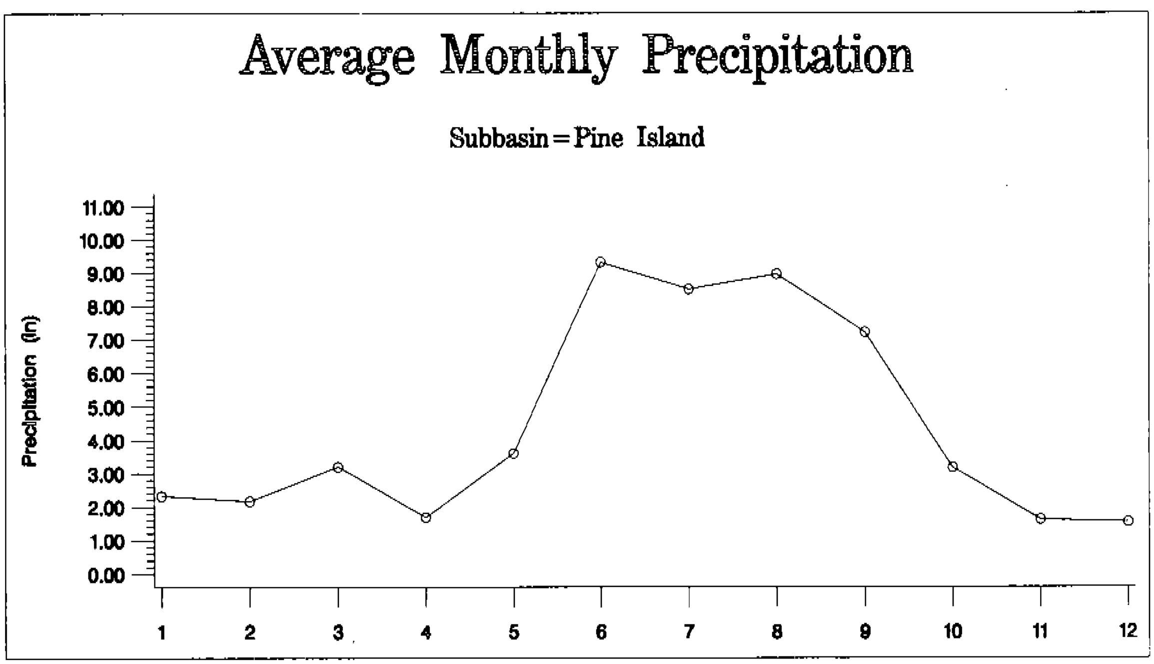


Figure 6-4. Total annual and monthly rainfall plots for the Pine Island/ Matlacha Pass Basin.

6.1.3 Existing and Future Land Use

Existing and future land use acreages are presented in Tables 6-2 and 6-3. Existing and future land use maps are presented in Figures 6-5 and 6-6.

Land use classification systems for existing and future land use GIS coverages for the Charlotte Harbor NEP area are not consistent. Existing Land Use Coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SFWMD) land use data. Land Use data from SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We assigned new codes which make the SFWMD and SWFWMD land use classification systems comparable for this project.

Future Land Use Coverages for the Charlotte Harbor NEP were developed by Southwest Florida Regional Planning Council (SWFRPC). SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions.

The FLUM uses a different and much simpler, land use classification system than either of the existing land use coverages and does not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). As a result, residential areas may increase tremendously under future scenarios because existing development is not taken into account. Direct comparisons between acreages of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category.

6.1.3.1 Existing Land Use

Existing land use in the basin is primarily urban (14%) and non-agricultural land use such as range lands (34%), forested uplands (17%), and saltwater wetlands (22%). Agricultural land use makes up only 3% of the existing land use acreage in the basin. Existing residential land use comprises only about 8% of the basin. Barren lands (0.6%) and mining (0.2) make up very little of the land use in the Pine Island/ Matlacha Pass Basin.

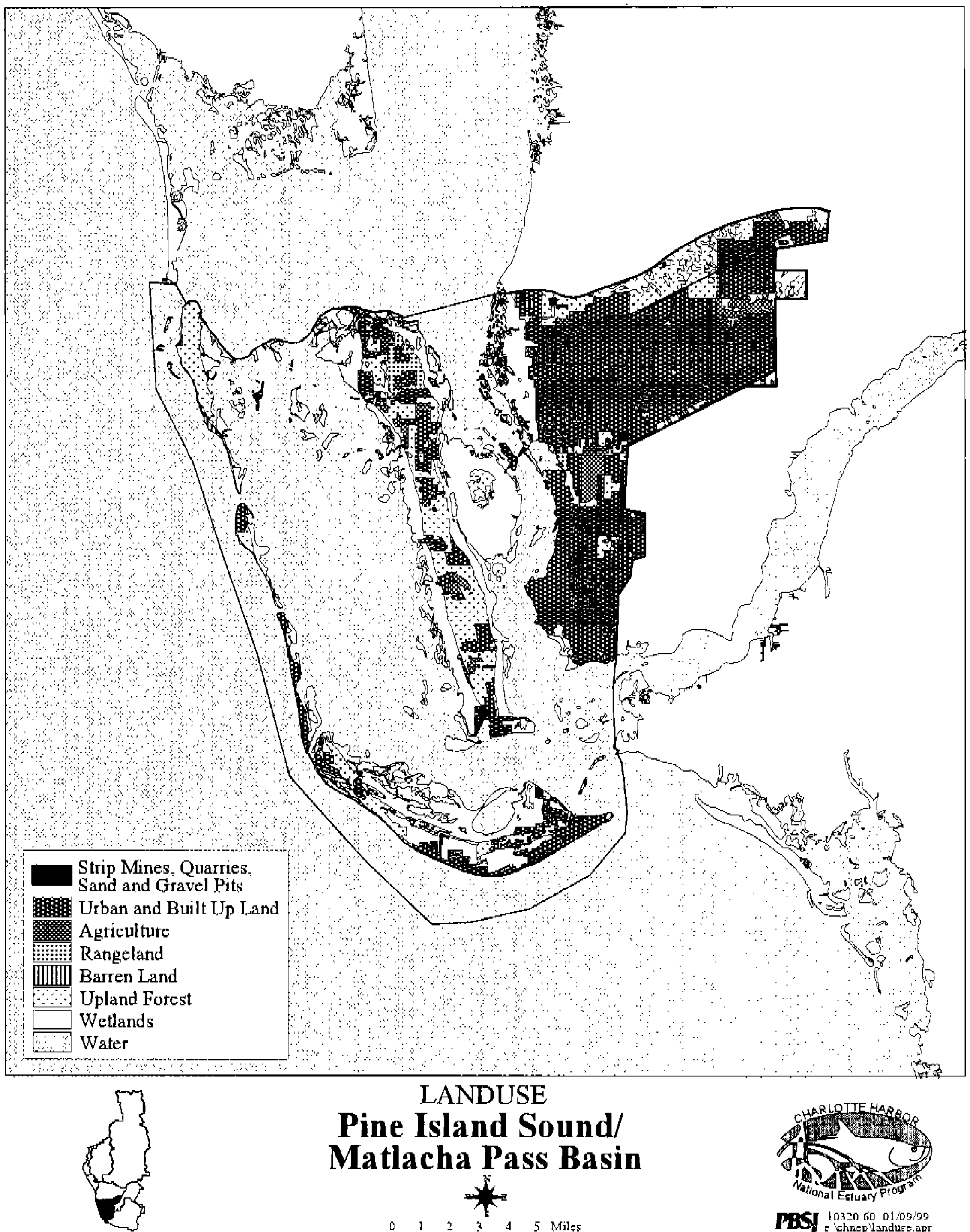


Figure 6-5. Existing land use map (SWFRPC, 1990) for the Pine Island/ Matlacha Pass Basin.

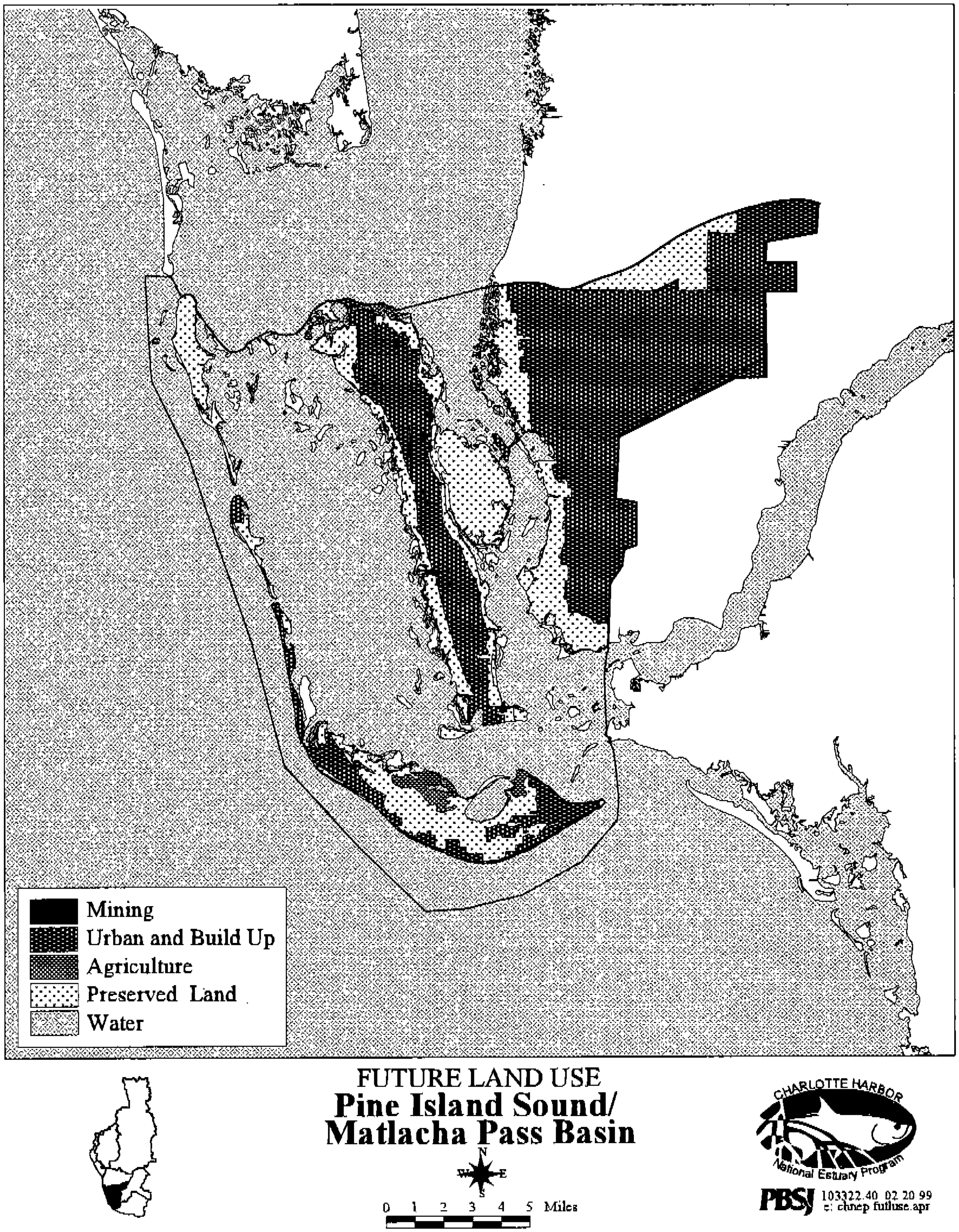


Figure 6-6. Future land use map (SWFRPC, 1990) for the Pine Island/ Matlacha Pass Basin.

Table 6-2. Current (1990) land use/cover in the Pine Island/Matlacha Pass Basin.

Land Use/Cover	Acres	%
Single Family Residential	3,506	4.0
Medium Density Residential	2,888	3.3
Multi-family Residential	834	0.9
Commercial	374	0.4
Industrial	4,559	5.2
Mining	167	0.2
Institutional	263	0.3
Range Lands	29,736	33.8
Barren Lands	541	0.6
Pasture	1,997	2.3
Groves	417	0.5
Feedlots	12	< 0.1
Nursery	130	0.1
Row and Field Crops	157	0.2
Upland Forested	14,591	16.6
Freshwater - Open Water	4,502	5.1
Saltwater - Open Water	0	0.0
Forested Freshwater Wetland	1,652	1.9
Saltwater Wetland	19,107	21.8
Non-forested Freshwater Wetland	2,415	2.7
Tidal Flats	0	0.0
TOTAL	87,848	100.0

6.1.3.2 Future Land Use

The predominant change in the basin under future land use plans include an increase to 51% urban land use from non-agricultural land use such as those described above. Conversions to urban are almost completely predicted to result from increases in single family residential (48%). No change in agricultural land use is predicted by the SWFRPC future land use maps.

Table 6-3. Future (2010) land use/cover in the Pine Island/Matlacha Pass Basin.

Land Use/Cover	Acres	%
Single Family Residential	44,511	48
Multi-family Residential	354	< 1
Rural Residential	3,121	3
Commercial	3,159	3
Industrial	7,749	8
Mining	0	0
Agricultural	0	0
Protected Resource	33,811	36
TOTAL	93,100	100

6.1.4 Surface Water Hydrology and Water Management

There are no streamflow gages in the Pine Island Sound/ Matlacha Pass Basin. Hydrologically, runoff and rainfall provide the major freshwater inputs directly to the Pine Island Sound area.

6.1.4.1 Urban Management Practices

The urbanized areas of the Pine Island Sound/Matlacha Pass Basin are found primarily on Sanibel Island and in the Cape Coral region, with some urban land uses on Pine Island. The discussion of urban management practices is divided into urban water uses and urban water discharges, including reuse. The water uses and water discharges are tabulated in the following descriptions.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. Discussion of water use is limited to facilities with an average permitted quantity greater than 0.5 MGD. Water use information for those parts of the CHNEP study area within the borders of the SFWMD is from SFWMD (1994). The Pine Island Sound/Matlacha Pass Basin is entirely within the SFWMD.

- Public Supply

Table 6-4 shows the public water supply facilities in the Pine Island Sound/Matlacha Pass Basin with permitted withdrawals of more than 0.5 MGD, as well as the withdrawal sources for the facilities. A discussion of the populations served by each plant, withdrawal amounts, and withdrawal methods follows.

Table 6-4. Public water supply facilities in the Pine Island Sound/Matlacha Pass Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
Cape Coral	11.59	Lower Hawthorn aquifer
Greater Pine Island Water Assoc.	1.31	Lower Hawthorn aquifer
Island Water Association	4.08	Lower Hawthorn, Suwannee aquifer

The Cape Coral water treatment plant withdraws from the Lower Hawthorn aquifer via 23 wells having depths of 642-900 feet, located between SR 78 and Cape Coral Blvd. The wells have individual withdrawal capacities of 200 to 850 GPM, and provide the permitted average of 11.59 MGD. An additional well was to be drilled in 1993, and is already covered by the permit for the utility. Average flow during 1990 was 8.44 MGD (SFWMD, Vol III, 1994).

The Greater Pine Island Water Association withdraws from theLower Hawthorn aquifer, with three wells having depths between 737 and 770 feet. The wells have individual capacities of 825 GPM. The permitted average withdrawal is 1.31 MGD, with an average flow of 0.88 MGD in 1990 (SFWMD, Vol III, 1994).

The Island Water Association withdraws from theLower Hawthorn and Suwannee aquifers via 19 wells on Sanibel Island. The wells have depths of 574-770 feet, and capacities of 30-525 GPM. Three of the wells are reserves, with another described as standby. The permitted average withdrawal is 4.08 MGD. In 1990, average flow was 3 MGD, with 0.53 MGD of this coming from theLower Hawthorne aquifer, and the remainder from the Suwannee aquifer. Three additional wells were permitted, and drilling was to occur in 1995 (SFWMD, Vol III, 1994).

- Mining

Mining makes up very little of the land use (0.2%) in the Pine Island/ Matlacha Pass Basin.

- Industrial

There are 4,559 acres of industrial land use found in the Pine Island Sound/Matlacha Pass Basin, according to the SFWMD 1988 land use coverage. This accounts for 5% of the total basin area. The total water demand for industrial self-supplied facilities was 31.3 MGD for 1990 (SFWMD, 1994), although the locations of the facilities are unknown.

- Recreational

In Lee County, landscape water demand for 1990 was 23.5 MGD, and golf course water use was 17.2 MGD, for a total water use demand of 40.7 MGD (SFWMD, 1994) for the entire county.

Water Discharge and Reuse

There are two major domestic waste water treatment plants in the Pine Island Sound/Matlacha Pass Basin. The Cape Coral Southwest WWTP is a 7.0 MGD AWT plant with reclaimed water disposal via the Water Independence for Cape Coral (WICC) program. The WICC program distributes water throughout Cape Coral for residential lawn and other green space irrigation, with approximately 10,000 properties connected to the system (SFWMD, Vol III, 1994). The Sanibel Island WWTP is a 1.25 MGD with effluent used for golf course irrigation and discharged to percolation ponds. Reclaimed water is used by the Beachview and Dunes Golf Club courses. Average flows for 1990 were 0.56 MGD.

6.1.4.2 Agricultural Management Practices

The Pine Island Sound/Matlacha Pass Basin consists mainly of range lands (34%), saltwater wetlands (22%), and forested uplands (17%) (Table 6-2). Agricultural land uses found are pasture (1997 acres), groves (417 acres), row and field crops (157 acres), nurseries (130 acres), and confined feeding operations (12 acres). The basin contains approximately 87,848 acres (137 square miles), all in Lee County.

Agricultural land use estimates for all major crops for 1990 in Lee County are shown in Table 6-5, as well as estimates of irrigated acreages for each of these crops and estimated water use.

Table 6-5. 1990 estimated crop acreages, irrigation types, and water use in Lee County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Citrus	9,692	Overhead Seepage	4,846 4,846	28.5
Tropical Fruit	1,680	Seepage	1,512	4.8
Vegetables	9,785	Seepage	9,785	23.0
Nursery	606	Overhead	606	2.8

Table 6-5. 1990 estimated crop acreages, irrigation types, and water use in Lee County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Sod	650	Seepage 650	3.0
Pasture	118,000	Cattle Watering	0.2
Totals	140,413	Overhead 5,452 Seepage 16,793	62.3

6.2 Water Quality Conditions

No comprehensive data were identified which allowed a comprehensive assessment of long-term and current water quality conditions either during the development of the "Compendium of Existing Information" or while compiling background data for this subsequent report.

6.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) was estimated for each major basin and subbasin by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to assign priority to major basins and subbasins. Thus, the method of development was focused on estimating relative loads in a consistent manner among subbasins to avoid biasing the basin or subbasin evaluation.

The detailed rainfall, 1988 SFWMD land cover, SWFWMD 1990 land cover, and USDA soil data were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow was used to discharge it from the basin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TN, TP and TSS loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, feedlots, row and field crops, and nursery. Undeveloped land uses were defined as range lands, barren lands, upland forests, and wetlands.

6.3.1 Load Estimates Pine Island Sound/Matlacha Pass Basin

This basin was estimated to have one of the smallest contributing areas among the major basins of the study area. The 88,000 acres contributed a total estimated annual runoff discharge of 96 million cubic meters. The estimated annual pollutant loads were 260 tons of TN, 76 tons of TP, and 4,528 tons of TSS.

Most (75%) of the hydrologic load from this subbasin was estimated to be discharged from undeveloped lands. In particular, these loads were from upland forests. Table 6-6 presents the loads from runoff by land use.

Developed urban and agricultural lands contributed the remaining 25% of the total hydrologic load. The 12,000 acres of urban land contributed 39 million cubic meters of runoff, 77 tons of TN, 12 tons of TP, and 2,935 tons of TSS. The 3,000 acres of agricultural land contributed 3 million cubic meters of runoff, 10 tons of TN, 3 tons of TP, and 53 tons of TSS. These lands were primarily comprised of medium and low density residential land uses.

Table 6-6. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Pine Island Sound Basin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	10	4%	2	2%	99	2%	4,965,225	5%
Medium Density Residential	16	6%	2	3%	234	5%	6,269,347	7%
High Density Residential	6	2%	1	1%	188	4%	2,649,170	3%
Commercial	3	1%	0	1%	138	3%	1,696,843	2%
Industrial	40	15%	7	9%	2,239	50%	21,673,867	23%
Mining	1	0%	0	0%	27	1%	486,604	1%
Institutional, Transport., Util.	1	0%	0	0%	9	0%	766,570	1%

Table 6-6. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Pine Island Sound Basin.

Range Lands	102	39%	51	67%	513	11%	35,603,243	37%
Barren Lands	2	1%	0	0%	21	1%	1,900,059	2%
Pasture	6	2%	2	3%	20	1%	2,165,346	2%
Groves	1	0%	0	0%	5	0%	449,747	1%
Feedlots	1	1%	0	0%	3	0%	56,442	0%
Nursery	1	0%	0	0%	14	0%	229,480	0%
Row and Field Crops	1	0%	0	1%	10	0%	272,084	0%
Upland Forests	69	27%	10	13%	1,006	22%	16,542,563	17%
TOTAL	260	100%	76	100%	4,528	100%	95,726,592	100%

6.3.2 Pollution Source Inventory

The purpose of this compilation of a point source inventory for the Pine Island Sound/Matlacha Pass Basin is to describe the numbers, locations, and discharge capacities of domestic and industrial point sources within the Pine Island Sound/Matlacha Pass Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources, as discussed previously.

Wastewater treatment plant discharges for those plants in the Pine Island Sound/Matlacha Pass Basin with greater than 0.5 MGD in the SFWMD (SFWMD, 1994) were previously discussed. The following discussion uses only the FDEP databases, as previously described.

The FDEP databases list 57 domestic point sources and seven industrial point sources within the basin (Tables 6-7 and 6-8). All of the domestic and industrial point sources are in Lee County (Figure 6-7).

Domestic point sources discharge capacities total 10.63 MGD, with 3.65 MGD of this sent to reuse. Of the total 10.63 MGD, 6.6 MGD from one water reclamation plant has no receiving body listed. Industrial point sources have a total discharge capacity of 3.34 MGD, with 0.04 MGD for reuse and 1.8 MGD disposed of 600 feet offshore in the Gulf of Mexico.

Table 6-7. Domestic point sources in the Pine Island Sound Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
MATLACHA PACKAGE PLANT	Lee	0.15	Percolation Ponds
MARINER HIGH SCHOOL	Lee	0.05	Percolation Ponds
PINE ISLAND ELEM./MIDDLE SCHOOL	Lee	0.01	Drainfield
DONAX WATER RECLAMATION FACILITY	Lee	1.6	Spray Irrigation

Table 6-7. Domestic point sources in the Pine Island Sound Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
SOUTHWEST WATER RECLAMATION FAC.	Lee	6.6	
SUMMERLIN GATEWAY/SUMMERLIN SQUARE	Lee	0.05	
VILLAS APARTMENTS OF SANIBEL	Lee	0.01	Drainfield
JERRY'S RESTAURANT	Lee	0.01	
PLAZA CENTRAL/TIMBERS RESTAURANT	Lee	0.01	Drainfield
PINE ISLAND SHOPPING CENTER	Lee	0.02	Percolation Ponds
LAKE FAIRWAYS/FFEC-SIX	Lee	0.3	Percolation Ponds/Spray Irrigation
SUNSET CAPTIVA W. W. T. P.	Lee	0.03	Drainfield
PUNTA RASSA CONDOMINIUMS	Lee	0.05	Drainfield
JANTHINA CONDOMINIUMS	Lee	0	Drainfield
CAPTIVA SHORES CONDOMINIUM	Lee	0.01	Drainfield
CORALWOOD VILLAGE	Lee	0.01	Percolation Ponds
FISHERMAN'S WHARF CONDOMINIUM	Lee	0.01	Drainfield
FOUNTAINVIEW R.V. CONDO PARK	Lee	0.07	Percolation Ponds
BOCILLA ISLAND CLUB	Lee	0.03	
CAPE CORAL MOOSE LODGE, #2199	Lee	0.01	
USEPPA INN & DOCK CO.	Lee	0.03	Percolation Ponds
TARA WOODS	Lee	0.1	Percolation Ponds
TWISTEE TREAT	Lee	0.03	
FOUR WINDS MARINA	Lee	0.01	
BELLINI'S RESTAURANT	Lee	0.02	
NORTH CAPE INDUSTRIAL PARK	Lee	0.02	Percolation Ponds
BLUE CRAB KEY	Lee	0.04	Absorption Fields
VILLAGES OF PINE ISLAND	Lee	0.04	Percolation Ponds
ISLES OF PINES SUB-DIVISION	Lee	0.01	
SEA OATS S/D	Lee	0.02	Percolation Ponds
SAFETY HARBOR CLUB VILLAGE	Lee	0.02	
PINE ISLAND COVE	Lee	0.05	Percolation Ponds
BREAKER'S WEST CONDO.	Lee	0.01	Drainfield
JONATHAN HARBOUR	Lee	0.04	
WEST WIND INN	Lee	0.02	Drainfield
SANIBEL CENTER BUILDING	Lee	0	Percolation Ponds
TAHITIAN GARDENS SHOPPING CENTER	Lee	0.01	Drainfield
SANIBEL BAYOUS UTILITIES, INC.	Lee	0.08	Percolation Ponds
TROPIC ISLES RV RESORT	Lee	0.02	Percolation Ponds
GULF PINES SUBDIVISION	Lee	0.03	Retention Pond

Table 6-7. Domestic point sources in the Pine Island Sound Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
RAINTREE R. V. RESORT	Lee	0.03	Spray Irrigation/ Dual Absorption
SEA SHELLS OF SANIBEL	Lee	0.02	Drainfield
TWEEN WATERS INN	Lee	0.04	Drainfield
CAPTAIN'S COVE	Lee	0.03	Drainfield
SUNSEEKERS R. V. PARK	Lee	0.05	Drainfield
NUTMEG VILLAGE	Lee	0.02	Drainfield
SEAGULL BAY	Lee	0.01	
WULFERT POINT AWWT	Lee	0.13	
ATRIUM CONDO.	Lee	0.01	
ISLAND INN	Lee	0.01	Drainfield
ENVIRONMENTAL SYSTEMS OF PINE ISLAND	Lee	0.1	Percolation Ponds
JOLLY ROGER RESORT MOTEL	Lee	0.01	Drainfield
GUMBO LIMBO ENTERPRISES	Lee	0.01	Retention Pond
PINE ISLAND KOA	Lee	0.03	Percolation Ponds
SOUTH SEAS PLANTATION	Lee	0.45	Percolation Ponds/Spray Irrigation
SHALIMAR	Lee	0.03	Percolation Ponds
PINK CITRUS TRAILER PARK	Lee	0.02	Drainfield

Table 6-8. Industrial point sources in the Pine Island Sound Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
THE CENTER, INC.	Lee	.	Percolation Ponds
ISLAND WATER ASSOC-SANIBEL ISL	Lee	1.8	Gulf 600 ft offshore
CAPE CORAL REV OSMOSIS WTP	Lee	1.2	
GREATER PINE ISLAND R/O TREATMENT PLANT	Lee	0.27	
U AUTO WASH	Lee	0.04	None -Recycled
USEPPA INN & DOCK	Lee	0.03	
BURGESS ISLAND ASSOCIATES, INC	Lee	0	

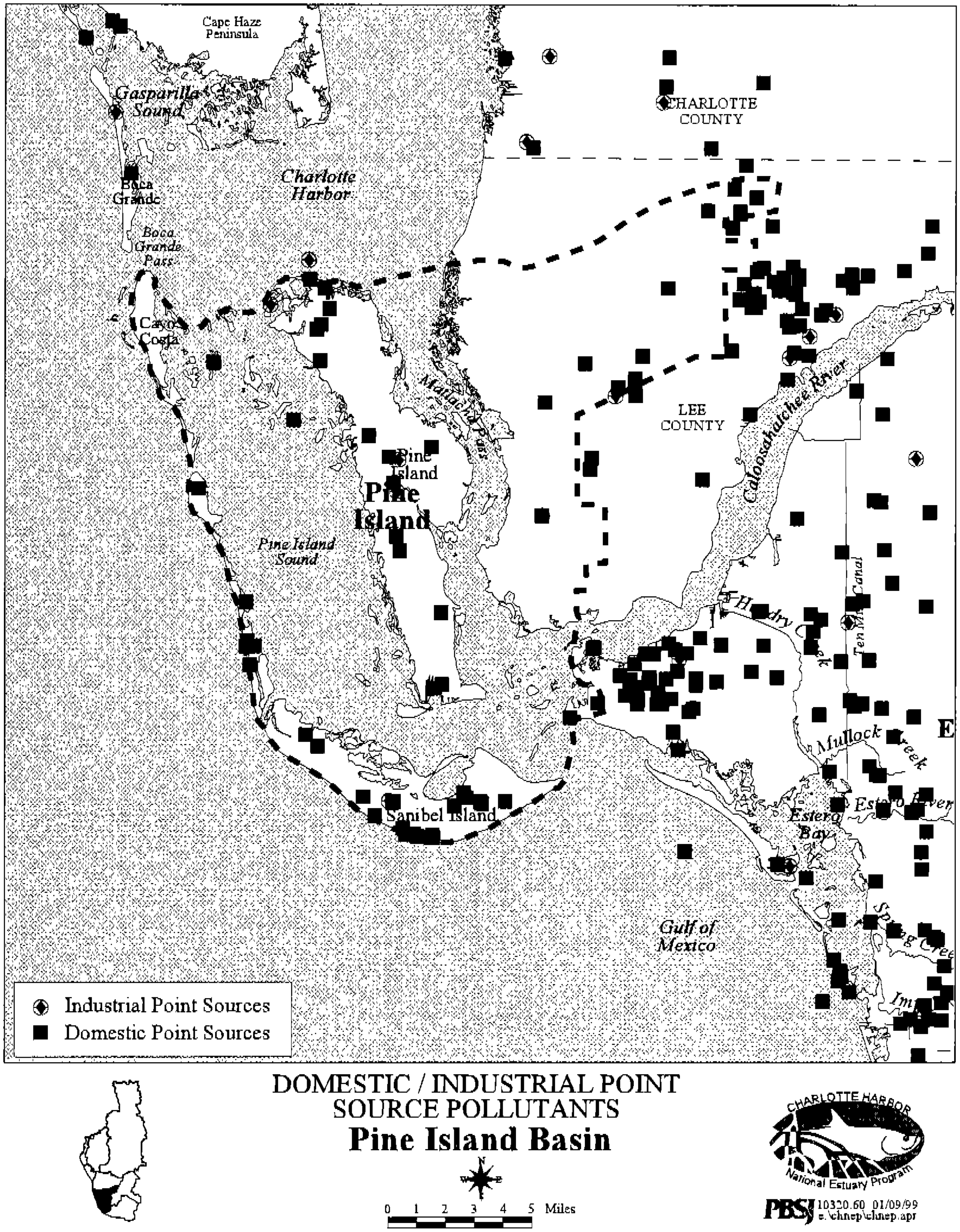


Figure 6-7. Location of domestic and industrial point sources in the Pine Island Sound/Matlacha Pass Basin.

7. Tidal Caloosahatchee River

This chapter presents a compilation and synthesis of information regarding the Tidal Caloosahatchee Basin portion of the Charlotte Harbor NEP area (Figure 7-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

7.1 Physical Setting

The Tidal Caloosahatchee River Basin includes portions of central Lee County and southeastern Charlotte County. The Tidal Caloosahatchee River Basin is divided into three subbasins, the Telegraph Swamp Subbasin, the Lower Caloosahatchee Subbasin, and the Orange River Subbasin. The tidal portion of the Caloosahatchee River extends from its mouth in San Carlos Bay, east of Sanibel Island and the southern end of Pine Island, to the S-79 Structure (Franklin Lock and Dam), east of Olga. Along the tidal river are the major urban centers of Ft. Myers and Cape Coral. The Orange River drains to the Caloosahatchee River downstream of Olga.

The water levels and flows in the Caloosahatchee River upstream of the Franklin Lock and Dam provide water level maintenance for Lake Okeechobee, as well as local drainage and flood control, irrigation and municipal water supply, navigation, and salinity management. Upstream of the Franklin Lock and Dam is the freshwater portion of the river, which has been channelized and is known as the C-43 Canal. Water levels and flows in the C-43 Canal are regulated by the Ortona Lock (S-78) and the Moore Haven Lock and Dam (S-77) at Lake Okeechobee.

7.1.1 Physiography

This section describes the topography, geology, soils, and land use in the Tidal Caloosahatchee River Basin.

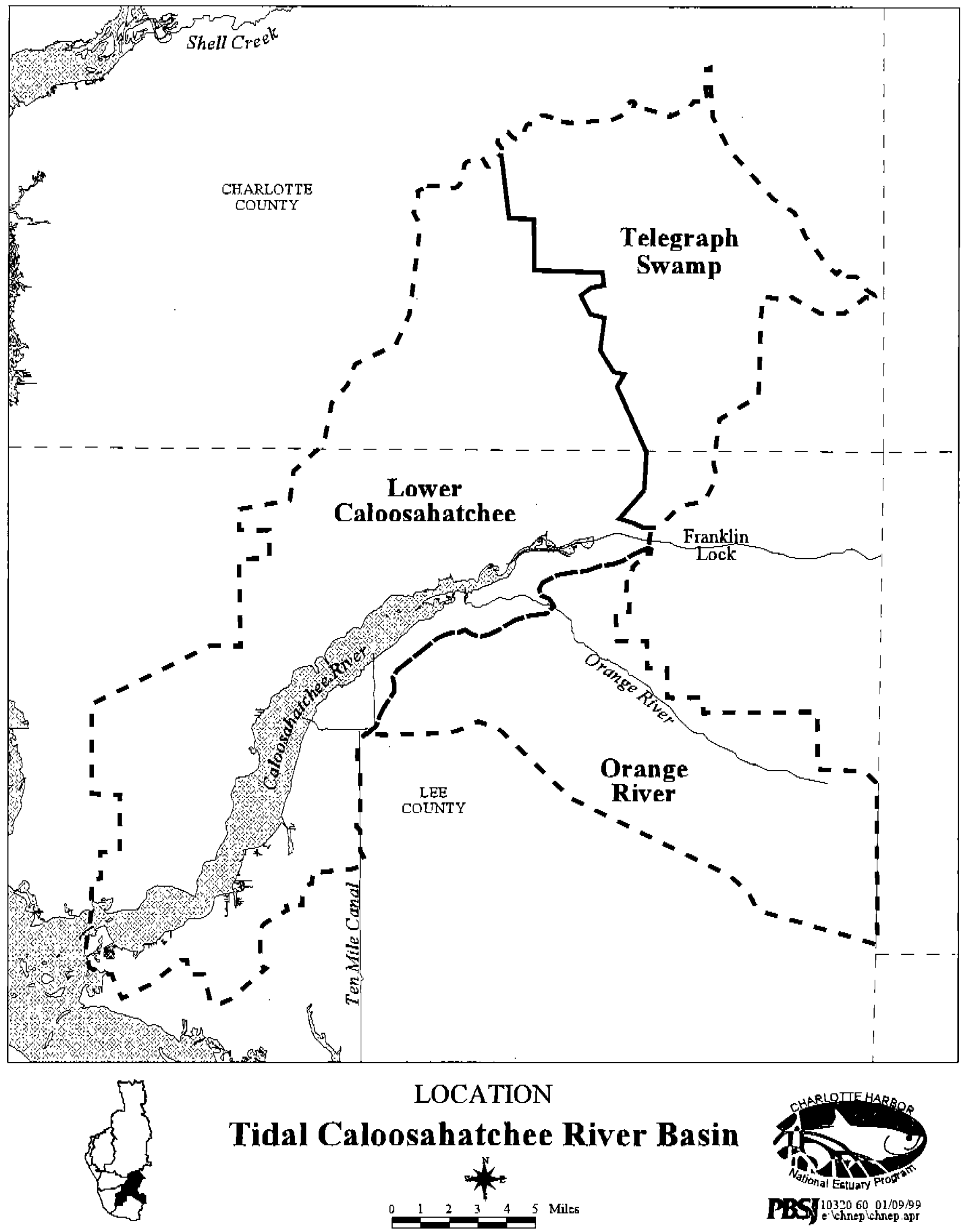


Figure 7-1. Location of the Tidal Caloosahatchee Basin and associated subbasins within the Charlotte Harbor NEP study area.

7.1.1.1 Topography

The Caloosahatchee Valley through which the tidal Caloosahatchee River flows, rises less than fifteen feet in elevation through Lee, Hendry, and Glades counties. The Caloosahatchee River Basin includes a portion of the Immokalee Rise to the southwest of the river. The Rise is generally twenty five feet in elevation, but in some areas it peaks at thirty-five and forty-two feet. The Caloosahatchee River was originally a shallow, meandering stream with headwaters near Lake Hicpochee. Historically, the river went dry during the dry season and the saltwater front moved upstream to the point of the existing Ortona Lock. The flat terrain and extensive drainage canal network leave the drainage divides ill-defined. Land-surface elevations reach a maximum of about 75 above MSL near the divide between the Peace and Caloosahatchee River basins. The land surface then slopes gradually over a distance of about 70 miles, from about 25 feet above MSL at Moore Haven to sea level at Charlotte Harbor.

7.1.1.2 Geology

The Caloosahatchee River is hydraulically connected only to the surficial aquifer system (USGS, 1988) and is a major discharge area for groundwater from the surficial aquifer system. The banks and riverbed along most of the downstream reach are composed of relatively impermeable clay and marl, which tend to prevent lateral or downward seepage from the river channel.

The Caloosahatchee River basin occurs predominantly within the Caloosahatchee Valley physiographic province, with portions of the Gulf Coastal Lowlands (described in section 2.0, above) to the north and the Immokalee Rise to the southeast. The Immokalee Rise occupies most of Hendry County, northern Collier County, and part of eastern Lee County and has a sandy surface underlain by clay, shell, and limestone deposits. It is generally twenty-five feet in elevation, but in some areas peaks at thirty-five and forty-two feet. The Immokalee Rise, formed as a marine shoal approximately 100,000 years ago, can be delineated by a number of small solution lakes at its borders.

7.1.1.3 Soils

Tidal Caloosahatchee River basin soils, like most of the Charlotte Harbor watershed, are predominantly flatwoods and sloughs soils (approximately 75%) with barrier island and tidally influenced soils in the coastal areas. There are large areas of artificially created Matlacha soils of shell and limestone fragments and smaller portions of tidal and barrier island soils at the mouth of the river. The tidal areas and barrier islands are composed of sandy Canaveral-Captiva-Kesson and more organic Peckish-Estero-Isles soil complexes which are very poorly to moderately well drained sand and muck soils.

Interior to the coast, swamp and sloughs soils are made up of Isles-Boca-Pompano soils over limestone. Flatwoods soils dominated by Immokalee-Myakka, Malabar-Oldsmar-Immokalee, and Wabasso-Pineda-Boca complexes are the most common series in the basin. The soils are nearly level with 0-2% slopes, are poorly drained, and have sandy soils with sandy or loamy subsoils.

In the northeastern portion of the watershed, soils characteristic of swamps, marshes, and slough soils are prevalent. Pineda-Floridana-Gator and Chobee-Felda-Pineda soils are nearly level with smaller slopes (0-1%), and are even more poorly drained when compared with the flatwoods soils.

The patterns in HSG designations for the Caloosahatchee River basin (Figure 7-2) are similar to those described for the Myakka and Peace River basins, above, although the HSG-designated B soils make up a larger proportion of the soils when compared with the other basins. Approximately 80% of the soils in the watershed are B soils (fairly well-drained), much of the acreage for this grouping results from the artificial drainage features in the basin (Table 7-1). D soils include less than 12% of the soils in the basin (poorly drained), while less than 1% fall into the A grouping (well-drained) and less than 9% fall into the C grouping (less well-drained).

Table 7-1. Hydrologic soil types in the Tidal Caloosahatchee River Basin.

Soil Type	Telegraph Swamp		Orange River		Lower Caloosahatchee	
	Acres	%	Acres	%	Acres	%
A	161	0.4	0	0.0	480	0.4
B	32,785	85.9	52,278	85.3	100,657	76.1
C	89	0.2	2,861	4.7	16,083	12.2
D	5,111	13.4	6,153	10.0	14,981	11.3
TOTAL	38,145	100.0	61,292	100.0	132,201	100.0

7.1.2 Rainfall

Data from twelve rainfall gages were used in calculating total annual rainfall since 1970 in the Tidal Caloosahatchee River Basin (Figure 7-3). Regional long-term rainfall data were available for calculating rainfall in the basin. Additional rainfall gauging stations occur throughout the SFWMD and resulted in more rainfall gauges in basins that occur in the SFWMD boundaries. Total annual precipitation and average monthly precipitation (Figures 7-4 through 7-6) were plotted for the basin.

The Tidal Caloosahatchee Basin appeared to have somewhat higher annual rainfall totals than other basins within the SFWMD boundaries. Total annual precipitation ranged from approximately 40 inches of rain to 80 inches of rain in 1995. Similar to other basins, peak annual precipitation

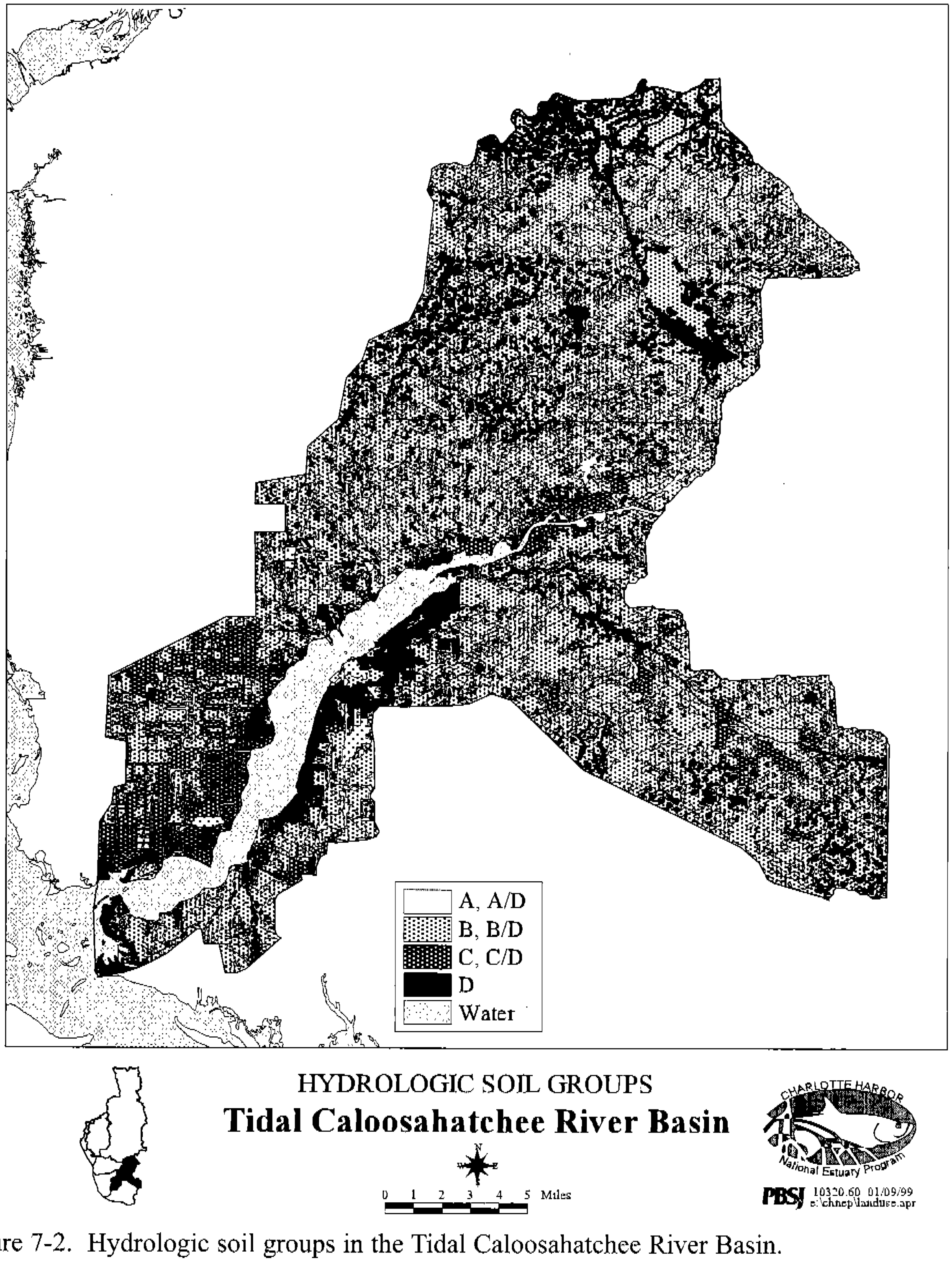


Figure 7-2. Hydrologic soil groups in the Tidal Caloosahatchee River Basin.

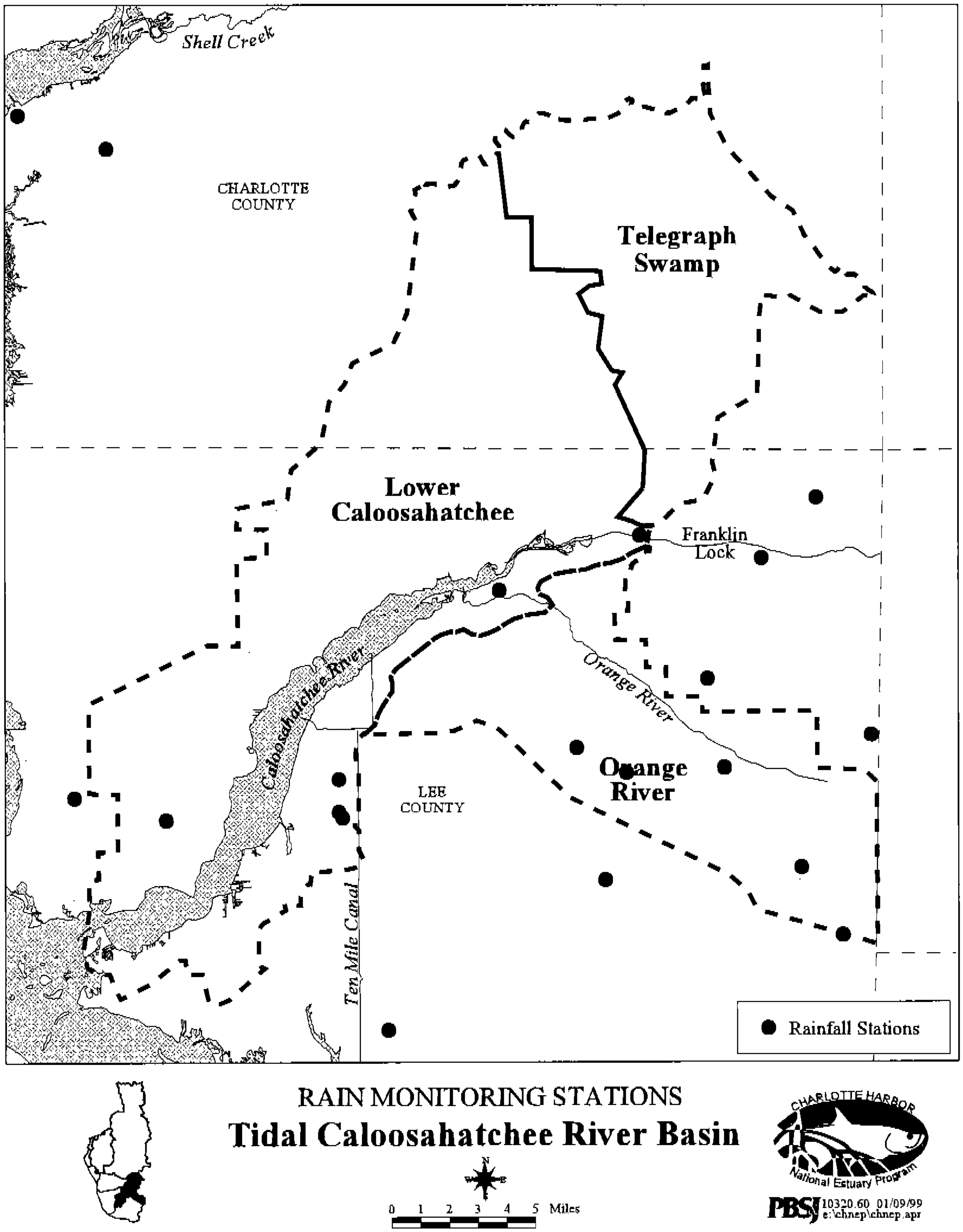
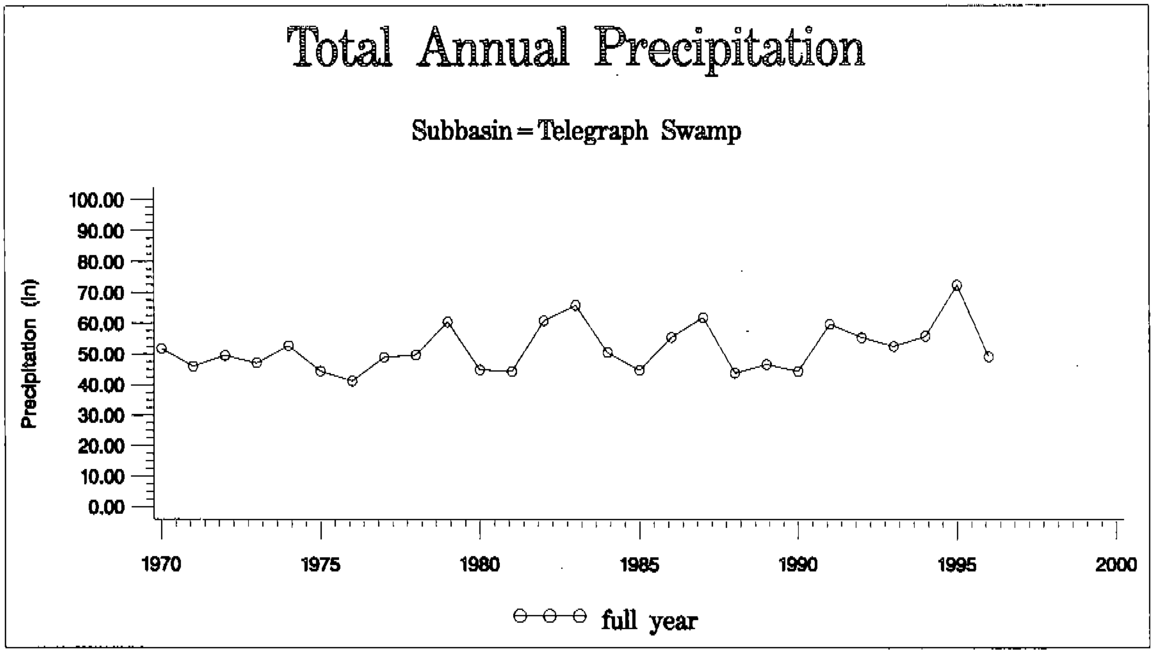


Figure 7-3. Rain gage locations in the Tidal Caloosahtchee River Basin.



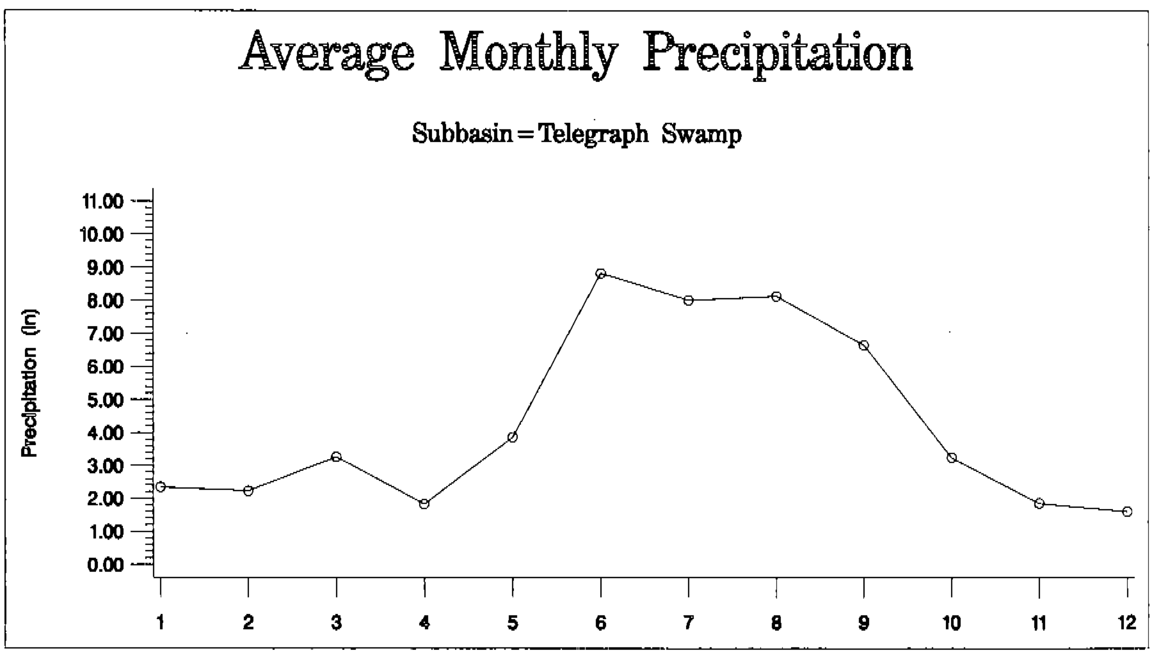
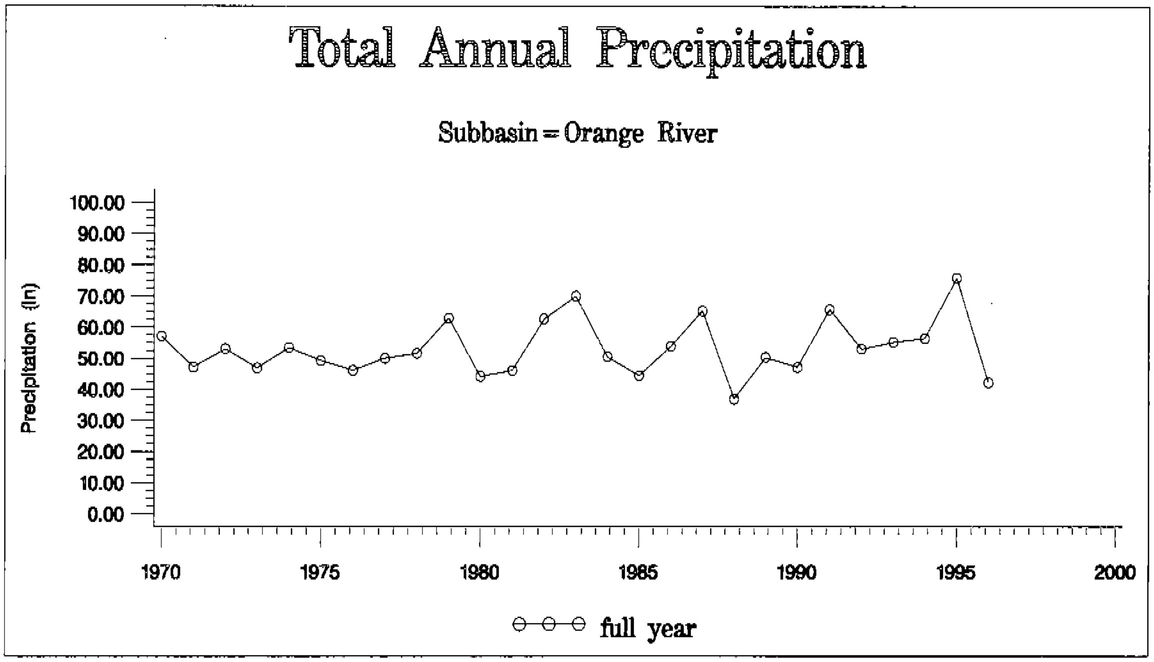


Figure 7-4. Total annual and average monthly rainfall plots for the Telegraph Swamp subbasin.



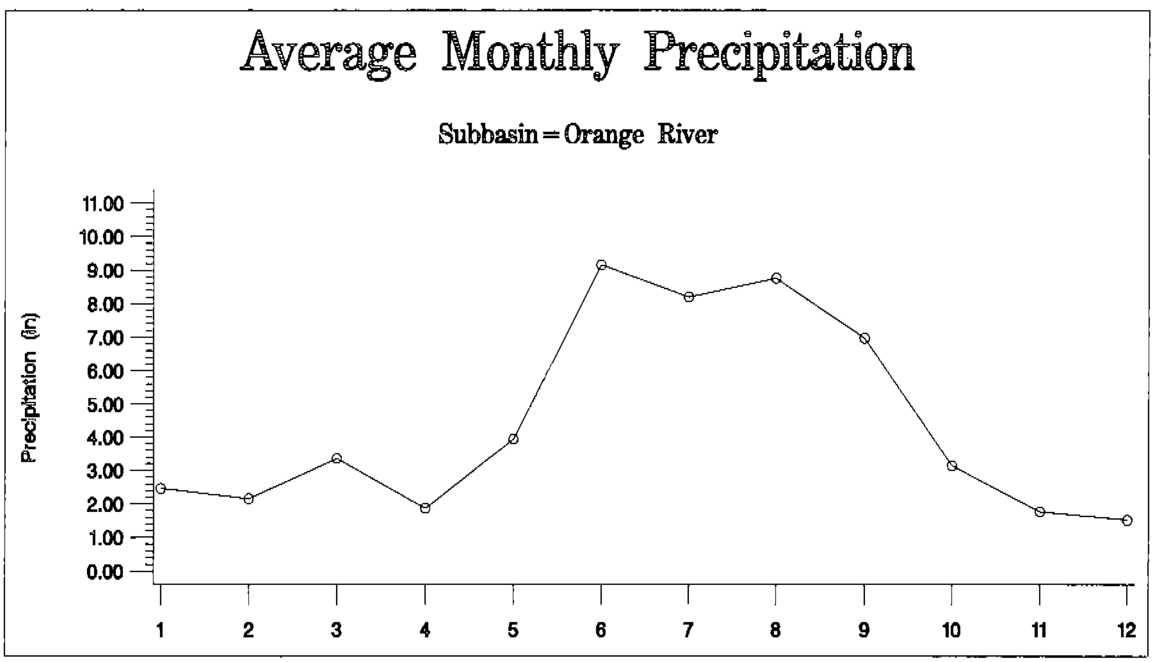
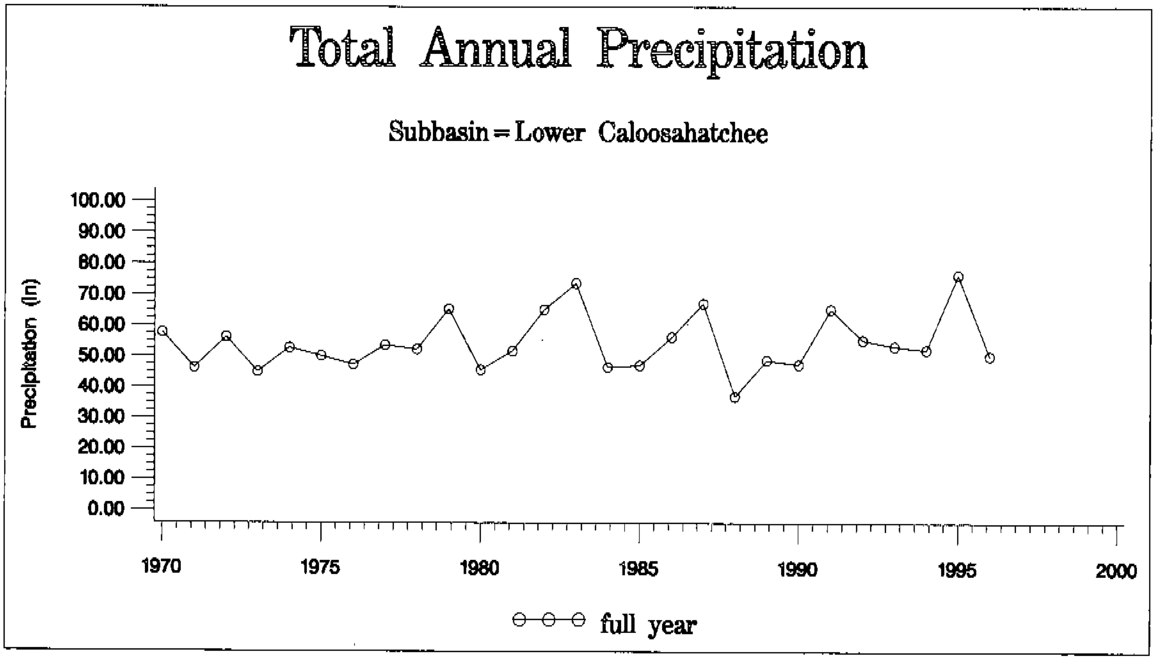


Figure 7-5. Total annual and average monthly rainfall plots for the Orange River subbasin.



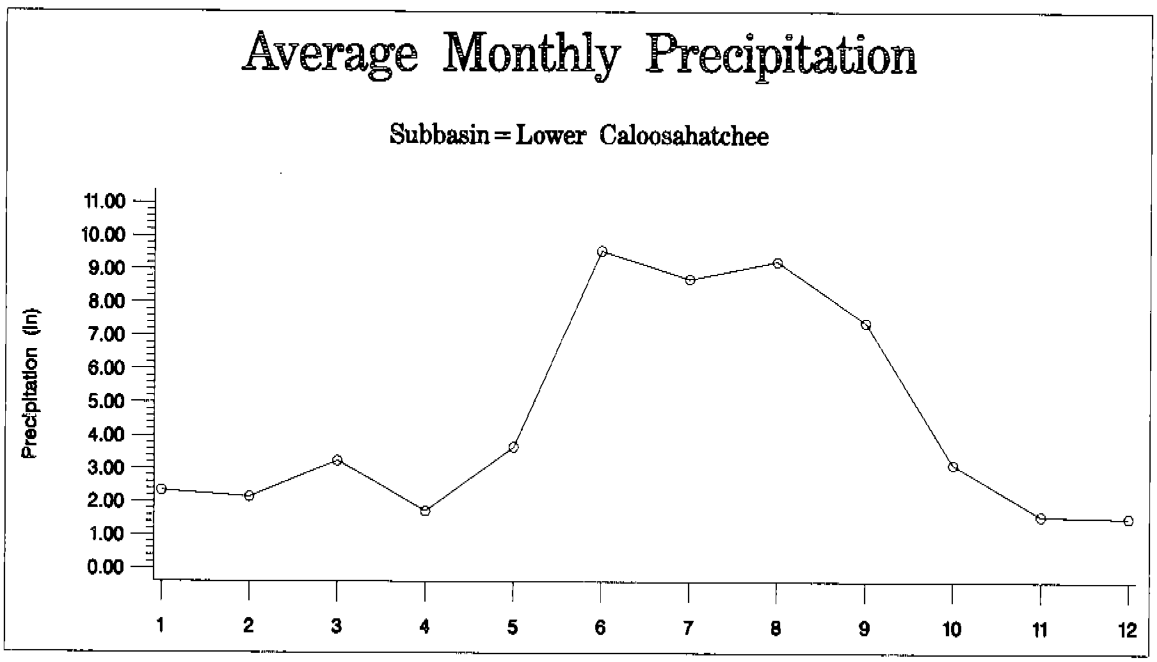


Figure 7-6. Total annual and average monthly rainfall plots for the Lower Caloosahatchee subbasin.

occurred during 1983 and 1995. Within-year rainfall patterns were similar to those observed in other basins.

7.1.3 Existing and Future Land Use

Existing land use acreages for Tidal Caloosahatchee River Basin are presented in Table 7-2 and future land use acreages are presented in Tables 7-3. Existing and future land use maps are presented in Figures 7-7 and 7-8, respectively. Land use data were obtained from SWFWMD, SFWMD, and the Southwest Florida Regional Planning Council (SWFRPC). Although other sources of data were available for various portions of the Charlotte Harbor NEP study area, these data sources provide a complete and consistent coverage for the entire study area.

Land use classification systems for existing and future land use GIS coverages for the Charlotte Harbor NEP area are not consistent. Existing Land Use Coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SWFWMD) land use data. Land Use data from SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We assigned new codes which make the SFWMD and SWFWMD land use classification systems comparable for this project.

Future land use coverages for the Charlotte Harbor NEP were developed by the SWFRPC. SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions.

The FLUMs uses a different and much simpler, land use classification system than either of the existing land use coverages and does not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). Residential areas, then, may increase tremendously under future scenarios because existing development is not taken into account. As a result, direct comparisons between acreage of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category.

7.1.3.1 Existing Land Use

Existing land use in the Lower Caloosahatchee and Orange River subbasins within the Tidal Caloosahatchee Basin include 38% and 42%, respectively, of urban land use. Agriculture makes up 30% of the land use in the Lower Caloosahatchee and only 13% in the Orange River subbasin.

Table 7-2. Current land use (1990) /cover in the Tidal Caloosahatchee River Basin.

Land Use/Cover	Telegraph Swamp		Orange River		Lower Caloosahatchee	
	Acres	%	Acres	%	Acres	%
Single Family Residential	9	< 0.0	19,953	32.6	23,311	17.6
Medium Density Residential	0	0.0	1,237	2.0	17,272	13.1
Multi-family Residential	0	0.0	2,777	4.5	2,792	2.1
Commercial	0	0.0	192	0.3	3,273	2.5
Industrial	0	0.0	603	1.0	1,011	0.8
Mining	0	0.0	490	0.7	1139	0.9
Institutional	0	0.0	1,013	1.7	2,340	1.8
Range Lands	693	1.8	18,930	30.9	8,288	6.3
Barren Lands	0	0.0	46	0.1	16	0.0
Pasture	9,610	25.2	6,736	11.0	32,377	24.5
Groves	9	< 0.0	383	0.6	352	0.3
Feedlots	0	0.0	309	0.5	42	< 0.1
Nursery	0	0.0	28	< 0.0	124	0.1
Row and Field Crops	10	< 0.0	640	1.0	1,624	1.2
Upland Forested	13,305	34.9	5,331	8.7	15,019	11.4
Freshwater - Open Water	0	0.0	211	0.3	1,528	1.2
Saltwater - Open Water	0	0.0	0	0.0	0	0.0
Forested Freshwater Wetland	7,041	18.5	1,054	1.7	479	0.4
Saltwater Wetland	0	0.0	0	0.0	3,248	2.5

Table 7-2. Current land use (1990) /cover in the Tidal Caloosahatchee River Basin.

Land Use/Cover	Telegraph Swamp		Orange River		Lower Caloosahatchee	
	Acres	%	Acres	%	Acres	%
Non-forested Freshwater Wetland	7,469	19.6	1,358	2.2	17,966	13.6
Tidal Flats	0	0.0	0	0.0	0	0.0
TOTAL	38,145	100.0	61,292	100.0	132,201	100.0

Table 7-3. Future land use (2010) /cover in the Tidal Caloosahatchee River Basin.

Land Use/Cover	Telegraph Swamp		Orange River		Lower Caloosahatchee	
	Acres	%	Acres	%	Acres	%
Single Family Residential	0	0	42,082	68.8	54,341	39.3
Multi-family Residential	0	0	1,528	2.5	2,786	2.0
Rural Residential	756	1.3	11,329	18.5	9,062	6.6
Commercial	0	0	2,554	4.2	10,331	7.5
Industrial	0	0	2,315	3.8	2,633	1.9
Mining	0	0	0	0	0	0
Agricultural	45,212	80.2	0	0	40,055	29.0
Wetlands	0	0	0	0	0	0
Protected Resource	10,394	18.5	1,380	2.3	19,142	13.8
TOTAL	56,362	100.0	61,188	100.0	138,350	100.0

Urban land use in both subbasins is primarily residential, making up about 30% of the land use in the Lower Caloosahatchee and 40% of the land use in the Orange River subbasin. Land use also includes approximately 40% upland forest and rangelands in the Lower Caloosahatchee Basin and 60% pasture and uplands in the Orange River subbasin.

In contrast, Telegraph Swamp subbasin, in the most northern reaches of the basin, includes no existing urban land use. Twenty five percent of the land use in this subbasin is in agriculture. The remaining 75% of the subbasin includes almost all pasture (25%), forested uplands (35%) and forested and non-forested freshwater wetlands. Less than 1% of any of the subbasins is in mining.

7.1.3.2 Future Land Use

The largest increase in urban land use in the Tidal Caloosahatchee Basin is a 70% increase predicted for the Orange River subbasin. Future land use maps include no agricultural land use in Orange River subbasin. Telegraph Swamp subbasin, however, has 80% of the future land use in agriculture. The lower Caloosahatchee subbasin has 29% future land use in agriculture and 50% in urban.

7.1.4 Surface Water Hydrology and Water Management Practices

The Caloosahatchee River is the primary water channel in this basin. Tributaries to the river include Owl Creek from the north, across the river from Fort Myers Shores, the Orange River, which joins the Caloosahatchee from the southeast just east of the I-75 crossing of the Caloosahatchee River, and Billy Creek and Whiskey Creek, which join the river in Fort Myers. Total annual and mean monthly flows at Structure S-79 on the Caloosahatchee River appear in Figure 7-9.

7.1.4.1 Urban Management Practices

Approximately 33% of the Tidal Caloosahatchee River Basin is classified as urban land (Table 7-2). The urbanized areas of the basin are found primarily in the Cape Coral and Ft. Myers regions. The discussion of urban management practices is divided into urban water uses and urban water discharges. The water uses and water discharges are tabulated in the following descriptions.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. Discussion of water use is limited to facilities with an average permitted quantity greater than 0.5 MGD. Water use information is from SFWMD (1994). The Tidal Caloosahatchee River Basin is entirely within the SFWMD.

- Public Supply

Table 7-4 lists the public water supply facilities in the Tidal Caloosahatchee River Basin with permitted withdrawals of more than 0.5 MGD and withdrawal sources for the facilities. A discussion of the populations served by each plant, withdrawal amounts, and withdrawal methods follows.

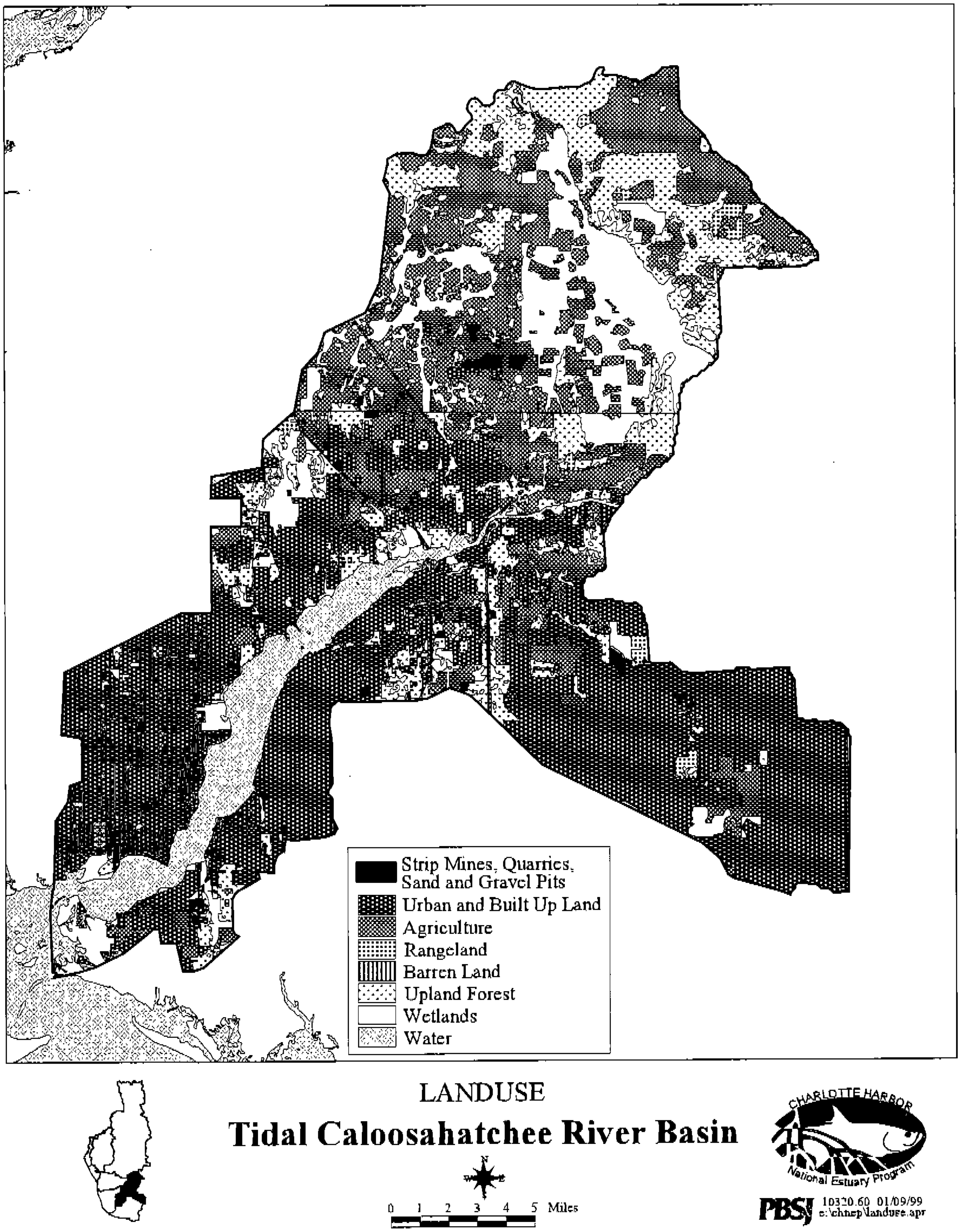


Figure 7-7. Existing land use in the Tidal Caloosahatchee River Basin (SWFWMD, 1988; SFWMD 1990).

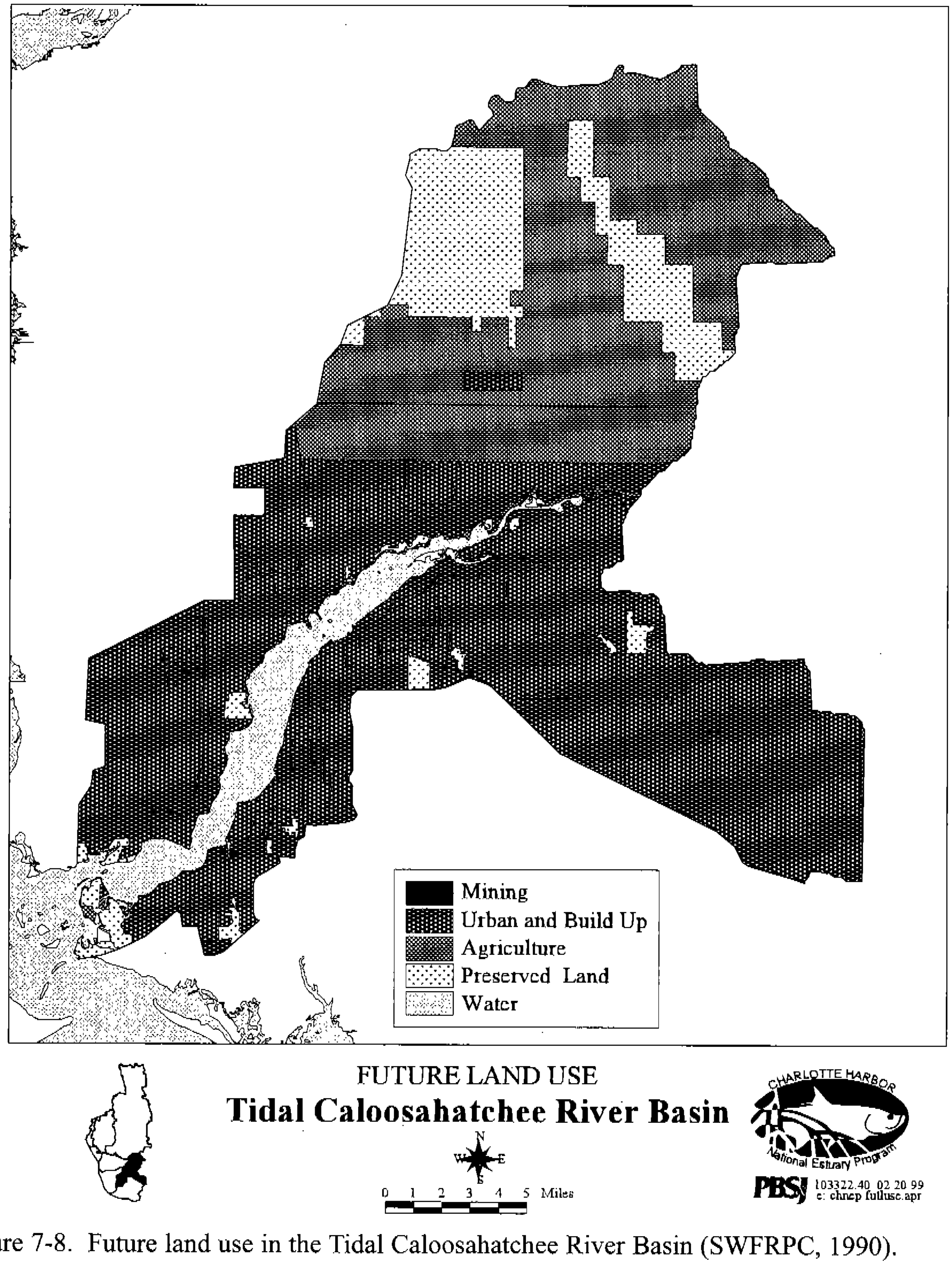
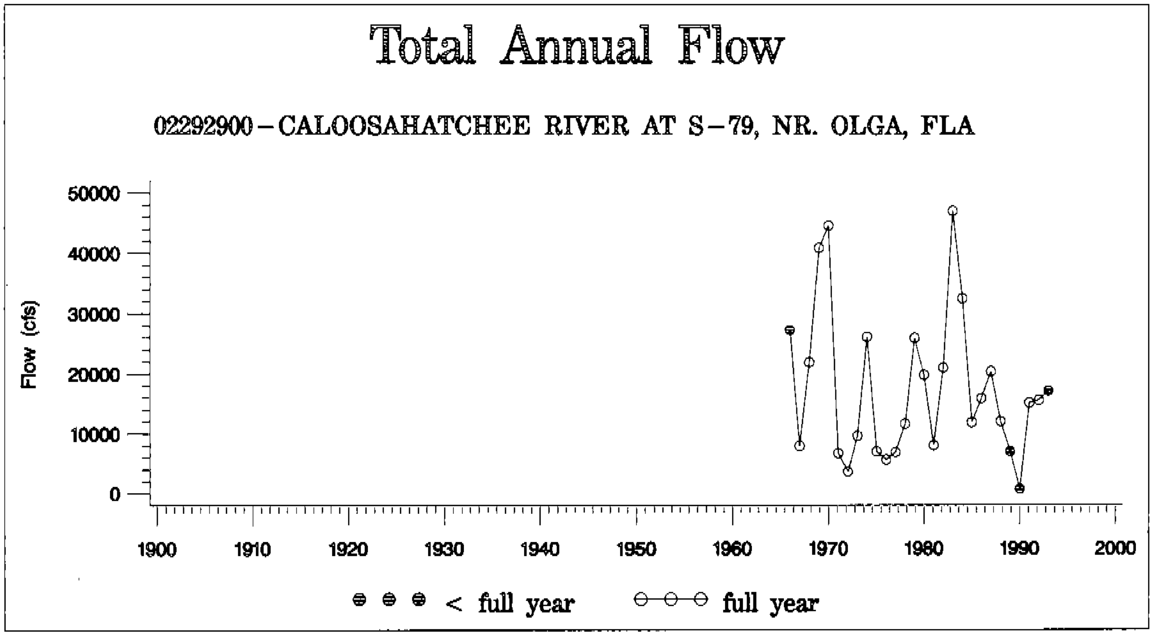


Figure 7-8. Future land use in the Tidal Caloosahatchee River Basin (SWFRPC, 1990).



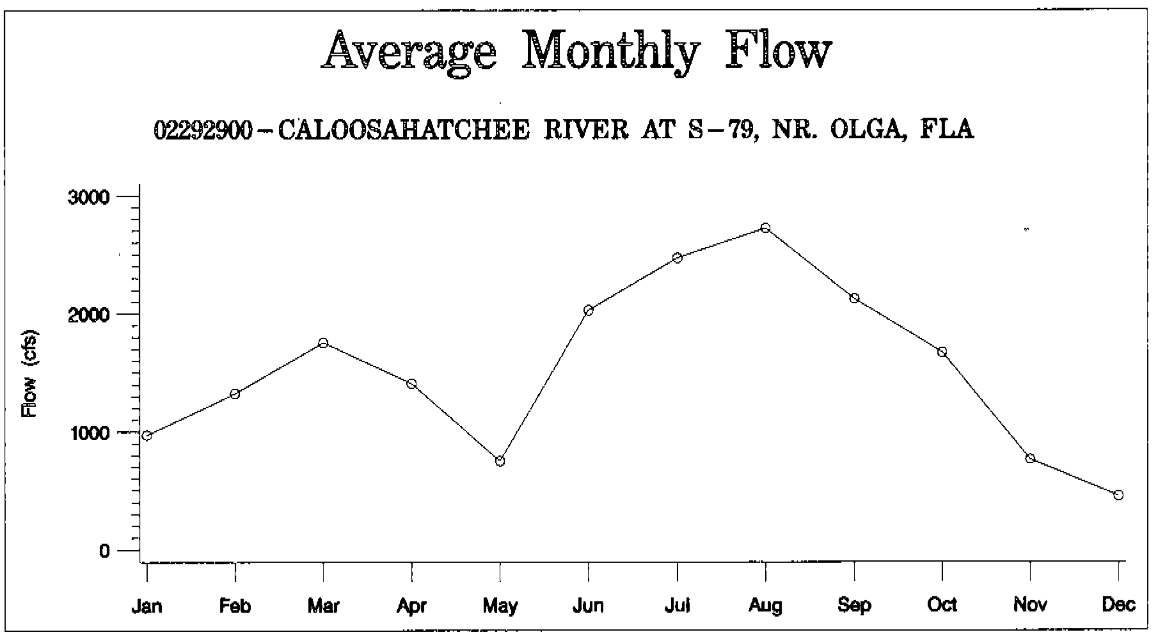


Figure 7-9. Plots of total annual flow and average monthly flow at S-79 in the Tidal Caloosahatchee River Basin.

Table 7-4. Public water supply facilities in the Tidal Caloosahatchee River Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
Florida Cities Waterway Estates	1.28	Mid- and Lower Hawthorn, Water Table aquifers
Fort Myers	8.92	Caloosahatchee River via Water Table aquifer
North Fort Myers Emergency Wellfield	MAX - 0.20	Mid-Hawthorn, Sandstone aquifers
Lee County Utilities Olga	3.42	Caloosahatchee River
Lehigh Utilities	2.08	Sandstone aquifer

The Florida Cities Waterway Estates (North System) water treatment plant withdraws from 18 wells located in the Waterway Estates development and in North Cape Coral. The wells are 45 to 600 feet deep, and withdraw from the water table aquifer (five wells) and the mid- (11 wells) and lower (two wells) Hawthorn aquifers. Withdrawal capacities of the wells are between 25 and 125 GPM. The permitted average withdrawal is 1.28 MGD, with average 1990 withdrawals of 0.99 MGD (SFWMD, 1994).

The Fort Myers water treatment plant withdraws from 20 wells located within a site west of Oritz Ave., between Anderson Ave. and Colonial Blvd., north of the Eastwood Golf Course. The water supply is from the water table aquifer, with the wells having depths between 20 and 34 feet, and withdrawal capacities of 460 GPM per well. Water is supplied to the wellfield from the Caloosahatchee River through an intake structure east of the W.P. Franklin Lock and Dam. Permitted average withdrawal is 8.92 MGD, with the 1990 average withdrawal being 6.22 MGD (SFWMD, 1994).

The North Fort Myers Emergency Wellfield and Treatment Facility operates two wells at the two million gallon finished water reservoir in North Fort Myers. Withdrawals are from the sandstone and mid-Hawthorn aquifers. Well depths are 198 and 105 feet, with pumping capacities of 15 and 125 GPM. The maximum allocation is 0.20 MGD, 0.18 MGD from the mid-Hawthorn and the remainder from the sandstone aquifer. The wells are for emergency short-term use, when the Olga water treatment plant (described below) cannot deliver enough water to the reservoir (SFWMD, 1994). The Lee County Utilities Olga water treatment plant withdraws water from the Caloosahatchee River upstream of the W.P. Franklin Lock and Dam, and stores finished water in the two million gallon reservoir. The permitted average withdrawal is 3.42 MGD, and average 1990 flows were 3.32 MGD (SFWMD, 1994). The Lehigh Utilities water treatment plant withdraws via

10 wells from the sandstone aquifer, with depths of 62-85 feet. Well withdrawal capacities are 100-350 GPM, providing a permitted average of 2.08 MGD to the plant. In 1990, average withdrawals were 1.28 MGD (SFWMD, 1994).

- Mining

The Tidal Caloosahatchee River Basin contains only 41 acres of mining land use, as derived from the SFWMD 1988 land use coverage. Little data on mining projects in this basin were found.

- Industrial

Industrial land uses in the basin made up approximately 0.7% of the basin, covering 1,614 acres, as determined from the SFWMD 1988 land use coverage. In all of Lee County commercial and industrial self-supplied water demand was 31.3 MGD for 1990 (SFWMD, 1994).

- Recreational

Information as to the locations of water usage within that area of the basin in the SFWMD is not given (LWCWSP, 1994), but total water use for golf courses and landscape is given by county. In Lee County, landscape demand for 1990 was 23.5 MGD, and golf course water usage was 17.2 MGD, for a total water use demand of 40.7 MGD (LWCWSP, 1994).

Water Discharge and Reuse

The Florida Cities Fiesta Village WWTP effluent is partially utilized for golf course irrigation, with the remainder discharged to the Caloosahatchee River. Two golf courses took 0.46 MGD from the plant in the first half of 1990, with an additional golf course initiating reuse in the second half of the year, utilizing an additional 0.28 MGD in 1990. Average discharge from the plant for 1990 was 1.71 MGD, with an average discharge to the river of 1.11 MGD in 1990. The North Fort Myers WWTP effluent is partially utilized for golf course spray irrigation on the Riverbend and Six Lakes Golf Course and at the Sabal Springs development, with the remainder of the effluent injected into deep wells. The 1990 average flow was 0.21 MGD, with 0.13 MGD of this going to reuse (SFWMD, Vol III, 1994).

The Fort Myers South AWT plant discharges to the Caloosahatchee River, with a 1990 average flow of 5.86 MGD. The Cape Coral Everest AWT plant also discharges to the river, with a 1990 average flow of 6.27 MGD. Another discharge to the river is from the Florida Cities Waterway Estates AWT plant, which had an average flow of 0.82 MGD in 1990 (SFWMD, Vol III, 1994).

7.1.4.2 Agricultural Management Practices

The Tidal Caloosahatchee Basin consists mainly of pasture (21%), single family residential (19%), forested uplands (15%), and non-forested freshwater wetlands (12%). In addition to pasture, other agricultural land uses found are row and field crops (2,274 acres), groves (744 acres), confined feeding operations (351 acres), and nurseries (152 acres) (see Table RP-22). The basin contains approximately 231,638 acres (362 square miles) in Lee and Charlotte counties.

Agricultural land use estimates for all major crops for 1990 in Charlotte County are shown in Table 7-5, and for Lee County in Table 7-6, along with estimates of irrigated acreages for each of these crops and estimated water use.

7.2 Water Quality Conditions

The Caloosahatchee River upstream of the Franklin Lock and Dam (S-79), also known as the C-43 Canal, serves as a drinking water source via the Olga plant. Low dissolved oxygen and algal blooms have been noted near the plant (CDM, 1994).

Table 7-5. 1990 estimated crop acreages, irrigation types, and water use in Charlotte County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Row/Field Crops	1,500	Seepage 1,500	4.4
Citrus	10,500	Low Volume 8,925 Seepage 1,050	13.6
Nursery	215	Overhead 215	1.4
Sod	1,200	Seepage 1,200	2.9
Irrigated Pasture	150	Seepage 150	0.3
Totals	13,565	Overhead 215 Low Volume 8,925 Seepage 3,900	22.6

Table 7-6. 1990 estimated crop acreages, irrigation types, and water use in Lee County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Citrus	9,692	Overhead 4,846 Seepage 4,846	28.5
Tropical Fruit	1,680	Seepage 1,512	4.8

Table 7-6. 1990 estimated crop acreages, irrigation types, and water use in Lee County.

Crop	Acreage	Irrigation Type - Acreage		Water Use (MGD)
Vegetables	9,785	Seepage	9,785	23.0
Nursery	606	Overhead	606	2.8
Sod	650	Seepage	650	3.0
Pasture	118,000	Cattle Watering		0.2
Totals	140,413	Overhead Seepage	5,452 16,793	62.3

The FDEP has set goals of 1 mg/l for total nitrogen and 0.15 mg/l for total phosphorus as maximum nutrient concentrations for the river, in an effort to maintain chlorophyll a concentrations below 20 μg/l (CDM, 1994). However, releases from Lake Okeechobee may cause excessive nutrient loads to the C-43 portion of the river, as well as the estuarine region of the river.

Historical and current water quality trends were determined as results of a study on water quality conditions in the C-43 Canal portion of the river (CDB, 1994). SFWMD data and data obtained from the study were combined for analysis. The study found a decrease in nitrogen over historical conditions near Lake Okeechobee and an increase in phosphorus near S-79. Also found was a positive relationship between the fraction of agricultural land use and some nutrient and eutrophication parameters, and an inverse relationship between urban land use fraction and many of the same parameters. Relationships were found between dissolved oxygen and conductivity and ammonia, as well as between dissolved oxygen and color and ammonia. System variability was found to be high, possibly as a result of releases from the lake and land use activities (CDM, 1994).

Water quality sampling in the Tidal Caloosahatchee at two stations downstream of the U.S. 41 bridge was done by the City of Cape Coral from 1988 to 1997 (Figure 7-10). Averages of the data collected from the two stations are shown in Figures 7-11 and 7-12. Salinity variability is high from month to month, with generally lower salinity found in the fall and early winter (dry season), and ranged from 0 ppt to greater than 30 ppt over the sampling period.

Turbidity is also highly variable, ranging from zero (0) NTU to approximately 13 NTU over the sampling period, and showing a slightly increasing trend from 1992 to 1997. Nitrate+nitrite levels are generally low (<0.02 mg/l), but show several instances of elevated concentrations during periods of low salinity, possibly because freshwater discharge from the C-43 Canal portion of the river.

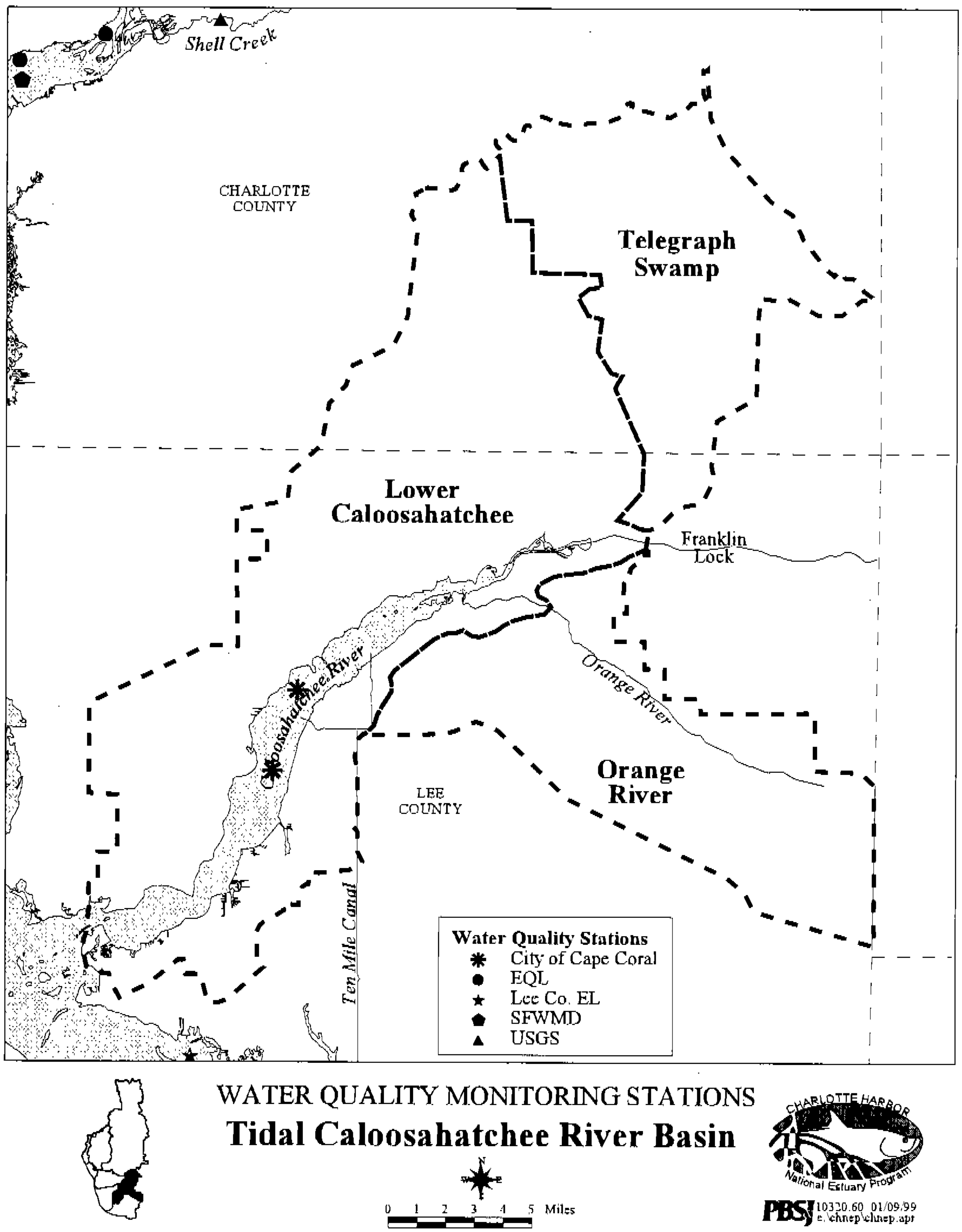


Figure 7-10. Location of water quality sampling sites in the Tidal Caloosahatchee River Basin.

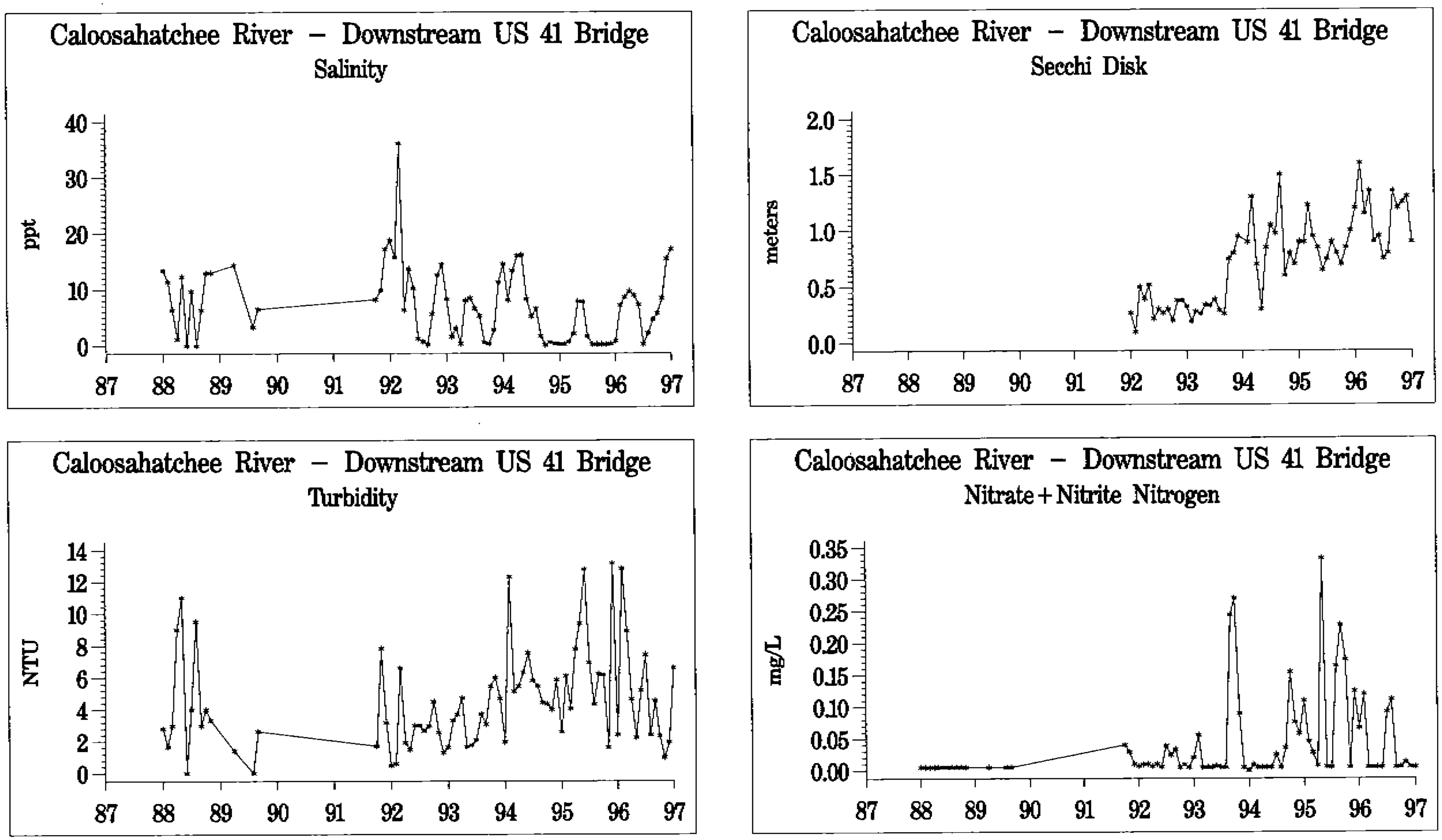


Figure 7-11. Time series graphs of water quality constituents measured in the Tidal Caloosahatchee River Basin (Cape Coral stations).

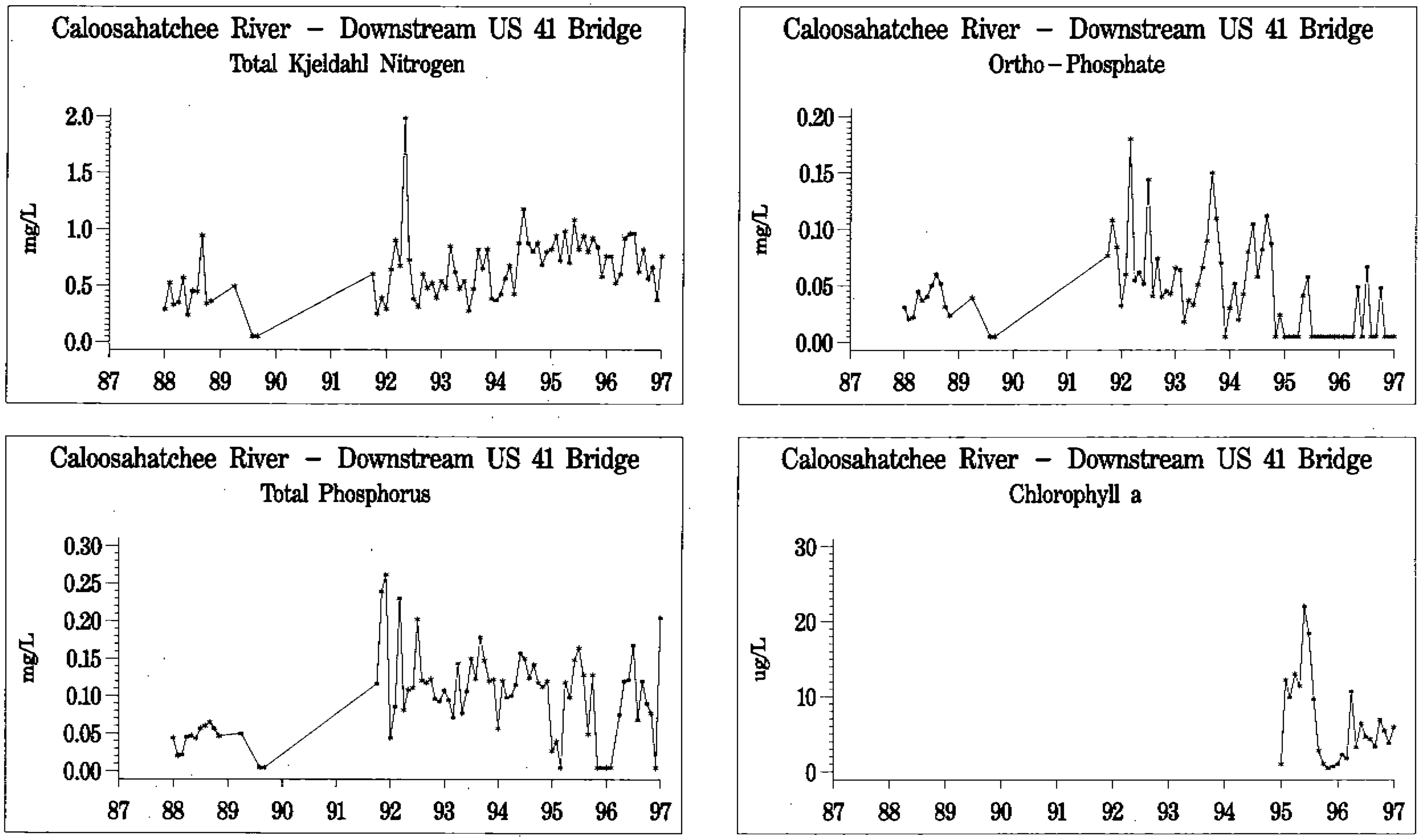


Figure 7-12. Time series graphs of water quality constituents measured in the Tidal Caloosahatchee River Basin (Cape Coral stations).

TKN does not appear to have as strong an inverse relationship with salinity, with variability normally between zero (0) and 1.0 mg/l, with a small increasing trend is visible from 1992 to 1995. Maximum annual ortho-phosphorus concentrations have declined since 1992, although total phosphorus does not appear to show the same trend. Secchi depths have increased over the same period, and chlorophyll a concentrations have declined from an annual maximum of >20 μg/l in 1995 to about 10 μg/l in 1996.

At present, the SFWMD has recently initiated an intensive water quality survey of the Tidal Caloosahatchee River. This effort is an integral part in the District's surface water management program development for the region.

7.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) was estimated for each subbasin by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to prioritize major basins and subbasins for the CCMP. Thus, the method development was focused on estimating relative loads in a consistent manner among subbasins to avoid biasing the evaluation of major basins and subbasins.

The detailed rainfall, 1988 SFWMD land cover, and USDA soil data were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow were used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TN, TP, and TSS loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and 1 ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, row crops, feedlots, and nursery. Undeveloped land uses were defined as range lands, barren lands, upland forests, and wetlands.

7.3.1 Load Estimates for Telegraph Swamp Subbasin

The total estimated annual runoff discharge for the Telegraph Swamp Subbasin was 23 million cubic meters from 24,000 contributing acres. The estimated annual pollutant loads were 85 tons of TN, 17 tons of TP, and 903 tons of TSS.

As suggested by the name of this subbasin, most of the nonpoint source loads for this drainage area were attributed to wetlands and other undeveloped lands. Sixty (60) percent of the contributing land area of this subbasin was reported as undeveloped (14,000 acres). These undeveloped lands discharged 14 million cubic meters of runoff, 57 tons of TN, 9 tons of TP, and 812 tons of TSS. Table 7-7 presents the loads from runoff by land use. As indicated in this table, most of the loads from undeveloped lands were attributed to forests.

The developed lands for this subbasin were agricultural. The 10,000 acres of agricultural lands were estimated to contribute 10 million cubic feet of runoff, 28 tons of TN, 8 tons of TP, and 90 tons of TSS. Except for 20 acres of grove and cropland, these agricultural lands were defined as pasture.

7.3.2 Load Estimates for Orange River Subbasin

In contrast to the Telegraph Swamp Subbasin, The Orange River subbasin has been largely developed as an urban area. The 59,000 contributing acres of the Orange River Subbasin were estimated to contribute a total annual runoff discharge of 78 million cubic meters. The estimated annual pollutant loads were 222 tons of TN, 587 tons of TP, and 2,385 tons of TSS.

Table 7-7. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Telegraph Swamp Subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	0	0%	0	0%	0	0%	11,493	0%
Range Lands	2	2%	1	6%	10	1%	688,345	3%
Pasture	28	33%	8	49%	90	10%	9,477,678	41%
Groves	0	0%	0	0%	0	0%	8,390	0%
Row and Field Crops	0	0%	0	0%	1	0%	15,749	0%
Upland Forests	55	65%	8	45%	802	89%	13,189,748	56%
TOTAL	85	100%	17	100%	903	100%	23,391,402	100%

The 26,000 acres of urban lands in the subbasin contributed 43 million cubic meters of runoff, 90 tons of TN, 14 tons of TP, and 1,586 tons of TSS loads per year. Table 7- 8 presents the loads from runoff by land use. The urban loads from runoff were attributed to residential and industrial land uses, and a relatively large amount of TSS loads were attributed to high density residential land use (561 tons per year).

Table 7-8. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Orange River Subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	54	24%	8	14%	516	22%	25,855,254	33%
Medium Density Residential	6	3%	1	2%	89	4%	2,380,085	3%
High Density Residential	18	8%	3	6%	561	24%	7,900,876	10%
Commercial	2	1%	0	0%	65	3%	799,016	1%
Industrial	4	2%	1	1%	248	10%	2,397,858	3%
Mining	2	1%	0	1%	74	3%	1,333,499	2%
Institutional, Transport., Util.	4	2%	0	0%	33	1%	2,708,954	3%
Range Lands	56	25%	28	47%	280	12%	19,404,328	25%
Barren Lands	0	0%	0	0%	2	0%	141,333	0%
Pasture	20	9%	6	10%	64	3%	6,764,232	9%
Groves	1	0%	0	0%	4	0%	391,348	1%
Feedlots	30	14%	6	10%	76	3%	1,380,048	2%
Nursery	0	0%	0	0%	3	0%	49,339	0%
Row and Field Crops	4	2%	1	3%	40	2%	1,038,830	1%
Upland Forests	23	10%	3	6%	331	14%	5,441,837	7%
TOTAL	222	100%	59	100%	2,385	100%	77,986,839	100%

The 8,000 acres of contributing agricultural lands in the subbasin were estimated to discharge 10 million cubic meters of runoff, 54 tons of TN, 13 tons of TP, and 187 tons of TSS per year. The loads from these lands were reported to be approximately one half from pasture and one half from feedlots, though the pasture lands were much more extensive with respect to geographic extent (Table 7-2).

7.3.3 Load Estimates for Coastal Lower Caloosahatchee Subbasin

The lower portion of the Caloosahatchee River drainage was also reported to have relatively widespread urban and agricultural development. The total estimated annual runoff discharge for the lower portions of the Tidal Caloosahatchee River was 166 million cubic meters from 109,000 acres of contributing drainage area. The estimated annual pollutant loads were 431 tons of TN, 92 tons of TP, and 5,930 tons of TSS.

The urban lands from this subbasin were estimated to cover 51,000 acres, and discharge 103 million cubic meters of runoff, 221 tons of TN, 33 tons of TP, and 4,350 tons of TSS per year. Table 7.9 presents the loads from runoff by land use. The urban loads were attributed to a wide variety of land uses including low, medium, and high density residential, commercial, industrial, and institutional.

The agricultural lands were estimated to cover 35,000 acres, and discharge 38 million cubic meters of runoff, 116 tons of TN, 33 tons of TP, and 458 tons of TSS per year. These lands were almost entirely comprised of pasture land use.

7.3.4 Pollution Source Inventory

The purpose of this compilation of a point source inventory for the Tidal Caloosahatchee River Basin is to describe the numbers, locations, and discharge capacities of domestic and industrial point sources within the Tidal Caloosahatchee River Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for

Table 7-9. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Lower Caloosahatchee River Subbasin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	66	15%	10	11%	633	11%	31,680,692	19%
Medium Density Residential	86	20%	13	14%	1,302	22%	34,817,231	21%
High Density Residential	18	4%	3	4%	569	10%	8,016,426	5%
Commercial	29	7%	4	4%	1,148	19%	14,129,561	9%
Industrial	8	2%	1	1%	436	7%	4,222,124	3%
Mining	6	1%	1	1%	180	3%	3,259,193	2%
Institutional, Transport., Util.	9	2%	1	1%	81	1%	6,617,034	4%
Range Lands	26	6%	13	15%	133	2%	9,263,477	6%
Barren Lands	0	0%	0	0%	1	0%	54,903	0%
Pasture	100	23%	31	33%	325	6%	34,322,313	21%
Groves	1	0%	0	0%	4	0%	363,027	0%
Feedlots	4	1%	1	1%	11	0%	197,664	0%
Nursery	0	0%	0	0%	13	0%	209,983	0%
Row and Field Crops	10	2%	4	4%	106	2%	2,770,264	2%
Upland Forests	68	16%	10	11%	988	17%	16,243,271	10%
TOTAL	431	100%	92	100%	5,930	100%	166,167,163	100%

domestic and industrial point sources, as discussed previously. The locations of domestic and industrial point sources in the Caloosahatchee River Basin are mapped in Figure 7-13.

Wastewater treatment plant discharges for those plants in the Tidal Caloosahatchee River Basin with greater than 0.5 MGD in the SFWMD (SFWMD, 1994) were previously discussed. The following discussion utilizes only the FDEP databases, as previously described.

The Tidal Caloosahatchee River Basin is divided into three subbasins, the Telegraph Swamp Subbasin, the Lower Caloosahatchee Subbasin, and the Orange River Subbasin. The FDEP databases list 76 domestic point sources and seven industrial point sources within the Tidal Caloosahatchee River Basin (Tables 7-10 and 7-11). Five of the domestic point sources are in the Orange River Subbasin, with the remaining 71 domestic point sources and all seven industrial point sources in the Lower Caloosahatchee Subbasin. Only two of the industrial point sources are in Charlotte County, and the remaining five and all of the domestic point sources are in Lee County.

Domestic point sources discharge capacities total 43.28 MGD, with 9.34 MGD of this sent to reuse and 31.8 MGD being discharged to the Caloosahatchee River from four plants. For those industrial point sources which have discharge capacity listed, combined discharge capacity is 590.62 MGD, of which 590.6 MGD is from the Ft. Myers FP&L power plant.

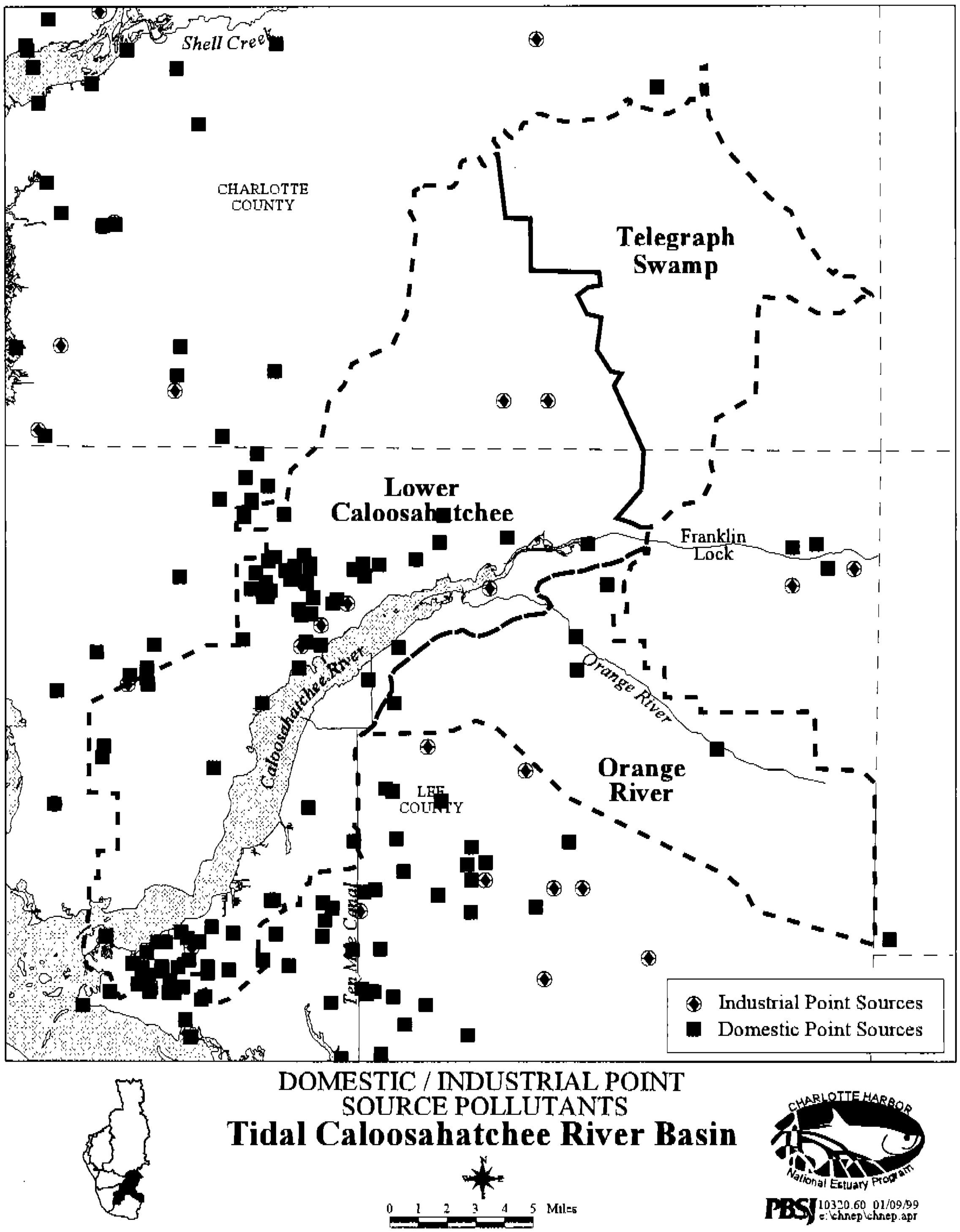


Figure 7-13. Locations of domestic and industrial point sources in the Caloosahatchee River Basin.

Table 7-10. Domestic point sources in the Tidal Caloosahatchee River Basin			
Facility Name	**County**	**Discharge Capacity (MGD)**	**Receiving Waterbody**
Subbasin: Lower Caloosahatchee			
F. M. CENTRAL ADVANCED WWTF	Lee	11	Caloosahatchee River
FT. MYERS SOUTH ADVANCED WWTF	Lee	12	Caloosahatchee River
CAPE CORAL-EVEREST PARKWAY WWTF	Lee	7.3	Caloosahatchee River
WATERWAY ESTATES ADVANCED WWTP	Lee	1.5	Caloosahatchee River
FIESTA VILLAGE W. W. T. P.	Lee	5	SW and GC Irrigation
HEIGHTS ELEMENTARY SCHOOL	Lee	0.01	Percolation Ponds
SUNCOAST ELEMENTARY SCHOOL	Lee	0.03	Percolation Ponds
BAYSHORE ELEMENTARY SCHOOL	Lee	0.01	Percolation Ponds
ELEMENTARY SCHOOL B S.T.P.	Lee	0.02	
J. COLIN ENGLISH ELEMENTARY SCHOOL	Lee	0.01	Ditch
CORAL LANES	Lee	0.01	
WHISPERING PINES CONDO. ASSOCIATION	Lee	0.01	Drainfield
JULIA PARK	Lee	0.02	Percolation Ponds
JONES MOTEL AND TRAILER PARK	Lee	0.02	Retention Pond
PALM FROND CONDOMINIUM	Lee	0.02	Drainfield
RIVERSIDE BEACH CONDOMINIUM	Lee	0.01	
SOUTHWIND VILLAGE WWTF	Lee	0.02	Drainfield
HORIZON MOBILE VILLAGE	Lee	0.1	Drainfield
SHELL FACTORY	Lee	0.02	Percolation Ponds
BAY POINTE CONDOMINIUM	Lee	0.03	Absorption Bed
IONA POINT SHOPPING CENTER	Lee	0.02	
HIGH POINT S/D, W. W. T. P.	Lee	0.01	Retention Pond
SANDY PARK REHABILITATION CENTER	Lee	0.01	Absorption Fields
LEE PLANTATION	Lee	0.02	Spray Irrigation
DAVIS COURT CONDO	Lee	0.01	Drainfield
RIVERS EDGE	Lee	0.07	Percolation Ponds
IONA LAKES S.T.P	Lee	0.1	Percolation Ponds
CORAL TRACE MANOR	Lee	0.02	Absorption Fields
FONG'S CHINESE RESTAURANT	Lee	0	
DAVIS WOODS	Lee	0.03	Drainfield
NORTH FORT MYERS UTILITY, DOMESTIC	Lee	2	
HIDEAWAY COUNTRY CLUB	Lee	0.05	Spray Irrigation
SPRING WOODS HOME OWNERS ASSN.	Lee	0.02	Spray Irrigation
IONA POINT PHASE I	Lee	0.05	
DEL TURA COUNTRY CLUB	Lee	0.2	Spray Irrigation

Table 7-10. Domestic point sources in the Tidal Caloosahatchee River Basin			
Facility Name	**County**	**Discharge Capacity (MGD)**	**Receiving Waterbody**
SEMINOLE CAMPGROUND	Lee	0.02	Percolation Ponds
VILLAGE OF ASCOT	Lee	0.02	Drainfield
MINERS SHOPPING PLAZA	Lee	0.01	Drainfield
SHELL POINT VILLAGE - PALM ACRES	Lee	0.2	Holding Pond
SAINT CHARLES CLUB	Lee	0.04	Spray Irrigation
FOREST PARK MOBILE HOME PARK, STP	Lee	0.05	Prec. Pond./ Abs.Field
PEPPERTREE POINTE	Lee	0.1	Percolation Ponds
MCGREGOR MOBILE HOME PARK	Lee	0.01	Retention Pond
PLANTATION ESTATES MHP	Lee	0.03	Drainfield
SIX LAKES M. H. P. & COUNTRY CLUB	Lee	0.1	Percolation Ponds
PALMETTO PINES COUNTRY CLUB	Lee	0.01	Drainfield
SWAN LAKE MOBILE HOME PARK	Lee	0.03	Percolation Ponds
GROVES CAMPGROUND	Lee	0.03	Drainfield
FORT MYERS BEACH RV RESORT	Lee	0.07	Percolation Ponds
SABAL SPRGS. GOLF & RACQUET CLUB	Lee	0.02	Spray Irrigation
TWIN PINES VILLAGE	Lee	0.02	Drainfield
CARRIAGE VILLAGE	Lee	0.06	Percolation Ponds
SOUTHERN VILLAS M. H. P.	Lee	0.01	Percolation Ponds
IONA TRAILER RANCH	Lee	0.01	Drainfield
WINDMILL VILLAGE	Lee	0.05	Percolation Ponds
STAR PLAZA SHOPPING CTR.	Lee	0	Percolation Ponds
THUNDERBIRD SERVICES INC	Lee	0.05	Percolation Ponds
TAMIAMI VILLAGE UTILITY, INC.	Lee	0.15	Retention Pond
GARDEN COVE MHP	Lee	0.01	Retention Pond
LAZY DAYS MOBILE VILLAGE	Lee	0.06	Percolation Ponds
JAMAICA BAY WEST, LARGE	Lee	0.3	Percolation Ponds
PIONEER VILLAGE WWTP	Lee	0.03	Percolation Ponds
SUNSHINE MOBILE VILLAGE	Lee	0.02	Percolation Ponds
GARDEN RV PARK	Lee	0.01	Percolation Ponds
BUCCANEER MOBILE ESTATES	Lee	0.17	Percolation Ponds
LAKE ARROWHEAD VILLAGE, EAST	Lee	0.1	Percolation Ponds
SWIFT'S TRAILER PARK	Lee	0.01	Percolation Ponds
SERENDIPITY MOBILE HOME PARK	Lee	0.04	Percolation Ponds
RIVER TRAILS MOBILE HOME PARK	Lee	0.1	Percolation Ponds
WHISPERING PINES UNIT II	Lee	0.01	Drainfield
ROYAL HAWAIIAN CLUB/P. U. D., INC.	Lee	0.05	Polishing Pond

Table 7-10. Domestic point sources in the Tidal Caloosahatchee River Basin			
Facility Name	**County**	**Discharge Capacity (MGD)**	**Receiving Waterbody**
Subbasin: Orange River			
HUT RESTAURANT	Lee	0.01	Drainfield
NATHANIAL HUNTER LAND SPREAD SITE	Lee	.	
LEHIGH UTILITIES, INC.	Lee	1.4	Retention Pond
MONTY'S SANITATION	Lee	0.02	
GULF COAST CENTER	Lee	0.1	Percolation Ponds

Table 7-11. Industrial point sources in the Tidal Caloosahatchee River Basin			
Facility Name	**County**	**Discharge Capacity (MGD)**	**Receiving Waterbody**
Subbasin: Lower Caloosahatchee River			
CORAL ROCK, INC. - THREE LAKES	Charlotte		
CHARLOTTE CO. ROCK PLANT EARTHSOUR	Charlotte		
PONDELLA COIN LAUNDRY	Lee		
FPL FORT MYERS PLANT	Lee	590.6	Caloosahatchee River
STAR PLAZA COIN LAUNDRY	Lee	0.01	Percolation Ponds
BAYSIDE LAUNDROMAT	Lee	0.01	Retention Pond
KAPOK VILLAGE LAUNDROMAT	Lee	0	

8. Estero Bay

This chapter presents a compilation and synthesis of information regarding the Estero Bay Basin portion of the Charlotte Harbor NEP area (Figure 8-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

8.1 Physical Setting

The Estero Bay basin includes the area in Lee County south of the Caloosahatchee River and the small portion of Collier County which drain into Estero Bay. Major surface water features include Hendry Creek, Mullock Creek, the Estero River, areas of Corkscrew Swamp, Spring Creek, and the Imperial River. The Estero River east of U.S. 41 has slow conveyance and is considered a recharge area along with the Imperial River east of I-75. In some areas local drainage canals provide limited flood protection, but also lead to over-drainage during dry periods. The basin includes all of Estero Bay, most of which lies within the Estero Bay Aquatic Preserve, and the adjacent barrier islands.

Much of the northern part of the basin is in the city of Ft. Myers. Other population centers include Bonita Springs and the City of Ft. Myers Beach, as well as Florida Gulf Coast University. Concern over the potential impacts of development in the watershed has led the SWFWMD to implement an additional study of the Estero Bay watershed in which the watershed will be examined in greater detail.

8.1.1 Physiography

This section describes the topography, geology, soils, and land use in the Estero Bay Basin.

8.1.1.1 Topography

The Estero River Basin watershed is relatively flat with elevations ranging from sea level to a maximum of 50 feet above MSL in the eastern portion of Lee County. Elevations gradually increase away from the coast and the Caloosahatchee River and peak in southeastern Lee County.

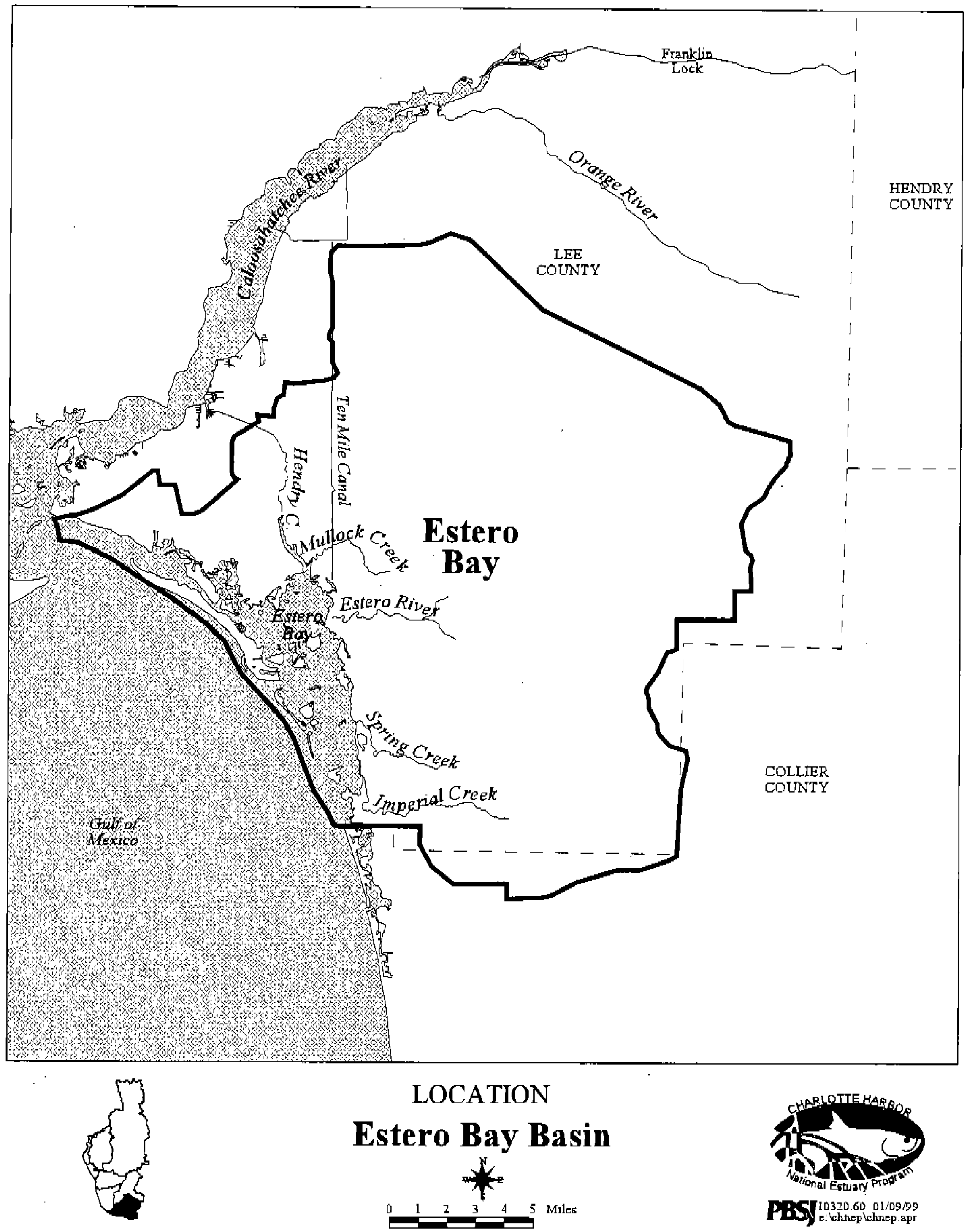


Figure 8-1. Location of the Estero Bay Basin in the Charlotte Harbor NEP study area.

8.1.1.2 Geology

The land within the Estero River Basin is a mixture of uplands and wetlands which displays very little topographic relief and lies within the Southwestern Slope region of the Southwestern Flatwoods physiographic province. The Southwestern Slope most likely originated as a marine terrace during periods of higher sea level and varies in elevation from a high of 25 feet to sea level. The surface consists of shells, marls, and organic material underlain by limestone.

The largely low, flat lands developed on rocks and sediments that are mainly Miocene to Pleistocene in age. The landscapes include low plateaus and ridges, flatwoods, prairies, rockland/marl plains, and a variety of coastal features. Surficial materials are dominated by sand (often with relatively clayey substrata), limestone, and organic deposits.

8.1.1.3 Soils

Approximately 60% of the soils in Lee County are coastal and interior flatwoods and sloughs soils of the Hallandale-Boca and Isles-Boca-Pompano complex. They are nearly level, poorly drained, sandy soils with loamy subsoil. The remaining soils are Wulfert-Kesson-Captiva and Peckish-Estero-Isles soils of tidal areas and barrier islands which are poorly drained, sandy and mucky soils.

More than half the contributing soils in the Estero Bay basin are in agricultural use. Less than two percent of the soils are classified as very well-drained (HSG), while 72.1% are classified as B (well-drained), only 3.2% as C (less well-drained), and 22.8% are classified as D (poorly drained) (Table 8-1). Most of the soils throughout the basin, like much of the watershed, are classified as B/D, and have been artificially drained to accommodate land use (Figure 8-2).

Table 8-1. Hydrologic soil types in the Estero Bay Basin.

Soil Type	Acres	%
A	3,320	1.8
B	134,601	72.3
C	5,981	3.2
D	42,259	22.7
TOTAL	186,161	100.0

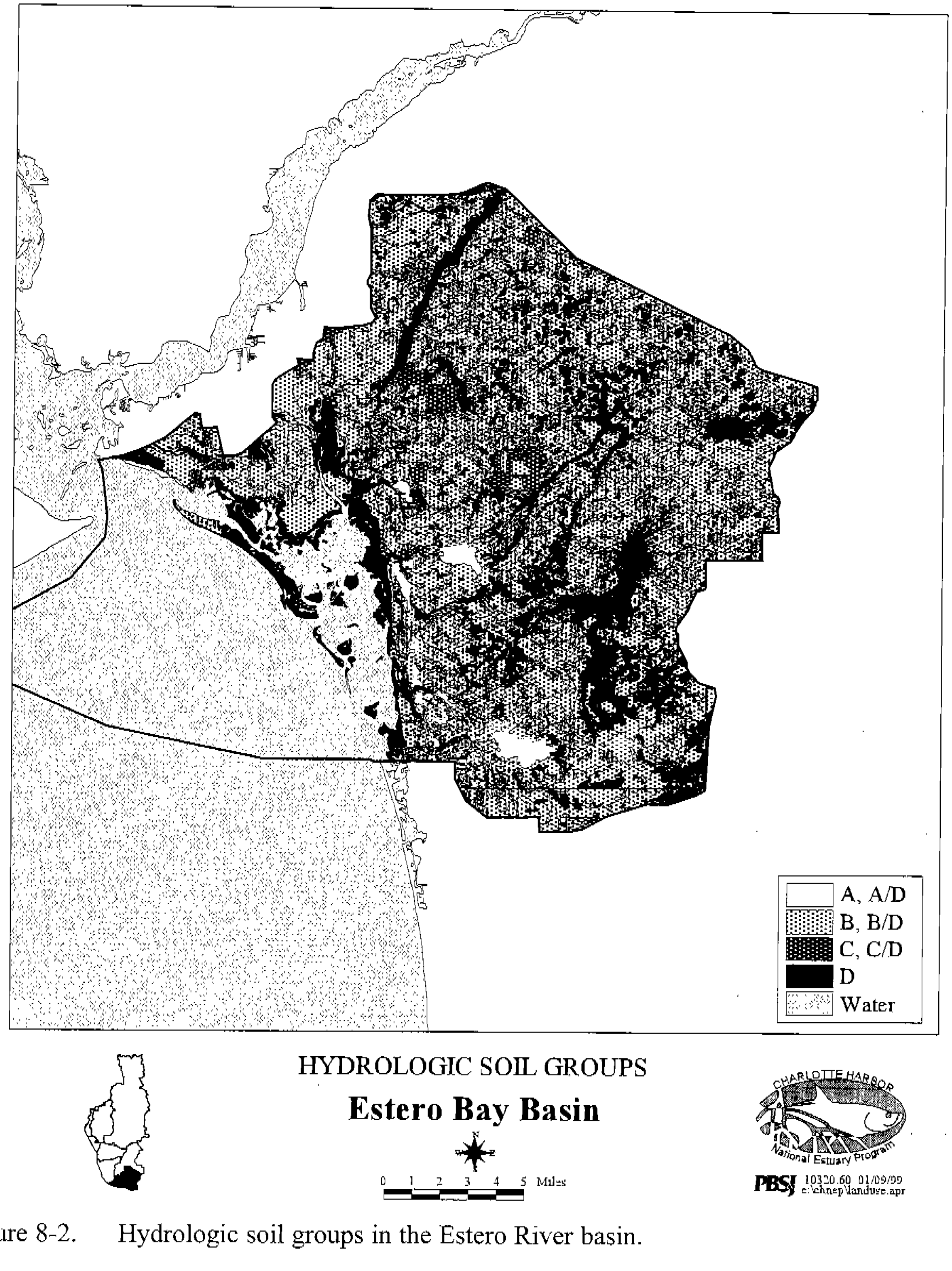


Figure 8-2. Hydrologic soil groups in the Estero River basin.

8.1.2 Rainfall

Data from a total of eight rainfall gages were used in calculating total annual rainfall since 1970 in the Estero Bay Basin (Figure 8-3). Total annual precipitation and average monthly precipitation (Figure 8-4) were plotted for the basin. Like other basins within the SFWMD, there are more rainfall gages in basins in the Estero Bay Basin as a result of additional SFWMD rainfall gages.

Minimum total annual precipitation ranged from approximately 32 inches of rain in 1987 to 80 inches of rain in 1995. Similar to other basins, peak annual precipitation occurred during 1983 (74 inches) and 1995. The within-year variation in rainfall also was similar to that observed in other basins.

Monthly precipitation was highest from June to September, and wet season average values ranged from 7.4 inches in September to 9 inches in June. Average monthly rainfall values were lowest during November (approximately 1.4 inches). Average values did not exceed 3.8 inches from October through May, although this was slightly higher than the 3.4 inches maximum for the dry season in the other basins.

8.1.3 Existing and Future Land Use

Existing and future land use for Estero Bay Basin is discussed in this section. Maps of future and existing land use and tables of acreages are presented.

8.1.3.1 Existing Land Use

Twenty-three percent of the basin lands are in agriculture, compared with 14% in urban use (Table 8-2). The remaining 63% includes predominantly forested freshwater wetlands (23%) and upland forests (19%). Residential land use makes up about 10% of the land use in the Estero Bay Basin (Figure 8-5). Mining and barren lands combined make up about 1% of the land use in the basin.

These percentages contrast with the greater proportions of agriculture in the Peace and Myakka basins (32-36% by basin). In addition, agriculture in the Peace River Basin alone includes 18% of the agriculture in the entire Charlotte Harbor Basin, compared with 1.7% in Estero Bay.

The current land use plan of Lee County classifies the entire Estero River corridor east of Koreshan State Historic Site as Urban Community/suburban. The area immediately west of the state historic site is classified as Outlying Suburban. The state historic site and the area surrounding the mouth of the river are classified as Resource Protection Zones. Estero Bay is a designated Aquatic Preserve and an Outstanding Florida Water. The Estero River is a designated Recreational Canoe Trail. In addition to the public land associated with the historic site, much of the land surrounding Estero Bay and extending south for approximately two miles has been purchased by the State of

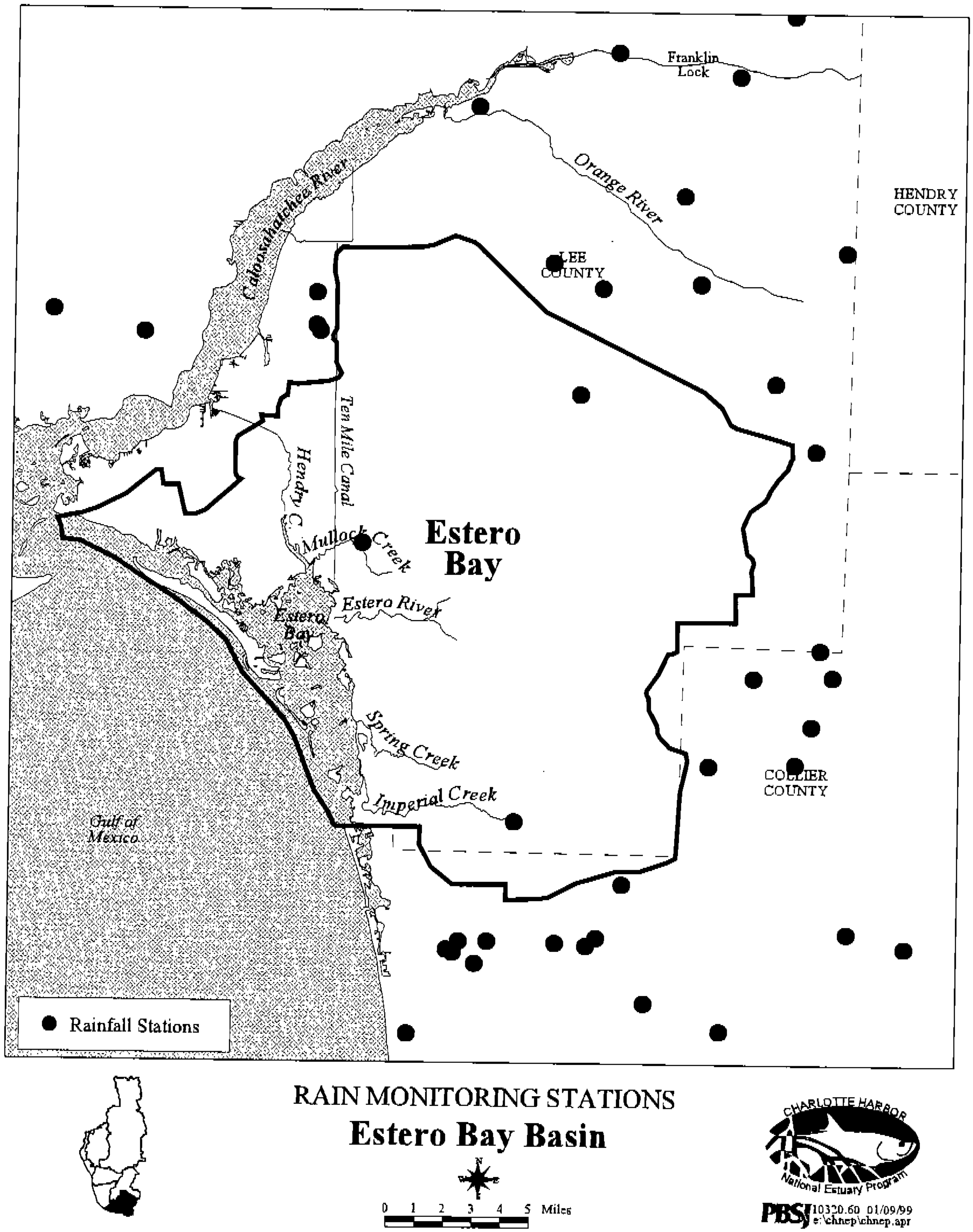
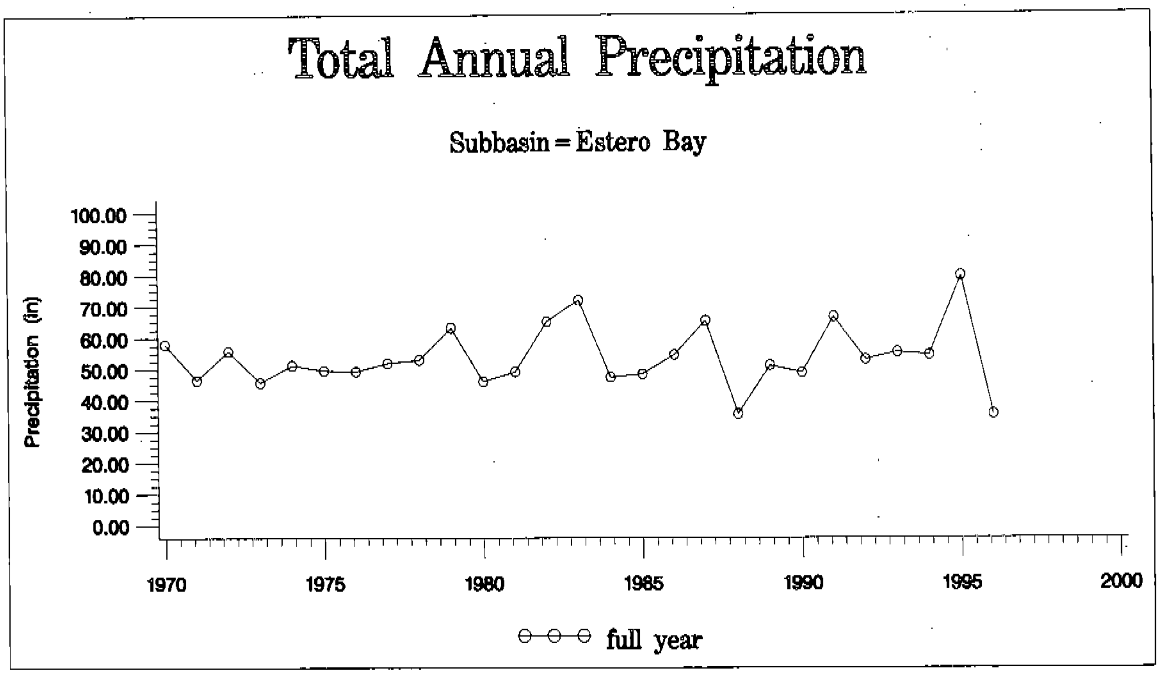


Figure 8-3. Rain station locations in the Estero River Basin.



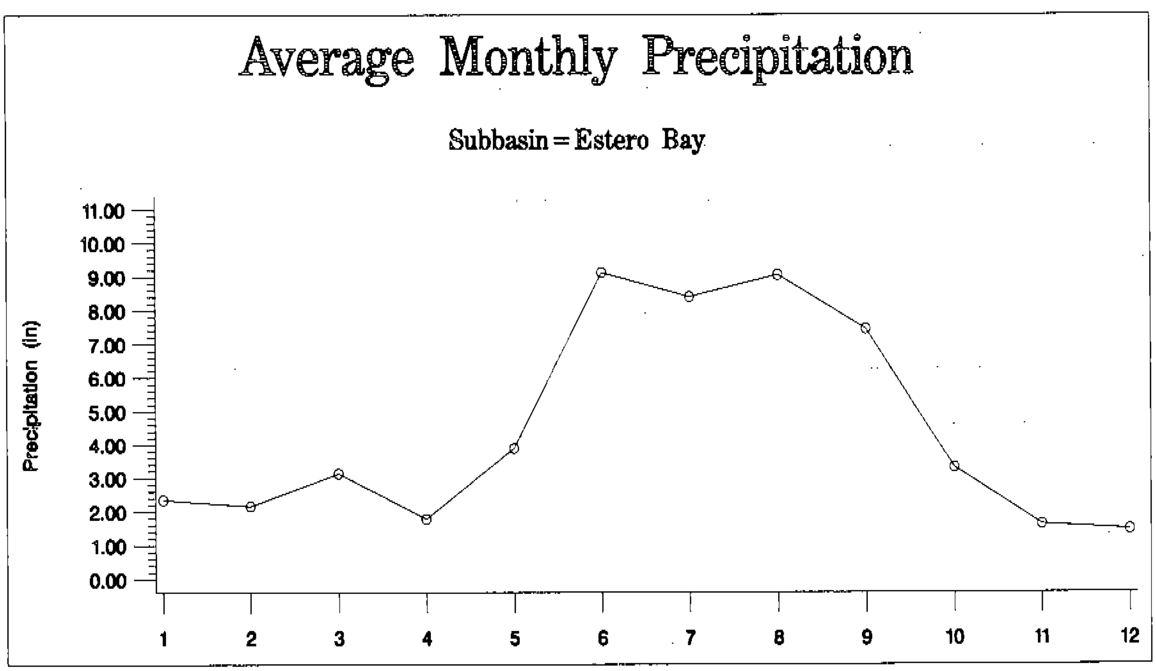


Figure 8-4. Total annual and average monthly rainfall plots for the Estero Bay Basin.

Table 8-2. Current (1990) land use/cover in the Estero Bay Basin.

Land Use/Cover	Acres	%
Single Family Residential	9,108	4.9
Medium Density Residential	6,001	3.2
Multi-family Residential	4,308	2.3
Commercial	1,170	0.6
Industrial	1,718	0.9
Mining	1,889	0.9
Institutional	3,471	1.9
Range Lands	8,127	4.4
Barren Lands	265	0.1
Pasture	31,582	17.0
Groves	2,087	1.1
Feedlots	213	0.1
Nursery	104	0.1
Row and Field Crops	9,309	5.0
Upland Forested	35,491	19.1
Freshwater - Open Water	2,059	1.1
Saltwater - Open Water	0	0.0
Forested Freshwater Wetland	41,029	22.0
Saltwater Wetland	11,439	6.1
Non-forested Freshwater Wetland	16,790	9.0
Tidal Flats	0	0.0
TOTAL	186,161	100.0

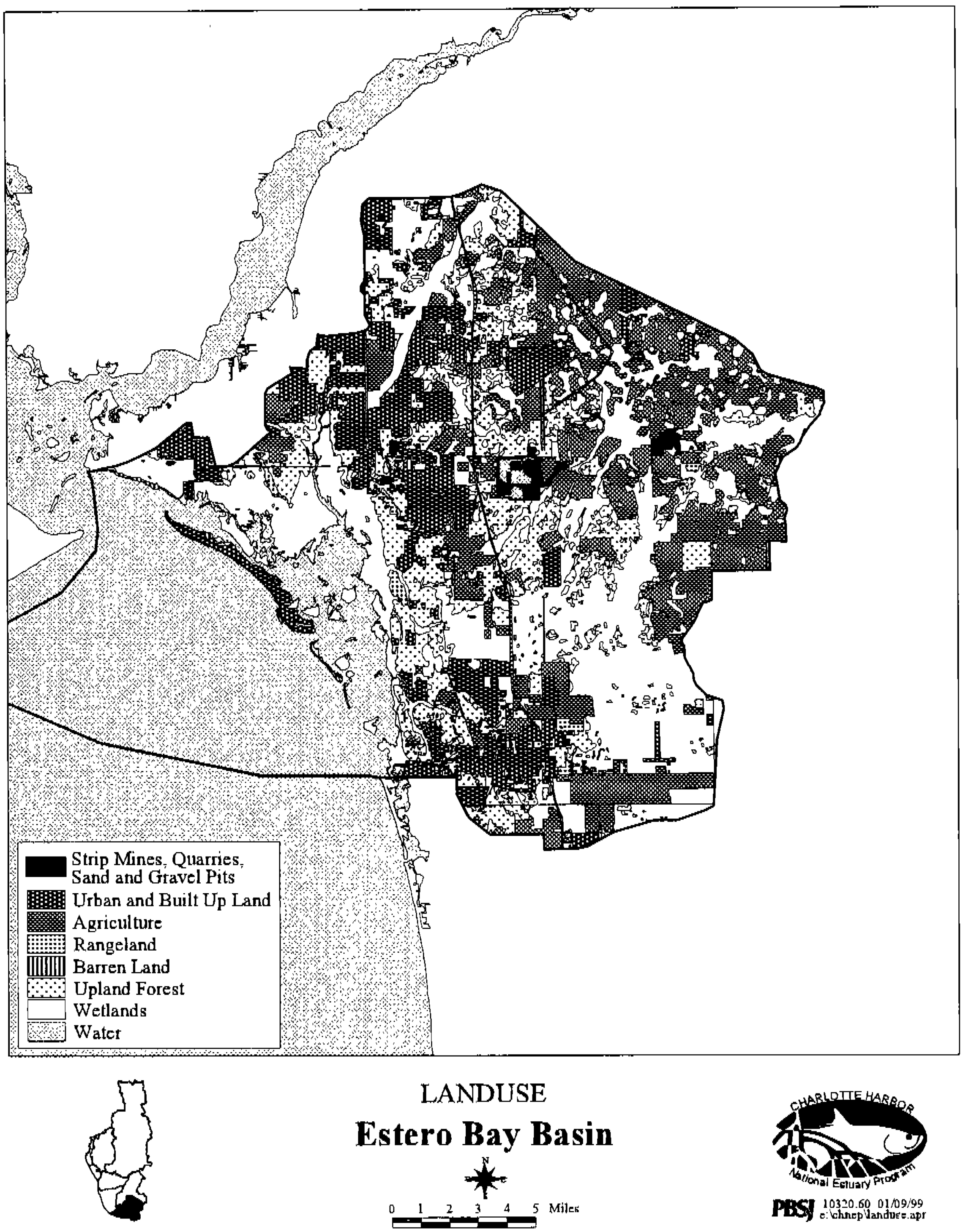


Figure 8-5. Existing land use map for the Estero Bay Basin (SWFWMD, 1990; SFWMD, 1988).

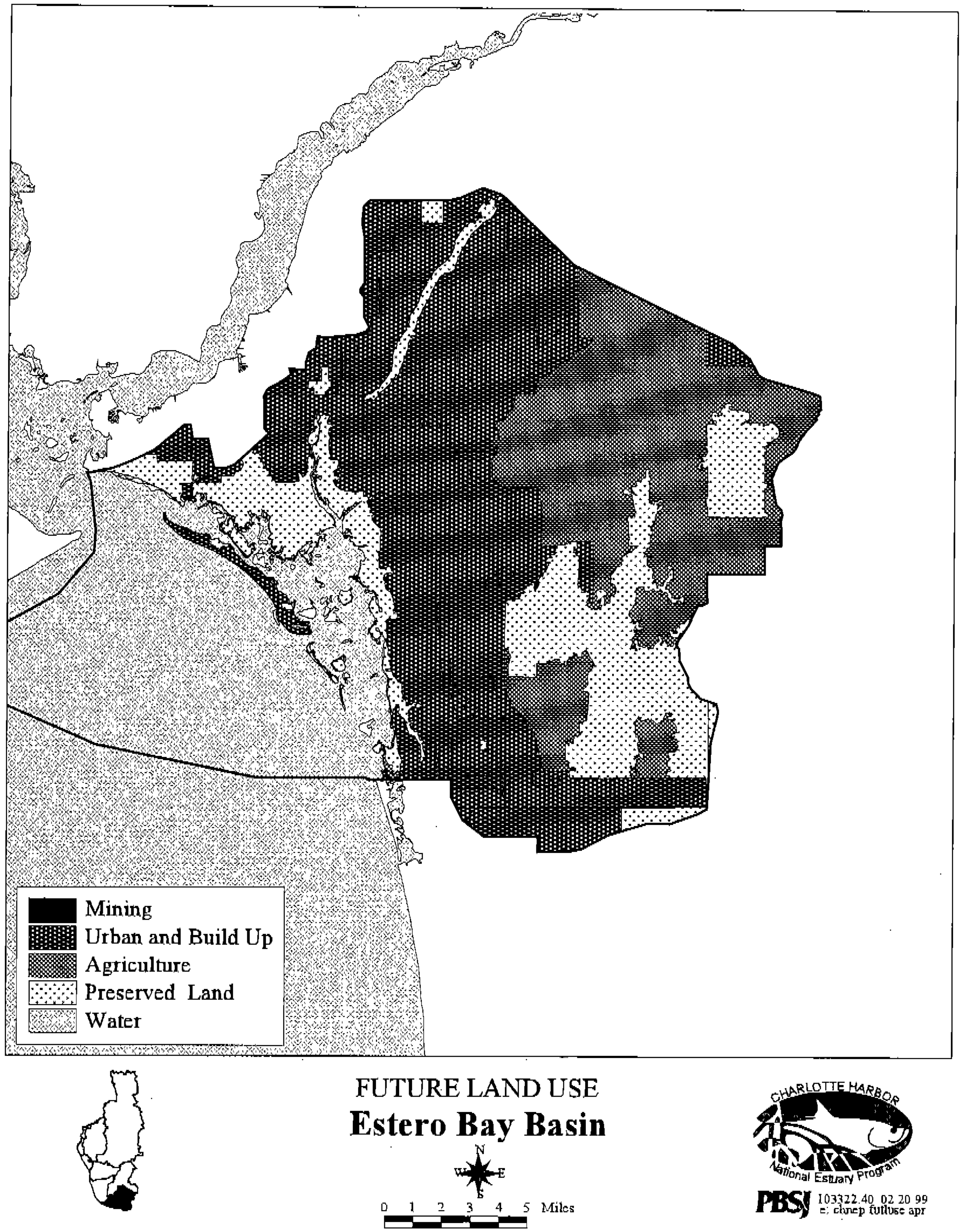


Figure 8-6. Future land use map for the Estero Bay Basin (SWFRPC, 1990).

Florida under the Conservation and Recreation Lands (CARL) program to maintain the pristine nature of the environment.

8.1.3.2 Future Land Use

Future land use maps from the SWFRPC for the Estero Bay Basin (Figure 8-6) indicate increases in urban land use, from 14% to 44%. Increases in agricultural land use are minimal, from 23% to 28%.

Table 8-3. Future (2010) land use/cover in the Estero Bay Basin.

Land Use/Cover	Acres	%
Single Family Residential	58,555	31
Multi-family Residential	965	1
Rural Residential	11,512	6
Commercial	7,521	4
Industrial	14,419	8
Agricultural	52,847	28
Protected Resource	43,503	23
TOTAL	189,492	100

8.1.4 Surface Water Hydrology and Water Management Practices

There are no streamflow gages in the Estero Bay Basin. Freshwater inflow into the Estero Bay estuary generally peaks in September (Drew and Schomer, 1984). Flows measured in the Imperial River from 1940 to 1952 indicate that flow in dry months (December to May) averages only about 7% of the total annual inflow. Tidally induced flows in Estero Bay are far greater than freshwater inflow. Because freshwater inflow into Estero Bay is low, salinities at the mouths of the rivers and creeks in the Estero Basin seldom fall below 10 ppt during the rainy season.

8.1.4.1 Urban Management Practices

Approximately 14% of the Estero Bay Basin is classified as urban land (Table 8-2). The urbanized areas of the Estero Bay Basin are found primarily in the Fort Myers and Bonita Springs regions, as well as along the U.S. 41 and I-75 corridors and on Estero Island. The discussion of urban management practices is divided into urban water uses and urban water discharges. The water uses and water discharges are tabulated in the following descriptions.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. Discussion of water use is limited to facilities with an average permitted quantity greater than 0.5 MGD. Water use information is from LWCWSP (1994).

Table 8-4 shows the public water supply facilities in the Estero Bay Basin with permitted withdrawals of more than 0.5 MGD, as well as the withdrawal sources for the facilities. A discussion of the populations served by each plant, withdrawal amounts, and withdrawal methods follows.

Table 8-4. Public water supply facilities in the Estero Bay Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
Bonita Springs Utilities	3.18	Lower Tamiami aquifer
Gulf Utility Corkscrew	1.40	Sandstone, Water Table aquifers
Gulf Utility San Carlos	1.75	Water Table aquifer
Florida Cities College Parkway	9.17*	Mid-Hawthorn aquifer
Florida Cities Green Meadows	9.17*	Water Table, Sandstone aquifers
Lee County Utilities Corkscrew	10.00	Water Table, Sandstone aquifers

* Both Florida Cities College Parkway and Green Meadows are permitted under the same permit, with total permitted average withdrawal of 9.17 MGD.

The Bonita Springs Utilities water treatment plant withdraws from its west wellfield, with an east wellfield permitted and constructed in 1994. The west wellfield contains 16 wells which withdraw from the lower Tamiami aquifer, and have depths of 80 to 115 feet. Well capacities are from 125 to 250 GPM, supplying the permitted average of 3.18 MGD prior to completion of the east wellfield. The average flow during 1990 was 2.15 MGD (LWCWSP, Vol. III, 1994).

The Gulf Utility Corkscrew water treatment plant withdraws via 12 wells from the water table (11 wells) and sandstone (one well) aquifers. The capacities of the water table wells are 450 GPM each, with depths of 16-22 feet. The sandstone aquifer well is 123 feet deep, with a withdrawal capacity of 60 GPM. The permit for this utility also approved four more sandstone aquifer wells, with depths of 125 feet and withdrawal capacities of 60 GPM. The permitted average withdrawal from the water table aquifer is 1.05 MGD, and 0.35 MGD from the sandstone aquifer. The permit for this utility includes the Gulf Utility San Carlos wellfield as well (discussed below), and allows a total withdrawal of 3.15 MGD from all sources (LWCWSP, Vol. III, 1994). The Gulf Utility San Carlos withdraws from four wells in San Carlos Park. The wells are between 40 and 45 feet deep, withdraw from the water table aquifer, and have withdrawal capacities of 211-283 GPM. The permitted average withdrawal for this utility is 1.75 MGD, with average 1990 flow of 1.46 MGD (LWCWSP, Vol. III, 1994).

The Florida Cities College Parkway withdraws water from the mid-Hawthorn aquifer via 14 wells near Cypress Lake Drive and College Parkway. The wells are between 220 and 285 feet deep, and have pumping capacities between 80 and 150 GPM. Average flows during 1990 were 0.53 MGD. The wells supply part of the permitted average withdrawal of 9.17 MGD from the plants covered by this permit. Also included in this permit is the Florida Cities Green Meadows water treatment plant. This plant withdraws from the water table aquifer via 14 wells and from the sandstone aquifer via 13 wells. The water table wells are 24-43 feet deep, with capacities of 200 GPM per well. The sandstone aquifer wells are between 84 and 105 feet deep, with capacities of 350-500 GPM. The wells supply the remaining part of the 9.17 MGD permitted average withdrawal for this plant and the Florida Cities College Parkway plant. The 1990 average withdrawal for the Green Meadows plant was 4.89 MGD (LWCWSP, Vol. III, 1994).

The Lee County Utilities Corkscrew plant withdraws from 23 wells in the southeastern portion of the county. Both the sandstone and the water table aquifers are utilized, with 17 water table wells and six sandstone aquifer wells. The water table aquifer wells are 105 to 150 feet deep, with capacities of 500 GPM each. The sandstone aquifer wells are between 205 and 300 feet deep, with capacities of 350 GPM each. The permitted average withdrawal form the wells is 10.00 MGD, with average 1990 flows of 5.56 MGD (LWCWSP, Vol. III, 1994).

- Mining

Mining in the basin is limited to sand and gravel mining and makes up less than 1% of the land use in the basin.

- Industrial

Industrial land use in the Estero Bay Basin covers 1,718 acres, or approximately 0.9% of the basin area. In all of Lee County commercial and industrial self-supplied water demand was 31.3 MGD for 1990 (LWCWSP, 1994).

- Recreational

Information as to the locations of water use within the basin is not given (LWCWSP, 1994), but total water use for golf courses and landscape is given by county. In Lee County, landscape demand for 1990 was 23.5 MGD, and golf course water use was 17.2 MGD, for a total water use demand of 40.7 MGD (LWCWSP, 1994).

Water Discharge and Reuse

The Bonita Springs Utilities WWTP has a capacity of 2.40 MGD. Effluent from the plant is for reuse via spray irrigation of golf courses, residential properties, and other green spaces of the Bonita Bay area. In 1990, average flow was 0.07 MGD. The utility has plans for expanding the capacity of the current plant to 6.0 MGD, and constructing another plant with 2.0 MGD capacity east of I-75 and north of Bonita Beach Road (LWCWSP, Vol. III, 1994). The Forest Utility WWTP has a capacity of 0.50 MGD, with water disposal to reuse on the Forest Golf Course. This plant had a 1990 average flow of 0.30 MGD (LWCWSP, Vol. III, 1994). The Gateway Utility WWTP also disposes of its wastewater via reclaimed water use. The capacity of the plant is 1.00 MGD, with 1990 average flows of 0.01 MGD. Reclaimed water is for use on the development's residential areas and green spaces (LWCWSP, Vol. III, 1994).

8.1.4.2 Agricultural Management Practices

Approximately 23% of the Estero Bay Basin is occupied by agricultural land uses (Table 8-2). In addition to pasture (17%), other agricultural land uses found are row and field crops (9,309 acres), groves (2,087 acres), confined feeding operations (213 acres), and nurseries (104 acres).

Agricultural land use estimates for all major crops for 1990 in Lee County are shown in Table 8-5, and for Collier County in Table 8-6 below, along with estimates of irrigated acreages for each of these crops and estimated water use.

Table 8-5. 1990 estimated crop acreages, irrigation types, and water use in Lee County.

Crop	Acreage	Irrigation Type - Acreage	Water Use (MGD)
Citrus	9,692	Overhead 4,846 Seepage 4,846	28.5
Tropical Fruit	1,680	Seepage 1,512	4.8
Vegetables	9,785	Seepage 9,785	23.0
Nursery	606	Overhead 606	2.8
Sod	650	Seepage 650	3.0
Pasture	118,000	Cattle Watering	0.2
Totals	140,413	Overhead 5,452 Seepage 16,793	62.3

Table 8-6. 1990 estimated crop acreages, irrigation types, and water use in Collier County.

Crop	Acreage	Irrigation Type -	Acreage	Water Use (MGD)
Citrus	23,565	Micro-irrigation Overhead Seepage	16,966 943 5,656	66.1
Vegetables	32,152	Seepage	32,152	75.8
Nursery	1,382	Overhead	1,382	7.4
Pasture	330,000	Cattle Watering		0.2
Totals	387,099	Micro-irrigation Overhead Seepage	16,966 2,325 37,808	149.5

8.2 Water Quality Conditions

The Lee County Environmental Lab has collected water quality in Estero Bay since 1991. The sampling site locations are presented in Figure 8-7. For sake of discussion and evaluation the sampling sites have been aggregated into three regions, upper, middle, and lower Estero Bay. Figures 8-8 through 8-13 present the Lee County water quality data.

Several notable observations can be made upon review of these data. First, there is little difference in the concentrations of nitrogen, phosphorus, and chlorophyll in the three regions of Estero Bay. Secondly, the water quality of Estero Bay is superior to that observed in Charlotte Harbor. Chlorophyll concentrations in Estero Bay are typically less than 10 g/L, in contrast to the chlorophyll concentration in Charlotte Harbor that usually range from 10-20 g/L. Nitrogen and phosphorus concentrations in Estero Bay are also lower than those observed in Charlotte Harbor. Clearly, the natural sources of phosphorus in the Peace River contribute to this observed difference as does the fact that the watershed to receiving water body ratio is considerably greater in Charlotte Harbor.

8.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) were estimated for each subbasin by calculating nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to prioritize major basins or subbasins. Thus, the method development was focused on estimating relative loads in a consistent manner among subbasins to avoid biasing the major basin or subbasin evaluation.

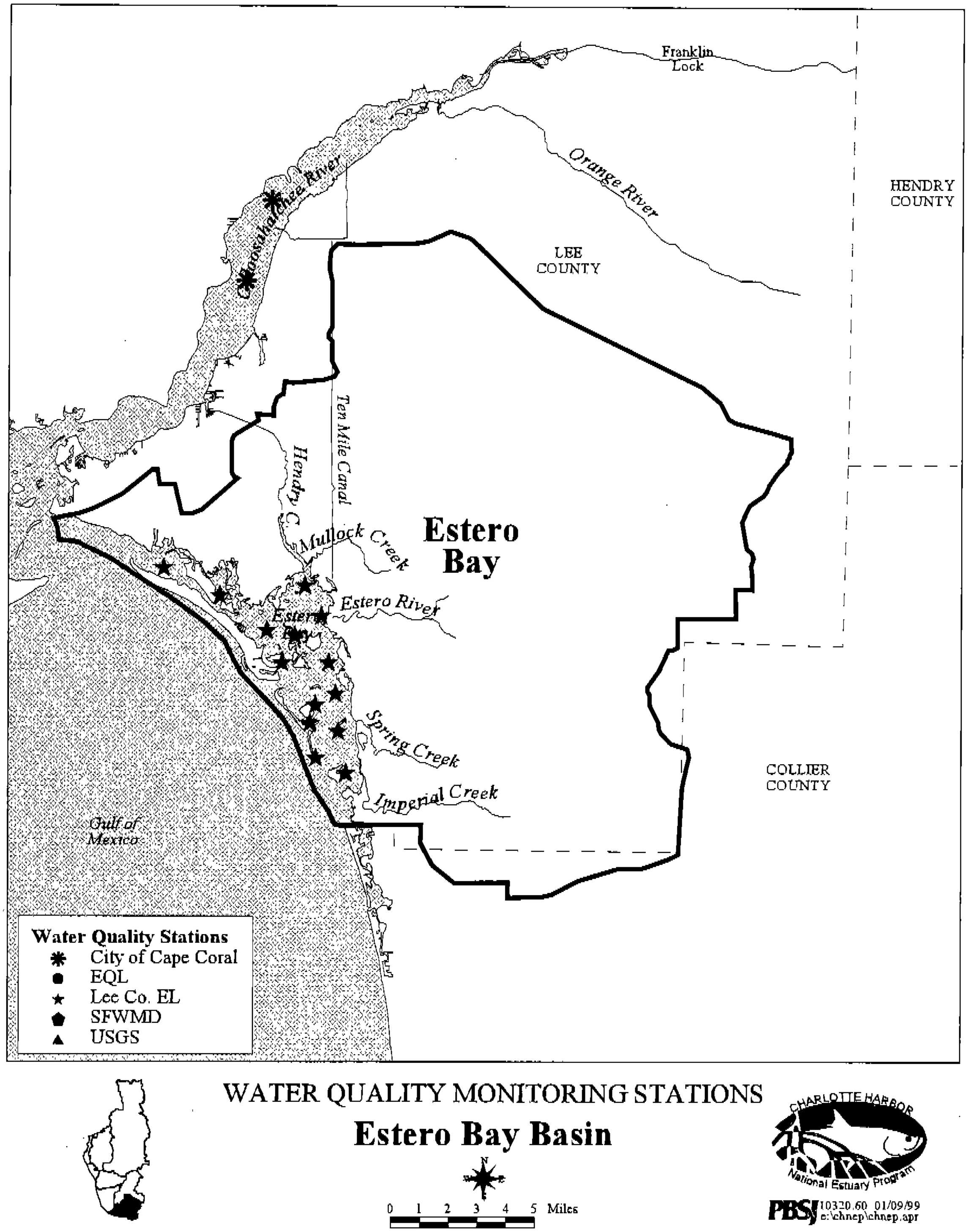


Figure 8-7. Location of water quality sampling sites in the Estero Bay Basin.

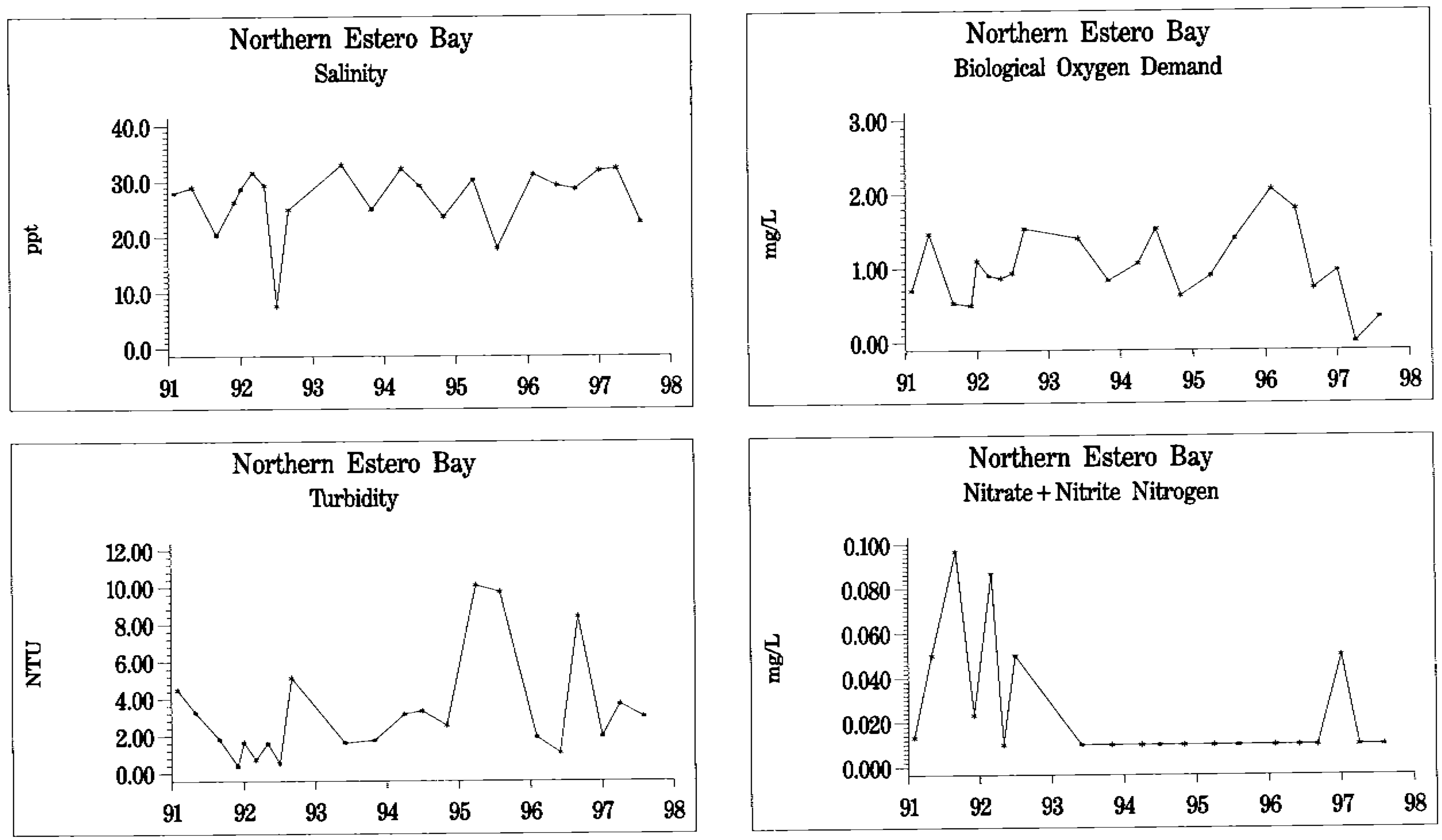


Figure 8-8. Time series graphs of water quality constituents measured in northern Estero Bay (Lee County stations).

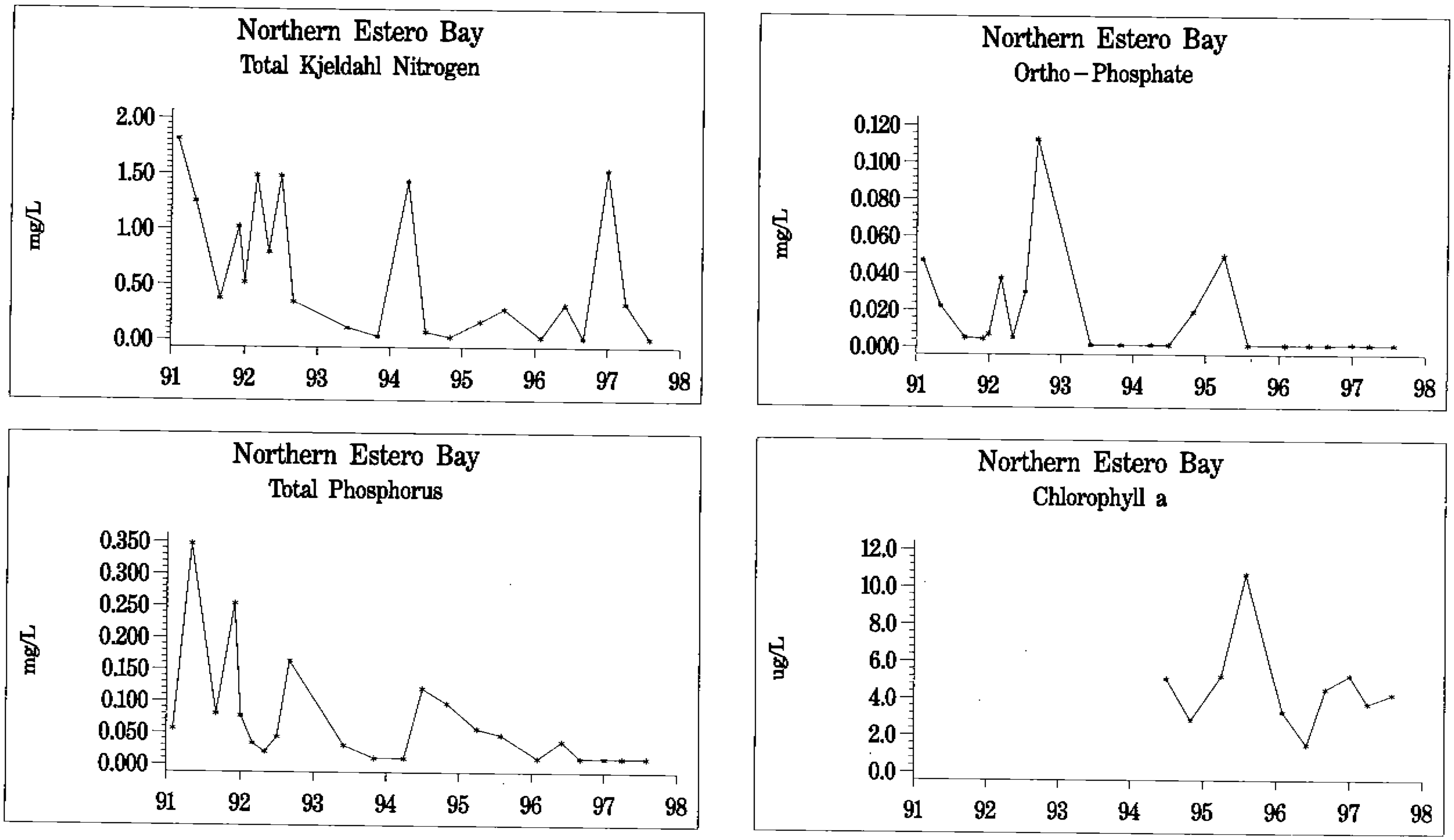


Figure 8-9. Time series graphs of water quality consituents measured in northern Estero Bay (Lee County stations).

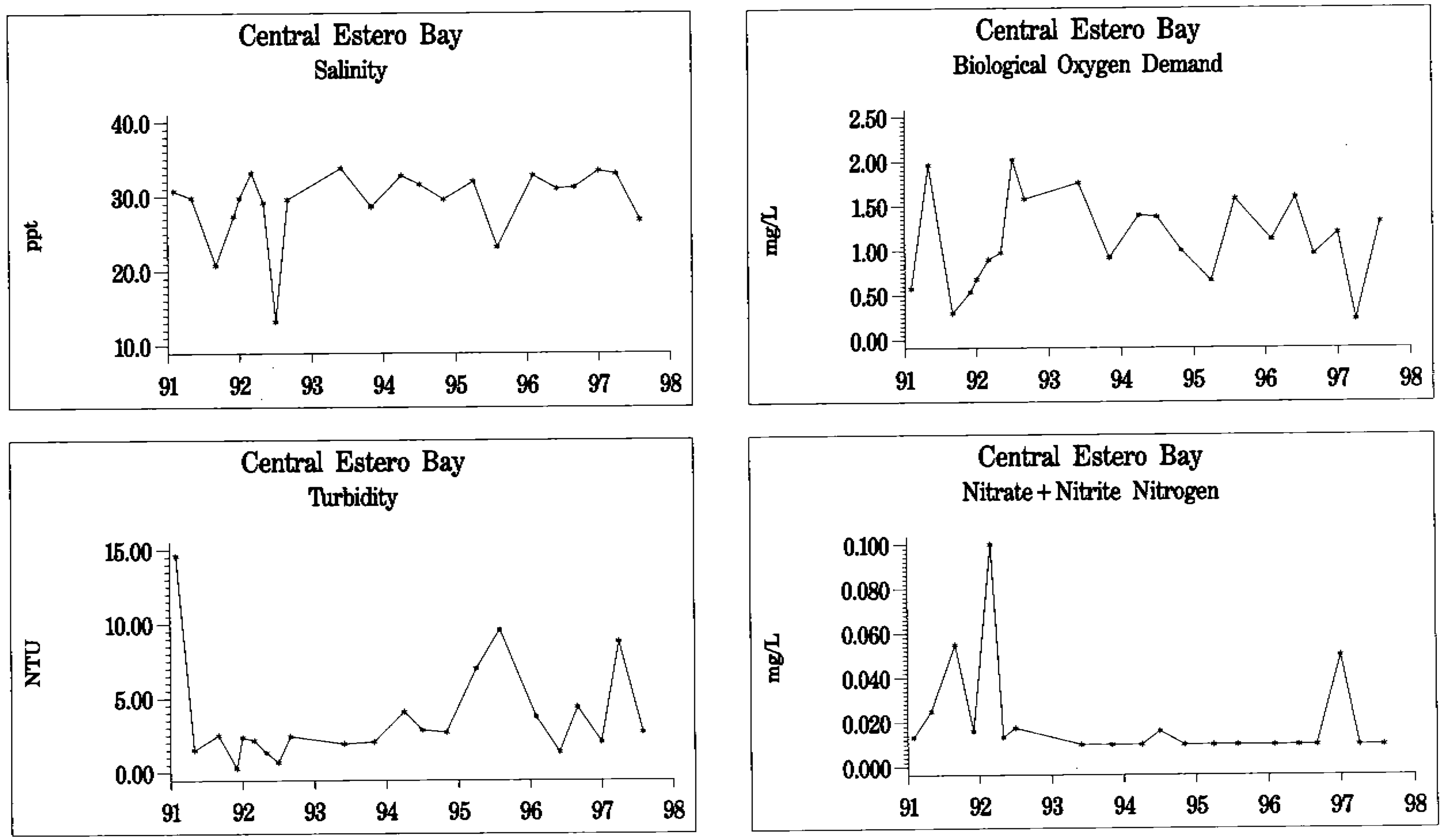


Figure 8-10. Time series graphs of water quality consituents measured in central Estero Bay (Lee County stations).

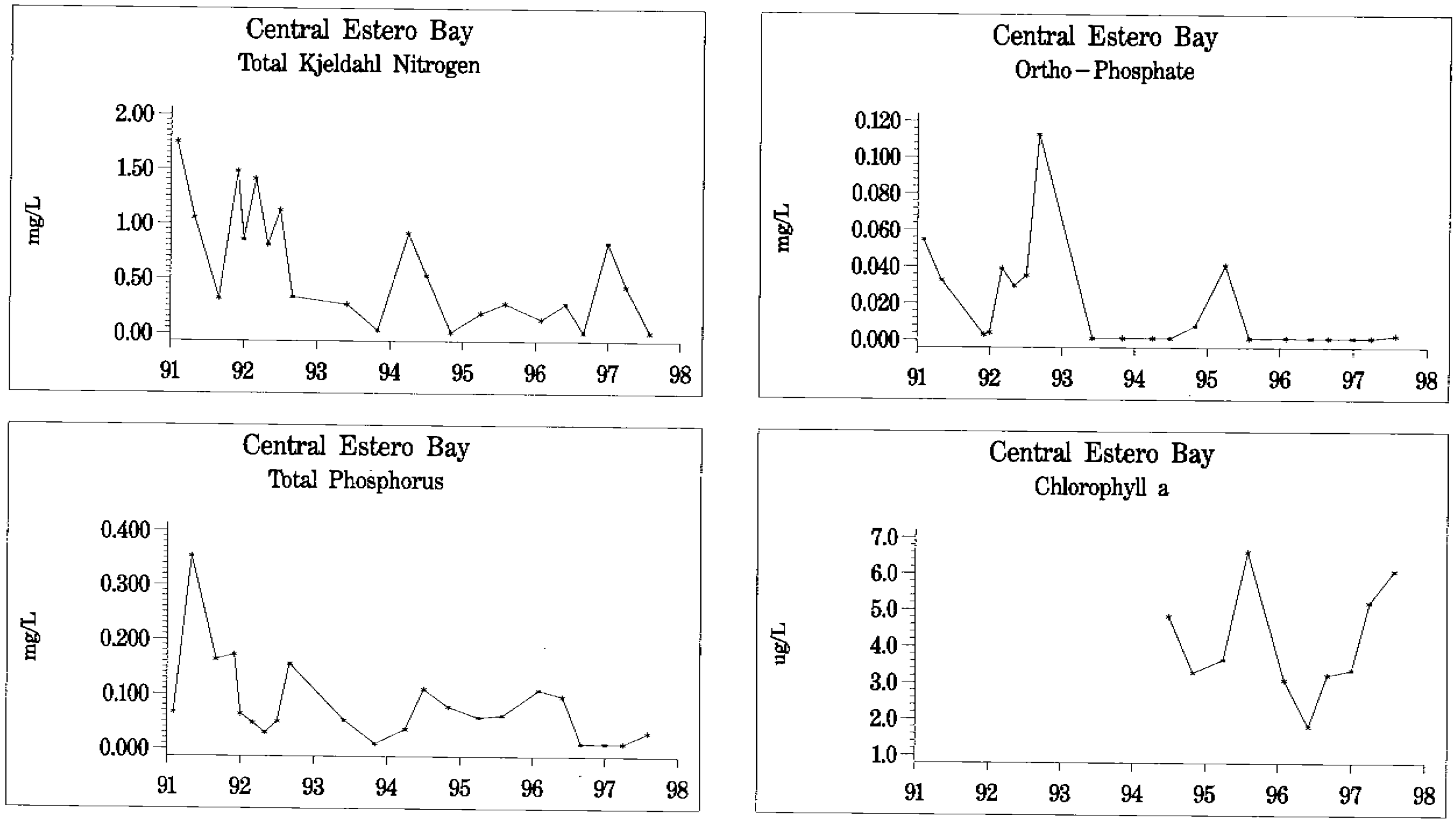


Figure 8-11. Time series graphs of water quality consituents measured in central Estero Bay (Lee County stations).

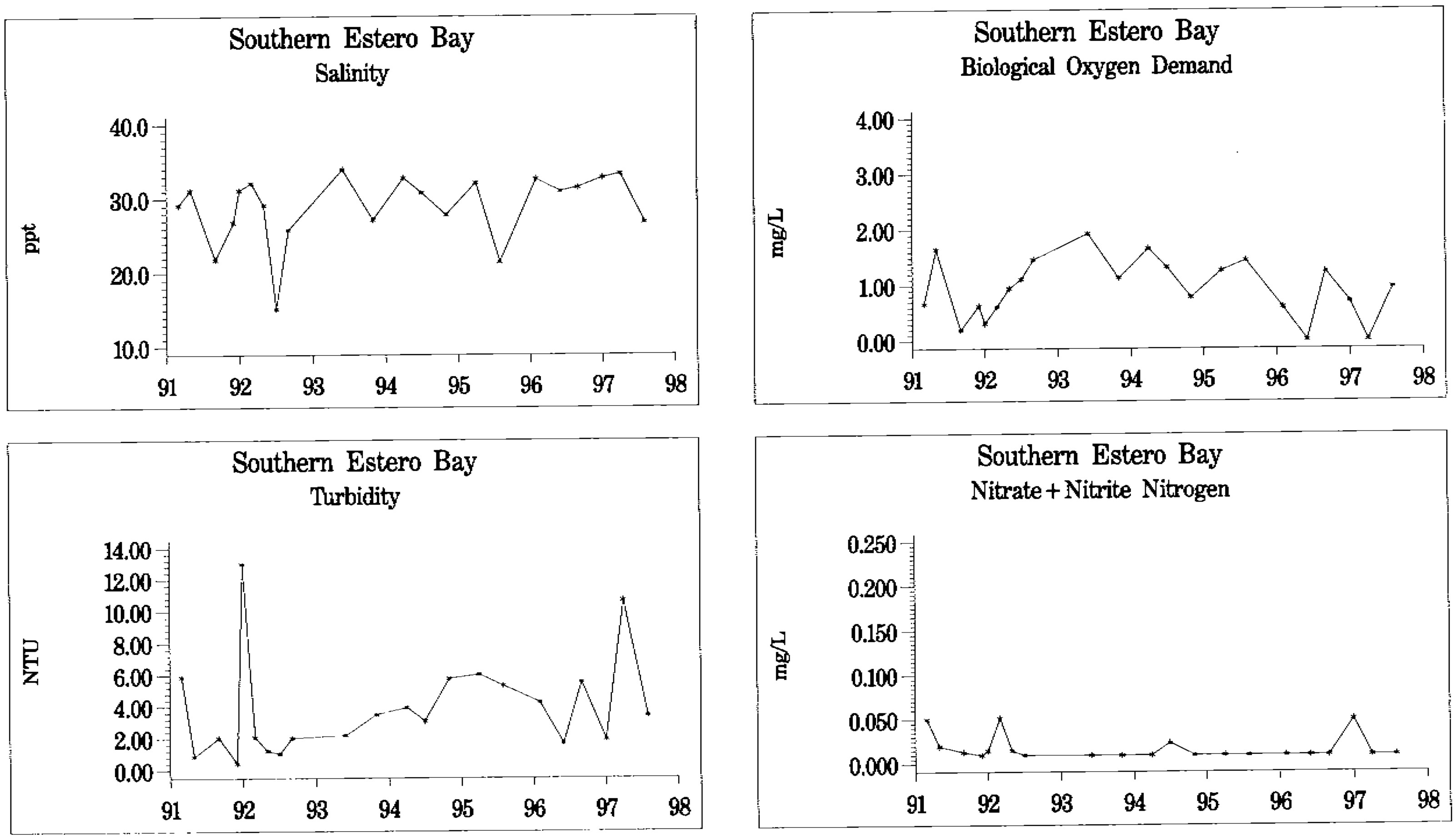


Figure 8-12. Time series graphs of water quality consituents measured in southern Estero Bay (Lee County stations).

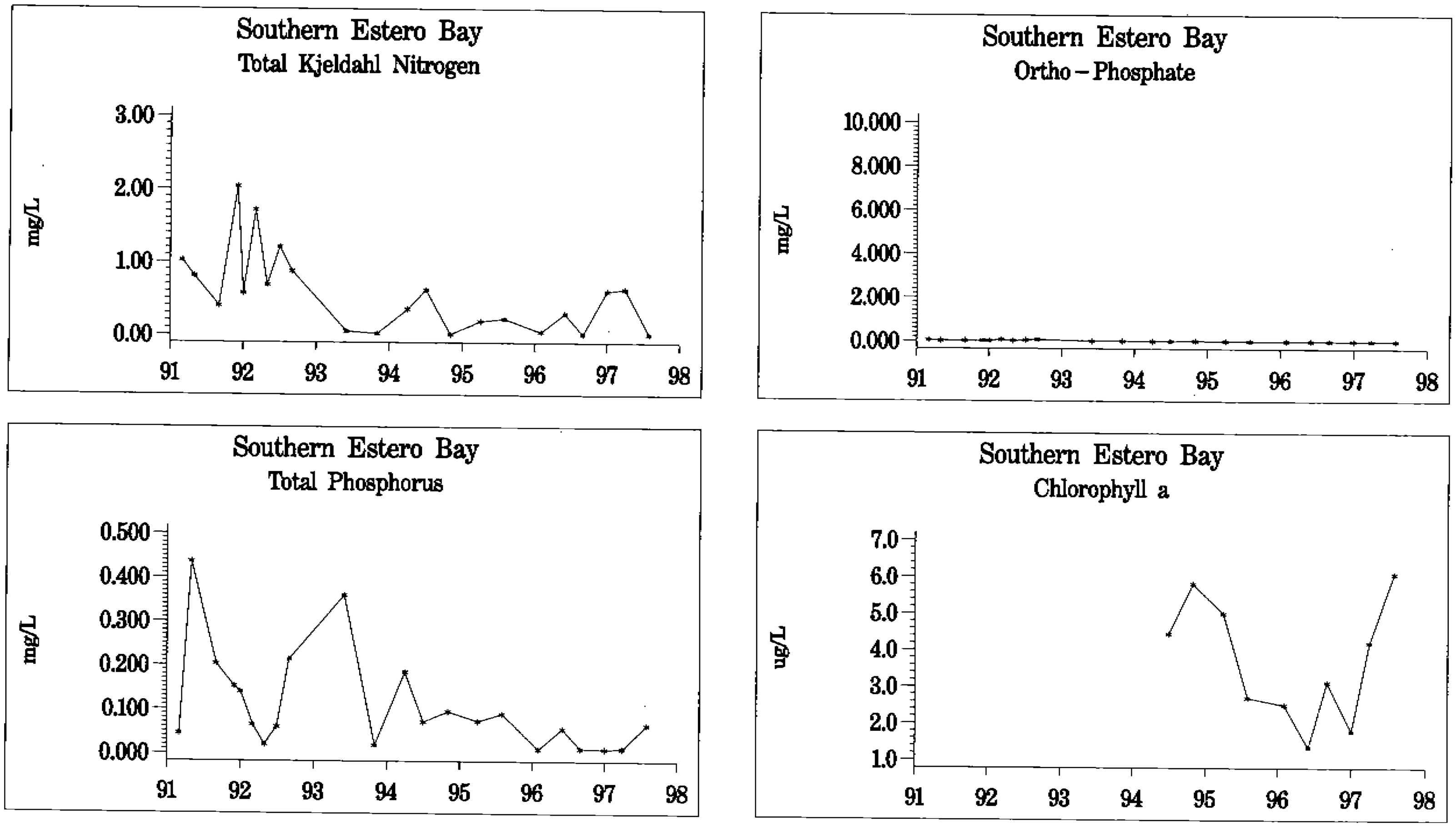


Figure 8-13. Time series graphs of water quality consituents measured in southern Estero Bay (Lee County stations).

The detailed rainfall, 1988 SFWMD land cover and USDA soil data were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for South Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow were used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TN, TP and TSS loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and 1 ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, feedlots, field and row crops, and nursery. Undeveloped land uses were defined as range lands, barren lands, upland forests, and wetlands.

8.3.1 Load Estimates for Estero Bay Basin

The Estero Bay Basin was estimated to have the second highest TSS load among all of the subbasins of the study area. However, it was not among the six largest subbasins with respect to contributing drainage area of the Charlotte Harbor NEP area (115,000 acres). The total estimated annual runoff discharge was 171 million cubic meters. The estimated annual pollutant loads were 513 tons of TN, 116 tons of TP, and 6,888 tons of TSS.

A large portion of the nonpoint source pollutant loads in this subbasin, in particular the TN loads, were attributed to the undeveloped lands such as forests. A total of 38% of the subbasin contributing area was defined as undeveloped land uses. Table 8-7 presents the loads from runoff by land use. In total, the undeveloped lands contributed 49 million cubic meters of runoff, 191 tons of TN, 36 tons of TP, and 2,524 tons of TSS per year to the estuary. Forested freshwater wetlands comprised the majority of these lands.

The developed lands in this subbasin totaled 43,000 acres of agricultural land and 28,000 acres of urban land. The agricultural lands were estimated to contribute 55 million cubic meters of runoff, 187 tons of TN, 60 tons of TP, and 1,062 tons of TSS per year. The urban lands were estimated to contribute 67 million cubic meters of runoff, 136 tons of TN, 20 tons of TP, and 3,302 tons of TSS per year. Theses loads were primarily from residential land uses and pasture (Table 8-7).

Table 8-7. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Estero Bay Basin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	26	5%	4	3%	253	4%	12,660,943	7%
Medium Density Residential	30	6%	4	4%	460	7%	12,306,027	7%
High Density Residential	31	6%	6	5%	949	14%	13,366,531	8%
Commercial	11	2%	2	1%	428	6%	5,264,229	3%
Industrial	14	3%	2	2%	771	11%	7,460,300	4%
Mining	10	2%	2	1%	317	5%	5,725,920	3%
Institutional, Transport., Util.	14	3%	1	1%	124	2%	10,216,909	6%
Range Lands	26	5%	13	11%	132	2%	9,137,905	5%
Barren Lands	1	0%	0	0%	11	0%	954,924	1%
Pasture	101	20%	31	26%	325	5%	34,386,662	20%
Groves	5	1%	1	1%	24	0%	2,211,230	1%
Feedlots	22	4%	4	4%	57	1%	1,032,988	1%
Nursery	0	0%	0	0%	11	0%	180,246	0%
Row and Field Crops	59	12%	24	21%	645	9%	16,926,788	10%
Upland Forests	163	32%	23	20%	2,381	35%	39,150,003	23%
TOTAL	513	100%	116	100%	6,888	100%	170,981,605	100%

8.3.2 Pollution Source Inventory

The purpose of this compilation of a point source inventory for the Estero Bay Basin is to describe the numbers, locations, and discharge capacities of domestic and industrial point sources within the Estero Bay Basin. The inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources, as discussed previously.

Wastewater treatment plant discharges for those plants in the Charlotte Harbor Proper Basin with greater than 0.5 MGD in the SFWMD (SFWMD, 1994) were previously discussed. The following discussion utilizes only the FDEP databases, as previously described.

The FDEP databases list 113 domestic point sources and 14 industrial point sources within the Estero Bay Basin (Tables 8-8 and 8-9). Two of the domestic point sources and one of the industrial point sources are in Collier County, with the remaining 111 domestic point sources and 13 industrial point sources in Lee County (Figure 8-14).

Domestic point sources discharge capacities total 15.09 MGD, with 12.76 MGD of this sent to reuse. For the seven industrial point sources which have discharge capacity listed, combined discharge capacity is 0.35 MGD, of which 0.27 MGD is for reuse. One of the industrial plants with no discharge capacity listed has Estero Bay listed as its receiving waterbody.

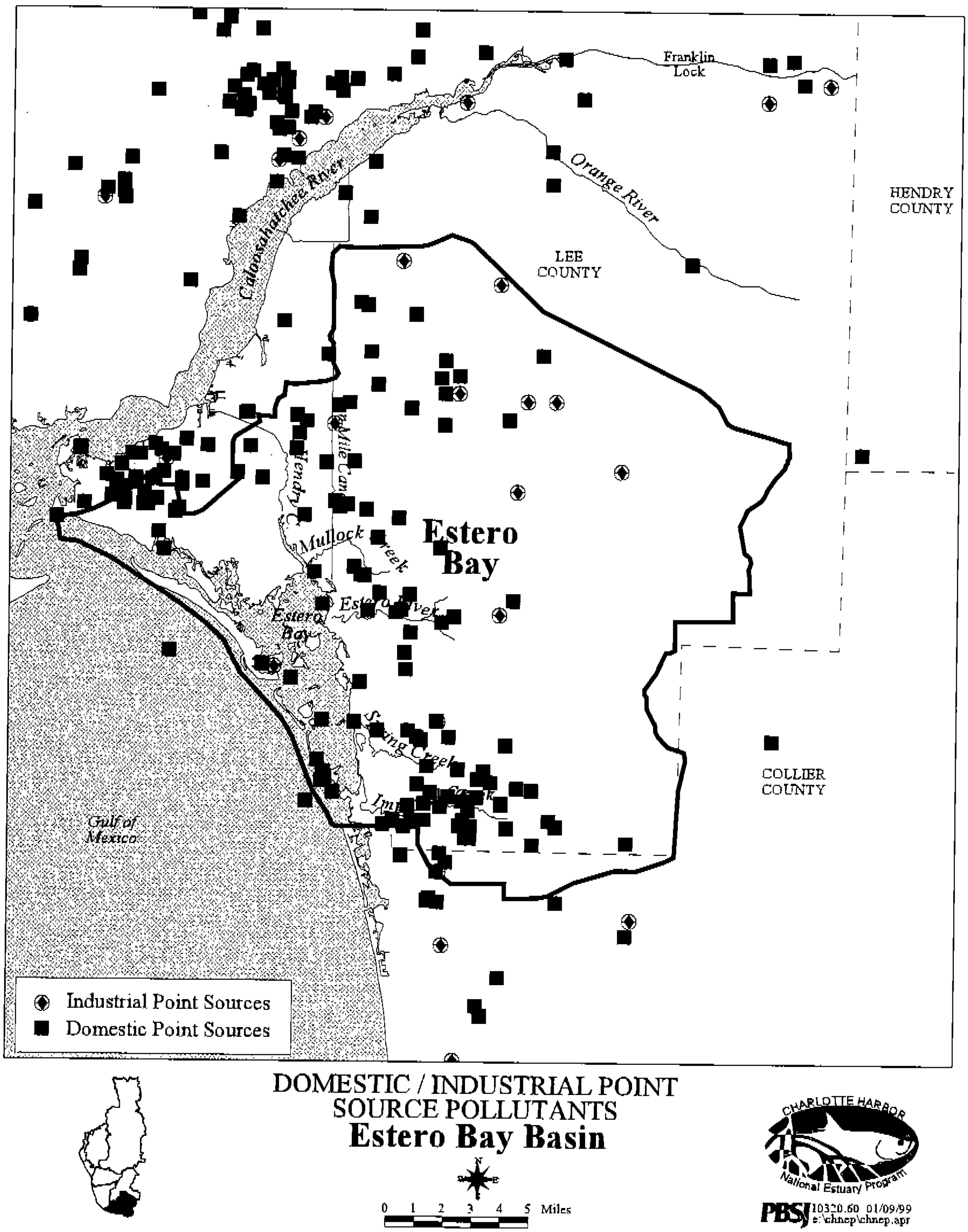


Figure 8-14. Location of domestic and industrial point sources in the Estero Bay Basin.

Table 8-8. Domestic Point Sources in the Estero Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
NAPLES TOMATO GROWERS-CAMP SANDY	Collier	0.01	Retention Pond
SANDY RIDGE LABOR CAMP	Collier	0.02	Percolation Ponds
BONITA SPRINGS MIDDLE SCHOOL	Lee	0.03	Percolation Ponds
SPRING CREEK ELEMENTARY SCHOOL	Lee	0.02	Drainfield
ESTERO HIGH SCHOOL	Lee	0.05	Percolation Ponds
JETPORT PACKAGE PLANT	Lee	0.15	Sheet Flow
FORT MYERS BEACH S. T. P.	Lee	6	Reuse w/ Percolation Ponds
MARINER'S LODGE	Lee	0	
WILDCAT RUN W. W. T. P.	Lee	0.3	
LIMETREE CAMPSITES	Lee	0.05	
RIVER TERRACE CONDO.	Lee	0.01	Drainfield
WOODSMOKE CAMPING RESORT	Lee	0.04	Percolation Ponds
BONITA SPRINGS COUNTRY CLUB	Lee	0.3	Percolation Ponds
BONITA SPRINGS WATER RECLAMATION	Lee	2.5	Percolation Ponds/ Spray Irrigation
BAY HARBOR CLUB	Lee	0.04	Drainfield
BONITA LANES	Lee	0.01	Drainfield
L. C. M. SEWER AUTHORITY	Lee	0.07	
GULF COAST CAMPING RESORT	Lee	0.04	
BONITA ST. JAMES VILLAGE	Lee	0.01	Absorption Fields
SPANISH WELLS	Lee	0.05	
GRANADA LAKES RV WWTP	Lee	0.03	Percolation Ponds
OAK CREEK TRAILER PARK	Lee	0.01	Retention Pond
KELLY GREENS STP	Lee	0.05	
JONES MOBILE VILLAGE	Lee	0.02	Percolation Ponds
LEISURE TIME CAMPSITES & CLUB, INC.	Lee	0.02	Absorption Fields
BONITA SPRINGS TRAILER PARK	Lee	0.02	
CITRUS PARK, NORTH	Lee	0.1	Percolation Ponds
FOREST UTILITIES, INC.	Lee	0.5	Spray Irrigation
SUNSHINE FOODWAY	Lee	0.01	
SANIBEL HARBOUR RESORT	Lee	0.08	
FIDDLESTICKS COUNTRY CLUB	Lee	0.25	Spray Irrigation
PADDLE CREEK	Lee	0.1	
ANGLERS PARADISE TRAILER PARK	Lee	0.01	Drainfield
LUCKEY 48 CONDO.	Lee	0.02	Drainfield

Table 8-8. Domestic Point Sources in the Estero Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
PALMETTO PALMS RV RESORT CONDO	Lee	0.05	
PALM BAY ESTATES/HICKORY POINT	Lee	0.01	Drainfield
DAVIS LAKE CONDOMINIUM WWTP	Lee	0.03	
EAGLE RIDGE W. W. T. PLANT	Lee	0.1	Spray Irrigation
BLACK ISLAND RESORT/DAYS INN	Lee	0.02	
LAUREL OAKS W. W. T. P.	Lee	0.03	Drainfield
SANTA MARIA RESORT	Lee	0.02	
CROSS CREEK COUNTRY CLUB	Lee	0.25	Spray Irrigation
PINK SHELL ISLAND SHORES	Lee	0.01	
MCGREGOR BAPTIST CHURCH	Lee	0.01	Drainfield
SAN CARLOS ESTATES VILLAS	Lee	0.05	Absorption Fields
THREE OAKS W. W. T. FACILITY	Lee	0.75	Spray Irrigation
INDIAN CREEK SHOPPING CENTER	Lee	0.03	
IMPERIAL BONITA ESTATES WW PLANT, 2	Lee	0.05	Percolation Ponds
CHARTER GLADE MEDICAL CORP.	Lee	0.05	
DANPORT CENTER	Lee	0.08	Drainfield
SOUTHERN PINES	Lee	0.04	
SHADY ACRES MOBILE HOME SUBDIVISION	Lee	0.02	
FOREST MERE, S. T. P.	Lee	0.07	
HACIENDA VILLAGE S. T. P.	Lee	0.08	Absorption Fields
AIRPORT WOODS COMMERCE CENTER	Lee	0.02	
ECONO LODGE	Lee	0.04	
SHADY ACRES MOBILE HOME S/D	Lee	0.03	
HUNTER'S RIDGE W. W. T. P.	Lee	0.2	
GATEWAY SERVICES DISTRICT I	Lee	1	Percolation Ponds
CYPRESS BEND R.V.RESORT	Lee	0.07	Percolation Ponds
BROOKSHIRE VILLAGE STP	Lee	0.09	
MANA CHRISTIAN	Lee	0.05	Percolation Ponds
CORKSCREW WOODLANDS	Lee	0.05	Percolation Ponds
WEST RIDGE VILLAS	Lee	0.01	
CENTER OF BONITA SPRINGS	Lee	0.07	
CHIPPENDALE	Lee	0.01	Drainfield
JETPORT INTERSTATE COMMERCE PARK	Lee	0.16	
SAN CARLOS W. W. T. PLANT	Lee	0.3	Spray Irrigation
WORTHINGTON W. W. T. P.	Lee	0.1	
SIX MILE COMMERCIAL PARK	Lee	0.03	Drainfield

Table 8-8. Domestic Point Sources in the Estero Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
RIVERWOODS PLANTATION R. V. PARK	Lee	0.09	Percolation Ponds
SIESTA BAY RV PARK	Lee	0.08	Drainfield
BONITA BY THE SEA	Lee	0.02	Drainfield
GREYHOUND INDUSTRIAL PARK	Lee	0.01	
PINE HAVEN CONDO.	Lee	0.06	Percolation Ponds
SUNNY GROVE PARK, INC.	Lee	0.02	Spray Irrigation
MANGOLD'S MOTEL	Lee	0	Drainfield
ROYAL PELICAN ASSOCIATION, INC.	Lee	0.02	
MORTON GROVE APARTMENTS	Lee	0.06	
BONITA LAKE RESORT	Lee	0.02	Retention Pond
FORT MYERS CAMPGROUND	Lee	0.04	Percolation Ponds
HICKORY SHORES CONDOMINIUM	Lee	0.01	Drainfield
BEACH AND TENNIS CLUB	Lee	0.05	Percolation Pond/ Drainfield
GULF COAST HOSPITAL	Lee	0.03	Absorption Fields
EGRET CONDOMINIUMS W. W. T. P.	Lee	0.01	Drainfield
BONITA BEACH TRAILER PARK	Lee	0.02	Percolation Ponds
DANIELS CROSSING SHOPPING CENTER	Lee	0.03	Percolation Ponds
CORAL WOODS	Lee	0.02	Absorption Fields
S.W. FLA. REGIONAL CONVENTION CTR.	Lee	0.05	
BONITA FAIRWAYS S.T.P.	Lee	0.04	
NAPLES-FT. MYERS KENNEL CLUB	Lee	0.04	Retention Pond
TIP TOP TRAILER VILLAGE	Lee	0.01	Percolation Pond/ Drainfield
TROPICANA MOBILE MANOR	Lee	0.06	Retention Pond
GULF AIR TRAVEL PARK SAN C	Lee	0.02	Drainfield
MARINERS COVE MHP	Lee	0.02	Percolation Ponds
SPRING CREEK ESTATES	Lee	0.05	
CREWS SANITATION CO.- REGIONAL RESIDUAL MGMT. FA	Lee	0.02	
TAHITI MOBILE VILLAGE	Lee	0.03	Retention Pond
SPRING CREEK VILLAGE	Lee	0.04	Percolation Ponds
BONITA BEACH CLUB CONDO.	Lee	0.1	Drainfield
CENTURY 21 MOBILE COM	Lee	0.04	Retention Pond
IMPERIAL HARBOR, DOMESTIC	Lee	0.05	
COVERED WAGON TRAILER PARK	Lee	0.02	Percolation Ponds

Table 8-8. Domestic Point Sources in the Estero Bay Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
WIND SONG CONDOMINIUM	Lee	0.01	Drainfield
FOUNTAIN LAKES WWTP	Lee	0.1	Percolation Ponds
THREE S DISPOSAL	Lee	0.05	Drainfield
BAMBOO MOBILE VILLAGE	Lee	0.01	Retention Pond
IMPERIAL BONITA ESTATES WW PLANT, 1	Lee	0.09	Percolation Ponds
SAN CARLOS TRAILER PARK	Lee	0.01	Drainfield
AMERICA OUTDOORS TRVL. TR. PK.	Lee	0	Percolation Ponds
PINEBROOK LAKES	Lee	0.03	
BONITA RESORT AND CLUB	Lee	0.01	Drainfield
I-75 REST AREA	Lee	0.02	

Table 8-9. Industrial Point Sources in the Estero Bay Basin

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
BAY BEACH STORMWATER	Lee		Estero Bay
GULF DISPOSAL, INC	Lee		None -Recycled
FORT MYERS MEMBRANE SOFTENING WTP	Lee		Spray Irrigation/ Golf Course outfall
ALAMO RENT-A-CAR	Lee		
HARPER BROS., ALICO QUARRY - AKA GREEN MEADOW MINE	Lee		
FORT MYERS MINE (FL ROCK)	Lee		
SOUTHWEST FLORIDA PIPELINE CO.	Lee		
GULF UTILITY CO.- CORKSCREW PLANT	Lee	0.25	Spray Irrigation
SOUTHWEST FLORIDA REGIONAL AIRPORT	Lee	0.04	Sanitary Sewer
NTGARGIULO-NAPLES TOMATO GROWERS	Collier	0.02	
HARBOR UTILITIES WTP	Lee	0.02	
GULF COAST CAMPING RESORT	Lee	0.01	Percolation Ponds
TISCH COIN LAUNDRY	Lee	0.01	Percolation Ponds
ACS II, INC.	Lee	0	None -Recycled

9. Coastal Venice Basin

This chapter presents a compilation and synthesis of information regarding the Coastal Venice Basin portion of the Charlotte Harbor NEP area (Figure 9-1). The following sections provide:

- a characterization of the physical setting, including topographic, geologic, soils, and land use descriptions of the basin;
- a review of the rainfall and hydrologic characteristics of the basin;
- a review of the water management practices and water uses within the basin;
- a summary of current and historical water quality conditions; and
- an estimation of pollution potential from nonpoint and point sources within the basin.

9.1 Physical Setting

The southern end of the Coastal Venice Basin begins at the bridge from Manasota Key to the mainland in south Venice. It includes the coastline north from that point to the Venice Inlet. From there the basin continues northwest and includes the portion of Sarasota County in the Cow Pen Slough Drainage Basin. Along its eastern boundary the basin includes areas such as Curry Creek, Hatchett Creek, and Alligator Creek which drain southwest and not into the Myakka River. The basin is comprised of portions of Sarasota County and Manatee County.

The Coastal Venice Basin lies almost completely within the Gulf Coastal Lowlands. Except for the coast along the City of Venice, the Gulf Coast along Sarasota County consists of barrier islands, spits, and lagoons. Two small areas in the northeastern part of the county are within the boundaries of the DeSoto Plain. The DeSoto Plain is a flat area that occurs in only a small portion of northeastern Sarasota County and the Coastal Venice Basin. The portion of the DeSoto Plain in the basin consists mainly of relatively steeper slopes between the very edge of the plain and the inland edge of the Gulf Coastal Lowlands.

9.1.1 Physiography

This section describes the topography, geology, and land use in the Coastal Venice Basin.

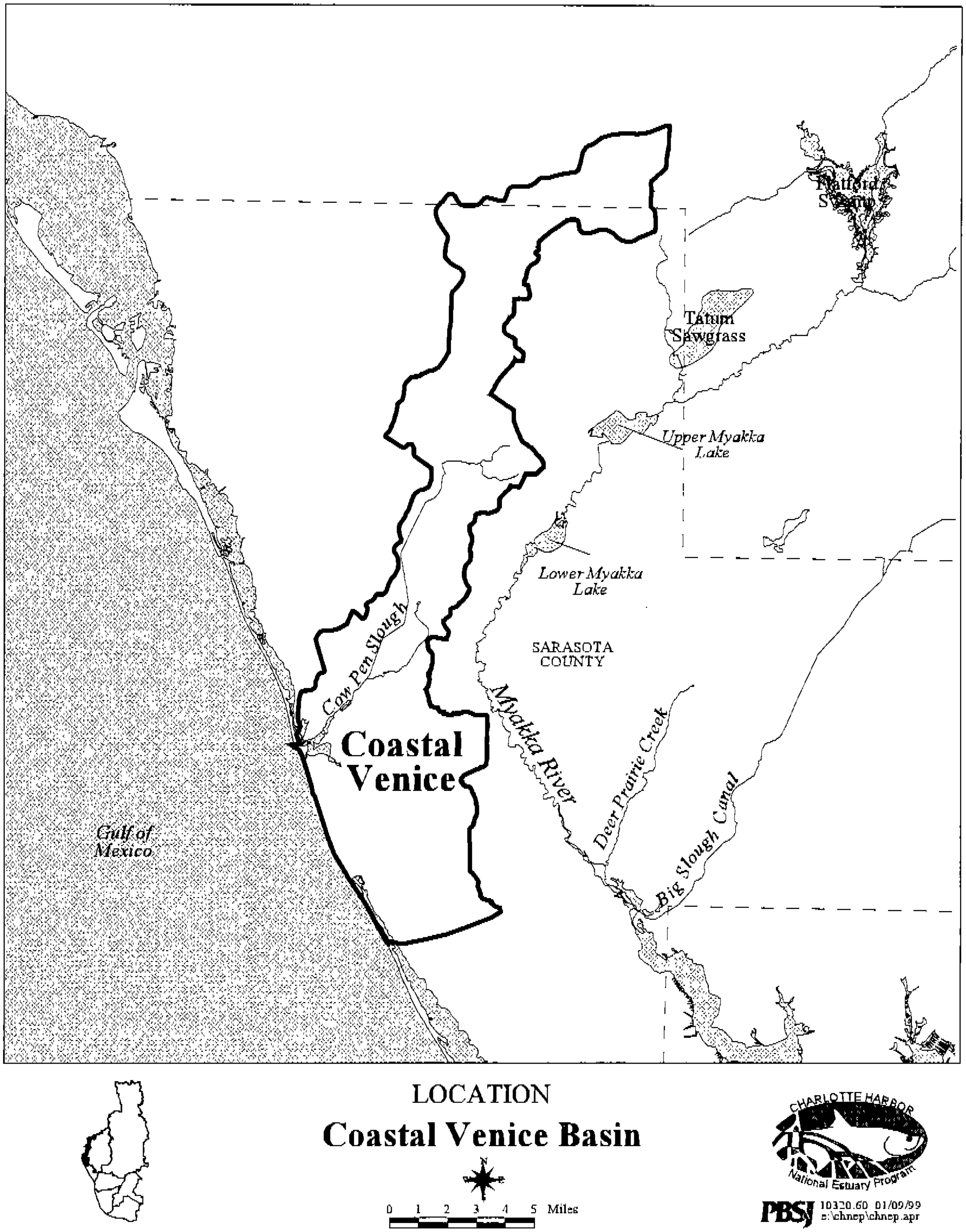


Figure 9-1. Location of the Coastal Venice Basin within the Charlotte Harbor NEP study area.

9.1.1.1 Topography

Elevations in the Coastal Venice Basin range from near sea level, along the coast, to their highest point in the extreme northeastern portion of the basin, directly south of Verna. Elevations increase very gradually from the west and southwest toward the northeast. The topography tends to be flat and steeper near and around water channels.

9.1.1.2 Geology

Sediments at or near the surface of the Coastal Venice Basin in Sarasota County consist of quartz sand, consolidated and unconsolidated shell beds, clay, limestone, and dolomite. The older sediments are Oligocene in nature and occur as Suwannee Limestone in Sarasota County. The limestone is about 350 feet below MSL in the northeastern most part of the basin and increases in depth to 650 feet below MSL in the southern most portion of the county.

The Green Swamp region in Polk County is believed to be a recharge area for the part of the Floridan Aquifer that underlies Sarasota County. Except for this recharge area, most of the Floridan aquifer is under a confining layer of clay or other impermeable material. This confining layer is responsible for artesian water pressure and occurs as the Hawthorn Formation in the basin.

9.1.1.3 Soils

Flatwoods soils comprise the majority of the Coastal Venice Basin in Sarasota County. Interior flatwoods soils are Eugallie-Myakka-Holopaw-Pineda soils. These soils are nearly level, poorly drained to very poorly drained and have a sandy surface layer and sandy and loamy subsoils. Flatwoods and sloughs soils along the upper half of Cow Pen Slough in the upper basin are Kesson-Wulfert soils and are associated with mangrove swamps. These soils are nearly level, very poorly drained, sandy, and organic soils.

Flatwoods soils at the mouth of Cow Pen Slough and along the coastal portion of the basin are characterized by Pomello-Myakka-Eugallie soils. These soils are nearly level, moderately well to poorly drained, sandy soils. The coastal beaches which parallel the coastal flatwoods are Canaveral-Beaches-Kesson. These soils are nearly level to gently sloping, moderately to very poorly drained, sandy soils with shell fragments or mucks.

The Coastal Venice basin has approximately 65% soils in the HSG-designated B soils and nearly 25% in the D group (Table 9-1). Like many basins, most B and D soils were originally B/D soils and the B soils are drained as a result of artificial features, such as irrigation canals (Figure 9-2).

9.1.2 Rainfall

Data from a total of eight rainfall gages were used in calculating total annual rainfall since 1970 in the Coastal Venice Basin (Figure 9-3). Total annual precipitation and average monthly precipitation (Figure 9-4) were plotted for the basin. A summary of the data is presented in Appendix A.

Table 9-1. Hydrologic soil types in the Coastal Venice Basin.

Soil Type	Acres	%
A	1,025	1.6
B	41,022	64.6
C	5,859	9.2
D	15,614	24.6
TOTAL	63,520	100.0

Minimum total annual precipitation ranged from approximately 38 inches of rain in 1990 to 78 inches of rain in 1983 and 1995. Peak annual precipitation during 1983 and 1995 is consistent with precipitation in the other basins.

Monthly precipitation was highest from June to September, and wet season average values ranged from 7.2 inches in September to 9 inches in August. Average monthly rainfall values were lowest during November (approximately 2 inches). Average values did not exceed 3.4 inches from October through May.

9.1.3 Existing and Future Land Use

Existing and Future Land Use GIS Coverages for the Charlotte Harbor NEP Area are not always consistent in land use codes and coverages. Existing Land Use Coverage presented in this document is a combination of 1990 Southwest Florida Water Management District (SWFWMD) and 1988 South Florida Water Management District (SFWMD) land use data. Land Use data from SWFWMD was based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III (Appendix E). The SFWMD land use categories, however, were identified using the District's own classification system (not FLUCCS). We evaluated the two systems and developed a hybrid that is now in use for this project.

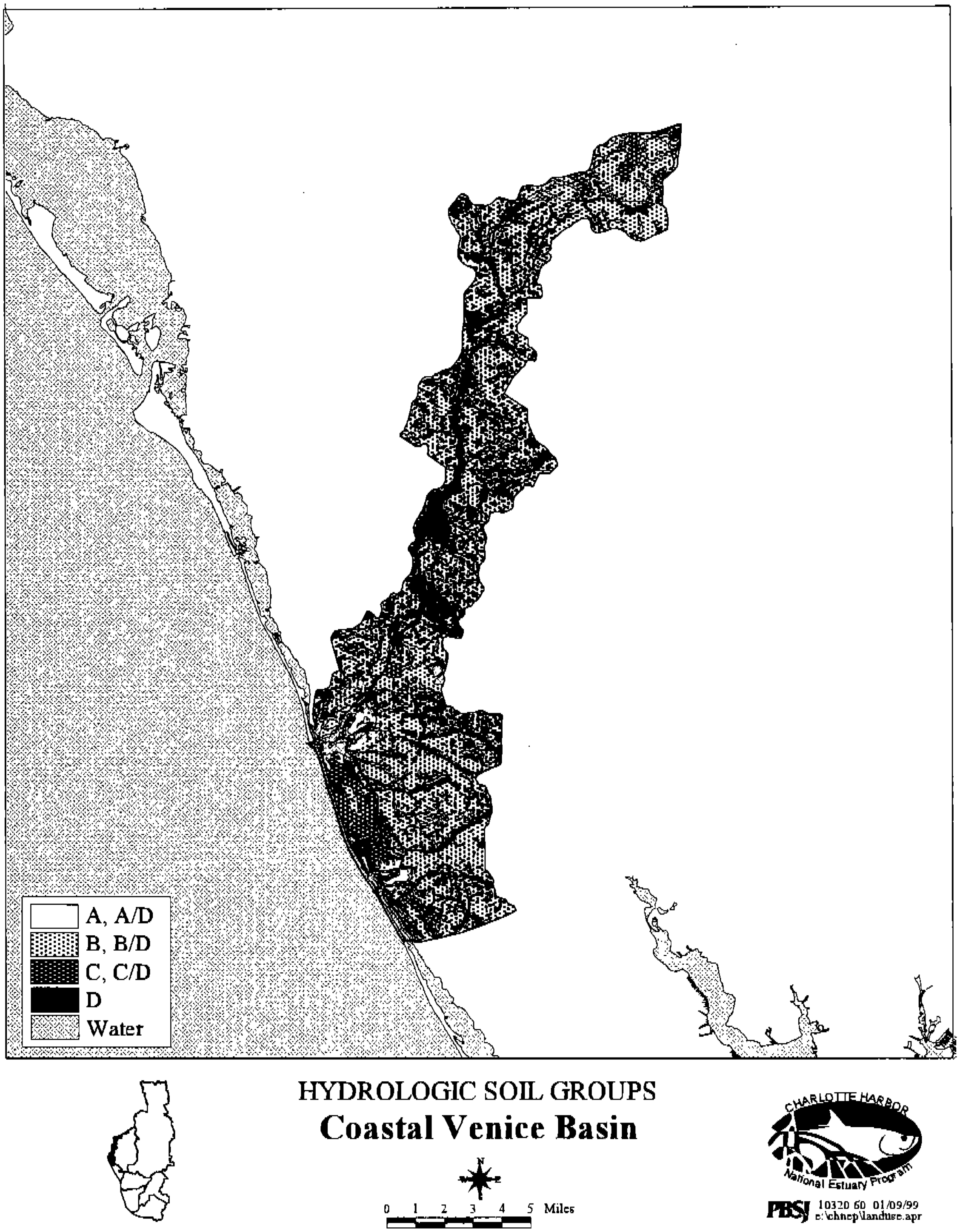


Figure 9-2. Hydrologic soil groups in the Coastal Venice Basin.

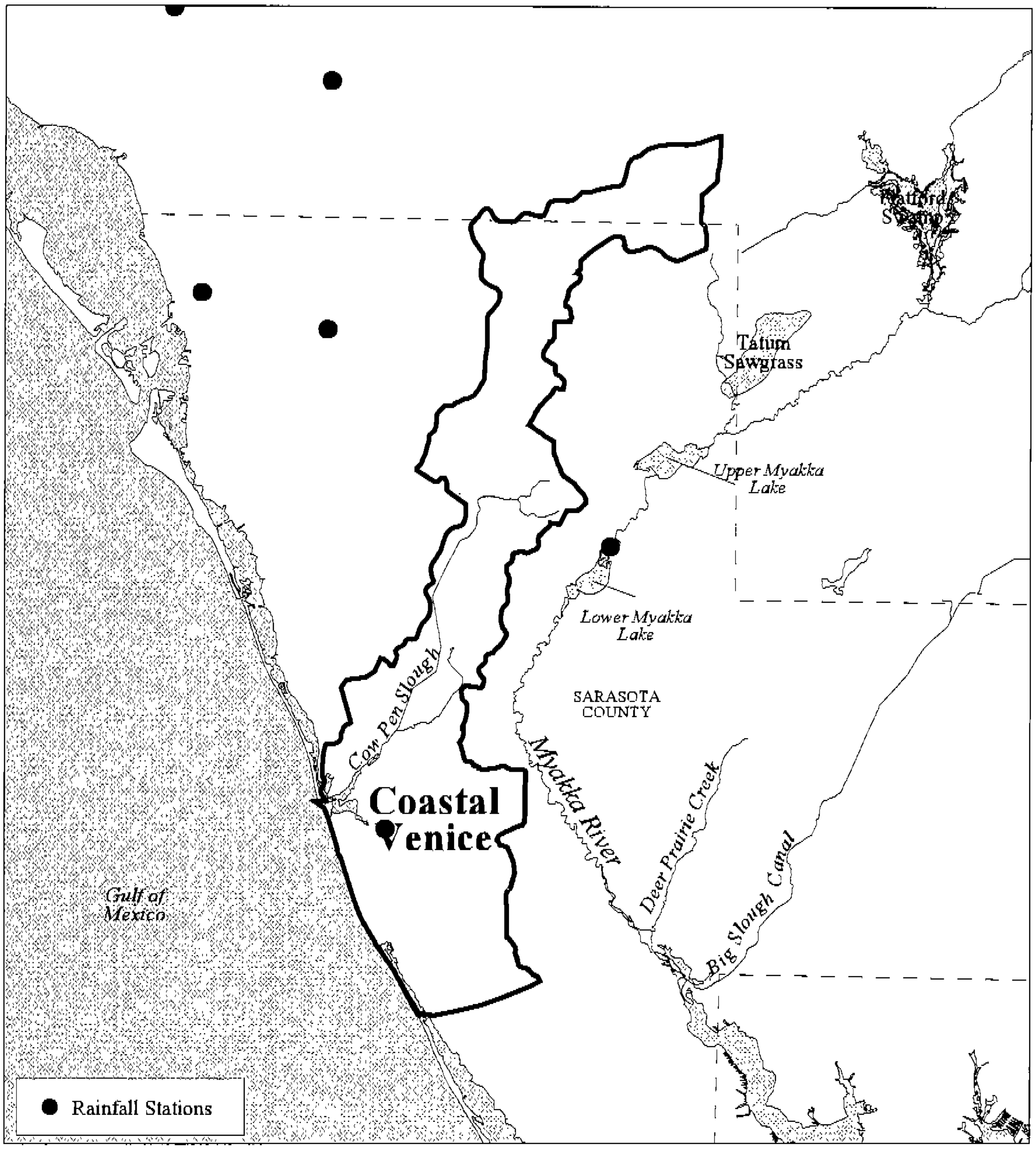
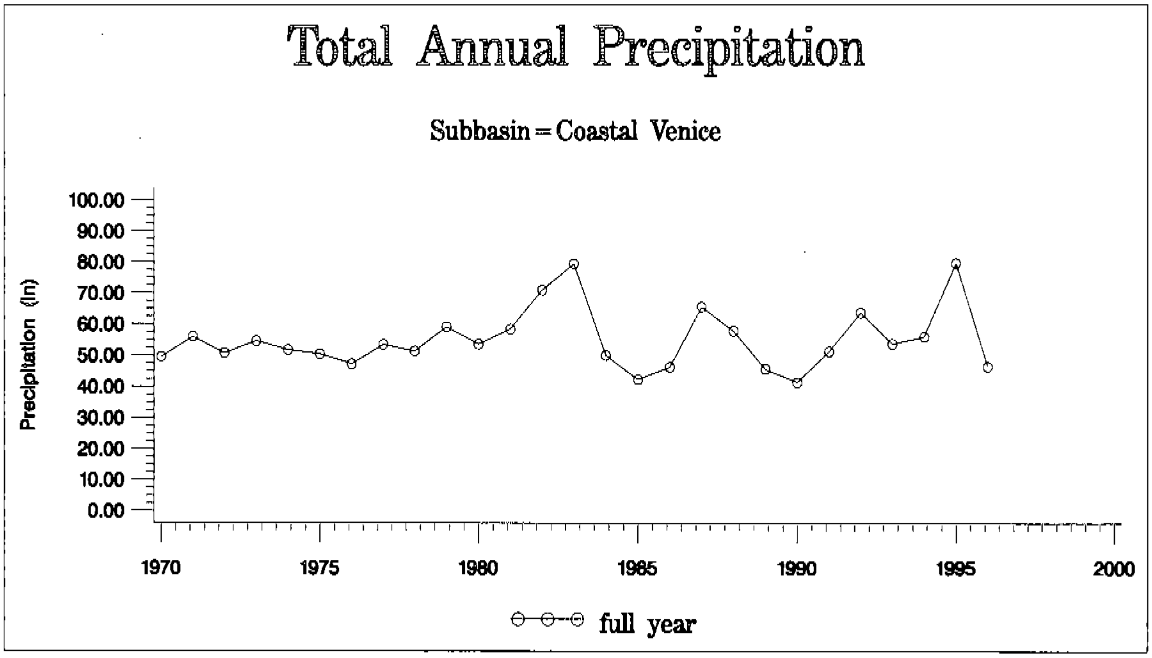


Figure 9-3. Rain station locations in the Coastal Venice Basin.



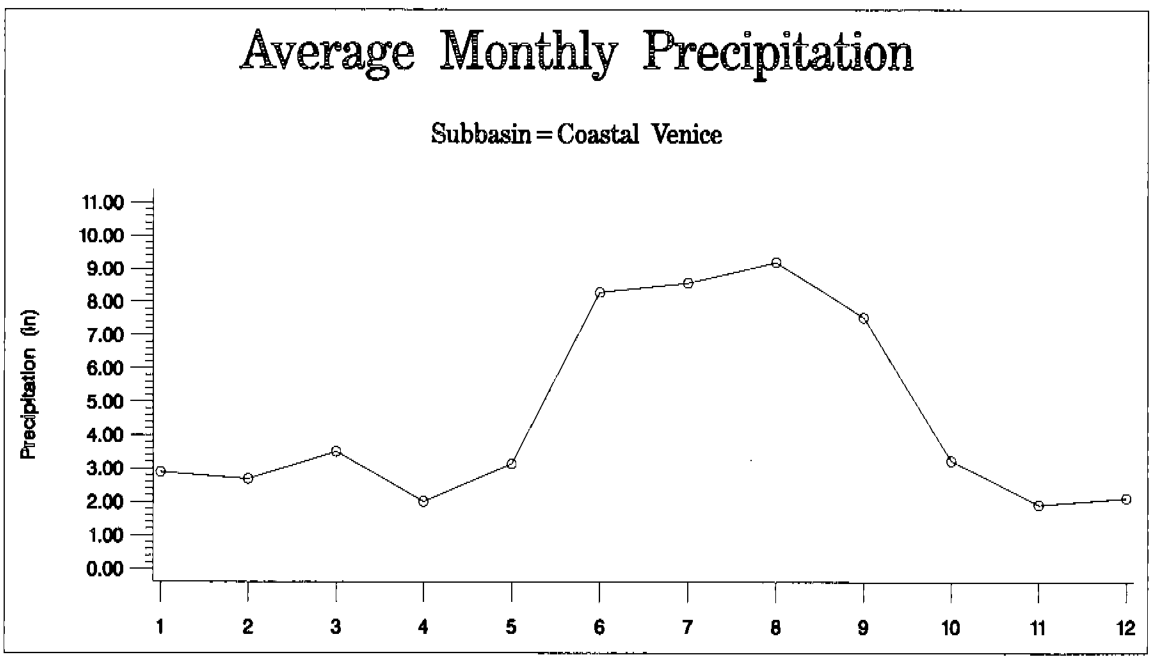


Figure 9-4. Total annual and monthly rainfall plots for the Coastal Venice Basin.

Future Land Use Coverages for the Charlotte Harbor NEP were developed by Southwest Florida Regional Planning Council (SWFRPC). SWFRPC obtained future land use maps from all RPCs in the state, and digitized the maps to develop a state-wide coverage. The future land use maps (FLUMs) are general and intended to guide future growth. They are not based on present conditions, nor do they recognize many features that will probably be present in the future (such as smaller wetlands). Importantly, FLUMs provide a 100% build-out scenario which does not take into account areas which will not be developed as result of land use regulations and restrictions. The FLUM uses a different and much simpler, land use classification system than either of the existing land use coverages and does not identify existing developed urban land use or land cover. A geographic area designated for future residential growth on the FLUM might encompass existing commercial, institutional, or wetland areas (Rains et al. 1993). As a result, residential areas may increase tremendously under future scenarios because existing development is not taken into account. Direct comparisons between acreages of a particular type of land use for existing and future conditions cannot be made without evaluating the criteria used to develop that land use category.

Table 9-2. Current (1990) land use/cover in the Coastal Venice Basin.

Land Use/Cover	**Acres**	**%**
Single Family Residential	2,183	3.4
Medium Density Residential	4,812	7.6
Multi-family Residential	4,871	7.7
Commercial	1,084	1.7
Industrial	215	0.3
Mining	74	0.1
Institutional	1,993	3.1
Range Lands	9,854	15.5
Barren Lands	45	0.1
Pasture	9,563	15.0
Groves	1,421	2.2
Feedlots	6	0.0
Nursery	67	0.1
Row and Field Crops	366	0.6
Upland Forested	14,104	22.2

Table 9-2. Current (1990) land use/cover in the Coastal Venice Basin.		
Land Use/Cover	**Acres**	**%**
Freshwater - Open Water	1,494	2.4
Saltwater - Open Water	1,246	2.0
Forested Freshwater Wetland	4,234	6.7
Saltwater Wetland	209	0.3
Non-forested Freshwater Wetland	5,706	9.0
Tidal Flats	0	0.0
TOTAL	63,520	100.0

9.1.3.1 Existing Land Use

Present land use in the Coastal Venice Basin includes predominantly forested uplands (22%), rangelands (16%), and pasture (15%) (Table 9-2). Eighteen percent of the basin is in agricultural use and 24% of the land use is urban. The remainder of the basin is identified as wetlands. Most of the urban land use is single family, medium density, and multifamily residential (18% of the total basin land use). The remainder includes commercial, industrial, and institutional uses.

9.1.3.2 Future Land Use

Like other coastal basins, future land use in the Coastal Venice Basin includes large increases in urban development, primarily residential. Future land use maps produced by the Regional Planning Council include 34% urban land use, compared with 24% under existing use (Table 9-3). Thirty percent of the total land use is single family residential alone.

Agricultural land use nearly doubles in future land use maps (increases from 18% to 48%) (Figure 9-6). If these increases occurred, commensurate decreases in forested uplands, rangeland, and pasture would be expected.

Table 9-3. Future (2010) land use/cover in the Coastal Venice Basin.		
Land Use/Cover	**Acres**	**%**
Single Family Residential	20,787	30
Multi-family Residential	1,489	2
Rural Residential	4,489	6
Commercial	1,768	3

Table 9-3. Future (2010) land use/cover in the Coastal Venice Basin.		
Land Use/Cover	**Acres**	**%**
Industrial	1,243	2
Agricultural	33,111	48
Wetlands	37	< 1
Protected Resource	6,134	9
TOTAL	69,085	100

9.1.4 Surface Water Hydrology and Water Management Practices

Most of the basin is poorly drained. Cow Pen Slough is the major drainage channel in the basin. The area has numerous small streams and is generally an area of artesian flow. The water table is at or near the surface throughout much of the basin. Natural drainage systems have been channelized and extensive ditch systems constructed to improve drainage. There are no streamflow gages in the Coastal Venice Basin.

9.1.5 Water Management Practices

The following describes the current urban and agricultural water management practices employed in this basin.

9.1.5.1 Urban Management Practices

Approximately 14% of the Coastal Venice Basin is classified as urban land, and approximately 23% of the basin is occupied by agricultural land uses. The urbanized areas of the Coastal Venice Basin are found primarily in Venice and the surrounding area, and southward along the Gulf coast. The discussion of urban management practices is divided into urban water uses and urban water discharges, including reuse. The water uses and water discharges are tabulated in the following descriptions.

Water Use

Urban water uses include public water supply, mining facilities, industrial operations, and recreational uses. Discussion of water use is limited to facilities with an average permitted quantity greater than 0.5 MGD. Water use information is from SWFWMD (1994). The Coastal Venice Basin is entirely within the SWFWMD.

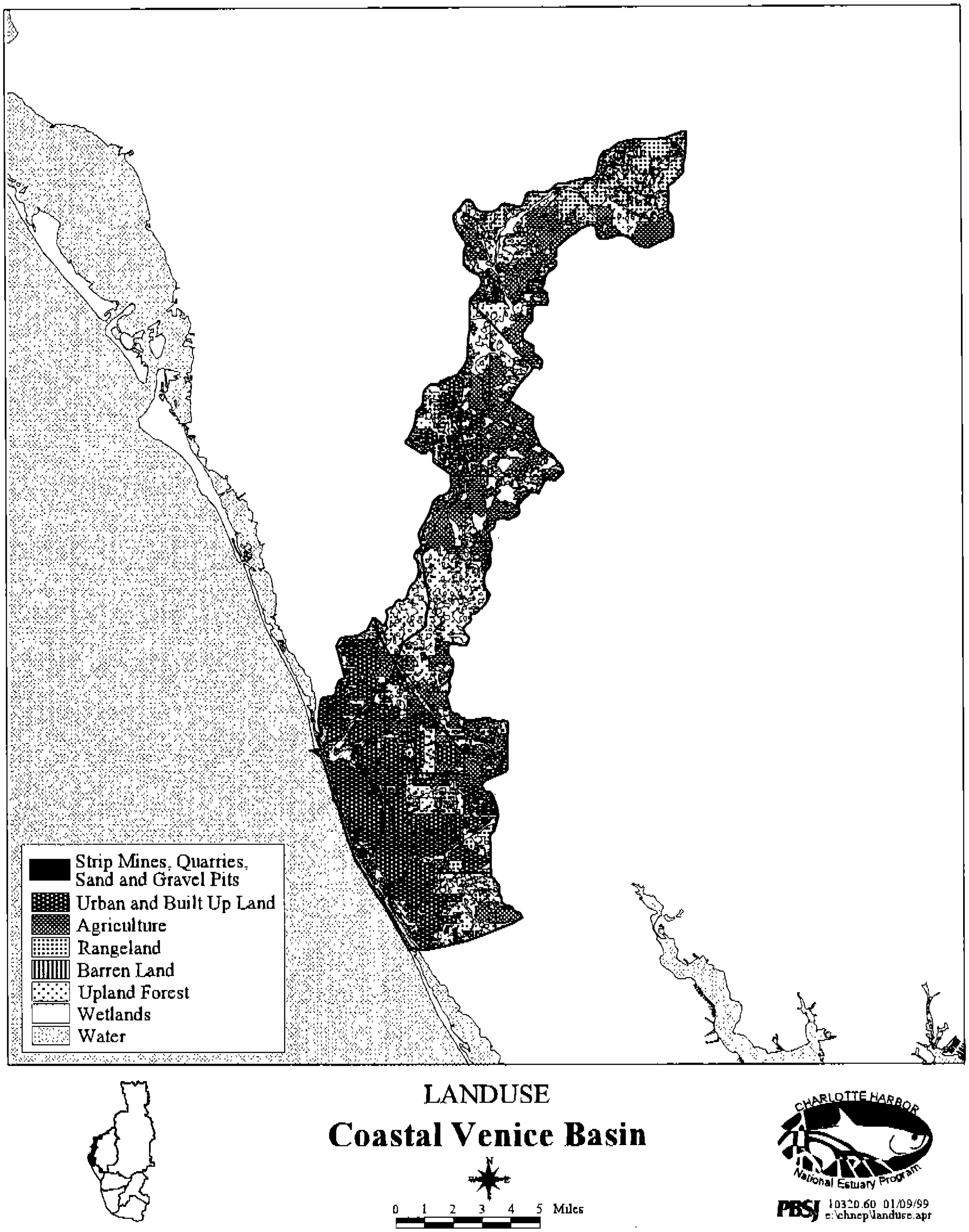


Figure 9-5. Existing land use map (SWFWMD, 1990; SFWMD, 1988) for the Coastal Venice Basin.

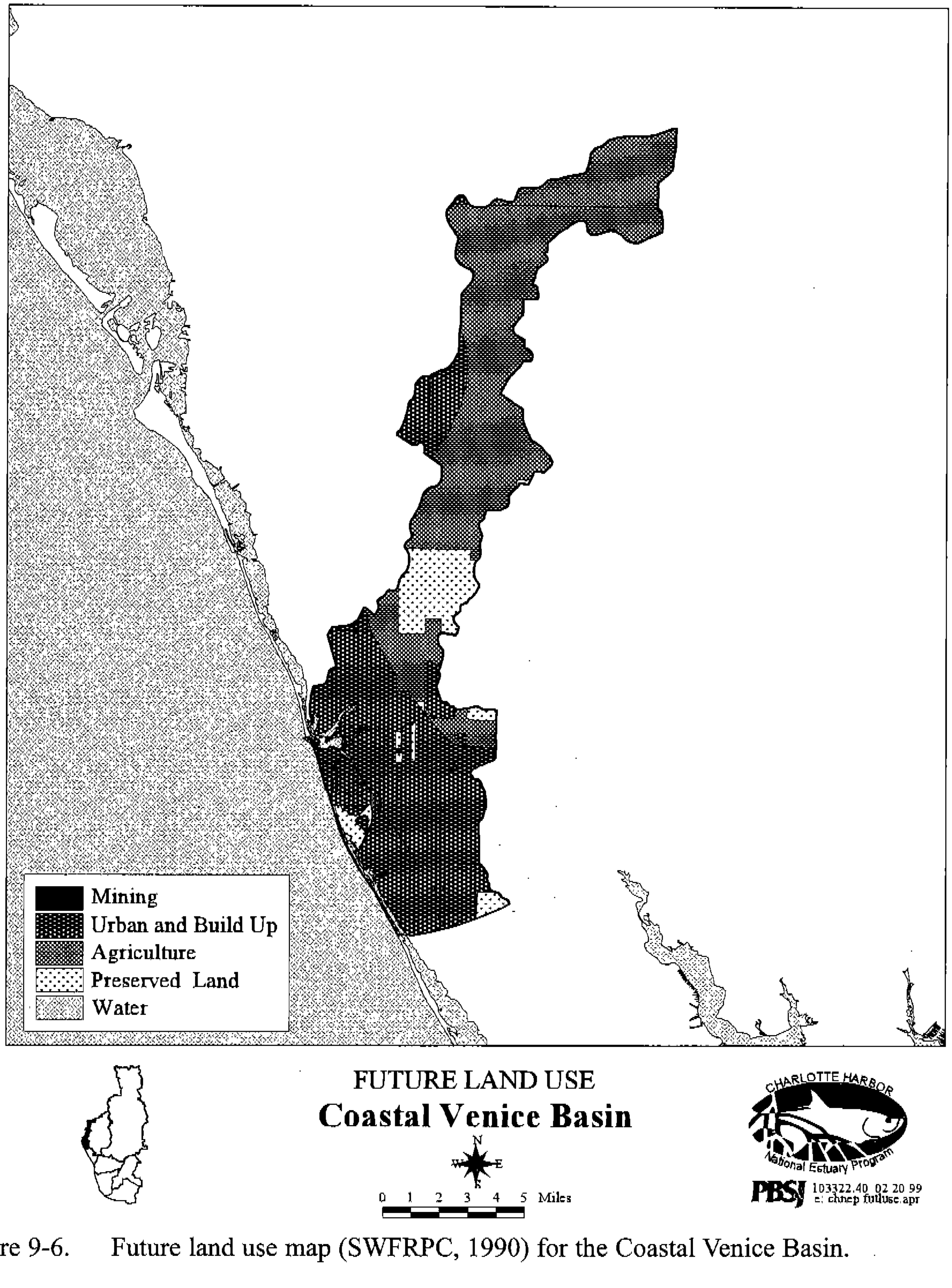


Figure 9-6. Future land use map (SWFRPC, 1990) for the Coastal Venice Basin.

Table 9-4 shows the public water supply facilities in the Coastal Venice Basin with permitted withdrawals of more than 0.5 MGD, as well as the withdrawal sources for the facilities. A discussion of the populations served by each plant, withdrawal amounts, and withdrawal methods follows.

Table 9-4. Public water supply facilities in the Coastal Venice Basin.

Facility	Permitted Average Withdrawal (MGD)	Source
Venice Gardens Utility/Southern States	4.54	Intermediate, Floridan aquifers
City of Venice	5.09	Lower Intermediate, Upper Floridan aquifers

The Venice Gardens Utility/Southern States water treatment facility is a private utility which provides service to a 6,320-acre development south of Venice. In 1990, 14,061 people were provided with 1.8 MGD of water, from withdrawals of 2.17 MGD. The Intermediate aquifer provides water through 42 wells, with six wells withdrawing from the Floridan aquifer, with a total permitted average withdrawal of 4.54 MGD. Permitted average withdrawals from the Intermediate aquifer are 0.12 MGD, with 4.42 MGD from the Floridan aquifer.

The City of Venice operates the Intracoastal Wellfield and the eastern wellfield located in the Waterford Development. Eight wells in the Intracoastal Wellfield average 450 feet in depth and the one well in the eastern wellfield is 500 feet deep, all withdrawing from the Lower Intermediate and Upper Floridan aquifers. The permitted average withdrawal is 5.09 MGD, with a 1990 withdrawal of 4.21 MGD providing service to 18,079 people.

- Mining

There are no mining operations with water use greater than 0.5 MGD within the Coastal Venice Basin.

- Industrial

There are no industrial facilities with greater than 0.5 MGD water use within the Basin.

- Recreational

Golf courses and landscape (parks, medians, attractions, cemeteries, and other green areas) water use locations are not identified in SWFWMD (1997), so that no basin-specific water use may be associated with these land uses. However, the document does provide water use by county for golf courses and landscape for that portion of the county within the SWFWMD. Sarasota County water use associated with golf courses for 1994 was 7.9 MGD, and landscape water use for the same time period was 0.4 MGD, for a total recreational use of 8.3 MGD for the county. In Manatee County, golf course water use was 3.0 MGD in 1994, and landscape water use was 0.1 MGD, totaling 3.1 MGD for the county.

Water Discharge and Reuse

Venice Gardens has two wastewater treatment plants. Plant 1 has a capacity of 1.3 MGD, and flow was 0.6 MGD in 1990, with 0.35 MGD of reclaimed water supplied to the Jacaranda West County Club that year. The remainder of the discharge is sent to percolation ponds. Plant 2, with a capacity of 1.0 MGD, had 0.4 MGD flow since 1986, with all discharge sent to percolation ponds (SWFWMD, 1992).

The City of Venice operates two wastewater treatment plants as well, the Venice plant and the Venice Eastside plant. The Venice plant is permitted for 2.8 MGD, with averages of 0.5 MGD after 1991. The Venice Eastside plant operates at approximately 1.5 MGD, supplying reclaimed water to the Waterford, Capri Isles, and Bird Bay golf courses and residential areas in Waterford (SWFWMD, 1992).

Table 9-5. 1990 estimated crop acreages, irrigation types, and water use in Manatee County.

Crop	Acreage	Irrigation Type -Acreage		Water Use (MGD)
Agronomic	2,000	Seepage	2,000	2.1
Row/Field Crops	24,200	Low volume Seepage	2,800 20,900	77.0
Citrus	19,300	Overhead Low Volume Seepage	965 13,510 965	18.5
Nursery	2,175	Overhead Low Volume Seepage	975 100 1,100	14.6
Sod	3,200	Overhead Low volume	2,200 1,000	6.4
Irrigated Pasture	1,450	Seepage	1,450	2.4

Table 9-5. 1990 estimated crop acreages, irrigation types, and water use in Manatee County.

Crop	Acreage	Irrigation Type -Acreage		Water Use (MGD)
TOTALS	52,325	Overhead Low Volume Seepage	4,140 17,410 26,415	121.0

9.1.5.2 Agricultural Management Practices

The Coastal Venice Basin consists mainly of forested uplands (22%), range lands (16%), and pasture (15%). In addition to pasture, other agricultural land uses include groves (1,421 acres), row and field crops (366 acres), and nurseries (67 acres). The basin contains approximately 63,500 acres (99 square miles) in Sarasota and Manatee counties.

Agricultural land use estimates for all major crops for 1990 in Manatee County are listed in Table 9-5, and for Sarasota County in Table 9-6, along with estimates of irrigated acreages for each of these crops and estimated water use.

Table 9-6. 1990 estimated crop acreages, irrigation types, and water use in Sarasota County.

Crop	Acreage	Irrigation Type -	Acreage	Water Use (MGD)
Agronomic	200	Seepage	200	0.2
Row/Field Crops	3,100	Seepage	3,100	9.1
Citrus	1,800	Low Volume Seepage	1,530 180	3.2
Nursery	220	Overhead	220	1.5
Sod	5,000	Seepage	5,000	10.0
Irrigated Pasture	555	Seepage	555	0.9
TOTALS	10,875	Low Volume Seepage	1,530 9,035	24.9

9.2 Water Quality Conditions

No comprehensive data bases were identified which allowed a comprehensive assessment of long-term and current water quality conditions either during the development of the "Compendium of Existing Information" or while compiling background data for this subsequent "Synthesis of Existing Information".

9.3 Estimation of Pollution Potential

Nonpoint source loading of runoff, total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) was estimated for each major basin and subbasin by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover. The pollution load potential was estimated in order to assign priority to major basins and subbasins. Thus, the method development was focused on estimating relative loads in a consistent manner among subbasins to avoid biasing the evaluation of major basins and subbasins.

The detailed rainfall, SWFWMD 1990 land cover, and USDA soil data were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for the years 1970 to 1996. Runoff was calculated by multiplying the rainfall estimate by a literature-based runoff coefficient value for each parcel in the land cover and soil database. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. Hydrologic loadings were estimated on an "off the land" basis, and it was assumed that all runoff entered the estuary, regardless of whether pumps or gravity flow was used to discharge it from the subbasin.

Monthly-specific pollutant loading estimates for TN, TP, and TSS were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use specific pollutant concentration estimates specific for south Florida. Pollutant concentrations reported in the literature have widely varying values, and this resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TN, TP, and TSS loading to the estuary, and the pollutant load prioritization of subbasins for this study reflects these load source patterns. Existing domestic and industrial point sources within the basin are also listed and their potential impacts discussed.

Unless otherwise indicated, the following estimates were rounded to the nearest 1 thousand acres, 1 million cubic meters of discharge, and 1 ton of pollutant load. For purposes of discussion, urban land uses were operationally defined as residential, commercial, industrial, mining, institutional, transportation, and utilities. Agricultural land uses were operationally defined as pasture, groves, feedlots, row and field crops, and nursery. Undeveloped land uses were defined as range lands, barren lands, upland forests, and wetlands.

9.3.1 Load Estimates for Coastal Venice Basin

The total estimated annual runoff discharge for the Coastal Venice Basin was 82 million cubic meters from 51,000 contributing acres. The estimated annual pollutant loads were 225 tons of TN, 50 tons of TP, and 3,401 tons of TSS.

Similar to the Estero Bay Basin, the Coastal Venice Basin was defined as primarily undeveloped land (47%). The 24,000 acres of undeveloped land contributed 28 million cubic meters of runoff, 100 tons of TN, 26 tons of TP, and 1,149 tons of TSS per year. Table 9-7 presents the loads from runoff by land use.

Developed lands in this subbasin were reported as 11,000 acres of agricultural lands and 15,000 acres of urban lands. The agricultural lands were estimated to contribute 39 tons of TN, 11 tons of TP, and 157 tons of TSS per year. The urban lands were estimated to contribute 86 tons of TN, 13 tons of TP, and a relatively large 2,096 tons of TSS. The TSS from urban runoff was primarily attributed to medium and high density residential development and commercial land use.

9.3.2 Pollution Source Inventory

This point source inventory for the Coastal Venice Basin describes the numbers, locations, and discharge capacities of domestic and industrial point sources within the Coastal Venice Basin. The

Table 9-7. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Coastal Venice Basin.

Land Use Type	TN		TP		TSS		Hydrologic Load	
	tons/yr	% of subbasin	tons/yr	% of subbasin	tons/yr	% of subbasin	m^3	% of subbasin
Low Density Residential	6	3%	1	2%	62	2%	3,100,913	4%
Medium Density Residential	26	11%	4	8%	386	11%	10,317,003	13%
High Density Residential	34	15%	6	12%	1,060	31%	14,932,540	18%
Commercial	10	5%	1	3%	404	12%	4,967,239	6%
Industrial	2	1%	0	1%	98	3%	949,417	1%
Mining	0	0%	0	0%	12	0%	221,216	0%
Institutional, Transport., Util.	8	4%	0	1%	74	2%	6,041,697	7%
Range Lands	32	14%	16	32%	162	5%	11,248,798	14%
Barren Lands	0	0%	0	0%	2	0%	145,293	0%
Pasture	32	14%	10	19%	102	3%	10,833,521	13%

Table 9-7. Total nitrogen, total phosphorus, total suspended solids, and hydrologic load by land use type within the Coastal Venice Basin.

Groves	4	2%	1	1%	20	1%	1,864,569	2%
Feedlots	1	0%	0	0%	2	0%	27,223	0%
Nursery	0	0%	0	0%	8	0%	125,586	0%
Row and Field Crops	2	1%	1	2%	25	1%	650,772	1%
Upland Forests	68	30%	10	19%	985	29%	16,198,069	20%
TOTAL	225	100%	50	100%	3,401	100%	81,623,855	100%

inventory provides a relative assessment of the pollution potential from point sources within the basin. Point source inventory information was obtained from the Florida Department of Environmental Protection (FDEP) databases for domestic and industrial point sources, as discussed previously.

Wastewater treatment plant discharges for those plants in the Coastal Venice Basin with greater than 1.0 MGD were previously described, using information from SWFWMD (1992). The following discussion uses only the FDEP databases, as previously described.

The FDEP databases list 23 domestic point sources and seven industrial point sources within the Coastal Venice Basin (Tables 9-8 and 9-9). Three of the domestic point sources are listed as being in a county not in the Coastal Venice Basin. The remaining 20 domestic point sources and all seven of the industrial point sources are in Sarasota County (Figure 9-7).

Domestic point sources discharge capacities total 7.43 MGD, with 2.25 MGD of this sent to reuse. For the seven industrial point sources, only one has its discharge capacity listed, of 0.39 MGD. Three of the other industrial point sources are listed as having discharge going to reuse.

Table 9-8. Domestic point sources in the Coastal Venice Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
VENICE - ISLAND BEACH - WWTP	Sarasota	2.8	
SADDLEBROOK DEVELOPMENT	Pasco	0.24	
WESLEY CHAPEL SUBREGIONAL	Pasco	0.17	
NORTHWOOD AWT	Pasco	0.25	Wetlands System
SOUTH COUNTY ANNEX	Sarasota	0.01	
NOKOMIS ELEM SCH	Sarasota	0.02	
BEE RIDGE WRF	Sarasota	1.5	
KING'S GATE CLUB WWTP	Sarasota	0.05	Percolation Ponds
PALM & PINES MHP WWTP	Sarasota	0.01	
LAKE VILLAGE MHP	Sarasota	0.05	

Table 9-8. Domestic point sources in the Coastal Venice Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
FLORIDA PINES MHC	Sarasota	0.01	
VENICE RANCH MHP WWTP	Sarasota	0.04	
CIRCLEWOODS WWTP	Sarasota	0.08	
MISSION VALLEY GOLF & COUNTRY CLUB	Sarasota	0.01	
JAPANESE GARDENS MHP WWTP	Sarasota	0.05	
JAPANESE GARDENS MHP WWTP	Sarasota	0.05	
FAIR WINDS CONDOMINIUM	Sarasota	0.02	
MANASOTA BEACH GARDENS	Sarasota	0.01	
LYONS COVE CONDO	Sarasota	0.01	
SUPER BOWL INC	Sarasota	0.01	
KING'S GATE RVP WWTP	Sarasota	0.04	
GULFVIEW UTILITIES	Sarasota	0.05	
VENICE GARDENS WWTP	Sarasota	1.95	Spray Irrigation

Table 9-9. Industrial point sources in the Coastal Venice Basin.

Facility Name	County	Discharge Capacity (MGD)	Receiving Waterbody
KWALITY KWIK LAUNDRY	Sarasota		Drainfield
GULF OLDSMOBILE-PONTIAC, INC.	Sarasota		None -Recycled
SINGELTARY CONCRETE	Sarasota		None -Recycled
SNOWBIRDLAND VISTAS, INC	Sarasota		
SARASOTA COUNTY EDR DIW	Sarasota		
FLORIDA MINING & MATERIALS/LITTRELL	Sarasota		
VENICE, CITY OF - R/O PLANT	Sarasota	0.39	

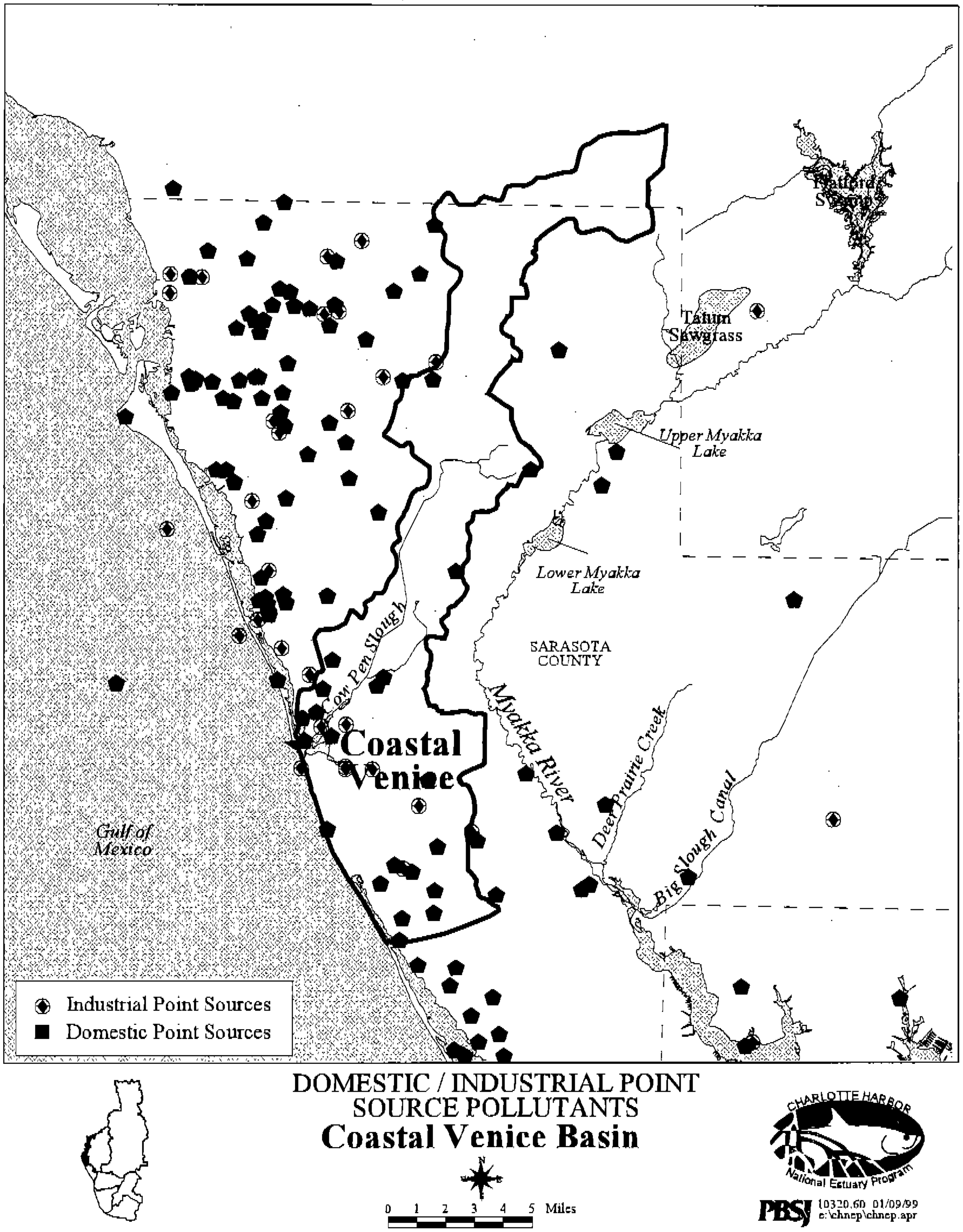


Figure 9-7. Location of domestic and industrial point sources in the Coastal Venice Basin.

10. Harbor Resources and Habitats

This chapter addresses several facets of the Charlotte Harbor NEP estuarine complex. The habitats discussed include emergent wetlands (mangroves and saltmarshes), seagrasses, tidal mud flats, artificial reefs, and shorelines. Lastly, a discussion of habitats at risk is presented.

10.1 Harbor Resources

The discussion of harbor resources examines fish, marine mammals, benthos, and bird populations of the Charlotte Harbor NEP study area.

10.1.1 Marine and Estuarine Fishes

The Charlotte Harbor NEP estuarine complex supports a widely diverse fish community. The following sections provide descriptions of some of the critical species that comprise this community.

Historical information is available from Wang and Raney (1971), Finucane (1966), Gunter and Hall (1965), and Phillips and Springer (1960). Taylor (1975) provides a review of these and other early fish studies. Recently Fraser (1997) has provided an analysis of 13 years of data from upper Charlotte Harbor from 1975 through 1988. The data from these studies suggest that the bay anchovy, *Anchoa mitchilli*, is one of the most common species in the Charlotte Harbor complex.

The Tampa Bay NEP produced a document (Killiam *et al.*, 1992) on the basic life histories of a number of species. Virtually all of these species can be found in Charlotte Harbor and many of the comments for Tampa Bay species apply to the Charlotte Harbor complex.

Another informative study (Peebles and Flannery, 1992) examined the relationship between freshwater discharge to Tampa Bay and nursery use by fishes in the Little Manatee River. Virtually all of these fish species and their prey can be found in the Charlotte Harbor complex. *Anchoa mitchilli* was the most abundant species (Peebles and Flannery, 1992) in this study.

A larval fish study investigated the tidal reaches of the Myakka River for spawning and growth of larval fishes during a two-year period, January 1986 to December 1987 (Estevez *et al.*, 1991). The bay anchovy, *Anchoa mitchilli*, was numerically dominant with the hogchoker, *Trinectes maculatus* the next most abundant species (Table 10-1). Several different distributions were also observed (Table 10-2).

A more comprehensive fish study within the Charlotte Harbor Complex is underway. The FDEP Fisheries-independent Monitoring Program (FIMP) began in Charlotte Harbor in 1989 (McMichael, 1997). This is a long-term program designed to monitor the relative abundance of fishery resources in major estuarine systems in Florida. The program was developed because of the critical need to

Table 10-1. Numerically dominant ichthyoplankton species in 1986 and 1987 from the Myakka River, all stages combined. Density statistics are in number of individuals per cubic meter. After Estevez *et al.*, 1991.

Taxon	n	Minimum	Median	Mean	Maximum
Anchoa mitchilli	1000	0.5	19.1	132.7	8266
Trinectes maculatus	368	0.5	2.6	7.2	118.9
Gobiosoma sp.	317	0.8	4.7	19.7	349.7
Clupeidae	172	0.9	3.5	13.6	303.6
Gambusia affinis	131	0.8	1.3	1.7	5.4
Cyprinodontidae	129	0.7	1.4	2.1	9.7
Cynoscion arenarius	109	0.9	3.5	11.4	103.1
Sygnathus sp.	91	0.5	1.5	2.4	11.0
Ictaluridae	90	0.5	1.5	2.8	12.8
Microgobius gulosus	81	0.8	2.5	9.2	165.8
Gobiosox strumosus	74	1.0	1.5	2.5	20.7
Blennidae	59	0.8	3.8	6.8	30.1

detect fluctuations in fish stocks quickly and accurately. The program objectives are to provide effective assessment techniques and monitor trends in the relative abundance of fishes in major estuarine systems throughout Florida. A description of the sampling methods and gear types (various nets) is available in the document (Table 10-3). Unlike all of the previous studies, this program is using a stratified random sampling program.

FDEP has conducted preliminary analysis for selected species in their annual reports. Table 10-4 presents a list of species that have particular commercial or recreational importance. The following discussion of some selected species is taken directly from the FDEP FIMP 1996 Annual Report and slightly modified for Charlotte Harbor. The local information for the bay anchovy is based on Estevez *et al.*, 1991; Fraser, 1997; Killiam et *al.*, 1992; and Peebles and Flannery, 1992.

Bay anchovy

The range of the bay anchovy extends from Maine (Bigelow and Schroeder, 1953) to Brazil (Hildebrand and Cable, 1930) and along the Gulf of Mexico to Yucatan, Mexico (Hildebrand, 1943).

Table 10-2. Unique distributions of ichthyoplankton species by river zone in 1986. Downriver: Charlotte Harbor to Myakka Bay stations; Middle River: Tarpon Point to Warm Mineral Springs stations; Upper River: Ramblers' Rest Resort to Snook Haven stations. After Estevez *et al.*, 1991.

UPPER RIVER
Cyprinodon variegatus
Ictalurus nebulosus
Jordanella floridae
Lepisosteidae

MIDDLE AND UPRIVER
Centrarchidae
Cyprinidae
Elops saurus
Gambusia affinis
Heterandria formosa
Ictalurus punctatus
Lucania parva

MIDDLE RIVER
Fundulus sp.
Gobiosoma bosci
Micropogonias undulatus

LOWER AND UPRIVER
Sciaenops ocellatus

LOWER RIVER
Chloroscombrus chrysurus
Hippocampus erectus
Microdesmus longipinnis
Sphaeroides sp.
Svmphurus plagiusa
Synodus foetens
Oligoplites saurus

LOWER AND MIDDLE RIVER
Anchoa hepsetus
Bathygobius soporator
Blennidae
Gobiosox strumosus
Menidia beryllina
Menticirrhus sp.
Myrophus punctatus

Table 10-3. Description of monthly monitoring sampling gears used in 1996. A more detailed description of each gear can be found in the FIMP Procedure Manual. This table is taken from the 1996 annual data summary.

Gear	Deployment	Mesh Size	Area Sampled	Description of Use	Period
21-m seine (center bag)	Beach	3.2 mm	377 m^2	used along gently sloping beach	Day
	Offshore	3.2 mm	153 m^2	used in shallow offshore areas (< 1.5m)	Day
	Boat	3.2 mm	68 m^2	used along river shorelines with steep drop-offs or soft mud bottoms	Day

Table 10-3. Description of monthly monitoring sampling gears used in 1996. A more detailed description of each gear can be found in the FIMP Procedure Manual. This table is taken from the 1996 annual data summary.

183-m seine (center bag)	Boat	38.5 mm	Variable	used along shorelines and shallow offshore sand bars	Day
6-m otter trawl	Straight tow	38 mm 32 mm liner	Variable	used in non-vegetated areas 1.8 m deep	Day
	Arc tow	38 mm 32 mm liner	Variable	used in non-vegetated areas 1.8 m deep	Day
198-m, 5-panel experimental gill net	NA	Four 45.7-m panels: 76 mm 102 mm 127 mm 152 mm; one 15-m panel w/ 51 mm mesh	NA	used perpendicular to shore 2 m deep	Dusk

Table 10-4. Species with commercial or recreational importance in the Charlotte Harbor NEP area.

Species Name	Common Name
Archosargus probatocephalus	sheepshead
Centropomusundecimalis	common snook
Cynoscion arenarius	sand seatrout
Cynoscion nebulosus	spotted seatrout
Elops saurus	ladyfish
Epinephelus morio	red grouper
Leiostomus xanthurus	spot
Lutjanus capechanus	red snapper
Lutjanus griseus	grey snapper
Lutjanus synagris	lane snapper
Megalops atlanticus	tarpon

Table 10-4. Species with commercial or recreational importance in the Charlotte Harbor NEP area.

Menticirrhus spp.	whiting/kingfish
Menticirrhus americanus	southern whiting
Menticinrhus littoralis	gulf kingfish
Menticirrhus saxatilis	northen kingfish
Mugil cephalus	striped mullet
Mugil curema	white mullet
Mugil gyrans	fantail mullet
Mycteroperca microlepis	gag
Paralichthys albigutta	gulf flounder
Pogonias cromis	black drum
Pomotomus saltatrix	bluefish
Rachycentron canadum	cobia
Sciaenops ocellatus	red drum
Scomberomorus maculatus	Spanish mackerel
Scomberomorus cavalla	king mackerel
Trachinotus carolinus	pompano
Trachinotus falcatus	permit

The bay anchovy is one of the most abundant fish species occurring in estuaries along the mid-Atlantic region and throughout the Gulf of Mexico (Wang and Kernehan, 1979). Bay anchovy biomass may be higher than that of any other fish along the south Atlantic and Gulf coasts (Gunter and Hall, 1963). As a widely distributed and abundant planktivore, bay anchovy represent a major link in estuarine food webs and probably play a significant role both in survival patterns of benthic invertebrate larvae and in the dynamics of estuarine zooplankton community (Johnson *et al.*, 1990).

Because of their abundance and small size they are an important trophic link between plankton and piscivorous fish (Baird and Ulanowicz, 1990). They are also important prey species for many commercial and recreationally important species (Robinette, 1983; Vouglitois *et al.*, 1987).

Peebles and Flannery (1992) collected eggs and post-flexion bay anchovy larvae in Tampa Bay waters adjacent to the Little Manatee River mouth (Figure 10-1). The collections of juveniles and

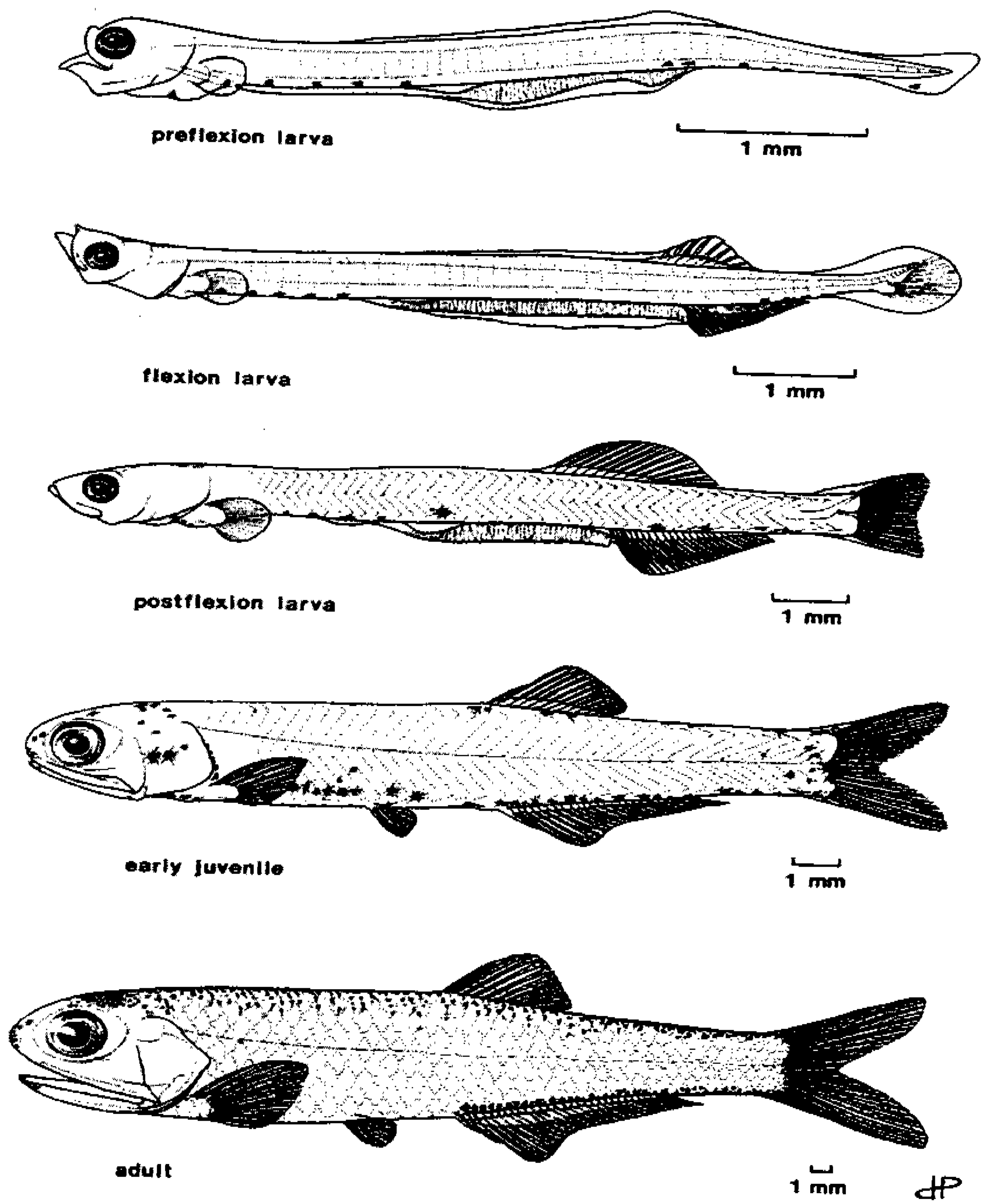


Figure 10-1. Development stages of the bay anchovy (*Anchoa mitchilli*) collected from the Little Manatee River estuary and Tampa Bay, 4.6, 7.0, 10.5, 16, and 33 mm standard length (after Peebles and Flannery, 1992).

adults tended to be largest upstream in the river. No bay anchovy eggs or larvae were reported in icthyoplankton collections at the mouth of Tampa Bay, although numerous striped anchovy *Anchoa hepsetus* were collected (Robison, 1985). These studies suggest that the bay anchovy spawns within, rather than offshore, the Tampa Bay estuary.

Although very little information on growth rates was ascertained, there appeared to be two and sometimes three separate year-classes. A major problem in examining bay anchovy growth is the protracted spawning season in Tampa Bay which makes distinctions between cohorts difficult. Peebles *et al.* (1992) reported early juvenile bay anchovy year round in the Little Manatee River. Bay anchovy collected monthly at fixed stations throughout Tampa Bay by the FDEP FIMP also showed large overlap in average sizes (FIMP, 1989 and 1990).

Numerous studies have documented feeding habits of the bay anchovy in various estuaries. The bay anchovy appears to be a selective feeder rather than a filter feeder and feeding is discriminatory as to both size and type of organisms (Datwyler and Houde, 1970; Odum, 1971; Johnson *et al.*, 1990). A thorough analysis of bay anchovy feeding habits in Tampa Bay suggests that calanoid copepods, gammarid amphipods, and decapod mysis larvae made up a large percentage (by volume) of food items in bay anchovy of approximately 16-50 mm standard length (SL). Copepod nauplii, diatoms, calanoid copepods, and invertebrate eggs made up a large percentage of the number of organisms ingested (Peebles and Flannery, 1992).

Larval, juvenile, and adult bay anchovy appear to be eurythermal and euryhaline (Springer and Woodburn, 1960; Robinette, 1983). They are common throughout the year and at variable salinities in the Tampa Bay estuary (Haddad *et al.*, 1992; Peebles and Flannery, 1992). Juvenile and adult bay anchovy are commonly collected in shallow estuarine waters (~ 2 m); however, they have not been associated with particular substrates (Orth and Heck, 1980; Gilmore, 1987; Thayer *et al.,* 1987).

The bay anchovy has a widespread distribution in the shallow waters of many estuaries. However, they have not been associated with particular substrates or types of cover (Orth and Heck, 1980; Gilmore, 1987; Thayer *et al.*, 1987). Bay anchovy were commonly collected in numerous habitats throughout Tampa Bay including those with vegetated and non-vegetated bottoms (Springer and Woodburn, 1960; FIMP, 1989 and 1990).

Their relatively small size and great abundance make the anchovies one of the most important groups of forage fish in the Gulf of Mexico (Robinette, 1983). In Charlotte Harbor, numerous species are predators of the bay anchovy, including various fish: ladyfish, jack crevalle, blue runner, spanish mackerel, snook, spotted seatrout, sand seatrout, tarpon gulf flounder, gag grouper, and mangrove snapper; and various birds: least tern, brown pelican, and white pelican; and humans use this species as bait or chum.

Fraser (1997) suggested that a relationship existed between relative abundance trends of the bay anchovy in upper Charlotte Harbor and freshwater inflow trends. Peebles and Flannery (1992) concluded that the bay anchovy congregated in low salinity habits as after the postflexion stage and as juveniles. Bay anchovies were caught on every trip in the Myakka River (Estevez *et al.*, 1991). Larval composition varied with the Myakka River length (Table 10-2). Seasonal use of the Myakka River by the bay anchovy was different for larvae and juveniles (Figure 10-2).

Redfish (red drum)

The redfish, *Sciaenops ocellatus*, is an estuarine-dependent species inhabiting coastal waters from Massachusetts to northern Mexico (Reagan, 1985). The species supports important recreational, and to a limited extent, commercial fisheries throughout the U.S. south Atlantic and Gulf of Mexico. In Florida, dramatic stock reductions in the mid 1980's resulted in a 1986 moratorium on the commercial and recreational red drum fisheries. A high proportion of commercial catches on the west coast of Florida came from the Charlotte Harbor system. In 1989, the fishery was reopened with strict size and bag limits, as well as a no sale provision which effectively concluded the commercial fishery in Florida. Since that time, redfish have shown signs of increase, and in 1994, abundances were equal to or slightly greater than those observed in the early to mid 1980's (Muller and Murphy, 1994).

In Florida, adult redfish spawn from mid-August through late November primarily near bay mouths or inlets and over nearshore continental shelf waters (Mercer, 1984; Murphy and Taylor, 1990), but may also occur inside the estuary (Murphy and Taylor, 1990; Johnson and Funicelli, 1991). In Florida estuaries, recruitment of juveniles begins in September and continues through January, with peaks in October and November (Reagan, 1985; Peters and McMichael, 1987; Daniel, 1988). Data collected by the FDEP FIMP from 1989 to 1996 indicate that settlement of juvenile red drum < 33 mm SL typically occurs in the middle or upper reaches of estuaries away from ocean inlets or passes, and is strongly influenced by the availability of low to moderate salinity habitats. In Charlotte Harbor, juvenile recruitment was greatest in habitats with salinities from 18 to 24‰. Juveniles were concentrated in areas of the bay adjacent to major freshwater sources.

The FDEP FIMP develops indices of juvenile redfish recruitment for selected Florida estuaries in an effort to monitor year-class strength and to increase the ability to predict future adult redfish abundances. Data from the fall stratified-random sampling season (September-December) were examined to assess the recruitment of juvenile redfish into Charlotte Harbor.

Relative abundance of juvenile redfish decreased in 1996 significantly from the peak values reached in 1995 (Figure 10-3). Specific reasons for this apparent decline are currently unknown, and may be related to fluctuations in adult spawning success, unsuitable environmental conditions for juveniles, or other recruitment related processes. It is also possible that relative abundance levels are resuming to "normal" levels after a very high recruitment year in 1995.

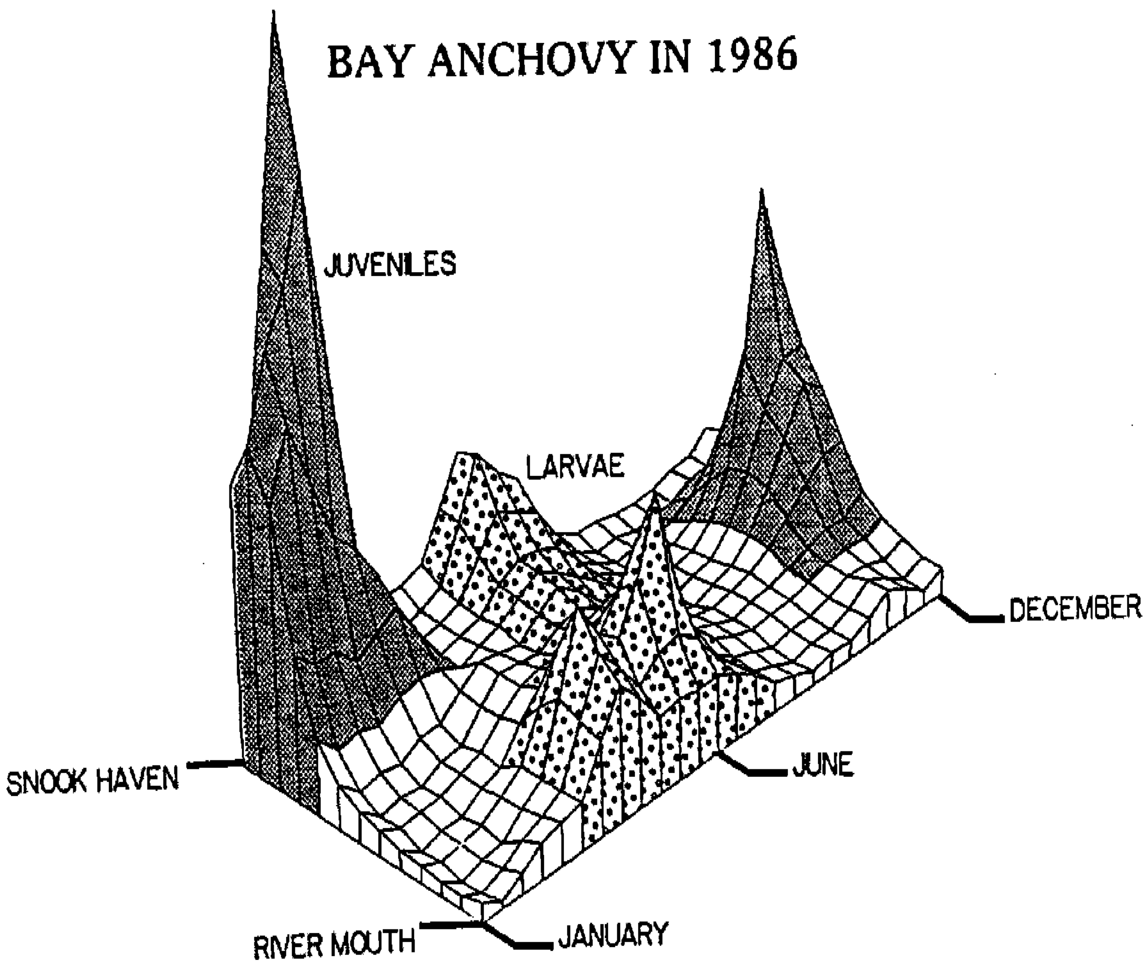


Figure 10-2. The distribution of *Anchoa mitchilli* in the Myakka River by time of year and distance (after Burns *et al.*, 1987).

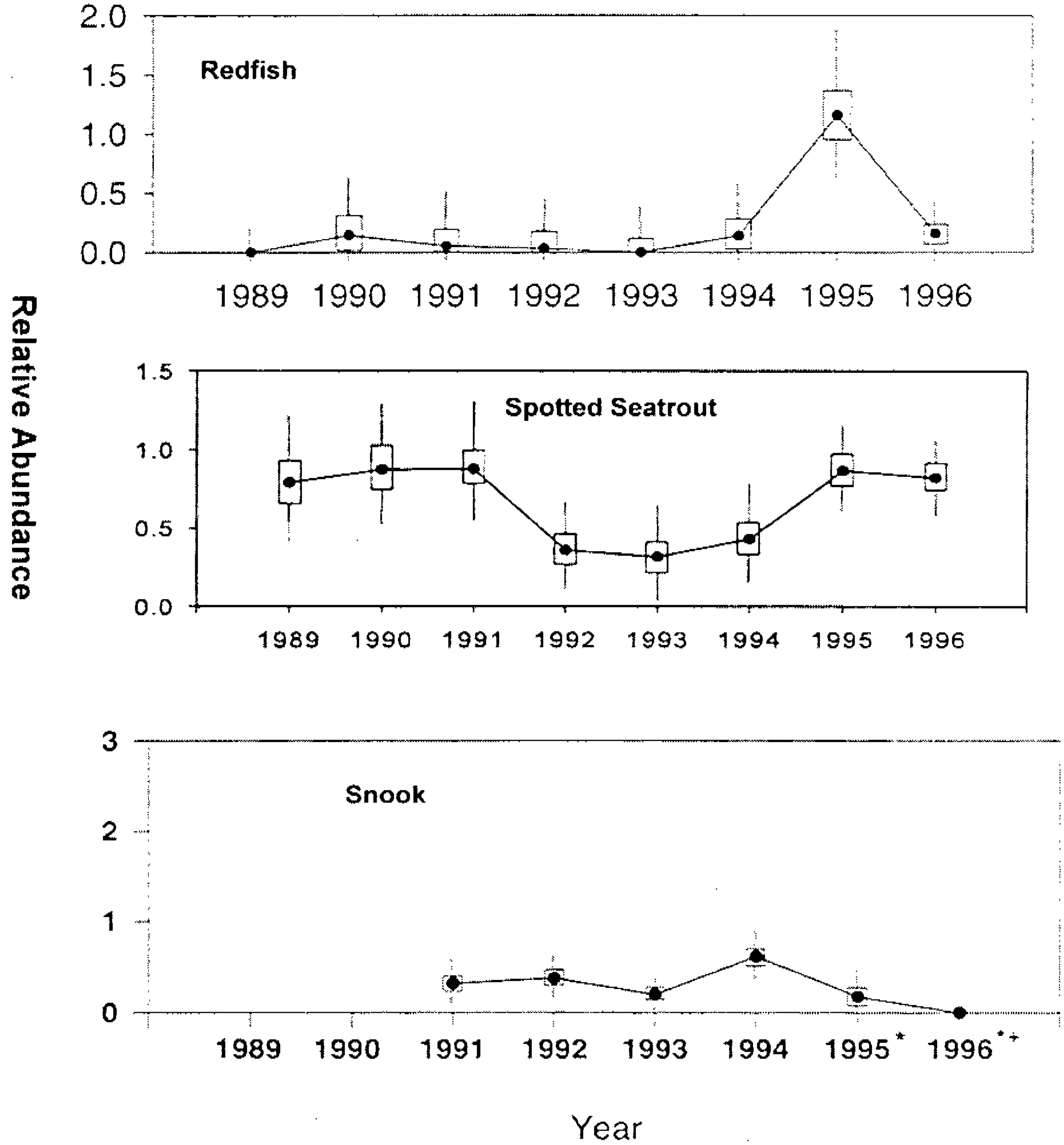


Figure 10-3. Relative abundance of juvenile common snook, spotted seatrout, and redfish ($\leq$ 33mm SL) (Charlotte Harbor 1996 Annual Data Summary Report). The box represents the 25th and 75th percentiles. The vertical line extends from the 25th and 97.5th percentiles. The filled circle represents the median value. Different sampling methods were used for some of these data.

Spotted Seatrout

The spotted seatrout, *Cynoscion nebulosus*, is an important recreational and commercial fish that is widely distributed in estuarine waters from Delaware southward along the coast of the United States and throughout the Gulf of Mexico (Idyll and Fahy, 1970). In Florida, spotted seatrout populations are closely monitored because of their recreational and commercial value, and they are in danger of being overexploited. Total landings of spotted seatrout have declined by 46% on Florida's East Coast and 45% on the West Coast since 1988 (Muller and Murphy, 1994). In 1993, over 3.08 million pounds of spotted seatrout were landed recreationally and commercially (Muller and Murphy, 1994).

Spotted seatrout populations are monitored in Florida by the FDEP FIMP. Data from spring (April-June) and fall (September-October) SRS surveys were combined and used to generate standardized indices of abundance for spotted seatrout (<100 mm SL) for each bay and year. Young-of-the-year (YOY) spotted seatrout recruit into Charlotte Harbor and other estuaries in Florida between April and October. This coincides with the protracted spawning period known for spotted seatrout in Florida (McMichael and Peters, 1989). The majority of YOY spotted seatrout (76.2%) were taken in seines; therefore, only catches of spotted seatrout from seines were used in the analysis.

In Charlotte Harbor, relative abundances (Figure 10-3) were stable from 1989 through 1991, declined in 1992 and remained low through 1994. In 1995, YOY spotted seatrout abundances increased and then remained stable through 1996.

Snook

The common snook, *Centropomus undecimalis*, is one of the most sought-after game fish in southwest Florida due to its large size (up to 44 inches and 50 pounds; Robins *et al.*, 1986), sporting qualities, and excellent food value. Increased stress on Florida common snook populations because of habitat loss and fishing pressure first led to a commercial fishing ban on this species in 1957 (Volpe, 1959), and has resulted in recreational harvest restrictions in more recent years. It was estimated that approximately 88,000 fish were taken by anglers in 1995, with slightly less than half of this total being caught on the Gulf coast (Muller *et al.*, 1996).

The common snook is found in tropical and subtropical coastal waters from the U.S. mid-Atlantic coast to southeastern Brazil, including the insular and mainland margins of the Gulf of Mexico and the Caribbean Sea (Lunz, 1953; Merriner *et al.*, 1970; Martin and Shipp, 1971). In Florida, snook are primarily found along the southern portion of the peninsula, with most occurring from Tampa Bay south on the Gulf coast, and from the Indian River Lagoon south on the Atlantic Coast. Their geographic distribution is limited by water temperature, which reaches a lethal level below 12-14 C (Shafland and Foote, 1983). Adults generally winter in rivers and inland waterways and move to higher-salinity areas such as passes and beaches during the warmer months (Volpe, 1959). In southwest Florida, most spawning takes place in late spring and summer (April-September), with individual females spawning about once a week during this extended period (Taylor *et al.*, 1993). Males in southwest Florida mature at about 2 years of age and 400 mm FL, while females are somewhat older and larger at maturity (2-3 years and 500 mm FL). Protandrous sex reversal has been shown to occur in this species (Taylor and Grier, 1993). Common snook are predacious throughout their lives; small juveniles (<45 mm SL) in Tampa Bay feed mainly on mysid shrimp and copepods, while larger fish prey on palaemonids and fish (McMichael *et al.*, 1989). Common snook are euryhaline, inhabiting a wide variety of inshore habitats, including mangrove-fringed bays, marshes, and tidal streams (Gilmore *et al.*, 1983; McMichael *et al.*, 1989). Post-larvae move into brackish and freshwater areas of estuaries, settling out in small streams, canals, and ditches (Kevin Peters, DEP-FMRI pers. comm.). Young-of-the-year (YOY) common snook especially appear to favor shoreline habitats with overhanging vegetation and adjacent dropoffs (Gilmore *et al.*, 1983; McMichael *et al.*, 1989).

In 1989-1995, the FIMP developed relative abundance indices of YOY common snook by using data from monthly fixed stations located in quiet backwater areas in Charlotte Harbor where small fish <55 mm SL were routinely collected. Relative abundance indices were generated from these data. In 1996, fixed-station sampling was discontinued in favor of year-round stratified-random sampling (SRS) and different seine gear. This change created challenges for computing relative abundance indices because fewer common snook were collected in SRS than in fixed-station sampling. In 1996, none were collected in Charlotte Harbor. In Charlotte Harbor, only a few sites where YOY common snook are abundant have been located. Peaks in relative abundance were observed in 1994 for Charlotte Harbor (Figure 10-3).

Increased information on age-1 and older common snook is now routinely collected in Charlotte Harbor by stratified-random sampling with 183-m haul seines. Sampling with the 183-m seines was initiated in May 1996 in Charlotte Harbor. In 1996, 237 common snook were collected in Charlotte Harbor. The 183-m seine data complement data collected from the 21-m seine samples by providing information on a much larger range of fish sizes. Data collected on adult and sub-adult common snook in the 183-m seine samples are being used for developing population estimates and management tools such as spawning potential ratios.

Striped mullet

The striped mullet, *Mugil cephalus*, is one of Florida's most abundant and widespread estuarine-dependent fish species (Odum, 1970; Leard *et al.*, 1995). Recreational anglers capture striped mullet for bait and as a food fish using castnets and small seines. Striped mullet also supported a valuable gill-net commercial fishery with approximately 90% of all U.S. production occurring in the Gulf of Mexico and over 80% of all commercially caught mullet landed in Florida waters between the early 1960s and late 1980s (Rives, 1980; Leard *et al.*, 1995). However, from 1991 to 1994 commercial mullet landings have severely declined in Florida from 79% to 46% of the total Gulf production (Leard *et al.*, 1995). Additionally, Florida's recent ban (July 1995) on entanglement gears in state waters will further decrease Florida's contribution to the striped mullet commercial fishery. Presently, commercial fishers are using castnets for exploiting the mullet stock. Therefore, a lower potential exists for commercial and recreational fishers to exploit this species. Abundance indices for newly recruited juvenile striped mullet will provide additional data for determining future stock fluctuations and abundances.

Striped mullet migrate offshore in the fall to spawn and larvae are transported to estuaries and nearshore areas through various mechanisms (Ditty and Shaw, 1996). Juvenile striped mullet move inshore from January through March. The FIMP eliminated fixed-station sampling in 1995 in favor of a monthly stratified-random sampling design. Abundance indices for each sampling area presented in this report were developed from January-April fixed-station sampling in 1989-1995, and from January-March SRS in 1996. In the 1996 analysis, only striped mullet <30 mm SL were included in the abundance indices.

Although the change in sampling designs does not allow valid comparisons between data collected in 1996 and data collected in 1989-1995, the relative abundance of juvenile striped mullet in Charlotte Harbor in 1995 was the highest abundance observed since the beginning of the program and may indicate a strong year class (Figure 10-4).

Sheepshead

The sheepshead, *Archosargus probatocephalus*, is common in coastal estuarine and inner- to mid-shelf water from Cape Cod to Brazil (Jennings, 1985). In Florida, sheepshead are commonly collected in recreational and commercial fisheries. Despite the recent net ban, which prohibited the use of most commercial nets from Florida waters, the potential remains for a commercial hook-and-line and cast net fishery for sheepshead. In addition, the recreational fishery has taken 1 - 6 million pounds of sheepshead annually between 1980 and 1993 (Muller and Murphy, 1994). A recent stock assessment of sheepshead in Florida waters indicated that they are currently being exploited at, or near, their maximum yield-per-recruit level (Muller and Murphy, 1994).

Adult sheepshead reproduce during early spring, and juveniles are most abundant in shallow estuarine areas between March and May. Catch data from 21-m seine stratified random sampling surveys conducted during March-May were examined to assess the relative abundances of juvenile sheepshead in Charlotte Harbor. The trend in relative abundances for juvenile sheepshead in Charlotte Harbor was similar to Tampa Bay, with the lowest relative abundances in 1989, peaks during 1991 and 1994 and fairly constant indices during 1992, 1993, 1995, and 1996 (Figure 10-4).

Inter-estuarine comparisons show a strong similarity between juvenile sheepshead recruitment into Tampa Bay and Charlotte Harbor. Although the two bays are physically separated by approximately 120 km, both estuarine systems have many physical characteristics in common and it is probable that similar dynamic processes influence recruitment success in both systems.

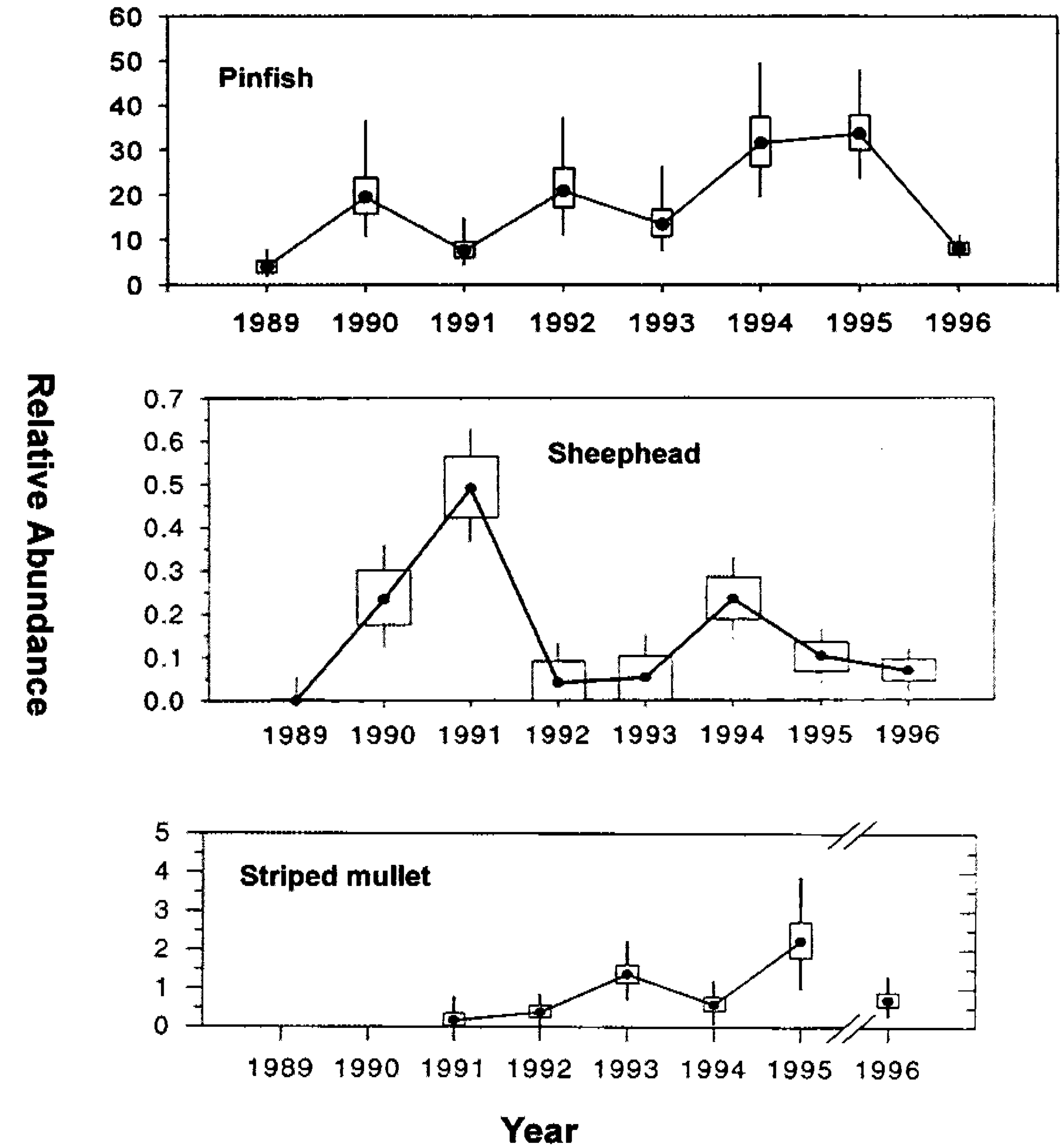


Figure 10-4. Relative abundance of juvenile sheepshead (≤ 35mm SL), juvenile pinfish (< 80mm SL), and juvenile striped mullet (< 35mm SL) (Charlotte Harbor 1996 Annual Data Summary Report). The box represents the 25th and 75th percentiles. The vertical line extends from the 25th and 97.5th percentiles. The filled circle represents the median value. Different sampling methods were used for some of these data.

Sharks

Sharks use the Charlotte Harbor complex as a forage area, a nursery ground and a place to give birth. This area has recently been included in a study of sharks by Heuter (1994) and a program is continuing. Many sharks are long lived and have a low reproductive potential. These characteristics are more like marine mammals then most fishes. The following information is taken from Heuter (1994), in which he demonstrates the use of the Charlotte Harbor complex as a nursery for some species of shark.

Average water temperatures in areas that support shark populations were 27-31 C and maximum temperatures were 30-34 C for most species. Lower temperature limits varied more by species, with bonnethead, blacknose, blacktip, Atlantic sharpnose, Florida smoothhound, and nurse sharks found in temperatures below 20 C, and bull, great and scalloped hammerhead, lemon, and spinner sharks not collected in temperatures below 20 C. The fall/winter preference of the Florida smoothhound is reflected in its narrow temperature range of 17-19 C.

Salinity ranges were narrow for most species, usually about 25-37‰ (with average salinities of about 31-33‰ for most species), with only two exceptions. The broad range of salinities where bull sharks were found, from near-freshwater at 3l C up to a maximum of 28.5l‰, is consistent with the well-known and unusual euryhalinity of this shark species (Castro, 1983).

Depth ranges were broad for about half of the documented species. Six species (blacknose, blacktip, bonnethead, Atlantic sharpnose, Florida smoothhound, and spinner) ranged from near the surface to 24-30 ft. Great hammerhead and nurse sharks were caught at depths varying from near the surface to about 20 ft. Bull, scalloped hammerhead, and lemon sharks were collected only in depths of 10 feet or less. Average depth of capture for the 13 species was about 4-9 feet in all but three cases: blacknose sharks (average depth about 15 ft), which were found more often in deeper regions of lower Tampa Bay and offshore from coastal beaches; the lone finetooth specimen; and Florida smoothhounds (average depth about 18 ft), which were found strictly off coastal beaches.

Relationships between shark species and habitat, in terms of type of benthic community at capture site, were discernable for the four most abundant species by sorting the shark database by species and location bottom type. Bonnethead (93%) and blacktip (85%) sharks were found over seagrass, with the remaining sharks predominantly found over sand or mud. Blacknose sharks showed a stronger preference for sand or mud bottoms (61%), with 24% found over seagrass and 15% over hard bottom. This is consistent with their generally being found in deeper water. Bull sharks showed no clear preference, with 54% being found over sand or mud and 46% found over seagrass.

Table 10-5 shows the breakdown of the total shark catch by species and stage of maturity. Neonates are defined as newborn, free swimming sharks with umbilical (or yolk stalk) scars that have not yet closed. Juveniles are all young sharks between neonate and adult stages, i.e., they have completely closed or no umbilical (yolk stalk) scars and they are not sexually mature. Adults are defined as sexually mature sharks as follows: adult males have enlarged, rigid, calcified claspers, and may have sperm in tubules or sacs of the urogenital system; adult females show ovarian and oviducal development, have mature eggs and possibly evidence of copulation (mating scars) during mating periods, and may have embryos during gestation periods. Sizes at maturity were established for each shark species by internal examination of dead specimens when possible, or by consulting the literature (e.g., Compagno, 1984; Castro, 1983).

Table 10-5. Life stages of sharks inhabiting Tampa Bay/Charlotte Harbor region. Modified from Heuter (1994, Table 38).

Common Name	Scientific Name	Neonates?	Juveniles?	Adults?
Bonnethead	*Sphyrna tiburo*	No(?)	Yes	Yes
Great hammerhead	*S. mokarran*	No(?)	Yes	Yes*
Southern hammerhead	S. *Iewini*	No(?)	Yes	Yes*
Blacktip	*Carcharhinus limbatus*	Yes	Yes	Yes
Blacknose	C. *acronotus*	Yes	Yes	Yes
Bull	C. *Ieucas*	Yes	Yes	Yes*
Finetooth	C. *isodon*	No	No	No
Spinner	C. *brevipinna*	No(?)	Yes	Yes*
Sandbar	C. *plumbeus*	No	No	Yes
Atlantic sharpnose	R*hizoprionodon terraenovae*	No	No	Yes
Nurse	*Ginglymostoma cirratum*	No(?)	Yes	Yes
Fla. smoothhound	M*ustelus norrisi*	No	No	Yes
Lemon	*Negaprion brevirostris*	Yes	Yes	Yes*

(?) Not captured in the study area but expected
*Known from other collections

The size of the fishing gear used in this study was selective for young sharks or adults of small species. Of the total catch of 1,862 sharks, 65% were neonates or juveniles, and of the total adult catch, 93% were bonnethead sharks. Neonates of four species (blacknose, blacktip, bull, and lemon) were caught in the study area, with an additional five species of sharks suspected of having neonates in the area because: 1) very small, post-natal juveniles and/or post-partum adult females were collected during the project; and/or 2) other collections or studies have indicated the presence of neonates in the region. Juveniles of all but two species (Florida smoothhound and sandbar sharks) were captured in the study area during this project. In addition, data from this study and other collections have demonstrated the regional presence of adult sharks of all 13 species collected in this study except the finetooth shark. Thus, by Castro's (1993) definition of shark nursery areas, the Tampa Bay and Charlotte Harbor estuaries and adjacent coastal waters serve as nurseries for at least 11 species of sharks, with at least four, and possibly as many as nine, of these species giving birth to pups within the region.

The geographical distributions by life stages of sharks in the study area are shown in Figure 10-5. Catches of neonates were concentrated in a few key spots, including southern Pine Island Sound (primarily blacktips). Catches of juveniles, on the other hand, were widespread in distribution throughout the study area. Adult distribution was similar to that of juveniles.

Neonate catches were restricted to the four months of May through August, with primarily blacktip neonates appearing in spring and bull neonates appearing in early summer. Juvenile catches were concentrated from late March through September, peaking in June and July for most species. Blacktip, Atlantic sharpnose, and scalloped hammerhead sharks showed a resurgence of juveniles in the September catch. Bonnetheads were the only species with juveniles showing up in the catch in all months of the year. Adult sharks in the catch were dominated by bonnetheads, also in the area as adults year-round, and blacknose sharks, for which adults were found in the area from late spring through summer. Several life stages are predicted for this region.

Stomach contents were analyzed for 546 sharks of eight species. Overall, 77% of these sharks had food items in the stomach. Of the five species for which more than 10 stomachs were examined, the percentage of non-empty stomachs by species ranged from a high of 95% for the bonnethead (n = 332) to a low of 39% for the blacknose (n = 33). The other six species are represented by much smaller sample sizes (blacknose, 13; Atlantic sharpnose, 10; bull, 6; great hammerhead, 5; scalloped hammerhead, 5; spinner, 1).

For the bonnethead shark, crustaceans were the dominant food category on a wet weight (%W = 84.2%), per number (%N = 62.9%), and occurrence (%O = 92.5%) basis. According to the %IRI, crustaceans made up 89.6% of the bonnethead diet, and this food category was dominated overwhelmingly by blue crabs *(Callinectes sapidus)*, with a species-level % Index of Relative Importance (IRI) of 85.9%. Several species of seagrasses constituted 8.4% of bonnethead stomach contents. The remainder of the bonnethead stomach contents was composed primarily of unidentifiable material (%IRI = 2.6%). In contrast to the bonnethead diet, that of the blacktip shark consisted mainly of teleosts. Total %IRI of teleosts of all species was 97.8% for the blacktip. Thus, the bonnethead and blacktip differ markedly in their feeding habits in the study area, in that bonnetheads specialize on crabs and blacktips specialize on teleost fishes, even though there is considerable overlap in their distributions.

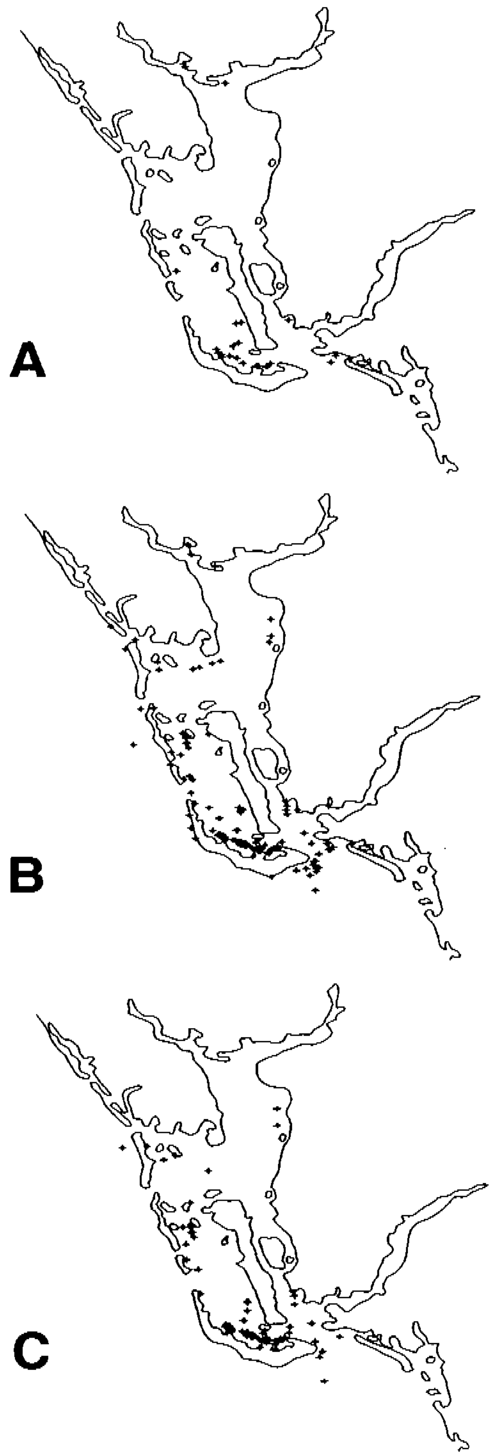


Figure 10-5. Neonate (A), juvenile (B), and adult (C) sharks captured in Charlotte Harbor (modified from Heuter, 1994).

For the other six shark species, stomach contents were dominated by teleosts. The only shark species of the group with any identifiable elasmobranch material in its stomach contents was the bull shark. One juvenile bull (out of 11 examined) of 64 cm FL had remains of a small cownose ray(s) in its stomach. As adults, bull sharks are known to feed on elasmobranchs as well as teleosts, with adults taking more elasmobranch prey than do young bull sharks (Compagno, 1984).

Sharks were, and still are in the Federal Management Zone, an important part of commercial fishing. The fins were exported and the meat sold for food. The blacktip was the most important inshore species to be caught in the Charlotte Harbor area. The State eliminated commercial fishing for sharks in State Water (3 leagues = 10.6 statute miles) in the Gulf of Mexico in 1992 with a bag limit of one per person and two sharks per boat. The net ban has also reduced the inadvertent bycatch in State Waters with mortalities estimated at 55% (Heuter, 1994). Some bycatch will still occur as the result of shrimping, however, the turtle excluder device will allow some sharks to escape the shrimp trawls.

Recreational fishing for sharks increased from the late 1970s through the 1980s. Landings along the Gulf Coast doubled between 1979 and 1987 (NMFS, 1987). During this time, about 30 organized shark tournaments involving over 3,000 anglers each year were held in state waters (Hueter, 1991). After 1988, the recreational fishery for sharks in Florida declined. Today, less than 10 of the 30 shark tournaments conducted in the state over the past 20 years remain active. Most of the larger, successful operations folded due to one major factor: lack of large sharks (Hueter, 1991). As large coastal sharks became relatively scarce, the recreational fishery abandoned offshore fishing for the larger sharks, and nearshore fishing for smaller sharks gained greater acceptance. These smaller sharks targeted by anglers include juveniles of large coastal species as well as adults of small coastal species.

Commercial Fisheries

Florida has managed its marine resources primarily through the legislature until 1985. All fisheries management regulations were passed as individual bills. There were a few regulations that applied state-wide. These rules mostly dealt with minimum size limits of a few species. Virtually all species could be sold. The State had no means of estimating how many pounds or numbers of individuals were landed (commercial or recreational) except through federal information until 1986. Fisheries records are now kept by FMRI for wholesale outlets and for recreational surveys. Attitudes changed very slowly after 1945 as Florida began to receive increasing numbers of new residents. During World War II, all regulations were suspended in order to provide as much seafood as possible. However, by 1985 there were more than 260 local laws dealing with marine resources.

Snook was the first important regional inshore food and recreational fish to have increased management. It was made a gamefish (no commercial sale) with a minimum size and bag limit in 1957. At the same time, the black mullet, an important state-wide food fish, which was not harvested for six weeks during the fall spawning season, was reopened to commercial fishing.

The legislature, during the early 1980's, decided to form an agency for the sole purpose of managing marine resources after serious controversies over whether there had been a king mackeral population collapse, increasing public pressure about perceived declines for spanish mackeral, snook, redfish, spotted seatrout, queen conch and other resources. This agency, the Florida Marine Fisheries Commission began reversing the declining trend in some resources. However, serious problems were occurring in both the recreational and commercial sections because of high rates of fishing related mortality. Some of these issues could not be effectively or timely resolved because of interest group pressure on the political system and legal actions in the courts. In July 1995, a grass-roots supported, constitutional amendment became effective, removing gill nets larger than 500 square feet from being fished in State waters.

Successful fisheries management simply involves reducing fishing mortality rates to a level above which species can maintain stable populations under natural or human altered conditions.

Because of changes in the fishery management attitudes of many people, for example, the sea is no longer viewed as an unlimited source of food. The general resource trend is positive. Marine fisheries resources in the Charlotte Harbor NEP are increasing as the result of changes in the management process (Muller et al., 1996; Mc Michael, 1996).

The gill net ban which became effective in July 1995 has reduced Gulf Coast commercial landings by about 82% (Muller *et al.*, 1996). In the Charlotte Harbor complex, the fish that will benefit from a significant decrease in fishing mortality are: striped (black) mullet, jack crevalle, pompano, spotted seatrout, sheepshead, ladyfish and sand bream (striped mojarra). Two gamefish species, snook and tarpon will have the benefit of not being inadvertently caught in commercial nets and an increase in prey species such as mullet.

Statistics, both commercial and recreational are given in Figures 10-6 to 10-9 for a number of species as examples. The 1995 data for commercial landings show significant declines from the initial effects of the net ban. Number of fish reported by recreational activity was about the same. These data include more than the Charlotte Harbor complex because of various constraints on how data are collected handled by the State and Federal agencies.

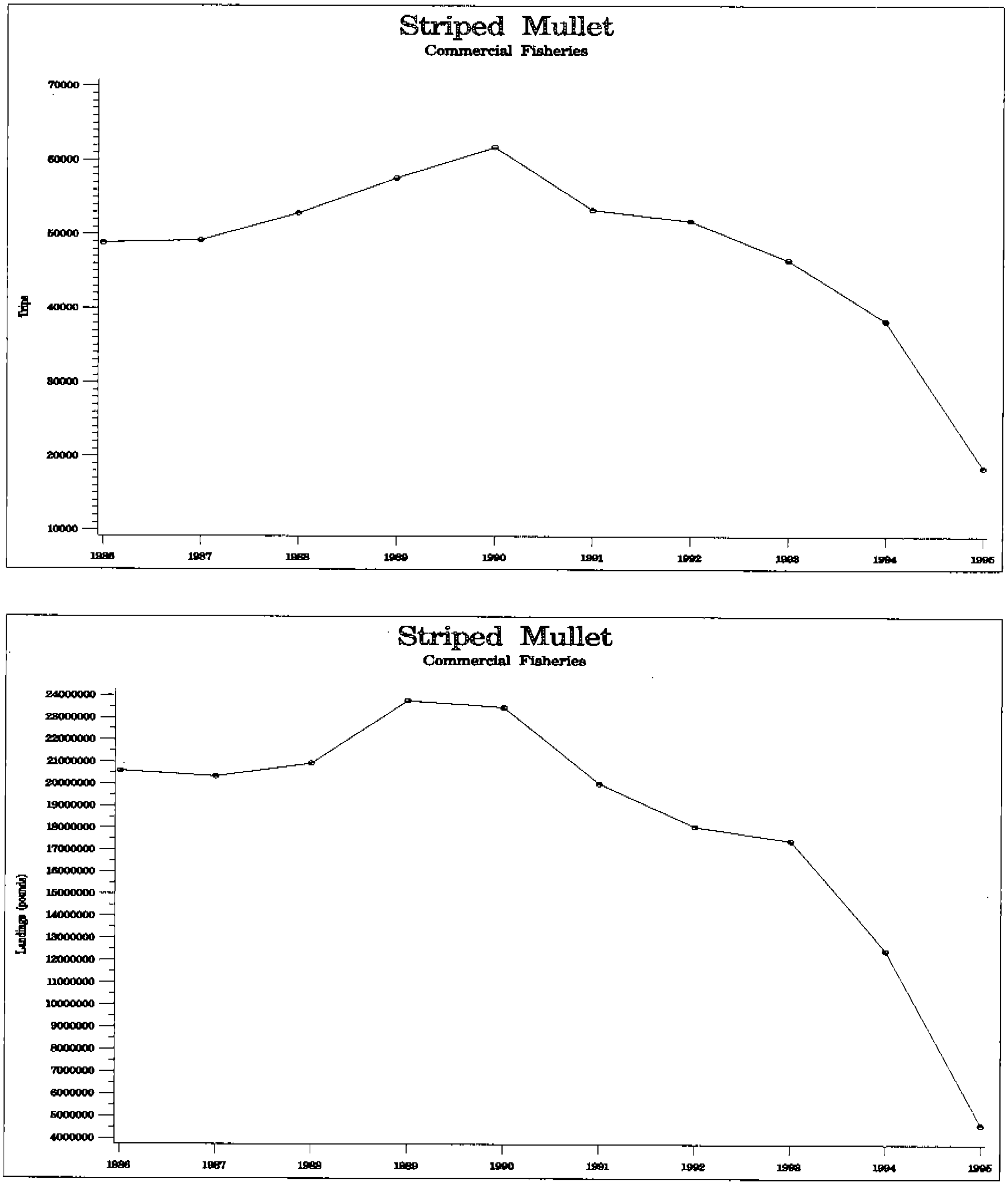


Figure 10-6. Number of trips and landings of striped mullet from the west coast of Florida.

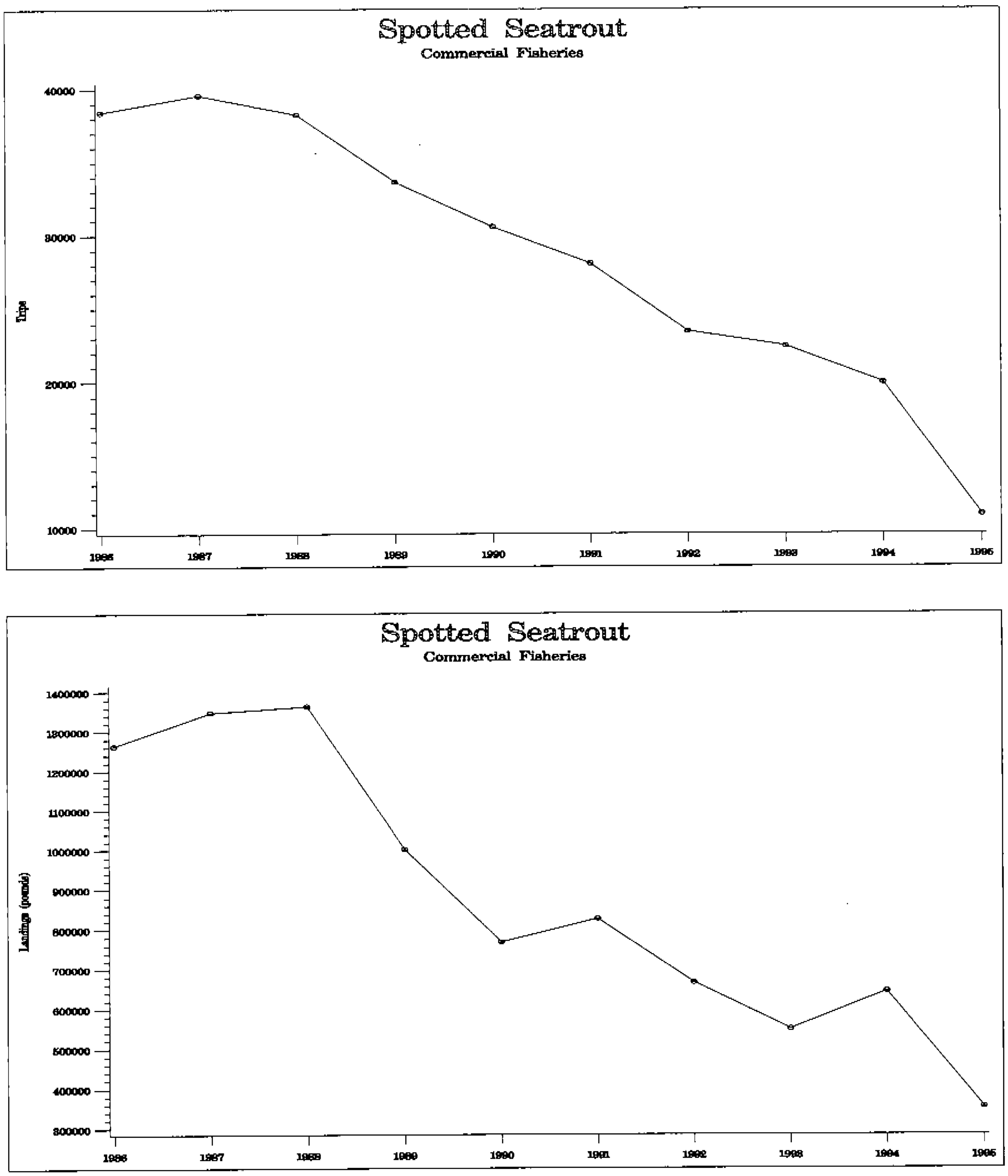
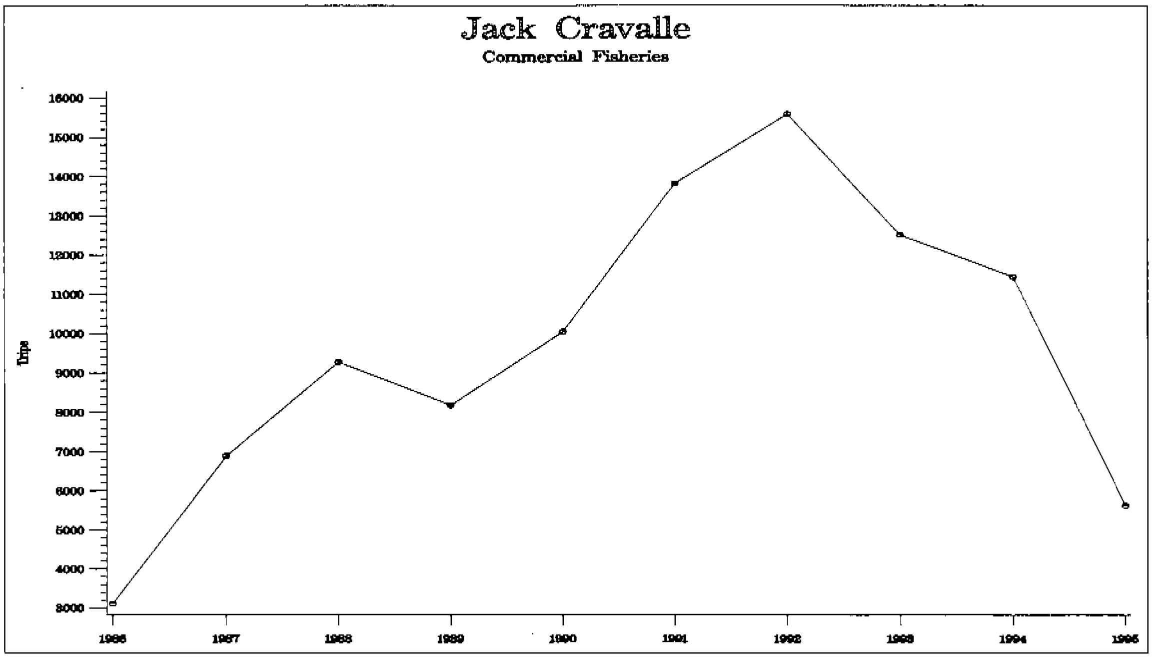


Figure 10-7. Number of trips and landings of spotted seatrout from the west coast of Florida.



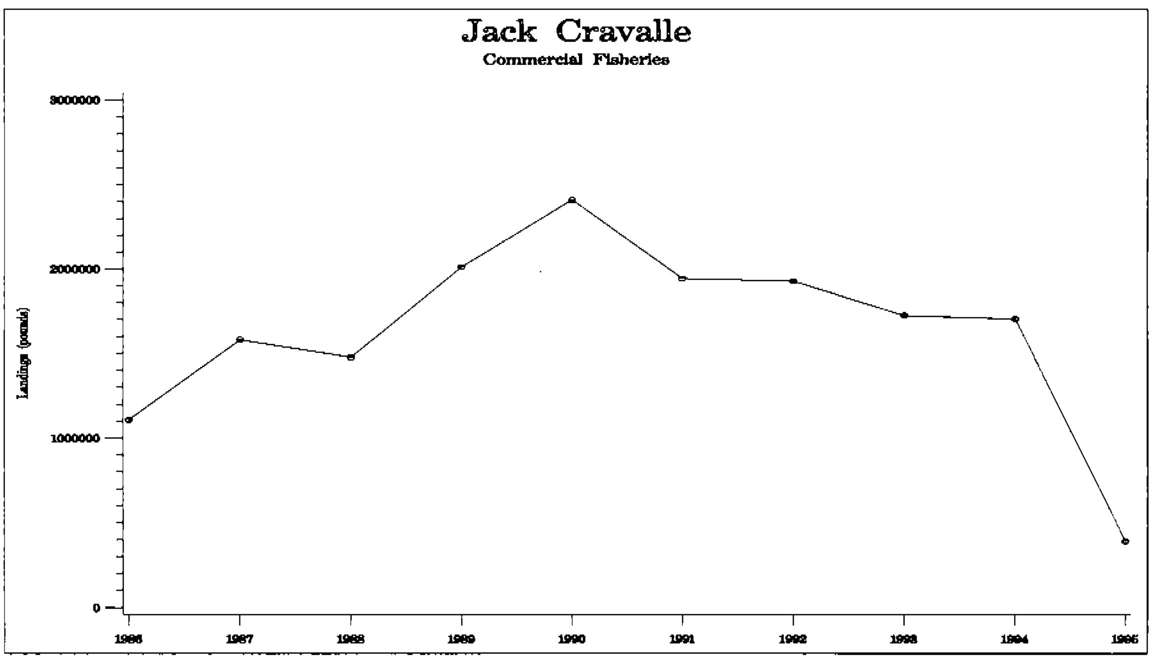
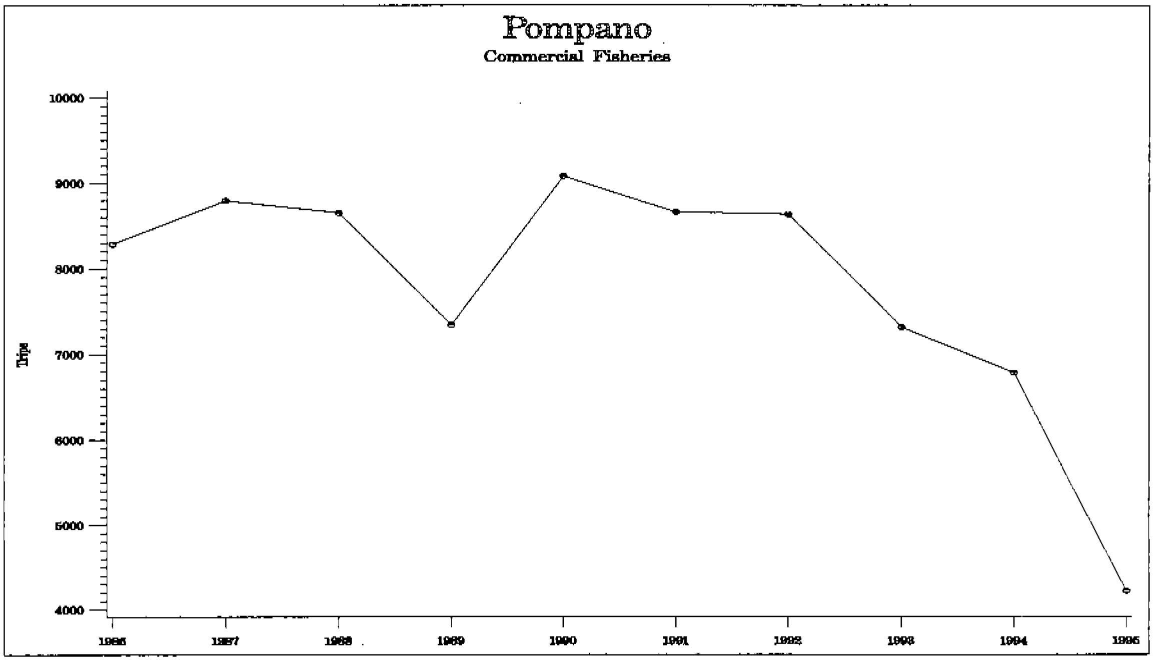


Figure 10-8. Number of trips and landings of jack cravalle from the west coast of Florida.



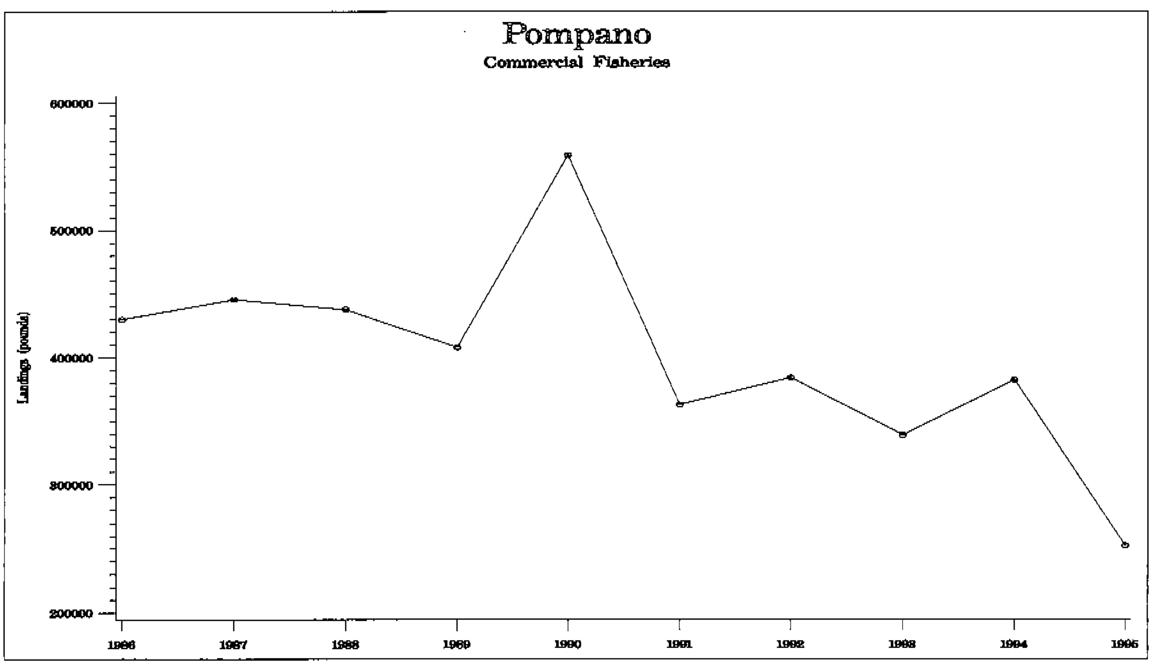


Figure 10-9. Number of trips and landings of pompano from the west coast of Florida.

10.1.2 Marine Mammals and Other Large Vertebrates

There are two important marine mammals that inhabit the Charlotte Harbor NEP study area, the manatee and the bottlenose dolphin. The following summarizes information on the distribution and abundance of these species in the Charlotte Harbor NEP study area.

10.1.2.1 Manatees

Manatees have been found in estuaries of the Charlotte Harbor NEP as long as records have been kept. The Charlotte Harbor estuarine complex is an important center of abundance for the Florida manatee. There are three species of manatee in the genus *Trichechus*. Only one species occurs in Florida and it is recognized as a valid subspecies *Trichechus manatus latirostris*. There are morphological differences with the West Indian subspecies (Domning and Hayek, 1986). A biological basis for restricted gene flow (breeding of the two subspecies) may be a result of the barrier of cooler waters of the western Gulf of Mexico shoreline and the strong northward flow of the Florida Current through the Straits of Florida, both limiting exchange of individuals from each population.

In the United States, the Florida manatee is considered an endangered species and was placed on the list in 1973 (USFWS, 1989). Knowledge of critical habitats is essential to protecting this species. The Florida manatee ranges as far north as Virginia and as far west as Mississippi or Louisiana during warm summer months. Manatees inhabit bays, estuaries, rivers and coastal areas where seagrasses and other vegetation are common. They rarely travel through deeper waters and generally use such water only as routes between coastal regions (Hartman, 1979).

A brief synopsis of the natural history of manatees is taken nearly verbatim from the Tampa Bay NEP Technical Publication #10-92 *Synthesis of Basic Life Histories of Tampa Bay Species* (Killam et al., 1992) and is in a smaller font.

Life History (Modified from NEP Tech Pub 10-92)

Hartman (1979) investigated the life history of the manatee near Crystal River, FL. Manatees of both sexes reach maturity at ages of 6-10 years and approximately 2.5 to 2.7 meters in length. The manatee gestation period lasts approximately 12-13 months and usually only one calf is born; however, they may have twins. Calves are born primarily during spring and summer months and may stay with the females for one to two years. Female manatees produce calves every two to five years. Manatees are long-lived and may exceed fifty years of age (Hartman, 1979).

Manatees are resident along the central part of the west coast of Florida in semi-isolated populations that are concentrated in rivers and estuaries that are of suitable depth and provide an adequate source of food and freshwater (Reynolds and Odell, 1991). In Lee County, the largest concentration of manatees is found in the upper tidal reaches of the Caloosahatchee River near the Orange River and the warm water outflow of the Florida Power & Light (FPL) power generating plant. Some studies have documented seasonal movements of manatees along the west coast of Florida (Lefebvre and Frohlich, 1986; Weigle *et al.*, 1988).

Ecological Role (Modified from NEP Tech Pub 10-92)

The Florida manatee is an opportunistic herbivore, feeding on a wide variety of plants, both aquatic and terrestrial, fibrous and nonfibrous and vascular and nonvascular (Hartman, 1979). In saltwater, manatees feed primarily on several species of seagrasses, including turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*). They may also eat some species of algae, mangrove leaves, and red mangrove seedlings. In freshwater, manatees feed on a variety of plants including *Hydrilla verticillata*, *Vallisneria*, *Eichornia*, *Paspalum*, and algae (Reynolds and Odell, 1991; Hartman, 1979; Bengtson, 1981).

Some studies have suggested preferences for specific seagrasses. Hartman (1979) reported that manatees appeared to favor *Syringodium* where it grew in mixed stands of *Thalassia*. On the east central coast of Florida, manatee distribution data showed a positive correlation with *Syringodium* and *Halodule* and a negative correlation with *Caulerpa prolifera,* an attached macroalgae (Provancha and Hall, 1991). These authors reported that this pattern suggested a selection for these seagrass dominated areas for feeding or potentially an avoidance of the areas containing large amounts of *Caulerpa.*

Hartman (1979) mentioned that manatees may supplement their diet by feeding on macroalgae in areas where other vegetation was sparse. Manatees have been observed feeding on marine algae at the mouth of the Alafia River, and similar algae may be an important food source for winter manatee populations in Lee County.

Contaminants (Modified from NEP Tech Pub 10-92)

Some information was available to document contaminant concentrations in manatee tissues. O'Shea *et al.* (1984) reported that copper buildup may result from feeding on vegetation in areas where copper based herbicides have been used to control aquatic vegetation. Copper residue concentrations in livers of manatees from high copper herbicide use areas near Crystal River (Citrus, Dixie, and Levy Co.) were greater than from medium (Brevard and Dade Co.) or low copper use areas (Broward, Collier, Hillsborough, Lee, Martin, Monroe and Palm Beach) (O'Shea *et al.* 1984). These authors reported that since high copper concentrations have been linked to toxic effects in domestic mammals, it may also be harmful to manatees and the use of copper-based aquatic herbicides should be carefully managed in freshwater areas used intensively by manatees such as the upper reaches of the Caloosahatchee River.

Analysis of blubber samples from 26 manatees indicated that these animals are relatively free from contamination by organochlorines. Five of 26 samples contained detectable residue concentrations of the metabolites of DDT (mean =0.19±0.10 ppm DDTR; range=0.14-0.28 ppm). Dieldrin was detected in 4 of 26 samples (mean=0.26± 0.10 ppm; range=0.12-0.36), and PCB's were detected in 13 of 26 individuals (mean=1.4±1.1 ppm, range = 0.50-4.6), primarily from urbanized northeast Florida (lower St. Johns River and Brevard County) (O'Shea *et al.* 1984). Low levels of these contaminants are most likely a result of the unique food habits and the well known findings of decreased exposure to these substances lower (e.g., herbivores) in the food chain.

Environmental Requirements (Modified from NEP Tech Pub 10-92)

Environmental requirements of the Florida manatee have been fairly well documented in Florida. Three critical manatee requirements include: warm water in the winter months, fresh water, and abundant seagrasses for food (Reynolds *et al.*, 1992). Specific requirements and limiting factors will be discussed in the following sections.

- Salinity

Access to fresh water is an important aspect of manatee distribution in Florida (O'Shea and Kochman, 1990). Manatees are frequently seen in areas where rivers, drainage canals, sewer outfalls, or other sources of fresh water predominate. Manatees move freely between fresh and salt water, although they prefer waters with salinities less than 25 ppt (Hartman, 1979).

Throughout the range of this species, presence in strictly marine habitat (salinities > 30 ppt) is not common (Lefebvre *et al.*, 1989; cited from O'Shea and Kochman, 1990). It is likely that for reasons of metabolic economy, manatees prefer to occupy habitats where osmotic stress is minimal or where periodic freshwater drinking is feasible (O'Shea and Kochman, 1990); they can, however, persist for periods in salt water . Manatees can live indefinitely in fresh water, however, the maximum duration in salt water is not known. They require fresh water for drinking (Reynolds and Odell, 1991; Reynolds *et al.*, 1992). Therefore, it appears that while the Florida manatees can tolerate a wide range of salinities, they will need access to areas of fresh water.

Natural freshwater sources in Lee County include most of the larger creeks and rivers. Artificial sources include the treated wastewater effluent sites in the Caloosahatchee River and many drainage and residential canals.

- Temperature

Manatee distribution is affected by seasonal temperature changes. In response to water temperature declines, the population shifts to warmer waters. During winter months manatees congregate at natural warm water springs on the Gulf coast and in regions of warm water discharges from power and other industrial plants (Reynolds and Odell, 1991). Reynolds *et al.* (1992) used aerial surveys to document seasonal distribution patterns of manatees in Tampa Bay. Manatees aggregated at warm water discharges from December-February (and to a lesser extent in adjacent months) and then dispersed to other areas. The FPL power plant warm water discharge into the Calossahatchee River has been examined as part of the winter census taken by FDEP (Frohlich *et al.*, unpublished). During warm months, manatees are found in many areas. Lower manatee counts occurred in known areas of dense winter aggregations during summer months, although these may have reflected seasonal differences in visibility rather than emigrations of manatees from the survey area.

It appears that manatee thermal neutrality reaches a lower limit in a range of 68-75 F (20-24 C), and when ambient water temperatures remain consistently below 68 F (20 C), manatees move to sources of warm water (Hartman, 1979; Bengston, 1981; Irvine, 1983; cited from O'Shea and Kochman, 1990). Hartman (1979) observed manatees feeding casually in lower Tampa Bay in water as cold as 66 F (19 C) and reported that they endure water temperatures at least as cold as 56 F (13.5 C). Thermal stress from prolonged exposure to cold water temperatures can result in manatee mortalities (O'Shea *et al.*, 1985). Five manatees were killed in Charlotte Harbor, FL when water temperatures dropped from 68EF (20 C) to 46 F (8 C) during a winter freeze in 1940 (Cahn, 1940). Over 50 manatee deaths occurred in Florida during the harsh winter freezes in December 1989 (FDEP, unpublished data) .

Manatees may find it more energetically advantageous to remain in warm water areas without feeding for up to a week rather than venturing into colder waters for food (Bengtson, 1981). Warm water refuges in Lee County include the FP&L plant with a cooling intake on the Caloosahatchee River and discharge into the Orange River (Packard *et al.*, 1984). Secondary treated waste water discharged to the Caloosahatchee River may also serve as warm water refuges as do some deeper quiet saltwater canals. When the FP&L power plant was down for repairs in January 1985, many manatees congregated at the Franklin Locks (Packard *et al.*, 1985).

Irvine and Campbell (1978) report that the impact of artificial warm water sources on manatee survival and winter distribution is unknown. The suitability of artificially warmed habitats has been questioned. Increased availability of these warm water sources may have altered historic winter distribution patterns of manatees by diverting animals from southward winter migrations (Campbell and Powell, 1976). In addition, the FP&L plant is not located where there is immediate access to a plentiful supply of food in the winter, although, *Vallisneria* has appeared recently over large areas of shallow water above and below the old U.S. 41 (Edison) bridge.

- Water Depth

Hartman (1979) reported that the range of the manatee on the east and west coasts of Florida is delimited by shallow water. In the Crystal River area, manatees carried out most of their activities in water two to three meters deep and normally traveled via waterways that were at least two meters deep. Flats and shallow areas that were less than one meter were avoided unless immediately adjacent to deeper water. In Tampa Bay, manatees were observed to favor water 1.5-2.0 m deep (Hartman, 1979). Tracking data in Lee County by FDEP suggests similar behavior.

Minimum available water depths for manatees will be a function of tides, but any water with seagrasses less than 1.5 feet deep at low water may rarely, if ever, have manatees present. The maximum annual astronomical tidal range for Lee County is about 3 feet. These tides usually occur in June. The average annual range (the difference between mean high water and mean low water) is about 1 foot in Lee County. There is a strong seasonal difference between the absolute heights of the high tides in the winter and summer. Access to shallow water is more restricted in the winter because the high and low tides are .5 to 1 foot lower than in the summer.

- Structural Habitat

Manatees inhabit bays, estuaries, rivers and coastal areas where seagrasses and other vegetation are common (Reynolds and Odell, 1991). Rather than any single environmental requirement other than minimum temperatures being critical to manatee survival in Florida, the interaction availability of aquatic vegetation, proximity to channels of at least 6 feet in depth and sources of freshwater probably best describe the critical combination for viable habitat.

Manatee Distribution Within the Charlotte Harbor NEP

Ackerman (1995) gives the dates and general area which were surveyed by airplane for southern Sarasota, Charlotte, and Lee counties. Ackerman is cautious when discussing the state-wide manatee population trend even though estimates have risen from about 700-800 in 1976 to 1,856 in 1992. In 1985, the minimum population estimate was about 1,200. This is because different areas were surveyed some times, surveys were sequential and then later synoptic. The latest unpublished estimates in 1995 were over 2,300.

A summary of information about the manatees in the Charlotte Harbor complex was provided by Koelsch and Pitchford as part of the symposium of the Charlotte Harbor NEP (1997). The 1984-1988 aerial survey data (Koelsch and Pitchford, 1997, Fig. 4) suggests that manatees use nearly all of the estuarine complex with some notable gaps in Pine Island Sound, open deeper water and the beaches. Calf numbers from aerial counts over time suggest a decline may have occurred in specific areas (Koelsch and Pitchford, 1997, Table 2; Reynolds and Wilcox, 1994).

FDEP unpublished quarterly aerial surveys for 1994-1995 and 1997 of Lee County suggest that minimum numbers from "good" survey conditions can vary from 97 to 236 and averaged 146 over

FDEP unpublished quarterly aerial surveys for 1994-1995 and 1997 of Lee County suggest that minimum numbers from "good" survey conditions can vary from 97 to 236 and averaged 146 over 21 sampling dates. Four synoptic winter survey dates ranged from 236 to 411 and averaged 286. The greatest number of manatees found in Lee County during FDEP surveys was 469 on January 10, 1996. On January 9, 1996, 434 manatees were in the vicinity of the FP&L power plant (Reynolds, 1996). Thirty-nine of these individual were identified as calves.

Previously, the most detailed description of manatee abundance and distribution in Lee County was an unpublished manuscript by Frohlich *et al.* They reported data obtained from twice-monthly flights from January 1984 - December 1985. An average of 58 manatees (range of 14-338) were observed during this study. The apparent high count of 338 manatees in the Caloosahatchee and Orange rivers was observed on 29 January 1985 (Packard *et al.*, 1989). Based on the aerial survey the annual use (distribution) of various water bodies was: Caloosahatchee River (including Orange River) 63%, Matlacha Pass 13%, Estero Bay 8%, Pine Island Sound 8%, and San Carlos Bay 7%. Frohlich *et al.* noted a strong seasonal difference in area of occurrence between winter (December - February) and summer (June - August):

	Winter	Summer
Caloosahatchee River	80%	45%
Bays	20%	55%

The VHF tracking data and the aerial survey data available in a GIS format show overall distribution and use of Lee County waters. One area on the western side of Pine Island above Regla Island extending to Part Island in Pine Island Sound appears to be used very little, if at all by manatees. The principal reason may be the prevalence of water less than three feet (Frohlich *et al.*). Matlacha Pass is a high use area by manatees. The Pass is a manatee travel corridor between Charlotte Harbor and the Caloosahatchee River or other locations. Frohlich *et al.* describe Matlacha Pass as being most heavily used by manatees in the summer and fall months. Estero Bay and Pine Island Sound had higher use in the summer and fall months.

Manatee Die-off Events in the Charlotte Harbor NEP

The 1982 natural death data provide some unusual information as the result of a high number of deaths which occurred in the winter. The dinoflaggelate which causes "red tide" appeared to be concentrated in small solitary filter-feeding tunicates of the family Mogulidae. Manatees were ingesting these tunicates while grazing for food near the mouth of the Caloosahatchee River (Buergelt *et al.*, 1984). Thirty-seven manatees died in this manner between February and April of 1982 (O'Shea *et al.*, 1991).

Another, more deadly natural event occurred in the late winter and spring of 1996 in the Charlotte Harbor area with the death of about 103 manatees being attributed to red tide (Koelsch and Pitchford, 1997). Cause of death was attributed to red-tide toxicity based on the body burdens. No "poison pills" were identified to suggest that the toxic vehicle was food.

Severe cold fronts can cause increased mortality (Ackerman *et al.*, 1995). Four events in 1977, 1981, 1984, and 1990 have killed 30-56 manatees state-wide since detailed records began in 1974. Long-term exposure to low temperature can also lead to death (Buergelt *et al.*, 1984; O'Shea *et al.*, 1985). These deaths have been treated in three different categories over time by FDEP (Ackerman *et al.*, 1995, see table 7).

General Mortality in the Charlotte Harbor NEP

Understanding where and how the Florida manatees die is very important to the determination of management goals and implemented programs. Data were obtained from FDEP for the State from 1974 through July 1997. Data collection began about 1974 along the west coast of Florida by Federal and State agencies. The first recorded under this program in Lee County occurred in 1975 (Table 10-6). Lee County leads the west coast of Florida in total number of manatee deaths and is much higher than Charlotte or southern Sarasota county (Tables 10-7 and 10-9). Lee County has the highest watercraft-related mortality in the Charlotte Harbor NEP (Table 10-9) despite having speed zones in the Caloosahatchee River since 1989.

Seasonal variations in overall mortality is higher in the winter-spring (54.3% January - April) (Table 10-7). In Lee County, 44.9% of manatee deaths occurred during these months (Table 10-7). The contrast between Lee County and Charlotte County is stark given the shared portions of the estuarine complex.

Perinatal deaths have a strong seasonal component with May through August representing 54.6% of all perinatal deaths. In all but a few cases, these perinatal individuals were found in sheltered waters. Deaths due to natural causes are extremely skewed to the winter-spring months (73.9%) when compared with the summer months (Tables 10-7 and 10-8).

These statistics suggest that Lee County manatee deaths represent a significant portion of all state-wide and west coast deaths. Within Lee County, the Caloosahatchee River and Estero Bay consistently stand out as the most common areas for finding dead manatees. Seasonal variations in these two water bodies show a strong January - May component for both total and watercraft-related deaths.

The State of Florida prohibited the hunting or killing of manatees in 1893. Manatees have received significant attention in Florida as the result of recent efforts by the State of Florida to expand protective speed limits in 13 counties. The Florida Manatee Recovery Plan (1989) suggests the historical winter boundary to be restricted south of Charlotte Harbor along the west coast.

The cooperative State-County speed limit programs are a part of the long range recovery goal required by the Marine Mammal Protection Act of 1972. The first local governmental efforts to locally protect manatees began in March 1979 with a vessel speed zone in the Orange River and

Table 10-6. Frequencies of apparent causes of manatee deaths for Sarasota (Venice south and Myakka River), Charlotte, and Lee Counties from 1975 through July 1997. Data taken from information provided by the FDEP.

Year	Death Categories					
	Watercraft	Other Human	Perinatal	Natural	Undetermined	Total
1975	0	0	1	0	1	2
1976	2	0	2	0	2	6
1977	2	0	3	0	11	16
1978	2	0	0	2	5	9
1979	0	1	1	2	2	6
1980	2	0	2	1	2	7
1981	4	1	3	4	7	19
1982	3	0	1	39	12	55
1983	2	1	4	3	6	16
1984	3	0	6	4	12	25
1985	5	0	4	4	5	18
1986	4	0	2	1	11	18
1987	5	0	3	1	6	15
1988	8	0	6	2	7	23
1989	4	1	5	5	15	30
1990	7	0	9	8	11	35
1991	9	0	7	2	7	25
1992	2	1	5	3	11	22
1993	7	1	7	5	4	24
1994	12	1	11	8	13	45
1995	12	1	11	11	10	45
1996	15	0	10	67	84	176
1997	4	0	5	4	5	18
Total	114	8	108	176	249	655

Table 10-7. Frequencies of manatee deaths for Sarasota (Venice south and Myakka River), Charlotte, and Lee Counties from 1975 through July 1997 by month. Data taken from information provided by FDEP.

Month	County			
	Charlotte	Lee	Sarasota	Total
1	14	54	1	69
2	7	58	1	66
3	18	114	4	136
4	14	68	3	85
5	4	37	4	45
6	4	28	10	42
7	7	24	5	36
8	7	28	3	38
9	9	22	5	36
10	2	28	2	32
11	4	28	2	34
12	5	29	2	36
Total	95	518	42	655

Table 10-8. Frequencies of apparent causes of manatee deaths for Sarasota (Venice south and Myakka River), Charlotte, and Lee Counties from 1975 through July 1997 by month. Data taken from information provided by FDEP.

Month	Death Categories					
	Watercraft	Other Human	Perinatal	Natural	Undetermined	Total
1	10	1	3	23	32	69
2	7	1	2	26	30	66
3	12	0	8	58	58	136
4	15	1	8	32	29	85

Table 10-8. Frequencies of apparent causes of manatee deaths for Sarasota (Venice south and Myakka River), Charlotte, and Lee Counties from 1975 through July 1997 by month. Data taken from information provided by FDEP.

Month	Death Categories					
	Watercraft	Other Human	Perinatal	Natural	Undetermined	Total
5	14	0	12	7	12	45
6	8	0	18	2	14	42
7	9	1	16	3	7	36
8	13	0	13	2	10	38
9	6	3	9	1	17	36
10	6	0	9	5	12	32
11	7	1	5	5	16	34
12	7	0	5	12	12	36
Total	114	8	108	176	249	655

Table 10-9. Frequencies of apparent causes of manatee deaths for Sarasota (Venice south and Myakka River), Charlotte, and Lee Counties from 1975 through July 1997. Data taken from information provided by FDEP.

County	Death Categories					
	Watercraft	Other Human	Perinatal	Natural	Undetermined	Total
Charlotte	21	1	10	27	36	95
Lee	88	7	90	138	195	518
Sarasota	5	0	8	11	18	42
Total	114	8	108	176	249	655

portions of the Caloosahatchee River. In December 1989, Lee County's Caloosahatchee River vessel speed zone plan to protect manatees became effective (Lee County Ordinance 89-39, FDEP Rule 16N-22.005). Lee County and the State have been working on a county-wide manatee plan for the past four years.

The City of Punta Gorda published a manatee protection plan in March 1995. A speed zone plan became effective with city ordinance 1149-96 in April 1996. Charlotte County has no manatee protection plan. The City of Sarasota's speed zone plan became effective with the State Rule. There is no companion county ordinance.

Long-term changes in winter habitat management may be considered to further separate manatees from boats. Such changes could include:

> 1) Long-term increase and maintenance of available aquatic vegetation in the vicinity of any winter warm water refuge. Food sources close to refugia will reduce the length of foraging trips. Light penetration appears to be an important water quality variable and could be related to excessive water discharged from Lake Okeechobee or other partially controlled systems.
>
> 2) A risk assessment of expected changes in total manatee mortality following removal of the FP&L discharge and other warm-water sources to encourage manatees to winter farther south in the Everglades National Park rather than in a busy, federally maintained waterway (Lake Okeechobee and the East Coast of Florida).

10.1.2.2 Bottlenose Dolphin

Bottlenose dolphins are present throughout the Charlotte Harbor NEP estuaries. The National Marine Fisheries Service (NMFS) has supported programs for monitoring of bottlenose dolphin stocks in southeastern U.S. waters, designed to detect major changes in the stocks. Charlotte Harbor and Pine Island Sound have been of interest to management agencies at least in part because of the use of this region from the 1960's through the 1980's for commercial dolphin collection. In addition to those removed by several active collectors prior to regulation under the Marine Mammal Protection Act of 1972 (R. Wells, pers. obs.), 43 dolphins were collected from these waters during 1973-1988 (Scott, 1990). All of the information present here is based directly on two studies by Wells et al. (1996) and a draft manuscript.

Data are available for inshore waters from Lemon Bay southward to northern Pine Island Sound on the central west coast of Florida. During August of each year from 1990 through 1994, an average of about 308 dolphins used the Charlotte Harbor study area. The number of dolphins increased from a range of 198 to 369 individuals (95% confidence limits) during 1990-1992 to a range of 315 to 463 individuals during 1993-1994. Part of this increase appeared to be due to an increase in reproduction. An increase in the proportion of calves in the observed populations from 0.120 in 1990 to 0.210 in 1993 and 1994 suggests a successful recruitment of many of the young-of-the year.

Evidence from the high proportion of animals present in multiple years and the absence of documentation of unidirectional movements between Charlotte Harbor and other adjacent and distant contiguous study areas along the central west coast of Florida indicate that permanent immigration and emigration appear to be rare events. About 9% of the dolphins appeared to be transients. Immigration, emigration, and transience are not major influences on the number of animals present at any given time, but they may be important ecologically by providing a means of genetic exchange between populations, as demonstrated for the Sarasota dolphin community and for Tampa Bay. A meaningful mortality rate could not be estimated, but stranding data mirrored patterns of mortality reported from other parts of the central west coast of Florida during the same period.

Aerial surveys to estimate bottlenose dolphin abundance in Charlotte Harbor have been conducted on four occasions since 1975: by Odell and Reynolds (1980) during 1975-76, and by the National Marine Fisheries Service during 1980-81, 1983, 1986, and 1994 (Thompson, 1981; Scott *et al.*, 1989; Blaylock *et al.*, 1995). The aerial survey study area included Charlotte Harbor Proper, as well as Pine Island Sound to the south, and Gasparilla Sound to the north. The results of these surveys are summarized in Table 10-10.

Table 10-10. Summary of bottlenose dolphin abundance estimates from aerial surveys of Charlotte Harbor and Pine Island Sound from 1975 through 1994.

Year	Season	Number of Dolphins (95% Confidence Limits)	Data Source
1975-76	All	64 (10-118)	Odell and Reynolds (1980)
1980	Summer	189 (3-375)	Thompson (1981)
	Autumn	157 (0-611)	
	Winter	434 (159-709)	
	Spring	191 (51-331)	
1983-86	Summer	206 (135-277)	Scott et *al.* (1989)
	Autumn	117 (77-157)	
	Winter	378 (244-512)	
1994	Autumn	209	Blaylock *et al. (1995)*

The natality rate, or the proportion of dolphins considered young-of-the-year, varied during the course of the surveys. An annual estimates of 7-17 young of-the-year have been derived for the Charlotte Harbor study area.

There were 116 records of stranded animals from South Sarasota, Charlotte, and Lee counties from 1979-1994; 70 of these records were from 1990 to 1994. A mortality rate was not calculated because of the bias associated with an increase in stranding response effort since the mid-1980's. Coastal development and boating activity on Charlotte Harbor waters have also increased dramatically, possibly contributing to the discovery of carcasses in previously isolated areas. However, there are still many remote and inaccessible areas within Charlotte Harbor where carcasses are unlikely to be found. All these factors confound determination of the actual number of strandings and make it impractical to calculate a mortality rate based on stranding records alone.

All available data indicate that permanent immigration and emigration were rare occurrences. None of the more than 900 dolphins identified from Sarasota Bay (1975-1994) and Tampa Bay (1975-1993), the adjacent waters to the north, nor the 272 dolphins in photographs provided by the Pine Island Sound study area immediately to the south, were identified as immigrants to the Charlotte Harbor area during the study. Conversely, none of the 411 dolphins identified from Charlotte Harbor waters during 1990-1994 were observed to take up residence in Sarasota Bay or Tampa Bay.

Residency in portions of the Charlotte Harbor study area was suggested by repeated sightings of some individuals in the same waters over multiple years (Table 10-11). Sixteen of the 411 dolphins in the catalog (3.8%) were also seen in the area prior to the initiation of the surveys in 1990. Twelve

Table 10-11. Number of dolphins (% in parentheses) in the catalog of a given year (bold) that were identified in previous or subsequent years. Dolphins identified in only a single survey year were considered "transients".

Year	1990	1991	1992	1993	1994
1990	**209**	106 (51%)	94 (45%)	108 (52%)	112 (54%)
1991	106 (60%)	**178**	82 (46%)	94 (53%)	105 (59%)
1992	94 (57%)	82 (50%)	**165**	102 (62%)	106 (64%)
1993	108 (50%)	94 (43%)	102 (47%)	**218**	148 (68%)
1994	112 (46%)	105 (43%)	106 (44%)	148 (61%)	**243**
Average	53%	47%	46%	57%	61%
No. of Transients	25 (12%)	18 (10%)	6 (4%)	15 (7%)	34 (14%)

of these were first identified during 1982 -1984. Twenty-seven dolphins (6.6%) were identified from the Charlotte Harbor study area during all five of the survey years; 97 (23.6%) were seen during at least four of the five survey years. During August of each year from 1990 through 1994, an average of about 308 dolphins used the Charlotte Harbor study area.

10.1.2.3 American Crocodile

The American crocodile (*Crocodylus acutus*) occurs primarily in coastal mangrove swamps and rivers in extreme southern Florida, which is the northern extent of the range. The American crocodile is a tropical species and climate appears to be the primary factor affecting crocodile distribution in southern Florida. The species is considered endangered by FGFWFC as well as the U.S. Fish and Wildlife Service (USFWS).

On Florida's east coast, Southern Biscayne Bay in Dade County appears to be the species northern limit, although individual crocodiles occasionally wander farther north. On the west coast of Florida, crocodile sightings have been rare. Historical sightings have been as far north as Pinellas near Tampa, and crocodiles still occur as far north as Sanibel Island in Lee County. Observations suggest that the west coast of Florida has been part of the overall range since the 1940's, but it is likely that most sightings are of transient or isolated individuals and not of breeding populations. Dr. Frank Mazzotti, the Extension Wildlife Scientist at the Broward County Extension Office in Davie, Florida, and leading researcher in crocodiles, indicates that crocodiles are regularly seen in southwest Florida around Estero Bay and Pine Island Sound. A non-viable nest was discovered on Sanibel Island in the summer of 1995 (Mazzotti, pers. comm.). The current breeding range of the American crocodile, however, is concentrated on the east coast of Florida including the mainland shoreline from southern Biscayne Bay (Turkey Point) west to Cape Sable, as well as North Key Largo and some of the islands in Florida Bay.

The American crocodile is largely confined to coastal estuarine swamps or landlocked saline lakes in the southern part of the Florida peninsula. The crocodile appears to prefer relatively deep estuarine habitats that are protected from wind and wave action. Banks that provide basking sites close to deep water are characteristic of crocodile habitat. American crocodiles seldom prey on anything larger than raccoon, rabbit or wading bird. The diet consists primarily of crabs, fish, snakes, turtles, birds and small mammals. Courtship behavior occurs in late January and February and peaks 6 to 8 weeks before nesting. Nesting occurs around the end of April and the beginning of May and eggs hatch in late July or early August. Nesting usually occurs in sand, marl, peat or rocky spoil. Crocodiles are shy and reclusive and easily disturbed by human activity. Disturbance at nest sites can cause females to abandon the site and change nesting sites in subsequent years.

Management measures for this species are not well-defined because of lack of information. Beyond current State and Federal protection, probably the greatest benefit comes from public information programs to increase public tolerance of large, breeding-size individuals and to reduce accidental mortality.

10.1.3 Benthos

The benthic communities of the open waters, bays, and riverine areas of Lemon Bay, Gasparilla Sound, Charlotte Harbor, the Peace and Myakka Rivers, Pine Island Sound/Matlacha Pass, the Caloosahatchee River, and San Carlos and Estero Bays are comprised of organisms represented by numerous genera from a number of key phyla. Other than tunicates, these groups are invertebrates.

10.1.3.1 Ecological role

Almost all of these species begin their life-cycles as members of the zooplankton, with their location within the estuary being dependent for the most part on physical factors that include currents, wind, and tides. During this stage of their life-cycles some of these organisms graze or filter-feed on the phytoplankton assemblages and other particulate matter also suspended within the water column. Still others are voracious predators of smaller members of the zooplankton communities. Irrespective of the primary food source, the growth and success of these benthic species are directly linked to the cycle of nutrients entering the estuaries. At some point, reacting to species dependent keys, these organisms descend to the bottom to start or begin transformation to the adult phase of their life-cycles. Success at this stage is critical to their settling in the proper type of habitat. This is especially true for species, such as oysters, barnacles and tunicates, which require hard substrate to complete their life cycles.

Upon reaching their adult phase, benthic organisms can be further divided into two groups depending on their relation to the substrate. Infauna include all those species which live within the substrate, while epifauna describes the structural niche of those species which live attached to or travel over the bottom. As adults, many of these species filter-feed on the bacterial, phyto-, and zoo-components of the plankton. Others feed on detrital materials either from the water column, along the surficial component of the sediments, or within the sediments. Beyond these species, which are directly connected to primary production, are the predatory members of the benthic communities.

Benthic organisms play an important role in these estuarine ecosystems in providing key linkages between primary producers and higher trophic levels, which include many commercially and/or recreationally important fishes. It is upon this basis that many of these taxa have been identified and used as keystone or indicator species in programs designed to monitoring estuarine systems and identify areas where potential anthropogenic impacts may be occurring. In the estuarine areas within the Charlotte Harbor NEP only a few such studies have been conducted either synoptically over wide areas or over long time periods. Taylor (1974) noted that "there has been no systematic study of invertebrates throughout the Charlotte Harbor region." Since that time there have been only a few notable additions to our knowledge of Charlotte Harbor invertebrates.

Between 1976 and 1982 EQL (1982) collected monthly trawls at twenty-four locations in Charlotte Harbor between the lower Peace River and Cape Haze for the sea star *Luidia clathrata* and ponar grabs six times yearly at fourteen locations in upper Charlotte Harbor/lower Peace River for a series of fourteen selected indicator species. Probably the most comprehensive investigation on benthic communities within the Charlotte Harbor NEP was a study of core samples taken both in the spring and late summer of 1980 by Mote Marine Laboratory (Estevez, 1986) at a total of twenty-five intertidal and subtidal stations covering: the lower Peace and Myakka Rivers; Charlotte Harbor, Pine Island Sound/Matlacha Pass; and San Carlos Bay. The findings of this study indicated that bottom sediments were in general similar throughout the area. Exceptions were the occurrence of much coarser sediments near the passes and higher organics near the mouths of the rivers. Not surprisingly they found the number of taxa increasing toward higher salinities, while the densities of organisms were the greatest in the organic sediments near the rivers.

10.3.1.2 Economically Important Species

Beyond their importance as key links between phytoplankton and detrital estuarine production and fishes, a number of benthic taxa are themselves recreationally and commercially important. In the estuarine areas of the Charlotte Harbor NEP such species include pink shrimp, blue crabs, American oyster, hard clams, and scallops. The following describes the life history, environmental requirements, distribution, and abundance of these species.

Pink Shrimp

Pink shrimp (*Penaeus duorarum*) are the only commercially important shrimp species which make up Florida's largest fishery (Figure 10-10). White and brown shrimp occur along the northeast coast of Florida and the panhandle, but not the west Gulf Coast. Due to gear size regulation, pink shrimp are not fished, other than as bait shrimp, within the waters of the Charlotte Harbor NEP. However, the seagrass beds and other bottom areas of these estuarine areas function as important shrimp nurseries. Juvenile shrimp use such estuarine areas to feed and grow. Pink shrimp are omnivores feeding on a variety of plant and animal material. Juvenile and adult pink shrimp often feed on items such as dinoflagellates, nematodes, polychaetes, copepods, mysids, isopods, amphipods, mollusks, and other shrimp. Upon reaching sexual maturity, pink shrimp emigrate to deeper offshore waters to spawn.

Although there is some direct recreational shrimp fishing, there is a tremendous recreational use of smaller shrimp as bait. Pink shrimp are a common and important prey species for a great number of estuarine fish species. In addition, many diving and wading birds feed on shrimp whenever possible. Pink shrimp have even been identified as a prey item for bottle nosed dolphins. Pink shrimp are an important species in the movement of energy between trophic levels within estuarine communities. It has been suggested that changes in the aerial coverage and density of seagrasses caused by anthropogenic impacts can affect the success of juvenile shrimp within an estuary. Figure 10-10 presents the number of trips and estimated landings for pink shrimp as reported by FDEP's Florida Marine Research Institute.

Blue Crab

The blue crab (*Callinectes sapidus*) is an economically valuable (Figure 10-11) and ecologically important species throughout the Charlotte Harbor NEP estuarine areas. After the net ban, many local commercial fishermen moved to fishing for blue crabs. In addition, there is also a traditional recreational fishery, which on a statewide basis is third only to spiny lobsters and stone crabs (Bell, 1993). Ecologically, the blue crab is an important species because of its high abundance, omnivorous feeding habits, and its role as a key prey species for a number of upper-level predators. As larva in the zooplankton, blue crabs are a valuable prey for small fish of many species.

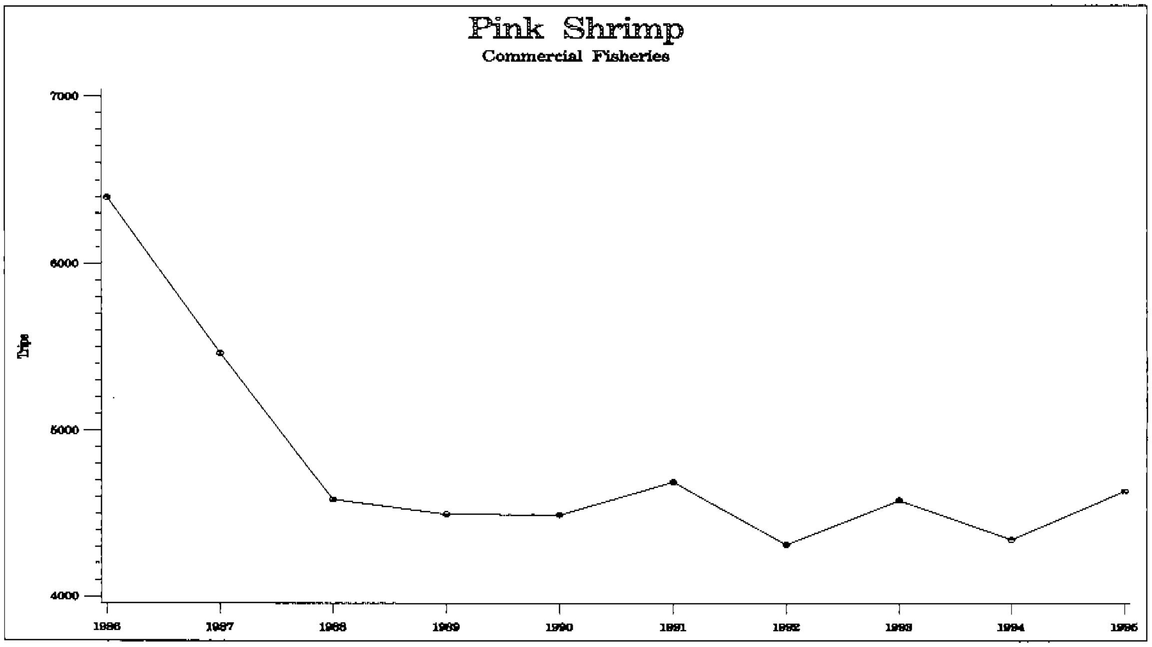
Juvenile and adult crabs are prey for several commercially and recreationally important fish species, including spotted seatrout, red drum, sheepshead, black drum, and tarpon. Mammalian predators include raccoons and otters, while small crabs are often preyed upon in the shallows by many of the wading birds. Blue crabs themselves are opportunistic feeders preying upon whatever food items are available. As such, blue crabs can play a major role in the transfer of energy within an estuary. Their feeding also makes them susceptible to many types of contamination, and a potential mechanism for the movement of such contaminants up the food chain.

American oyster

The distribution of American oysters (*Crassostrea virginica*) in the Charlotte Harbor NEP complex is generally widespread. Both live and dead oyster bars occur throughout the shallow bays and along inter- and sub-tidal regions near the mouths of many of the rivers and creeks within the Charlotte Harbor NEP (see Section 10.2.1.2, below). While there are no leased commercial beds within the Charlotte Harbor NEP, there is a limited amount of recreational use. However, even areas designated as approved shellfish waters are often closed during periods of high rainfalls due to excessive bacterial counts, or during red-tide blooms. The primary importance of oysters within the Charlotte Harbor NEP estuarine areas is primarily ecological. Oyster bars, whether alive or mostly dead, provide structural habitat which is important for many species. In some isolated areas with large living oyster bars, oyster filter-feeding can be an important factor in maintaining water clarity. Oyster larvae are important prey eaten by many species including crabs, fish and other mollusks.

Hard Clams

Historically southern quahogs (*Mercenaria* spp.) existed in great numbers along the lower Florida West Coast from Cape Romano southward through the Ten Thousand Islands. A sizeable fishery existed until the late 1940's when there was a dramatic decline. Within many of the more saline waters of the Charlotte Harbor NEP estuaries, there has always been a somewhat limited recreational



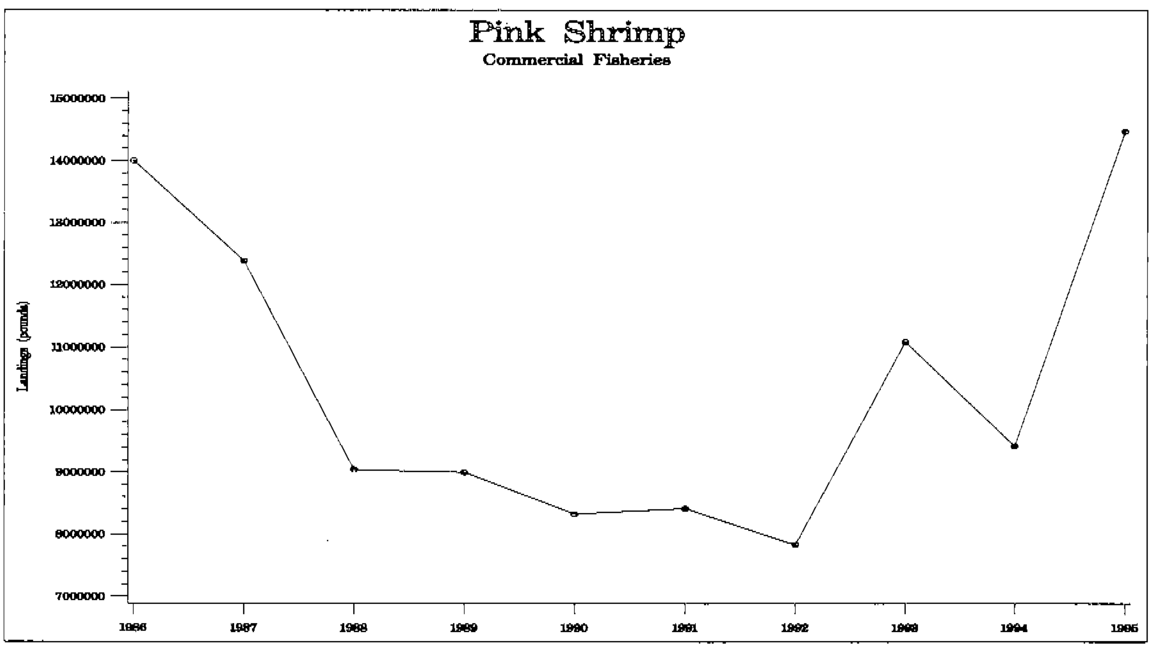


Figure 10-10. Number of trips and landings of pink shrimp from the west coast of Florida.

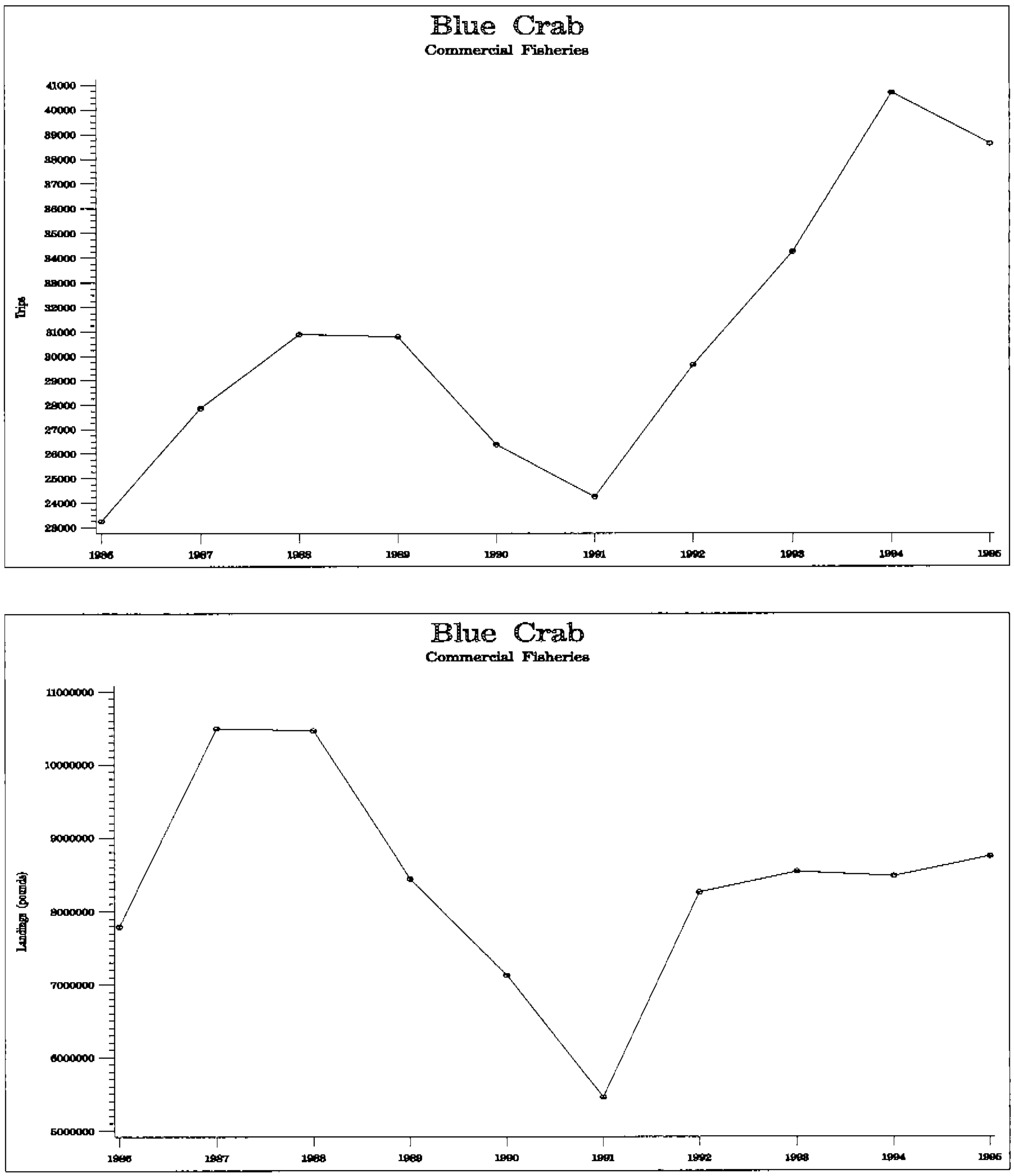


Figure 10-11. Number of trips and landings of blue crab from the west coast of Florida.

fishery. However, many of these areas are often closed because of water quality concerns. The net ban resulted in a renewed interest in the potential development of a commercial fishery. The State has leased, and is looking to expand, a number of sites for commercial clamming. As filter-feeders, clams are important components in the links between primary production and higher levels in the food-chain. A large number of species use clams as a prey species. Fish, wading birds, sea stars, crabs and other mollusks are all important predators on hard clams.

Southern Bay Scallop

The southern bay scallop (*Argopecten irradians concentricus*) historically supported considerable commercial and recreational fisheries along the southwest coast of Florida. In the early 1950's commercial landings in Lee County were between 10,000 and 120,000 pounds of meats. However, by the early 1960's Lee County commercial landings were near zero, and the species had all but disappeared from areas such as Tampa Bay. Although the exact causes of these marked declines are unknown, many have postulated that declining water quality may have been a prime factor. Of all the filter-feeding organisms within the Charlotte Harbor NEP systems, the southern bay scallop is far and away the most susceptible to poor water quality. Its relatively short life history and reproductive strategy make it particularly susceptible to rapid declines from areas. There is anecdotal evidence that the southern bay scallop continued to be a recreational species in limited areas during especially dryer years in Pine Island Sound and Estero Bay until the fishery was closed in the early 1990's. In the southern regions of the Charlotte Harbor NEP, it has been suggested that anthropogenic influences on not only water quality but on current patterns caused by activities such as increased navigational channels or the construction of causeways may have caused or been partially responsible for the observed declines. However, no systematic studies were conducted during the decline and there are very little historic water quality data from either Pine Island Sound or Estero Bay to support such contentions.

10.1.4 Birds

This section summarizes the life history and ecological significance of a number of important bird species. There are many birds that have special local significance in the Charlotte Harbor NEP area; the species discussed below represent a number of different types of environments and survival strategies. Birds representing wading and diving species, raptor species, and migratory species are included.

10.1.4.1 Diving and Wading Birds

Locations by county within the Charlotte Harbor NEP of wading bird colonies ranked in the top 100 sites in Florida for the years 1986-89 are listed in Table 10-12 . County distributions of selected colonial waterbirds in Florida, as determined by aerial and ground surveys in 1976-78 and 1986-89 ('+' = present during nesting season; '-' = presence not confirmed) are listed in Table 10-13.

Eastern Brown Pelican
(*Pelicanus occidentalis, carolinensis*)

The brown pelican, a Threatened Species, is a year-round resident of the southwest coast of Florida. These water birds are easily recognizable by their long, pouched bill. Although the males are slightly larger than the females the plumage is similar. Florida pelicans are divided into east and west coast populations. The species is highly gregarious, and is at ease around humans. It is a familiar sight in Florida to observe brown pelicans frequenting fishing piers and fish cleaning stations where scraps are available.

Distribution: Aerial surveys in Florida indicate a stable breeding population of 6,000 to 8,000 pairs exists within the state. Some of the largest breeding colonies of Brown pelicans in the Charlotte Harbor NEP area are mangrove islands in the lower Peace River, at the mouth of Shell Creek, in Gasparilla Sound, Pine Island Sound, and Estero Bay. Likely habitat areas for brown pelicans are mapped in Chapter 11.

Habitat: As it is the only pelican species that dives for its food, the brown pelican spends much time in open water habitats. Feeding occurs primarily in shallow estuarine waters with the birds seldom venturing more than 20 miles out to sea except to take advantage of especially good fishing conditions. Sand spits and offshore sand bars are used extensively for resting and nocturnal roosting areas. Brown pelicans nest primarily in mangrove trees from 2-35 feet above the high tide line. Preferred nesting sites are confined to coastal islands, which provide protection from mammal predators, especially raccoons, and sufficient elevation to prevent wide scale flooding of nests. Colonies may contain from 10 to 1500 pairs with a few hundred pairs occurring most commonly.

Ecological/Economic Significance: Other than the winter resident white pelican, the brown pelican is the sole representative of its family in Florida. As a top carnivore known to be sensitive to some forms of pollution, the brown pelican serves as an excellent indicator species for the quality of the marine-estuarine environment. The Florida adult population is presently stable, but many factors are in operation, including food source availability, habitat destruction, and water pollution that could change this status.

One factor that has been identified as an important local influence on brown pelican abundance is the availability of food. Reductions in brown pelican populations in some areas of Florida's west coast have been linked to drops in populations of sardines and other small finfish.

Table 10-12. County distribution of selected colonial waterbirds in Florida in 1976-78 and 1986-89 (+ = present during nesting season; - = not confirmed) (Rundle, 1991).

County and year	Great egret	Snowy egret	Cattle egret	Reddish egret	Great Blue Heron	Little blue heron	Tricolored heron
Charlotte							
1976-78	+	+	+	-	+	+	+
1986-89	+	+	+	-	+	+	+
DeSoto							
1976-78	+	+	+	-	+	+	+
1986-89	+	+	+	-	+	+	+
Hardee							
1976-78	+	-	+	-	+	+	+
1986-89	+	+	+	-	+	+	+
Lee							
1976-78	+	+	+	-	+	+	+
1986-89	+	+	+	-	+	+	+
Polk							
1976-78	+	+	+	-	+	+	+
1986-89	+	+	+	-	+	+	+

County and year	Wood stork	Glossy ibis	White ibis	Roseate spoonbill	Anhinga	Brown pelican	Doublecrested cormorant
Charlotte							
1976-78	+	+	-	-	+	+	+
1986-89	+	-	-	-		+	+
DeSoto							
1976-78	-	-	-	-	+	-	-
1986-89	-	-	-	-	+	-	-
Hardee							
1976-78	+	-	+	-	-	-	-
1986-89	+	+	+	-	+	-	+
Lee							
1976-78	-	-	+	-	+	+	+
1986-89	+	-	+	-	+	+	+
Polk							
1976-78	+	+	+	-	+	-	+
1986-89	+	+	+	-	+	-	+

Table 10-13. Bird colony locations by county within the Charlotte Harbor NEP of wading bird colonies ranked in the top 100 sites in Florida, 1986-89 (Rundle, 1991).

County	Atlas no.	Colony name	Total score	Town-ship	Range	Section
Charlotte	619012	Shell Creek Mouth	37.50	40S	23E	26NW
Charlotte	619015	Tucker's Corner	37.67	42S	25E	1SW
Hardee*	616016	El Claire Ranch	42.25	34S	27E	21SW
Hardee*	615006	Curtis Road	43.13	36S	23E	7
Highlands*	616020	Lake Istokpoga - Bumblebee Island	40.75	36S	3DE	13
Highlands*	616017	Bootheel Creek	40.25	38S	29E	15SE
Lee	619041	Midway Island (Caloosahatchee NWR)	39.00	42S	25E	32E
Lee	619040	Fort Myers Power Plant	37.80	43S	25E	26SE
Lee*	615012	Broken Islands	41.00	44S	21E	3NE
Lee*	615022	Useppa Bird Island	45.00	44S	21E	17
Lee*	615016	Hemp Key	42.75	44S	22E	31NW
Lee	615013	Cork Key	40.00	45S	22E	
Lee	615020	Sanibel Road (Matlacha Pass)	39.00	45S	22E	13NW
Lee*	615019	The Rocks Lake	45.00	46S	22E	33
Lee	619038B	Estero Bay (B1)	40.00	46S	24E	34SE
Lee	619038C	Estero Bay ©	37.80	47S	25E	19S
Polk*	612046	Northeast of Lakeland	40.60	27S	24E	23
Polk	612137	North of Lake Parker	38.50	27S	24E	
Polk*	612106	Saddle Creek Mine	40.30	27S	25E	IBW
Polk*	612045	Lake Hamilton	43.00	28S	27E	18SE
Polk	612048	Reedy Creek	38.00	28S	29E	1
Polk*	616036	Lake Hancock	40.30	29S	25E	6NW
Polk	616129	West of Homeland	39.13	30S	25E	31SW
Polk	616037	Lake Rosalie	38.00	30S	29E	4NE
Polk	616101	Bradley Junction	38.13	31S	23E	15S
Polk*	616041	Southwest of Homeland	41.50	31S	25E	5SW
Polk	616133	North of Whidden Creek	40.09	32S	24E	2SW
Polk*	616042	Widden Creek	42.71	32S	25E	9SW

* In the top 20 sites within the South Region Area defined by GFC.

White Ibis
(*Eudocimus albus*)

Several species of ibis exist in southwest Florida, including the glossy ibis and white ibis. Of these, the white ibis, a Species of Special Concern, is most commonly seen, feeding in shallow waters or in pasture and range land. The white ibis is a medium sized wading bird characterized by a long narrow down-curved bill. Ibis fly with neck outstretched, often in V-shaped or linear flocks.

Distribution: White ibis, like all wading birds, are attracted to water and short legged waders prefer the shallows associated with the coastal beaches and marshes. Suitable marsh habitat restricts the distribution of this species through peninsular Florida. The largest nesting colonies of white ibis are at Seahorse Key, Rookery Branch of the Shark River, and since 1972 in Water Conservation Area 3. It has been speculated that some birds from southeastern U. S. winter in Florida, although little detail is known. The white ibis prefers freshwater and estuarine wetlands with the largest colonies observed utilizing the broad expanses of the Everglades. White ibis are seen throughout the Charlotte Harbor NEP area (Figures 10-12 through 10-15), often feeding among cattle or in freshly plowed or harvested fields. Agricultural areas in the Peace and Myakka rivers support a large white ibis population.

Habitat: Shallow water habitats, marshes, as characterized by the Myakka River marshes and the wetlands of Estero Bay provide the preferred habitat for the white ibis. This species has an important ecological impact on the marshlands it inhabits. Rookeries are developed on islands within lakes, in marshes, or in mangroves. Feeding requires shallow water and nesting success depends on use of sequentially available feeding locations. Crayfish are the predominant prey item, however ibis will also feed on other aquatic invertebrates aquatic beetles, snails, insect larva and on fish. The diet is varied and generally opportunistic but feeding depends on suitable water conditions. White ibis are often at risk in areas with active development, as upland field and meadow feeding areas are often targeted for urban land uses.

Ecological/Economic Significance: The most important populations of white ibis in southwest Florida are the large coastal and inland colonies which require considerable areas of suitable feeding habitat. Many of these habitats, including freshwater marshes, sandy flatwoods, and coastal salt marshes, are threatened with destruction from human encroachment. Established breeding colonies are exhibiting significant declines in successful nesting opportunities. The most serious threats to this species are environmental contamination, loss of nesting sites, and loss of feeding habitat.

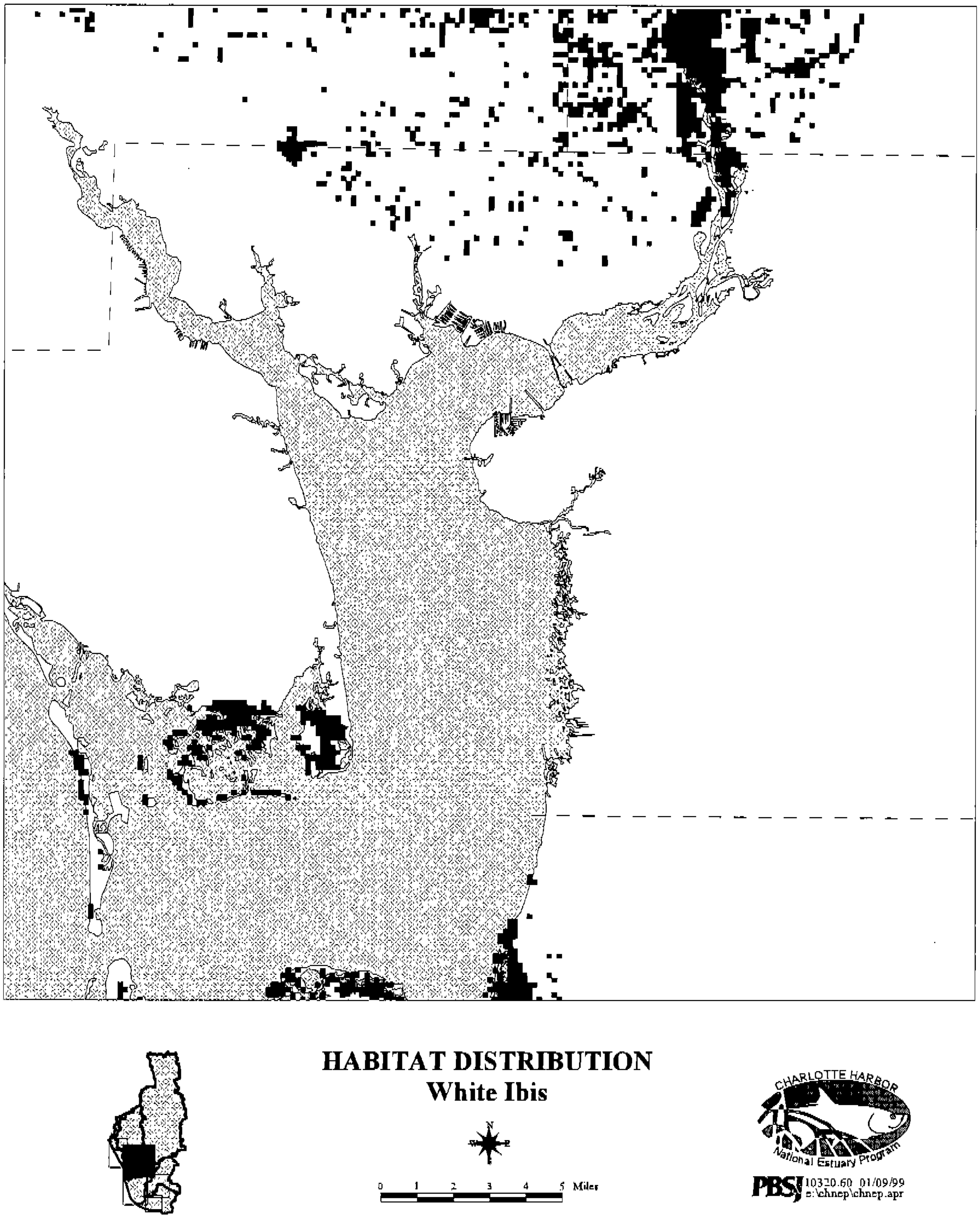


Figure 10-12. Habitat distribution for the white ibis in the Caloosahatchee River Basin (FGFWFC, 1994).

Figure 10-13. Habitat distribution for the white ibis in the Pine Island Sound / Matlacha Pass Basin (FGFWFC, 1994).

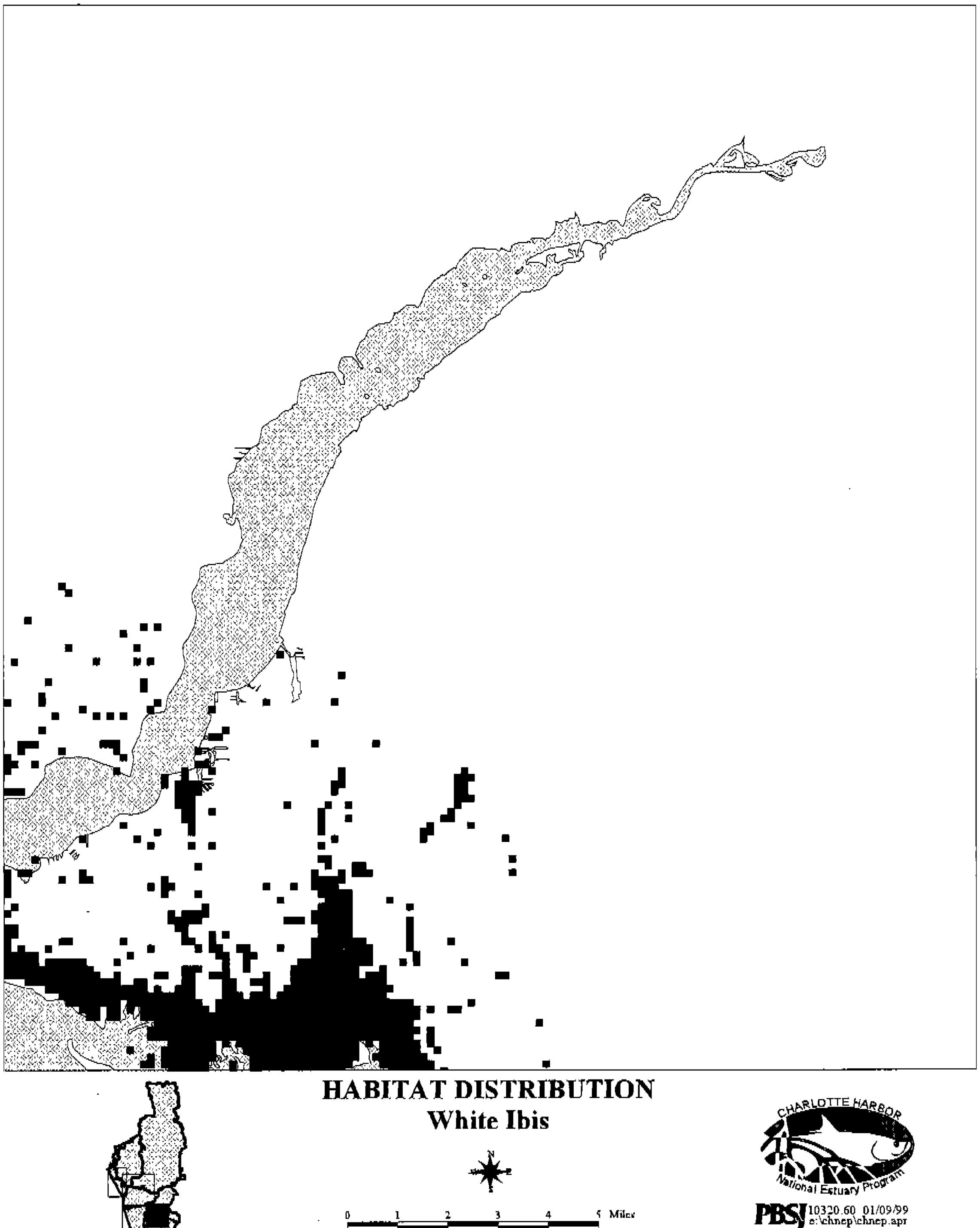


Figure 10-14. Habitat distribution for the white ibis in the Charlotte Harbor Basin (FGFWFC, 1994).

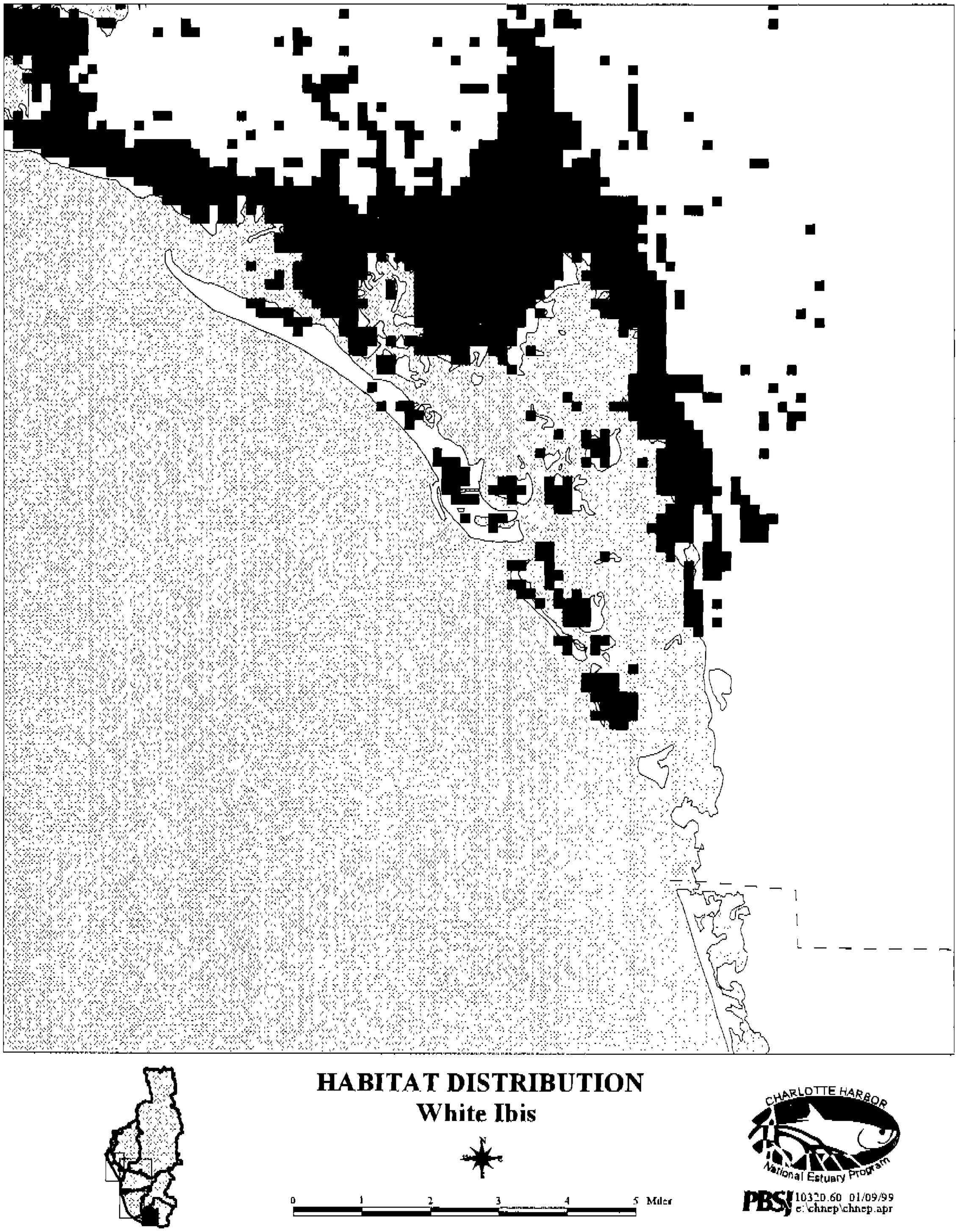


Figure 10-15. Habitat distribution for the white ibis in the Estero Bay Basin (FGFWFC, 1994).

Roseate Spoonbill
(Ajaia ajaja)

The spoonbill is a long-legged wading bird which stands about 32 inches tall, is generally pink in color and has a bill distinctively broadened and flattened at the distal end. Roseate spoonbills are not common, but can be seen flying over and feeding in both rural and urban settings in southwest Florida. Their status is currently Rare.

Distribution: Spoonbills occur and breed in peninsular Florida and along the entire Gulf coast. In Florida, spoonbills have had a limited nesting presence, breeding as far north as Tampa Bay on the Gulf Coast, and Lake Okeechobee in the interior. Nesting sites dropped considerably in the early 20th century with several nesting sites at Bottle Key, Florida Bay and possibly a few on Little Patricio Island in Charlotte Harbor. Since the addition of Florida Bay to Everglades National Park, the spoonbills have shown a remarkable recovery. They continue their dispersal to more northerly nest sites and have been observed as far north as Dixie and Alachua Counties.

Habitat: Spoonbills are primarily coastal birds with a specialized bill adapted for feeding on concentrations of small fish or prawns. Nests, mainly in Charlotte Harbor, Gasparilla Sound, and Estero Bay are located in thickets of red mangrove or black mangrove on islands. Feeding sites are dependant on concentrations of small fishes and prawns on the edges of coastal bays, in brackish ponds, pools and sloughs through mangrove swamps and less frequently in freshwater marshes. The most important predator to the spoonbill is the raccoon. The presence of raccoons is largely responsible for the distribution of nesting sites in the Charlotte Harbor area. Nesting occurs typically in November or early December but by March they have scattered widely.

Ecological/Economic Significance: Spoonbills have expanded their range since the 1940's, but are considered an indicator species of estuarine quality. Drainage for mosquito control and real estate development continue to threaten foraging habitat. Although eggs from some areas show relatively high pesticide levels, nest success does not seem to be impaired; apparently they are less sensitive than some other species of water birds.

10.1.4.2 Raptors

Osprey
(Pandion haliaetus)

Ospreys are commonly called fish hawks as their primary food source is fish. Ospreys are large hawks most commonly sighted in the Charlotte Harbor NEP area near lakes, large rivers, estuarine embayments, and along the Gulf Coast. Osprey currently are classified as Threatened.

Distribution: Ospreys nest through most of peninsular Florida, particularly along the coasts, along major rivers and around wooded shores. Ospreys are quite common in southwest Florida, and may be observed throughout the Charlotte Harbor NEP area. Ospreys in south Florida nest during winter and early spring, and either remain on their nesting grounds or only disperse locally northward in summer. Osprey from most of the United States including those that nest in northern and central Florida are migratory to wintering grounds south of the state. Florida provides a significant migratory corridor for southbound ospreys from September through November and again on the return northbound trip in March and April.

Habitat: Ospreys feed exclusively on fish, with the species of fish captured dependant on the fish species composition in a given water body. Species of mullet, marine catfish, and speckled trout are thought to be the dominant prey items in the Charlotte Harbor area. Being fish eaters, osprey tend to locate their nests along lake shores, river banks and sea coasts. Nests are placed in tops of large living or dead cypress, mangrove, pine or swamp hardwood trees. Occasionally, the nests may be close to or on the ground in areas such as islands, removed from predators. Nests are large, bulky assemblages of twigs and branches that are commonly reused and enlarged in successive years. Ospreys are quite tolerant of people and may locate their nests on man-made structures such as radio towers, channel markers, utility poles or nesting platforms. Provided suitable nesting trees are available and an abundant fish source, nesting concentrations have become quite dense in some areas. Between Florida Bay and the Ten Thousand Islands area in Everglades National Park an estimated 300 nests have been encountered.

Ecological/Economic Significance: Ospreys that nest in southern Florida differ from all other North American osprey in being non-migratory. As fish eaters, the health and successful breeding of the osprey depends on the health of the food source. Heavy metals, pesticide concentrations within the prey fish species will be passed along to the osprey. Probably all Florida osprey contain low levels of chlorinated insecticides and or polychlorinated biphenols, yet none has shown to contain enough to have any adverse effect on nesting. The primary causal factor to the decline of the osprey has been habitat destruction. Lakefront properties tend to remove the large nesting trees preferred by the osprey. In addition, runoff from the yards potentially contributes to poor water quality which in turn affects the fish populations.

Bald Eagle
(Haliaeetus leucocephalus)

The bald eagle is a large raptor, with a wing span of about seven feet. Bald eagles are most commonly sighted in the Charlotte Harbor NEP area near lakes, large rivers, estuarine embayments, and along the gulf coast. Bald eagles are opportunistic feeders, and feed off fish, but will also prey on a variety of birds, mammals, and reptiles, as well as carrion. The bald eagle is classified as Threatened.

Distribution: Eagles can be found throughout Florida, particularly along the coasts, along major rivers and around wooded shores. Bald eagles are not uncommon in southwest Florida, and can be seen throughout the Charlotte Harbor NEP area (see Chapter 11). Eagles in south Florida nest during winter and early spring, and either remain on their nesting grounds or only disperse locally northward in summer.

Eagles may be year-round residents, or may migrate. An eagle inventory of Florida reported 535 "occupied territories" in 1990, up from 340 ten years earlier. Occupied territory means that an occupied nest, but not necessarily young, was observed.

Habitat: Bald eagles are associated with lake shores, river banks and the gulf coasts. Nests are often placed in tops of large (usually) living or dead cypress or pine trees. Bald eagle nests are often located in the largest tree in the vicinity, within one-half mile of open water feeding grounds. Open coastal land and coastal pine flatwoods in Gasparilla Sound, the lower Peace River, and Estero Bay contain large areas of this type of habitat. Preferred habitat also contains perching areas, which may be occupied by solitary birds, or groups of dozens.

Ecological/Economic Significance: Like the osprey, bald eagles are fish eaters, and the health and successful breeding of the bird depends on the health of the food source. Heavy metals, pesticide concentrations within the prey fish species will be passed along to the eagle. The primary causal factor preventing increased eagle populations has been habitat destruction and human interference. Lakefront properties tend to remove the large nesting trees preferred by eagles. In addition, water quality degradation can affect the food fish populations.

10.2 Critical Harbor Habitats

Critical harbor habitats provide the environmental underpinnings the living resources of the estuary need to survive and reproduce, and knowledge of these critical habitats will be the most important source of information for establishing Quantifiable Objectives for the CCMP. The Charlotte Harbor NEP is developing living resource-based Quantifiable Objectives to ensure that the complete sets of environmental requirements of the estuarine life stages of the living resources are met. However, knowledge of the complete sets of environmental requirements for the diverse types of living resources found in the region is largely unknown or unreported in the scientific literature. For this reason, a habitat preservation paradigm of "build it and they will come" may be applied. Under this paradigm, the assumption is put forward that if the proper habitats can be provided on a sustainable basis, then the populations of living organisms associated with the habitats will be sustained. Thus, effective Quantifiable Objectives can be readily developed for the CCMP to target the restoration, protection, and enhancement of critical harbor habitats. The Indian River Lagoon NEP and the Tampa Bay NEP have recently adopted this approach by setting Quantifiable Objectives for the critical habitats of seagrasses, emergent saltwater wetlands, tidal flats, and others.

For this study, a "Critical Harbor Habitat" was operationally defined as

> *the sum of the physical, structural, and vegetative environmental components necessary for the maintenance and reproduction of marine mammals, birds, fish, invertebrates, and other living resources in the harbor.*

Thus, the vegetative components of these habitats are both living resources and structural habitats.

Given this definition, the habitats of the study area could be defined as many diverse and very specific types (e.g., infra-littoral wetlands, *Gorgonian* live bottoms, low stem height morphology *Thalassia* meadows, *Syringodium* and *Halodule* mixed meadows, *Rhizophora* dominated mangroves, and *Avicennia* dominated mangroves). The habitats of the estuary are diverse, overlapping, and comprising a vast number of combinations of physical and biological components. In order to focus the CCMP on management-scale planning, the Critical Harbor Habitats were grouped into several comprehensive submerged and emergent habitat types. These groups were based on the dominant physical and vegetation components, and they were centered on habitats at risk. The submerged habitats were defined as seagrasses, oyster reef/hard bottom, tidal/mud flats, and artificial reefs. The emergent habitats were defined as mangroves, saltmarshes, and shorelines. The emergent habitats were as a group termed "Emergent Saltwater Wetlands" in order to distinguish them from the freshwater and tidal oligohaline wetlands discussed under the Inland Habitat section of this document.

10.2.1 Submerged Habitats

The submerged habitats were operationally defined as seagrasses, oyster reef/hard bottom, tidal/mud flats, and artificial reefs. These habitats provide food sources, solid foundations, and protective structure for living resources, and they exist throughout all of the harbor segments. Although the current distributions of these habitats have been mapped and are presented in this document, the distributions remain in a state of constant slow change as sand shoals drift, seagrass meadows expand and are washed out by storms, oyster bars expand and are overtaken by mangroves, and dredge spoils and artificial reefs are deposited.

10.2.1.1 Seagrasses

Five species of marine and estuarine seagrasses occur in the shoal waters of the Charlotte Harbor complex. Four of the five species are commonly found in shallow waters (less than 6 ft) of the harbor. Two of these species can be found in 12-40 ft of water elsewhere in Florida where the water is much clearer. Seagrasses are most likely depth limited by light transparency in Charlotte Harbor similar to Tampa Bay and the Indian River Lagoon (Hall *et al.*, 1991; Kenworthy *et al.*, 1991) . Factors affecting transparency include seasonal change in total light each day, physical characteristics associated with absorption and scattering of light caused by dissolved organics, suspended material, and water depth. Microscopic plant and animal life, when abundant enough can affect light levels both in the water column and as epiphytes. Excessive nutrients may be an important factor for the production of epiphytes on seagrasses and loss of seagrasses with higher turbidity (Wetzel and Neckles, 1986; Neckles, 1991). One seagrass genus (*Halophila*) may prefer lower light levels and is generally found in water deeper than 6 ft (Kenworthy *et al.*, 1991) and may be a sporadic inhabitant of the harbor. Dixon and Leverone (1993) have summarized literature light requirements for *Thalassia* and *Halodule*.

Another species, *Vallisneria americana* can be found in freshwater and very low salinities. It is most common in the Caloosahatchee River. Small patches can be found in the oxbows of the Peace River below the State Road 761 bridge. Elsewhere in the study area, *Vallisneria* is uncommon. Quantity estimates of this species have not been conducted by any State or Federal agencies in the Charlotte Harbor complex.

Each seagrass species has a general range of salinity tolerances. *Thalassia*, *Syringodium*, and *Halophila* are most likely to be limited by light levels within their preferred salinity range in Charlotte Harbor. Inorganic nitrogen may seasonally affect epiphytic growth on seagrasses given its role as the likely limiting macro-nutrient in the harbor. Low salinity and high color levels appear clearly to control distribution of seagrasses toward each river mouth. *Halodule* and *Ruppia* are most common in very shallow water (McNulty *et al.,* 1972).

Information on the general distribution of seagrasses in Charlotte Harbor has a varied foundation. McNulty *et al.,* (1972) estimated about 23,383 acres of submerged vegetation. This estimate was made by using many different sources and may not have been verified by on-site inspections. The first attempt at a comprehensive study was completed by the Florida Department of Natural Resources in 1982 (Harris *et al.*, 1983). Black and white aerial photographs taken in 1946 and 1951 exist in FDOT files, and they have been digitized by FMRI. False color infrared aerial photographs were taken in 1981-1982 by FDOT, interpreted by FDOT and the results analyzed by FMRI. Verification of the aerial interpretations were done in most areas except for Estero Bay (per. comm., Ken Haddad). Harris *et al.* (1983) compare gross fisheries habitat changes between 1945 and 1982. Seagrass coverage is extensively analyzed and they estimated some 22,421 acres of seagrass to be present in 1982 in Charlotte Harbor (quads: El Jobean, Punta Gorda SW, Punta Gorda, Punta Gorda SE, Bokeelia, Port Boca Grande, and Matlacha). A more recent seagrass mapping program was completed by the SWFWMD in the Charlotte Harbor and Lemon Bay portions of the Charlotte Harbor NEP study area.

The Charlotte Harbor complex was reported to have a decline in seagrasses by Harris *et al.*, (1983). The study area included most of the Charlotte Harbor NEP area less Lemon Bay and the Caloosahatchee River. They reported a decline of 29% for the area. Adjusting for the lack of ground verification in Estero Bay by removing this system from the calculations, the total decline would be about 26%. The reported decline is not uniform across basins. The largest seagrass change, an estimated loss of 35%, occurred within Pine Island Sound. The Pine Island Sound loss represented 71% of the total estimated change from 1945 to 1982 or 18.5% of the 26% total. Harris *et al.*,

(1983) provided an extensive discussion of the potential causes. High on the list of suspected causes were the construction of the intracoastal waterway and the Sanibel bridges and causeways, finished in 1962. Bar graphs of seagrass, mangroves, and saltmarsh acreages in the basins appear in Figures 10-16 through 10-19.

Charlotte Harbor seagrasses declined by approximately 19.5% and represented 3.6% of the 26% total. However, Tomasko *et al.*, (in press) and unpublished SWFWMD data suggest that Charlotte Harbor seagrass coverage is dependent on freshwater discharge and can be variable, losing coverage in very wet years and regaining in dry years.

The FMRI recently published (Sargent *et al.*, 1995) an assessment of damage by propeller scarring throughout the state. Estimates of seagrasses are provided by county in Table 2 based on GIS source data from 1982 and 1987. Lee County was estimated to have 50,510 acres and Charlotte County 14,190 acres. About 59% of all the seagrass area from Tampa Bay south to the Collier County line occurs in the Charlotte Harbor complex. The relative amount of scarring in the Charlotte Harbor complex was estimated at 12.5% of the state total. Only Citrus and Monroe counties had greater percentages at 15.8% and 17.3%, respectively

Distribution in Lemon Bay

The distribution of seagrass in Lemon Bay as compiled by the SWFWMD is presented in Figure 10-20. North of Lemon Bay the Intracoastal Waterway connects to Roberts Bay in Venice. Except the previously discussed seagrass beds in the Gasparilla Sound portion of Charlotte Harbor, little seagrass is present in this region. This is because of the relatively small area of protected estuary behind the barrier islands. However, coverage of bay bottom in this region is relatively high. Seagrasses are most abundant south of the Tom Adams bridge in Lemon Bay, covering more than 70% of the bay bottom. North of the bridge, most of the seagrass can be found on the western side of the bay.

Distribution in Charlotte Harbor Proper

The SWFWMD 1994 seagrass distribution data for the Charlotte Harbor Proper portion of the Charlotte harbor complex are presented in Figure 10-21. All seagrasses are confined to the fringes of the harbor in shallow water and the mapped areas represent three species (*Thalassia*, *Halodule*, and *Ruppia*). The most extensive areas are the harbor-fringing shoal meadows along the eastern shore of the upper harbor. These occur from about Burnt Store Marina to Alligator Creek and in the shallow areas among the mangrove keys in the lower harbor in Gasparilla Sound and north of Bull Bay to Whidden Creek. In Gasparilla Sound north of the bridges, the largest seagrass beds are

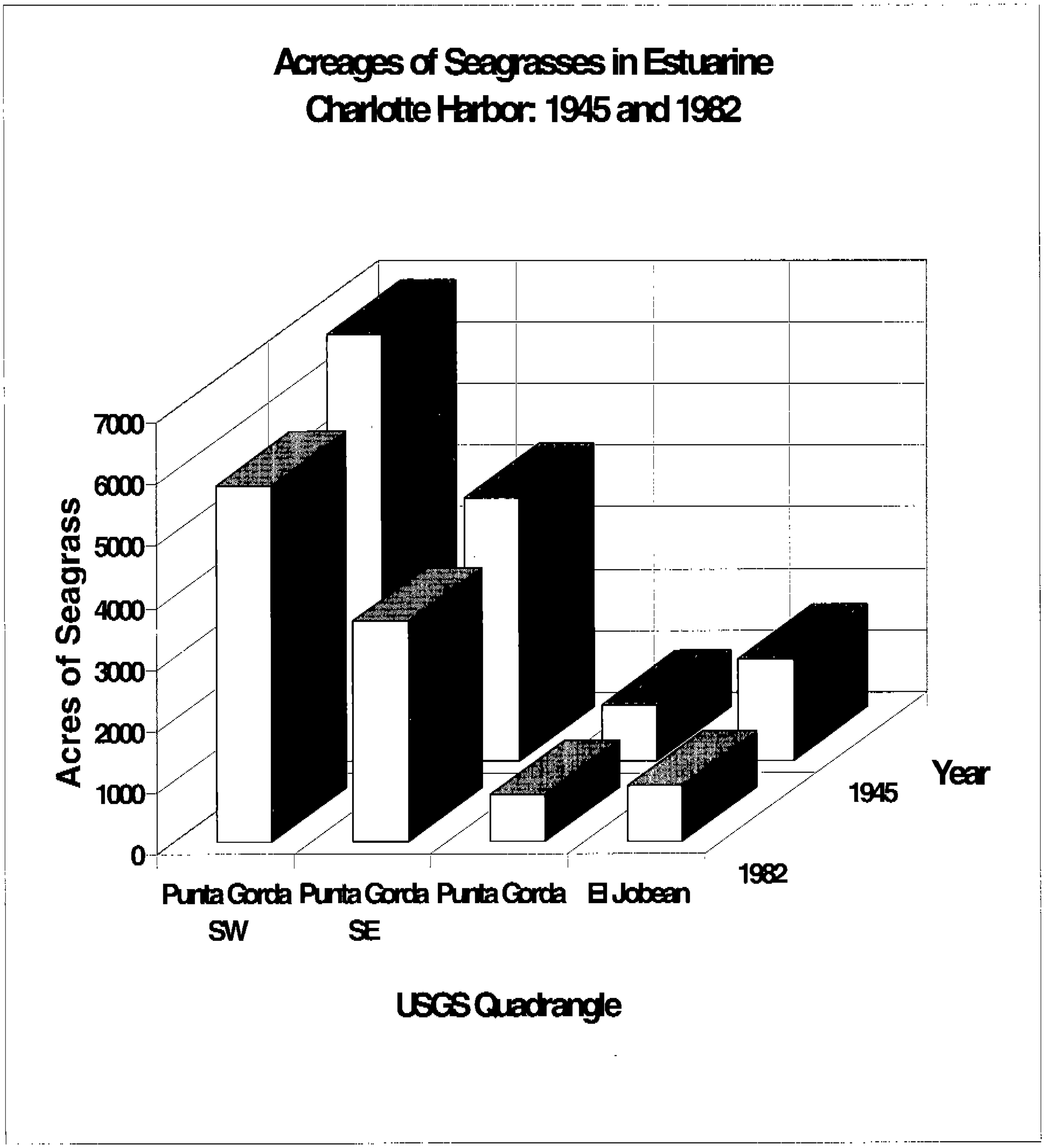


Figure 10-16. Acres of seagrasses in estuarine Charlotte Harbor: 1945 and 1982.

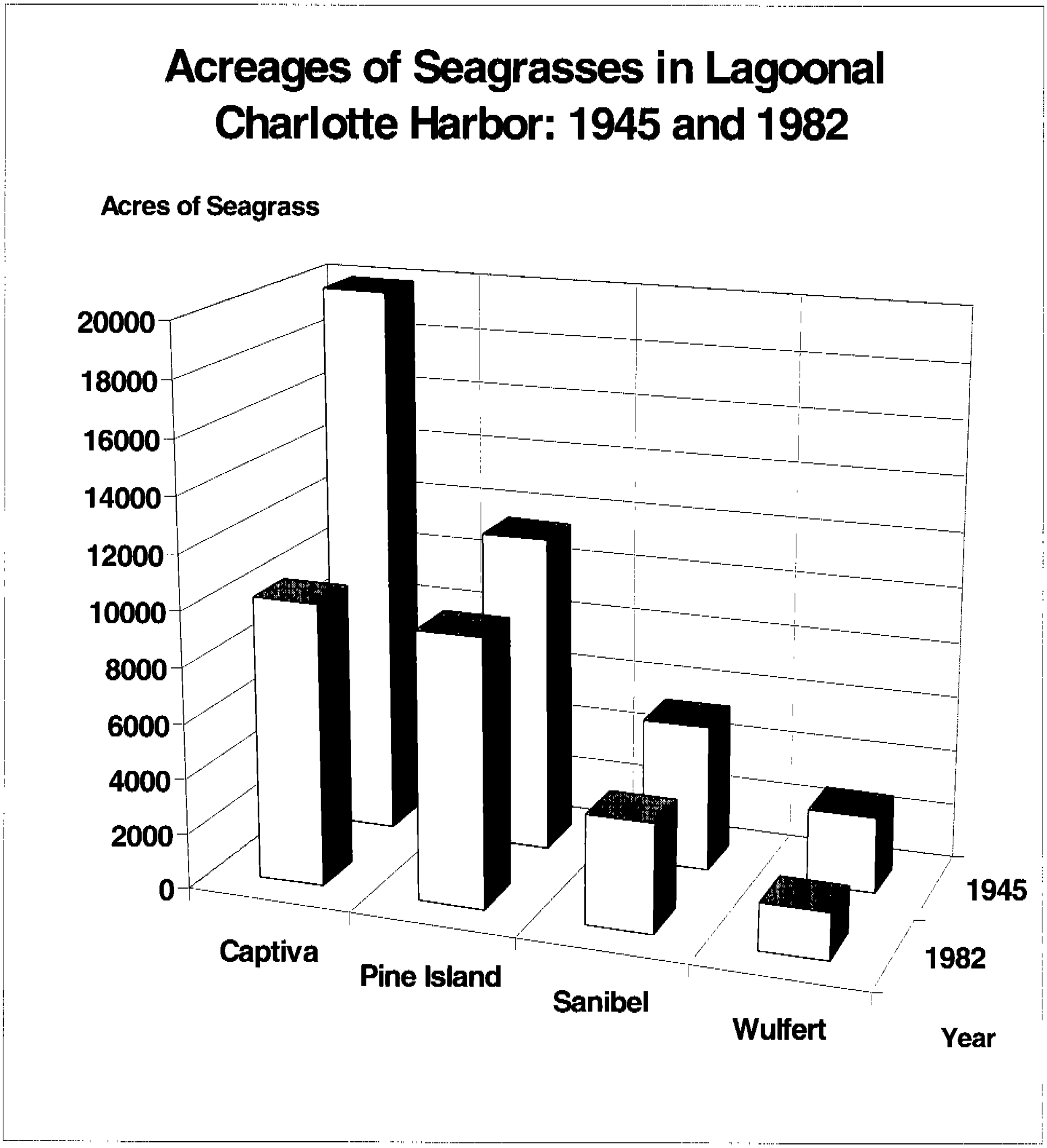


Figure 10-17. Acres of seagrasses in lagoonal Charlotte Harbor: 1945 and 1982.

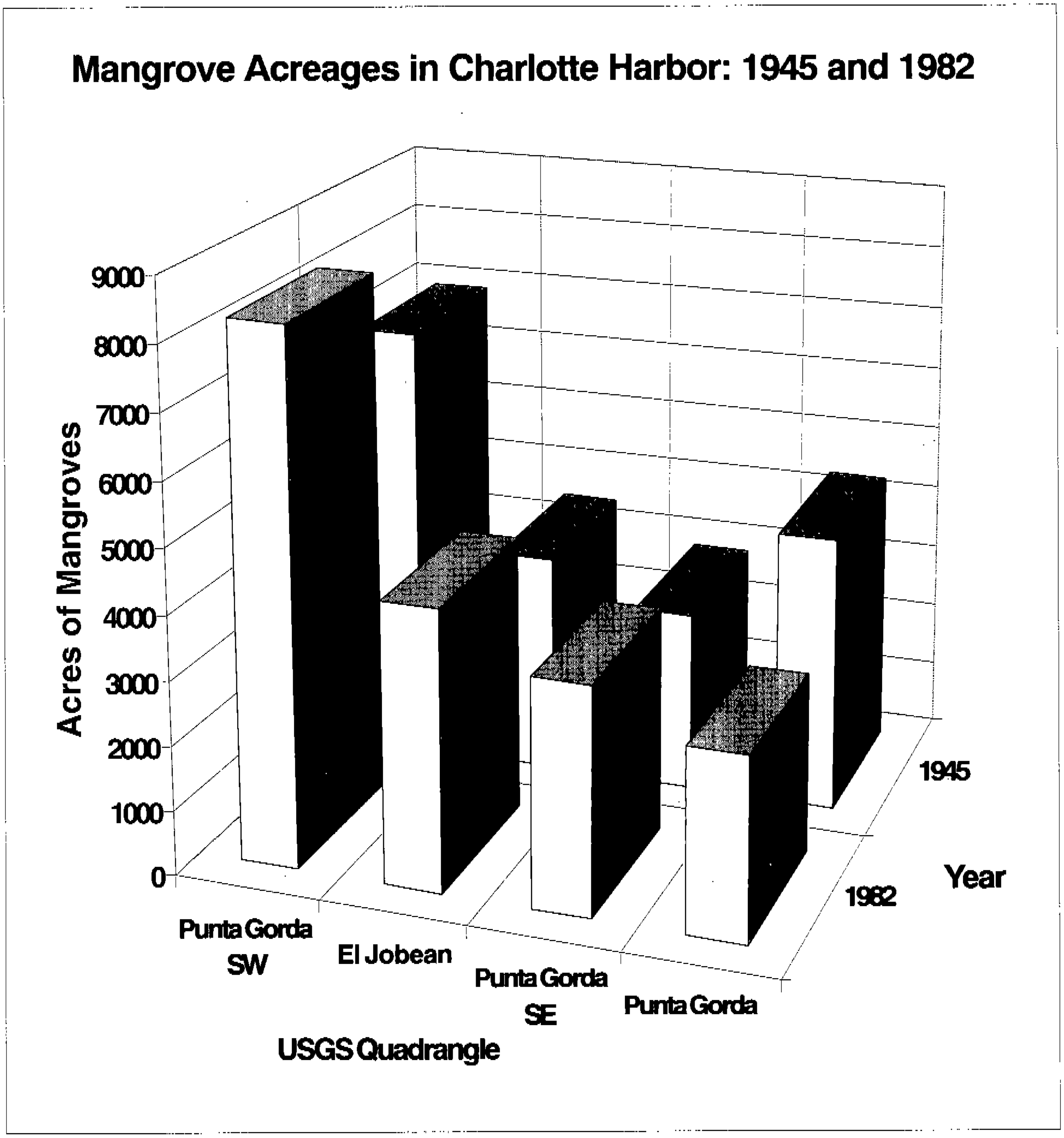


Figure 10-18. Acres of mangroves in Charlotte Harbor: 1945 and 1982.

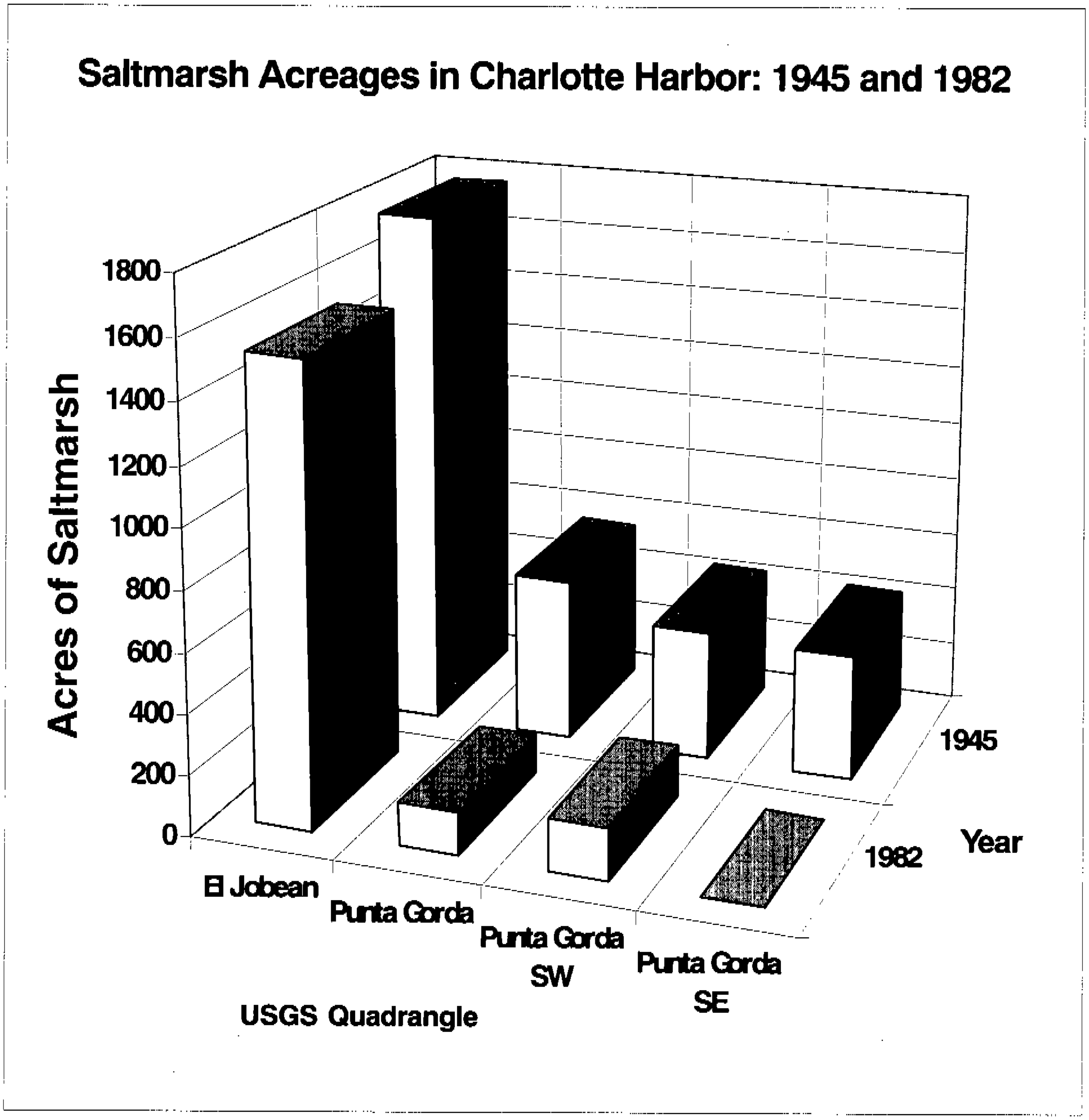


Figure 10-19. Acres of saltmarshes in Charlotte Harbor: 1945 and 1982.

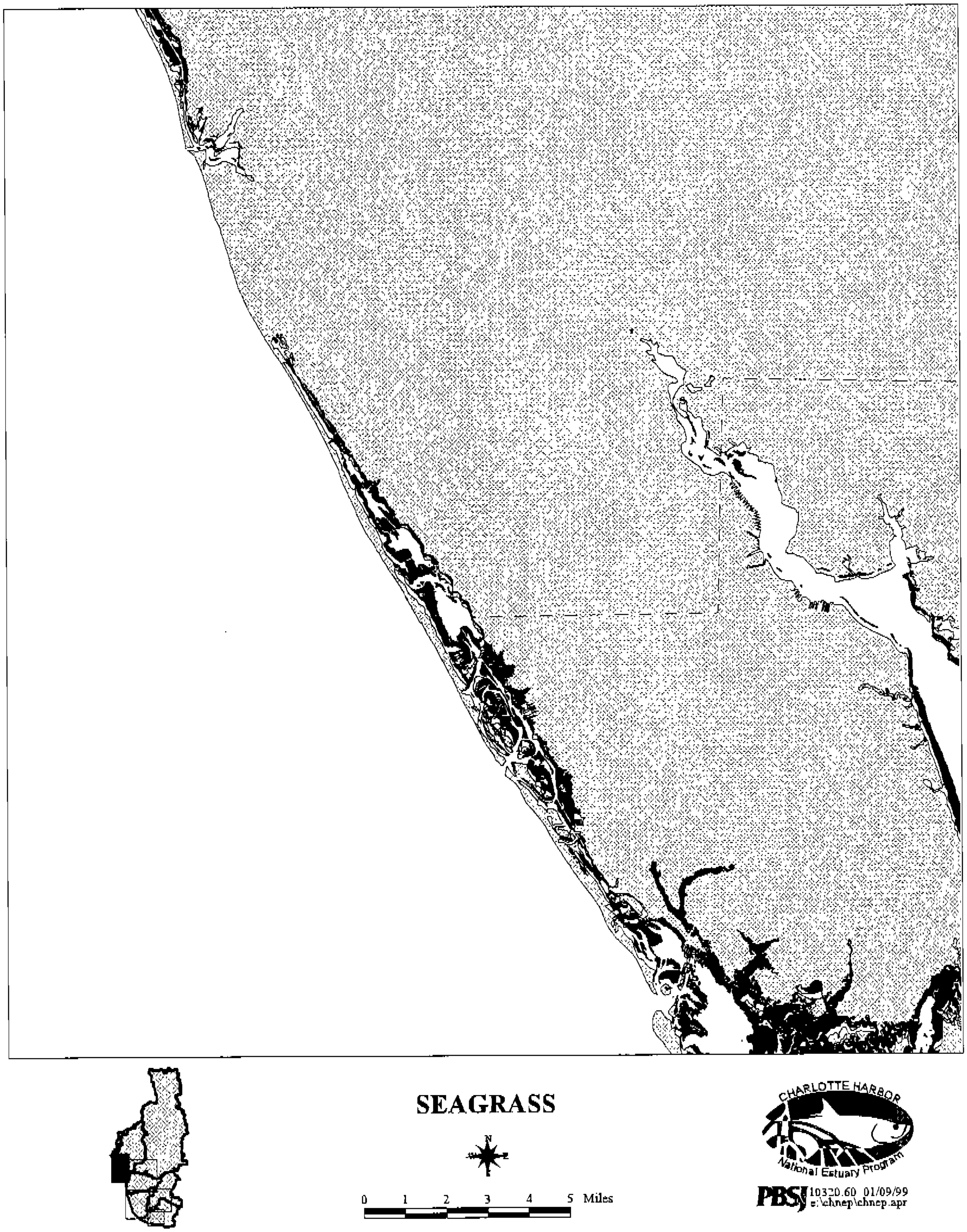


Figure 10-20. Seagrasses (black shaded areas) reported for Lemon Bay in 1994 by the SWFWMD.

west of the Intracoastal waterway. South of the bridges, the largest seagrass beds extend from the mouth of Coral Creek south to Charlotte Harbor. One extensive area occurs west of the intracoastal about midway down Gasparilla Island. A narrower fringe occurs south of Hog Island and along the western shore of the upper harbor. This distribution reflects the bathymetry of the harbor with broader shoal areas on the east shore than on the west shore. A similar bathymetric pattern exists for Tampa Bay to the North.

High salinities greater than about 37‰ have never been recorded in Charlotte Harbor and seagrass distributions of three species should not be influenced by high salinity. Low salinities toward the head of the harbor may be very important. Known lower salinity limits are approximately 20‰ for *Thalassia* and *Syringodium.* Morrison *et al.* (1989) observed localized declines in seagrass abundance in Matlacha Pass and attributed the changes to declining summer salinities. *Ruppia* prefers lower salinities from about 10‰ to 25‰. *Halophila* may occur when salinities are generally greater than 28 ‰.

The shallow bar on the south side of Hog Island marks the approximate northern limit of *Thalassia.* Only *Halodule* and *Ruppia* extend further up the Harbor.

Distribution in Pine Island Sound/ Matlacha Pass

The distribution of seagrass in Pine Island Sound and Matlacha Pass as compiled by the FMRI is presented in Figure 10-22. Pine Island Sound has the most extensive seagrass beds in the complex. On the western side of Pine Island, a nearly continuous broad band of about 17 miles from north to south. Extensive areas of the sound deeper than six feet, generally, do not have any of the three common species, but can have *Halophila* appearing in some years. Seagrasses are abundant on the eastern sides of the barrier islands and on the eastern depositional fan areas of Captiva, Redfish and Blind Passes. In Matlacha Pass, seagrass distribution is generally restricted to water depths of less than three feet because of the high water color in the summer months. Seagrasses occur throughout the pass on both sides.

Distribution in the Caloosahatchee River

The distribution of seagrass in the Caloosahatchee River as compiled by the Florida Marine Research Institute (FMRI) is presented in Figure 10-23. Small patches of *Thalassia* can be found mixed in with *Halodule* at the mouth of the river. *Halodule* extends up the river mostly along the southern shore to just above Whiskey Creek. A few patches of *Halodule* exist along the northern shore below the Cape Coral bridge. *Ruppia* appears in geographically variable areas from year to year from the Iona Cove area to just east of Beautiful Island (Railroad Trestle). *Vallisneria* extends from Beautiful Island to just below Whiskey Creek depending on the salinity. This species distribution appears stable above the Edison Bridge.

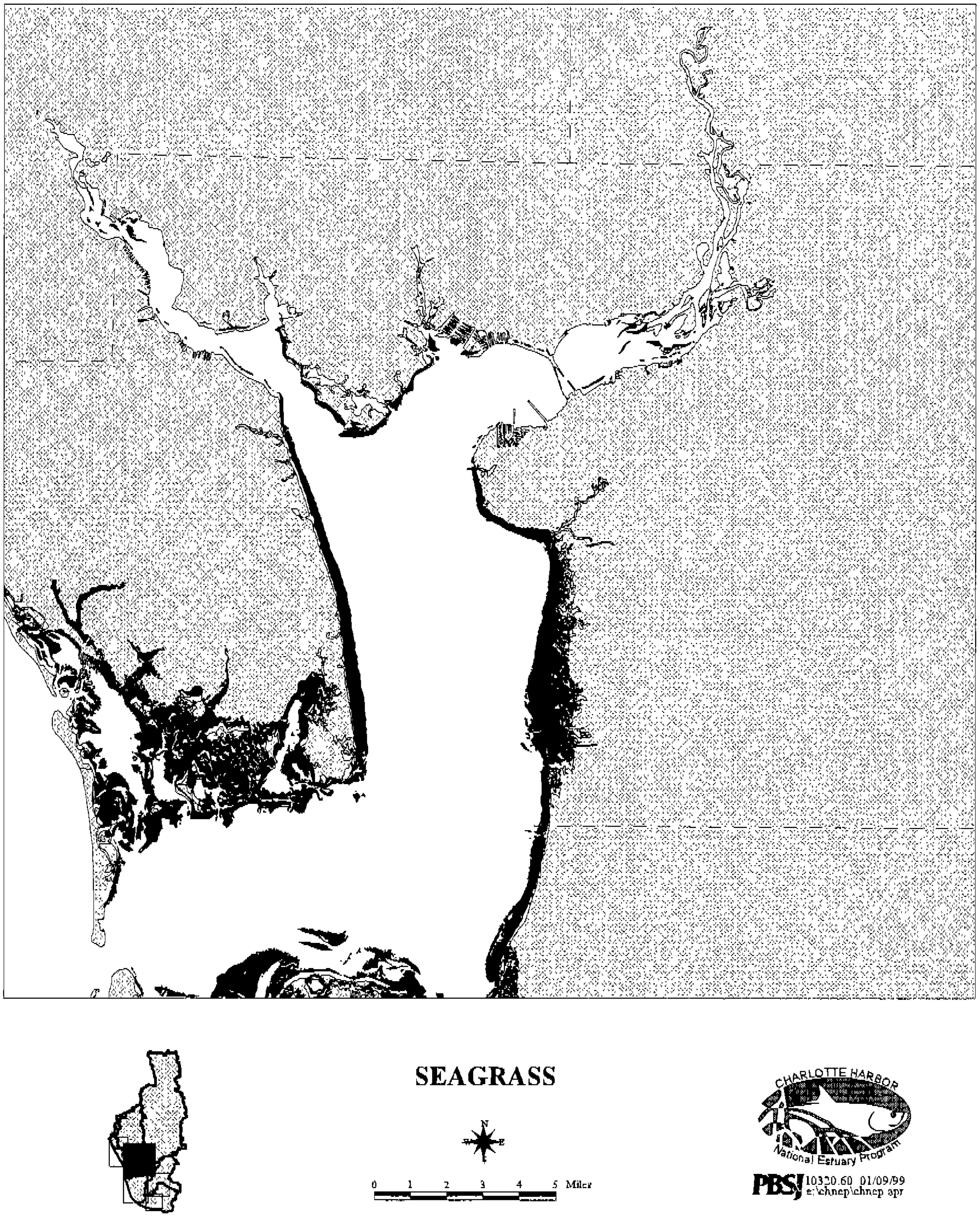


Figure 10-21. Seagrasses (black shaded areas) reported for Charlotte Harbor in 1994 by the SWFWMD.

Figure 10-22. Seagrasses (black shaded areas) reported for Pine Island Sound and Matlacha Pass from 1980's and 1990's data compiled by the Florida Marine Research Institute.

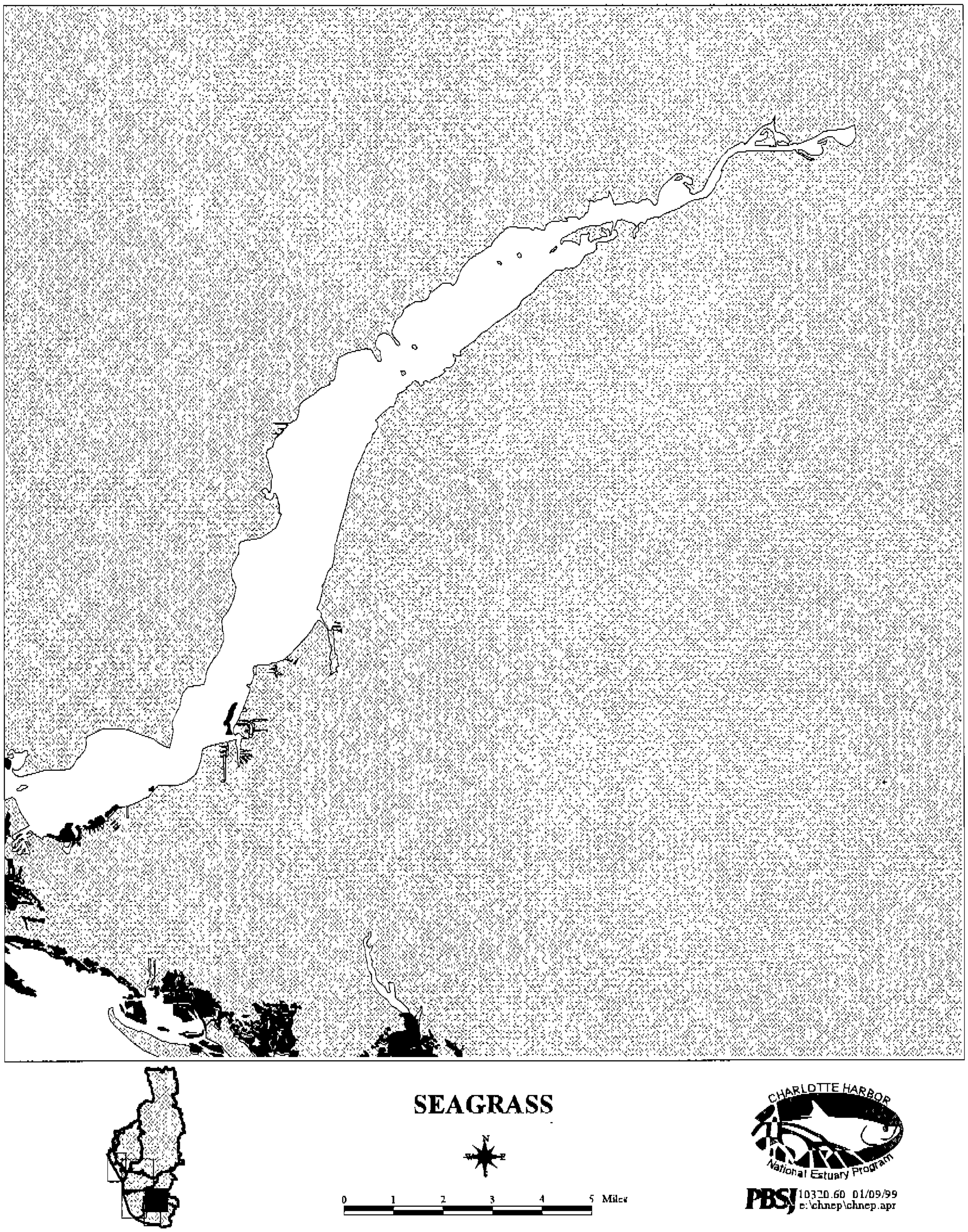


Figure 10-23. Seagrasses (black shaded area) reported for Caloosahatchee River from 1980's and 1990's data compiled by FMRI.

Distribution in Estero Bay

The distribution of seagrasses in Estero Bay as compiled by the Lee County Environmental Laboratory is presented in Figure 10-24. Most of the seagrass is found along the northern part of the bay on the landward side. Although seagrasses are shown in the FDEP GIS system for a large area south of Hendry and Mullock Creeks, few areas were actually seagrass beds. No verification of the aerial interpretations were done in Estero Bay (per. comm., Ken Haddad) for the 1982 study. Examination of the 1974-75 Lee County aerials and the Soil Conservation aerials in the 1940s - 1950s indicates a general lack of seagrasses in this area. A recent aquatic survey completed by Lee County (1991) did not record seagrasses in this area. The abundance of oyster bars in this area suggests salinities are frequently less than 20‰. The central part of the bay between Big Carlos and Big Hickory Passes also has relatively large areas of seagrasses. Few seagrass beds occur in the southern part of the bay. This bay tends to be much more turbid than the other bay systems.

10.2.1.2 Oyster Reef/Hard Bottom

Hard bottom communities are found throughout the Charlotte Harbor NEP study area. Although they include a variety of sessile invertebrates (e.g., gorgonian colonies, encrusting sponges) they are commonly represented by intertidal oyster reefs associated with mangrove forests and shoal areas. The hard substrate formed by oyster colonies creates critical harbor habitats for higher trophic level vertebrates including sport fish (gray snapper, snook, sea trout, red drum, and sheepshead). They are also exploited by avian predators (American oystercatcher, fish crow, white ibis) at low tide.

Distribution in Lemon Bay

As previously discussed, the bottom area of Lemon Bay is approximately 70% covered by seagrass meadows, and the oyster reef/hard bottom communities within this barrier island system are primarily limited to two large areas of habitat. However, as previously noted, important fringing oyster reef habitat exists throughout the estuary.

Distribution in Charlotte Harbor Proper

Important fringing oyster reefs are associated with the mangrove forests, shorelines, and seawalls throughout the bay. However, they are too small to be represented in this series of maps. Notably large oyster reef/hard bottom communities are located at the southeastern tip of Hog Island in the northernmost portion of the Harbor, and to the southwest of the Punta Gorda peninsula in the northeast portion of the Harbor. Larger oyster reef/hard bottom communities are also associated with the complex system of mangrove keys in the southwest.

Figure 10-24. Seagrasses (black shaded area) reported for Estero Bay from 1980's and 1990's data compiled by FMRI.

Distribution in Pine Island Sound/ Matlacha Pass

The larger areas of oyster reef/live bottom communities are relatively rare in the estuary, and are often found associated with the shoreline yet at a distance from it. Because of their relative rareness in the estuary, these habitats are particularly well suited for protection targets as part of the Quantifiable Objectives of the CCMP.

Distribution in the Caloosahatchee River

A notably large oyster reef exists at the mouth of the Caloosahatchee River, and is likely to be the most expansive type of this habitat within the Charlotte Harbor NEP study area. This area is aptly named Big Shell Island, and the mangrove-covered point to the northeast of it is named Shell Point.

Distribution in Estero Bay

Several large oyster reefs exist in Estero Bay, and are associated primarily with the mouth of Hendry Creek in the northern portion of the bay. Historically these oyster reefs have influenced anthropogenic impacts to Estero Bay as evidenced by the presence of the very large shell midden named Mound Key. This mound was constructed by Native Americans who lived in the region and used the abundant food supply provided by the oyster reefs. Ironically, later inhabitants may not have been as fortunate as evidenced by the adjacent mangrove island named Starvation Key.

10.2.1.3 Tidal/Mud Flats

Tidal/mud flats provide critical harbor habitats throughout the Charlotte Harbor system. Tidal flats are productive areas vegetated with epibenthic and drift algae, and they are inhabited by invertebrates such as crabs, oysters, clams , and worms. They are exploited as feeding areas by a diverse group of wading birds including white ibis, American oystercatcher, reddish egrets, and little blue herons, and they provide protected staging and resting areas for smaller migratory birds. The tidal flats in this region consist of estuarine beaches, areas waterward of mangroves, salt barrens at higher elevations, dredge spoil areas, mud flats, and channel shoals.

The geographic distribution of intertidal areas in the Charlotte Harbor system is one of the most dynamic of all of the critical harbor habitats. This is due to the shifting nature of the relatively exposed sediments and the impacts of anthropogenic activities. These anthropogenic activities include such activities as sediment resuspension from shipping, dredge spoil disposal, channel maintenance, shoreline hardening, and breakwater construction. The distribution of intertidal areas was compiled by the FMRI based on NOAA nautical charts. The data were delineated from 1:10,000 scale charts from navigable harbor areas, and 1:40,000 scale charts from other inner coastal areas.

Distribution in Lemon Bay

The tidal flats adjacent to the shorelines of this region are associated with mangrove fringes, and accretion areas off hardened seawalls. In addition, several tidal flats near the center of the bay are associated with maintenance dredging of navigational channels.

Distribution in Charlotte Harbor Proper

The tidal /mud flats of this region comprise the largest extent of this habitat within the study area. In particular, very large flats are located south of the Punta Gorda peninsula in the northeast portion of the harbor. From these large expanses, a series of fringing flats exists east of and adjacent to the seagrass meadows along the eastern shoreline of the harbor. Similar fringing flats exist to the south of the seagrass meadows in the Gasparilla Sound Region. Flats are also located in the southern portion of the harbor in an area that is likely to experience a higher energy wave environment.

Distribution in Pine Island Sound/ Matlacha Pass

Relatively few large tidal/mud flats are associated with mangrove keys in this region. In the southern portion of Pine Island Sound, a large flat exists in proximity to the mangrove fringed key, Chino Island. A series of small isolated tidal/mud flats is visible in Pine Island Sound running from northwest to southeast. These flats are associated with dredge spoil areas on either side of the heavily traveled Intracoastal Waterway. The expansive tidal flats located inside the barrier islands to the south of Pine Island Sound are protected areas inside the J.N. "Ding" Darling National Wildlife Refuge.

Distribution in the Caloosahatchee River

Notably expansive tidal/mud flats in this region include an area in the center of the river in the north. This area is associated with the aptly named Midway Island, and a large expansive flat near the mouth of the river. Several large designated dredge spoil disposal areas are also located near the mouth of the river adjacent to the maintained channel.

Distribution in Estero Bay

The tidal/mud flats, along with those previously discussed for Charlotte Harbor Proper, represent the most expansive flats of the study area. The large open areas provide unique and valuable habitats. In particular, this is perhaps the best example of a near pristine habitat mosaic within the NEP boundaries. Within this region, mangroves, seagrasses, oyster reef/hard bottom communities, and tidal/mud flats exist together in relatively large parcels.

10.2.1.4 Artificial Reefs

Artificial reefs are a type of hard bottom community that is created by man to improve recreational fishing. Hard substrates such as concrete rubble, rock, and bridge demolition debris are placed in deeper waters to provide habitats for sport fish. These areas function as habitat by attracting food fishes, providing shelter for juvenile predatorial fishes, and attachment sites for deeper water sessile organisms such as sponges, mussels, and tunicates. The distribution of artificial reefs within the study area is limited to deeper areas of Charlotte Harbor prope:1)south of hte Cape Haze bar: 2) off Alligator Creek on the harbors' northeast side; and 3) near Hog Island near the mouth of the Myakka River.

10.2.2 Emergent Saltwater Wetlands

The emergent habitats were defined as intertidal habitats that maintain vegetation that extends both above and below the waterline at normal high tides. These habitats included mangroves, saltmarshes, and shorelines. The emergent habitats were termed as a group "Emergent Saltwater Wetlands" in order to distinguish them from the freshwater and tidal oligohaline wetlands discussed under the Inland Habitat section of this document.

10.2.2.1 Mangroves

Mangrove trees are the most dominant emergent vegetation in the estuary. Four mangrove species occupy the inner, low energy shorelines of the estuary. These trees generally range from 12 to 60 feet in height, but may occur as stunted morphotypes on tidal flats with elevated salinities such as salt barrens. The four species include red mangroves (*Rhizophora mangle*) that inhabit the areas closest to the water's edge, black mangroves (*Avicennia germinans*) that are generally upland of red mangroves, white mangroves (*Laguncularia racemosa*) that are usually upland of black mangroves, and buttonwoods (*Conocarpus erectus*) which occur upland of white mangroves. Mangrove forests provide critical harbor habitats for the living resources of the estuary. The branches of these trees provide nesting sites, hunting perches, and protection for a very diverse group of estuarine birds including white ibis, wood stork, heron species, egret species, brown pelicans, white pelicans, ospreys, and bald eagles. The partially submerged prop roots of these trees support an even greater diversity of living resources including oysters, snook, red drum, mangrove snapper, crabs, and other organisms.

The distribution of mangroves in the Charlotte Harbor NEP study area was compiled from delineation completed in 1990 by the SWFWMD and in 1988 by the SFWMD (Table 10-14). The wetlands were delineated from color infrared aerial photographs. A series of maps from these data is presented and described in the following text. These data are currently being updated by both of the Water Management Districts using photographs made in 1995.

Table 10-14. Acreages of mangrove swamps in the Charlotte Harbor NEP area by major basin and subbasin.

Major Basin	Subbasin	Mangrove Swamps (acres)
Myakka River	Coastal Lower Myakka	835
Peace River	Coastal Lower Peace	2,858
Coastal Harbor Proper		14,219
Lemon Bay		757
Pine Island Sound/Matlacha Pass		19,107
Tidal Caloosahatchee River	Lower Caloosahatchee	2,995
Estero Bay		11,352
Coastal Venice		147

Distribution in Lemon Bay

Figure 10-25 presents the mangrove habitat of the Lemon Bay coastal region. The total reported mangrove acres for this subbasin was 757. These mangroves fringe the protected shorelines of the recreational beaches on the barrier islands. The several mangroves isolated by water in Lemon Bay are likely to provide very important roosting habitats for birds in this urban area.

Distribution in Charlotte Harbor Proper

Figure 10-26 presents the distribution of mangrove habitats in the Charlotte Harbor proper region of the study area. These compiled data report a total of 14,219 acres of mangroves in the Coastal Charlotte Harbor Proper Subbasin, a total of 2,858 acres of mangroves in the Coastal Lower Peace River Subbasin, and 835 acres of mangroves in the Coastal Lower Myakka River Subbasin. These mangroves occur along most of the inland shores of the harbor. They form groups of isolated keys away from the shoreline in the harbor, vast stretches of dense mangle habitat on the shoreline, and penetrate inland along most of the tidal creeks and coves. They are particularly concentrated in the northern portions of the harbor.

Distribution in Pine Island Sound/ Matlacha Pass

The distribution of mangroves of the Pine Island Sound and Matlacha Pass region is presented in Figure 10-27. The total reported mangrove acreage for the Pine Island Sound/Matlacha Subbasin

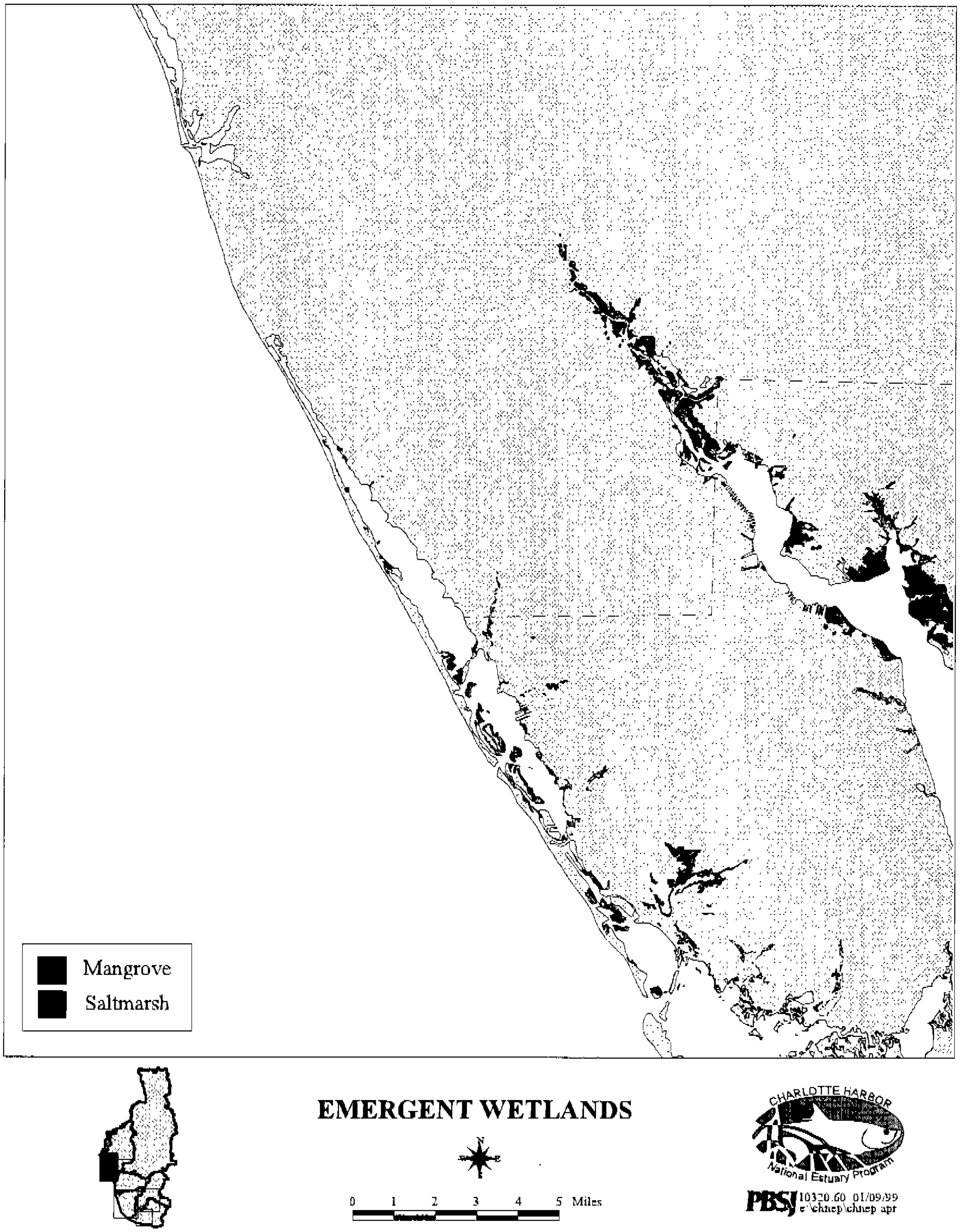


Figure 10-25. Emergent saltwater wetlands (black shaded areas) reported for Lemon Bay (SWFWMD, 1990).

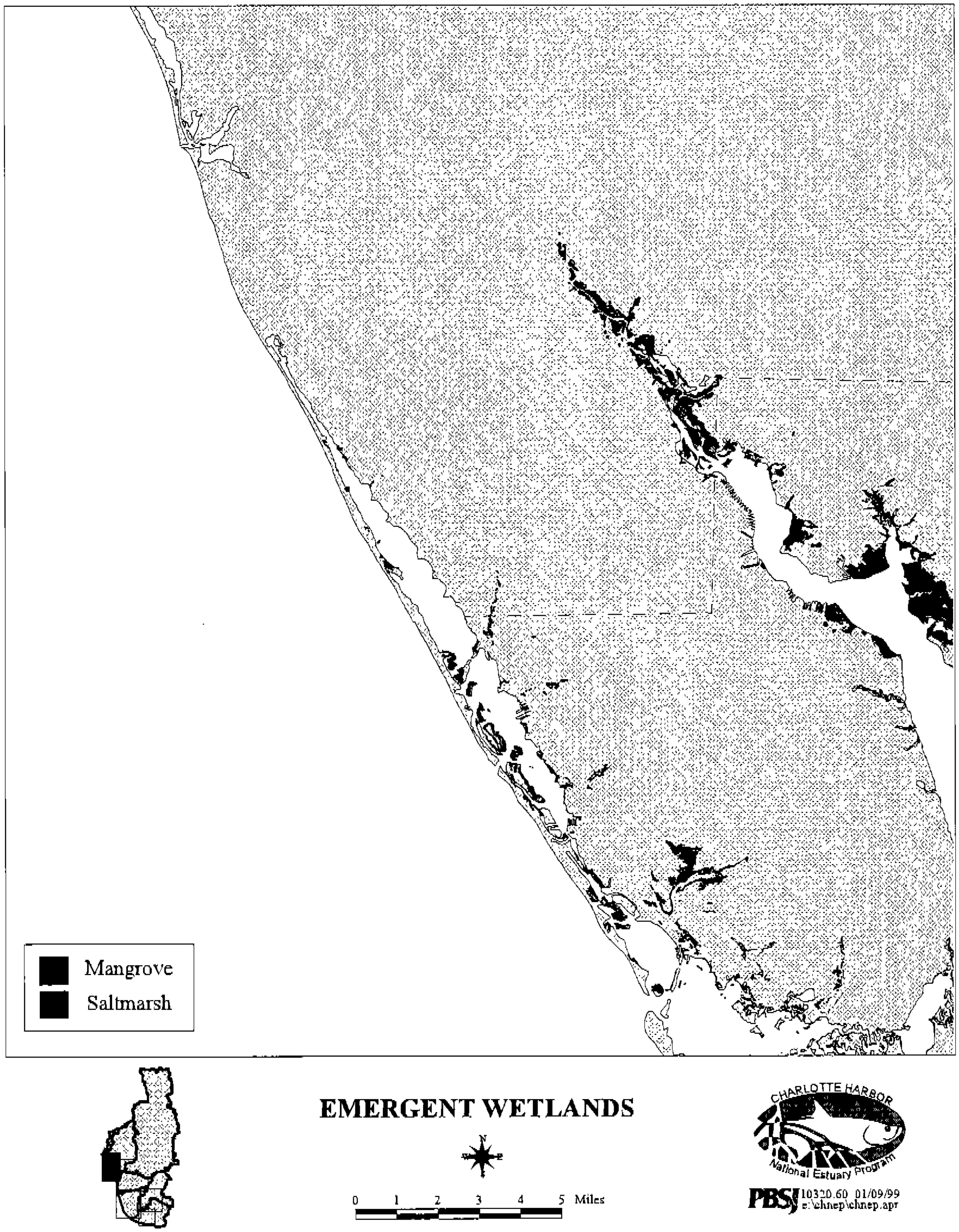


Figure 10-26. Emergent saltwater wetlands (black shaded areas) reported for Charlotte Harbor (SWFWMD, 1990).

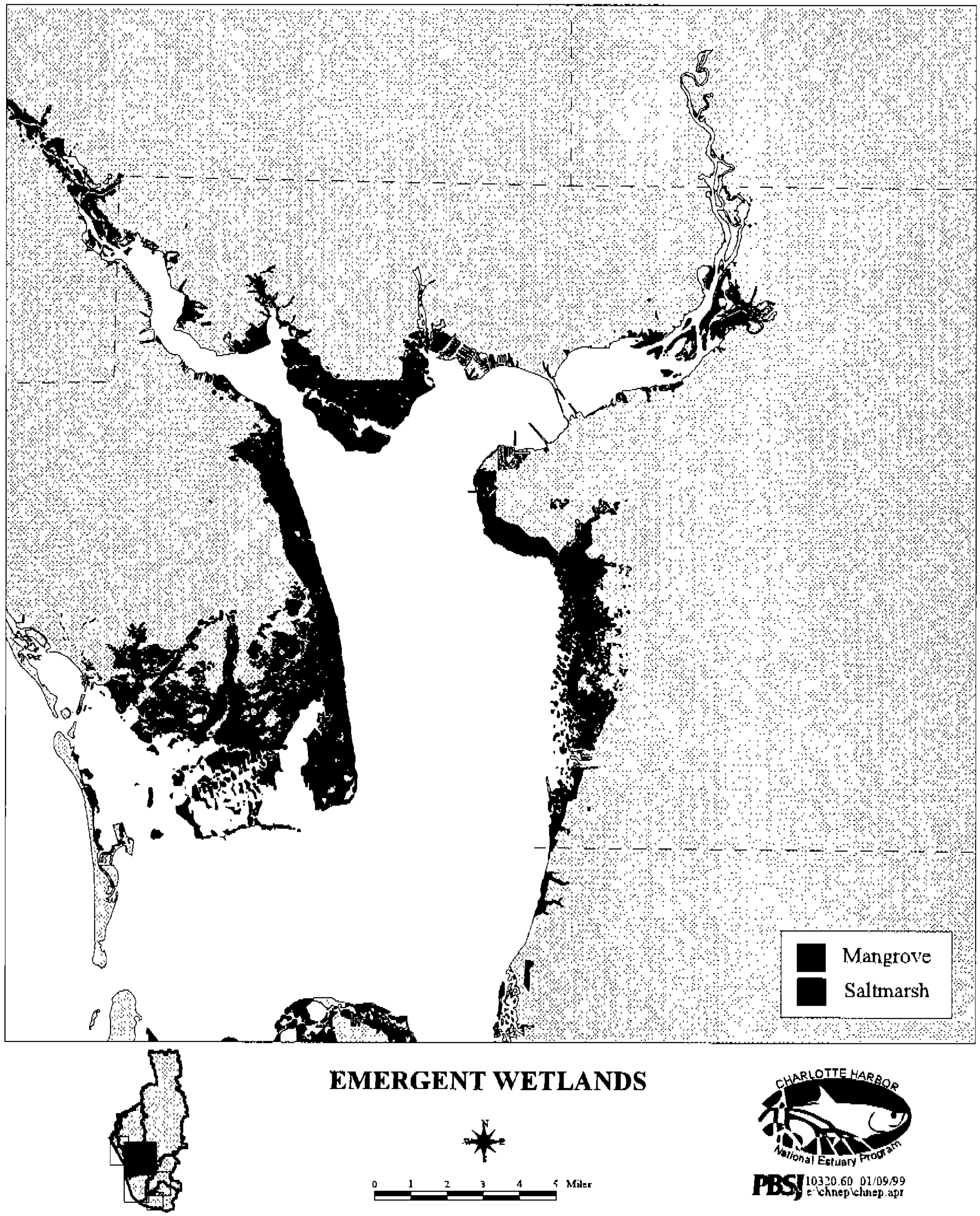


Figure 10-27. Emergent saltwater wetlands (black shaded areas) reported for Pine Island Sound and Matlacha Pass region (SWFWMD, 1990).

is 19,107 acres. The mangroves in this region are extensive and fringe all of the protected shorelines of the barrier islands. Little Pine Island in the center of Matlacha Pass was delineated as a particularly large mangrove forest. It is possible that a portion of this area will be reclassified as upland vegetation such as pine and Brazilian pepper when the more detailed 1995 land use delineation is completed by the SFWMD. The mosaics of mangroves in the southern portion of this region on the northern coast of Sanibel Island are particularly noted for the living resources they support such as large populations of roseate spoonbills. These mangroves are currently protected as part of the J.N. "Ding" Darling National Wildlife Refuge.

Distribution in the Caloosahatchee River

The mangrove forests in the Caloosahatchee River are presented in Figure 10-28. These mapped data report a total of 2,995 acres of mangroves in the Lower Caloosahatchee River Subbasin. These habitats have been almost entirely lost along the shores of the river. Two large isolated mangles exist. One of these is located at North Fort Myers midway up the river at a location named Marsh Point. The second of these is located in the northern portion of the broad area of the river. This latter area is currently protected as the Caloosahatchee National Wildlife Refuge. More extensive coastal mangroves exist at the mouth of the river along Piney Point on the north side of the mouth and Shell point on the south side of the mouth.

Distribution in Estero Bay

The Estero Bay mangrove forests are presented in Figure 10-29. Based on these mapped data, Estero Bay supported a total of 11,352 acres of mangroves. The mangroves of the Estero Bay region are primarily distributed as dense fringing mangles along the mainland shore. The large width of these fringes makes them particularly isolated from anthropogenic disturbances. Other relatively large mangrove keys are located in the center of the bay and are isolated from the mainland by water. The particularly large key in the center of the Bay is the previously discussed native American constructed site known as Mound Key. Mangrove-covered tributaries such as the split Spring Creek to the south are also notable for this region.

10.2.2.2 Saltmarshes

Saltmarshes are the most common emergent habitats in the riverine portions of the study area, and exist to some extent throughout the estuary. Saltmarsh communities often occur in the transitional area between mangroves, freshwater marshes, and salt barrens. Dominant saltmarsh plant species include cordgrass (*Spartina alterniflora*) in the lower elevational zones, black needlerush (*Juncus roemericanus*) in the mid-level zones, and salt grass (*Distichulus spicata*) and slender cordgrass (*Spartina patens*) in the higher elevation zones that are only inundated on occasion.

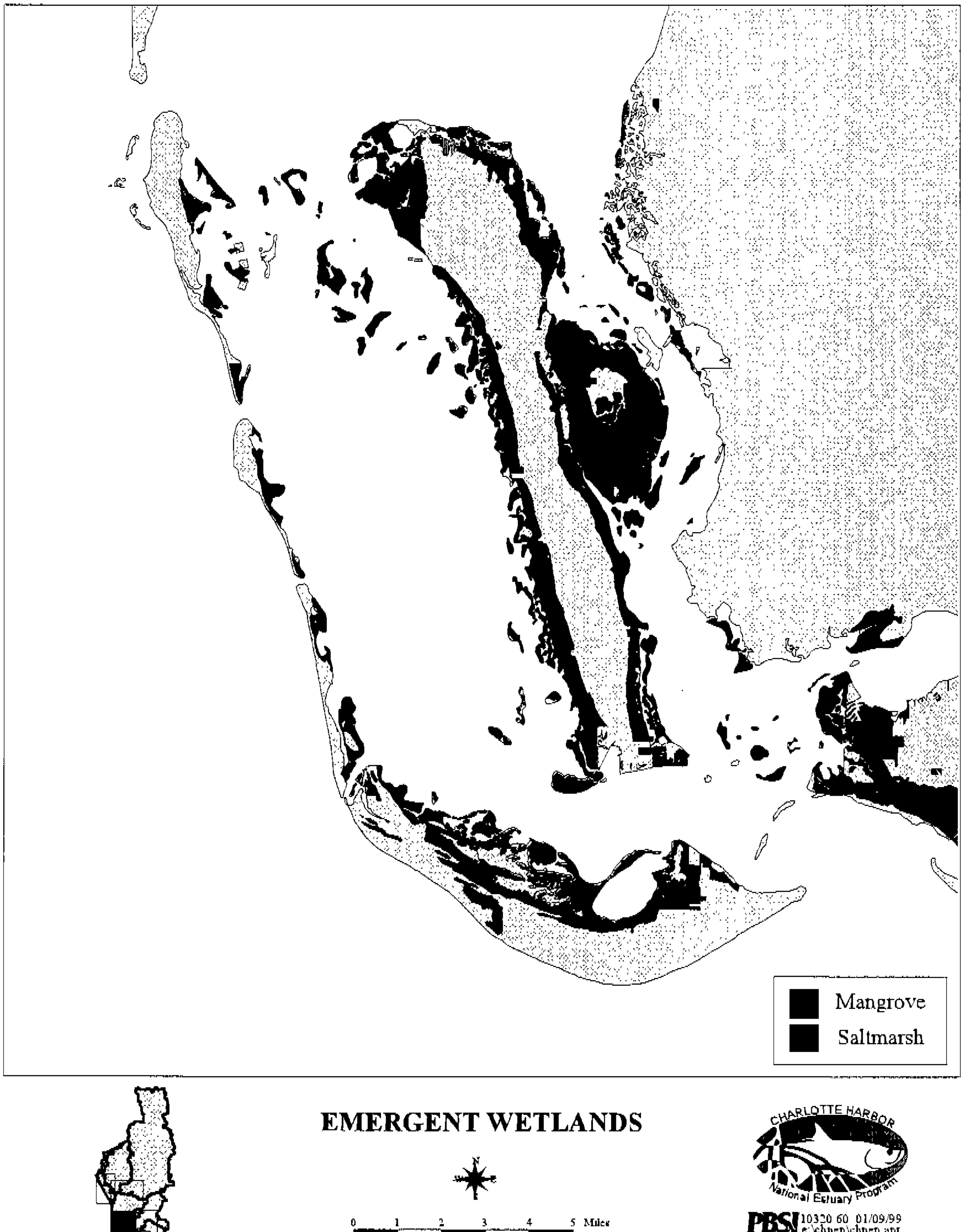


Figure 10-28. Emergent saltwater wetlands (black shaded areas) reported for the Caloosahatchee River area (SWFWMD, 1990).

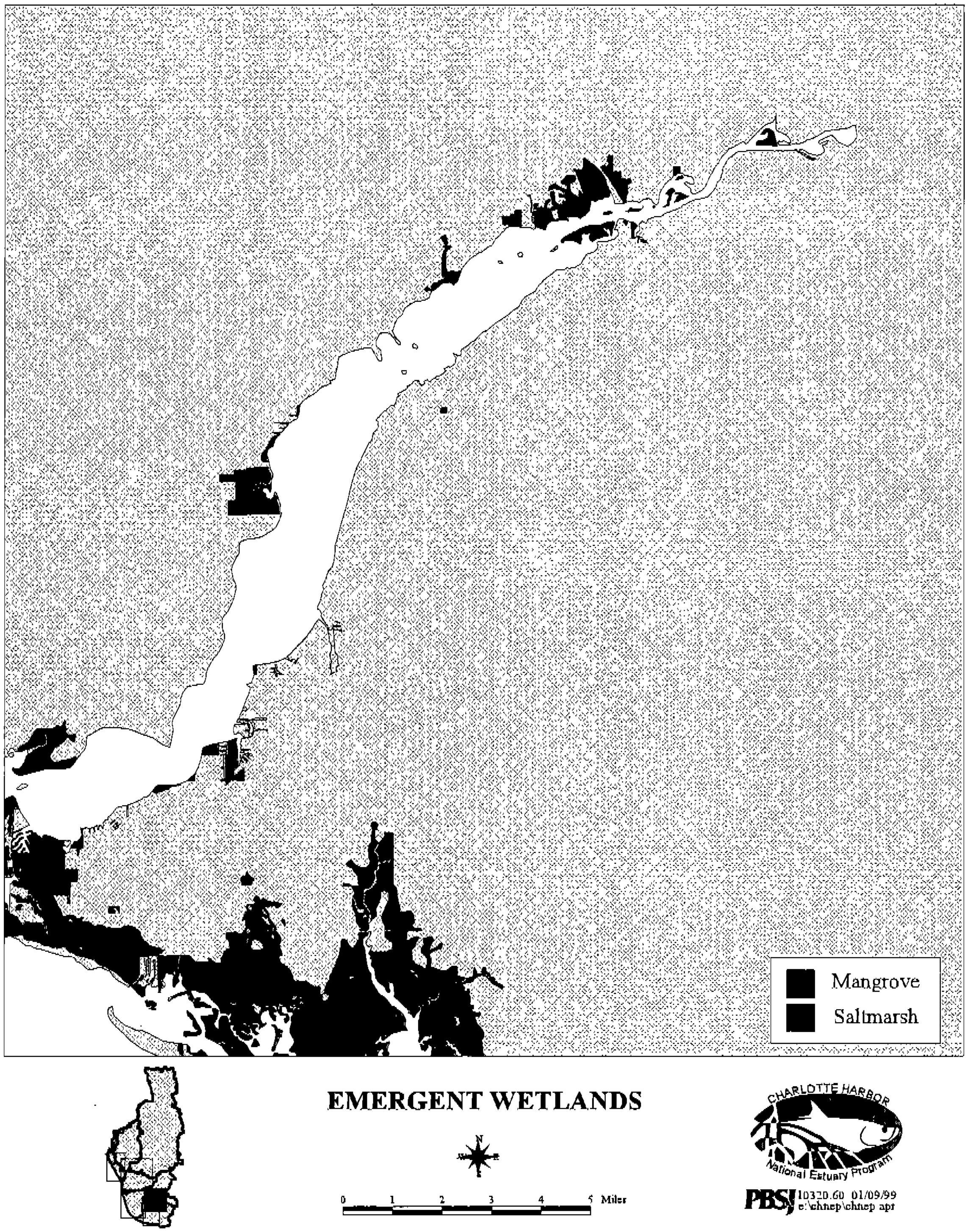


Figure 10-29. Emergent saltwater wetlands (black shaded areas) reported for Estero Bay (SWFWMD, 1990).

Similar to mangrove habitats, the submerged and emergent portions of the saltmarsh plants provide diverse functions for living organisms in the estuary. The emergent tops of the marsh plants provide hunting cover for animals such as bobcats and gray foxes; nesting sites for unique aquatic mammals such as rice rats (*Oryzmys palustris*); hunting and display perches for birds such as redwing blackbirds, boat-tailed grackles, and green herons, and protective cover for many animals such as racoons and marsh rabbits. The submerged portions of the marsh plants provide attachment sites for sessile organisms such as mussels and oysters, cover for intertidal aquatic animals such as fiddler crabs and killifish, and retain rich deposits of detrital food in riverine areas.

The distribution of saltmarshes in the Charlotte Harbor NEP study area was compiled from delineations completed in 1990 by the SWFWMD and in 1988 by the SFWMD. For comparison, a listing of basins and subbasins, and the acres of saltmarshes in each, appears in Table 10-15. The wetlands were delineated from color infrared aerial photographs.

Table 10-15. Acreages of saltmarsh in the Charlotte Harbor NEP area by major basin and subbasin.

Major Basin	Subbasin	Saltmarsh (acres)
Myakka River	Coastal Lower Myakka	1,369
Peace River	Coastal Lower Peace	1,681
Charlotte Harbor Proper		3,855
Lemon Bay		344
Pine Island Sound/Matlacha Pass		25
Tidal Caloosahatchee River	Lower Caloosahatchee	238
Estero Bay		1,644
Coastal Venice		62

A series of maps from these data is presented and descriptions given in the following text. These data are currently being updated by both of the Water Management Districts using photographs made in 1995.

Distribution in Lemon Bay

The saltmarsh habitat of the Lemon Bay coastal region was presented in Figure 10-25. The total reported saltmarsh acreage for this subbasin was 344 acres. Lemon Bay also has a very limited distribution of saltmarshes.

Distribution in Charlotte Harbor Proper

Figure 10-26 presented the distribution of saltmarsh habitats in the Charlotte Harbor proper region of the study area. These compiled data report a total of 3,855 acres of saltmarshes in the Coastal Charlotte Harbor Proper Subbasin, a total of 1,681 acres of saltmarshes in the Coastal Lower Peace River Subbasin, and 1,369 acres of saltmarshes in the Coastal Lower Myakka River Subbasin. There are two primary types of saltmarshes located in the Charlotte Harbor NEP study area, and both are represented well in this map. The first type is comprised of the meandering riverine saltmarshes depicted in both the Myakka and Peace Rivers. These riverine saltmarshes often are located apart from extensive mangrove forests due to the relatively steeper slopes of the upland river banks and the fact that the rivers are generally located in the more developed regions of the study area. The second type of saltmarshes are those located in pockets between the uplands and mangroves. These saltmarshes often have higher salinities associated with evaporative sandy depressions that are inundated only on higher tides. The saltmarshes and low growing, stunted mangroves in these areas are often surrounding sandy areas devoid of vegetation (saltbarrens). These pocket saltmarshes are visible along the western fringes of the Charlotte Harbor region.

Distribution in Pine Island Sound/ Matlacha Pass

The distribution of saltmarsh habitat of the Pine Island Sound and Matlacha Pass region was presented in Figure 10-27. The total reported saltmarsh acreage for the Pine Island Sound/Matlacha Subbasin is 25 acres. Pine Island Sound and Matlacha Pass have very few saltmarshes. Most of the emergent saltwater wetlands of this region are mangroves.

Distribution in the Caloosahatchee River

The saltmarshes in the Caloosahatchee River were presented in Figure 10-28. These mapped data report a total of 238 acres of salmarshes in the Lower Caloosahatchee River Subbasin. The saltmarshes are associated with the meandering portions of the river, and a mangrove fringed marsh near the mouth at Shell Point.

Distribution in Estero Bay

The Estero Bay saltmarshes were presented in Figure 10-29. Based on these mapped data, Estero Bay supported a total of 1,644 acres of saltmarshes. The saltmarshes of the northern portion of

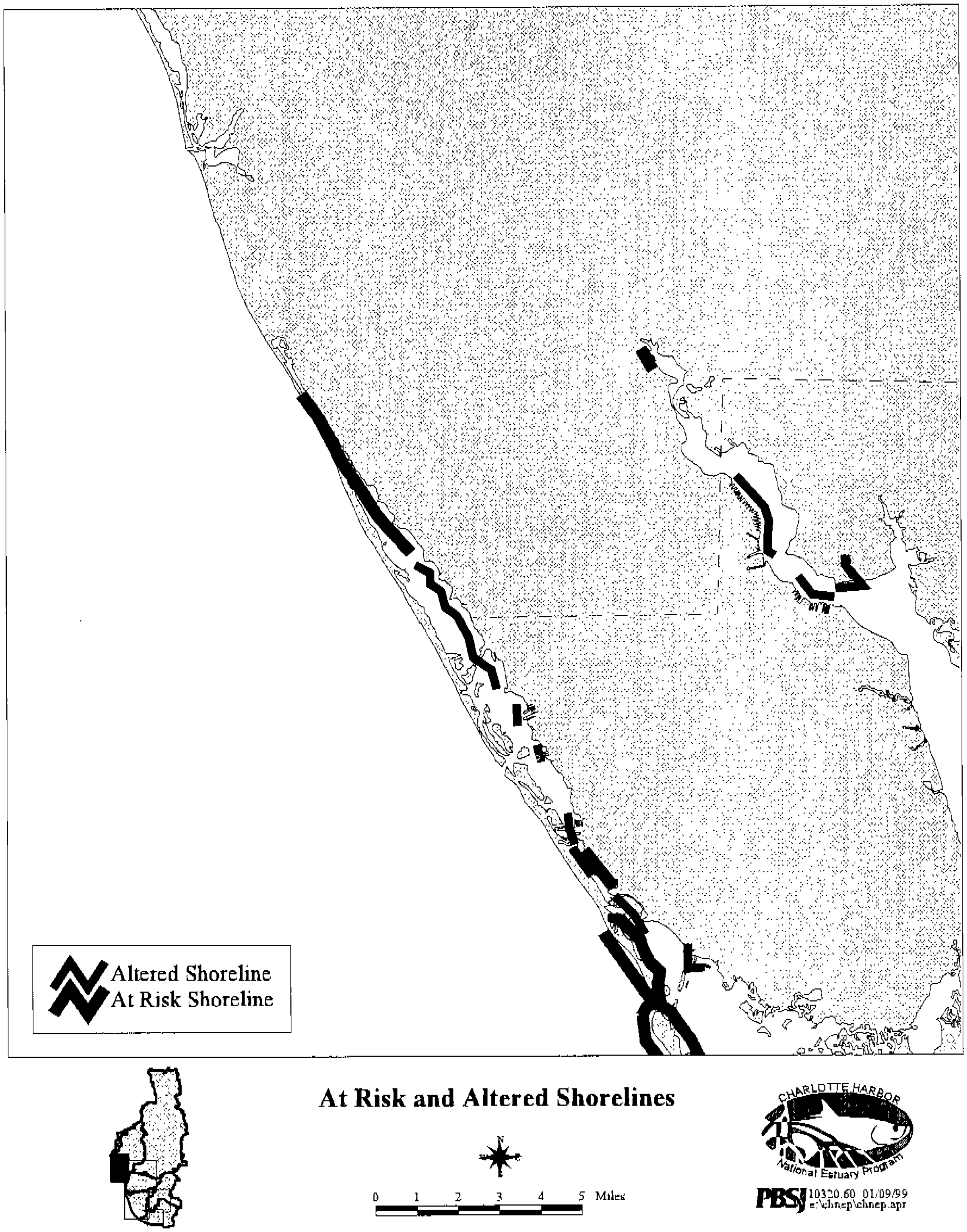


Figure 10-30. Altered and at risk shorelines in the Lemon Bay region.

Estero Bay represent some of the largest of the pocket type marshes (previously discussed) in the study area. In particular two expansive marsh systems exist along the northern shore of the Estero Bay Aquatic Preserve.

10.2.3 Shorelines

The shorelines of the Charlotte Harbor NEP study area represent important harbor habitats. The natural shorelines such as mangrove fringes, oyster reefs, and saltmarshes serve functions of feeding and nursery areas for living organisms, stabilize sediments and buffer the estuary from the impacts of urban and industrial development. The anthropogenically altered shorelines of the study area include hardened seawalls, rock rubble, and pile bulkheads. These hardened shorelines often lower the value of shoreline habitats by reducing the amount and diversity of physical structure, and decreasing the stability of near shore sediments.

For this Charlotte Harbor NEP project, the altered shorelines of the study area were delineated from topographic quadrangles, NOAA nautical charts, and field observations. The data were compiled in the form of a GIS database, and are summarized in the following maps.

Distribution in Lemon Bay

The Lemon bay altered shorelines are presented in Figure 10-30. The inland altered shorelines shown in this figure are associated with the town of Englewood to the north, and the town of Grove City to the South. The inner shorelines of the barrier islands are primarily mangrove-fringe, and the barrier islands are primarily used for recreational swimming on the Gulf side. The beaches include Blind Pass Beach, Englewood Beach, and Don Pedro Island.

Distribution in Charlotte Harbor Proper

Figure 10-31 presents the altered shorelines in the Charlotte Harbor Proper region. For the expansive size of this estuary, it is remarkable that the majority of the shoreline remains in an unaltered state. This area represents one of the least impacted large-water body estuary shorelines in the United States. The altered shorelines in the harbor proper are primarily associated with the cities of Port Charlotte, West Port Charlotte, and Punta Gorda to the north. These cities were built at the mouths of the Peace and Myakka Rivers, and the shorelines were developed accordingly. Other smaller extents of altered shoreline are located on the eastern side of the harbor. They are Alligator Creek to the north and Pirate Harbor to the south.

Distribution in Pine Island Sound/ Matlacha Pass

Figure 10-32 summarizes the distribution of altered shorelines in the Pine Island Sound and Matlacha Pass region. Very little of the shorelines in this region has been altered.

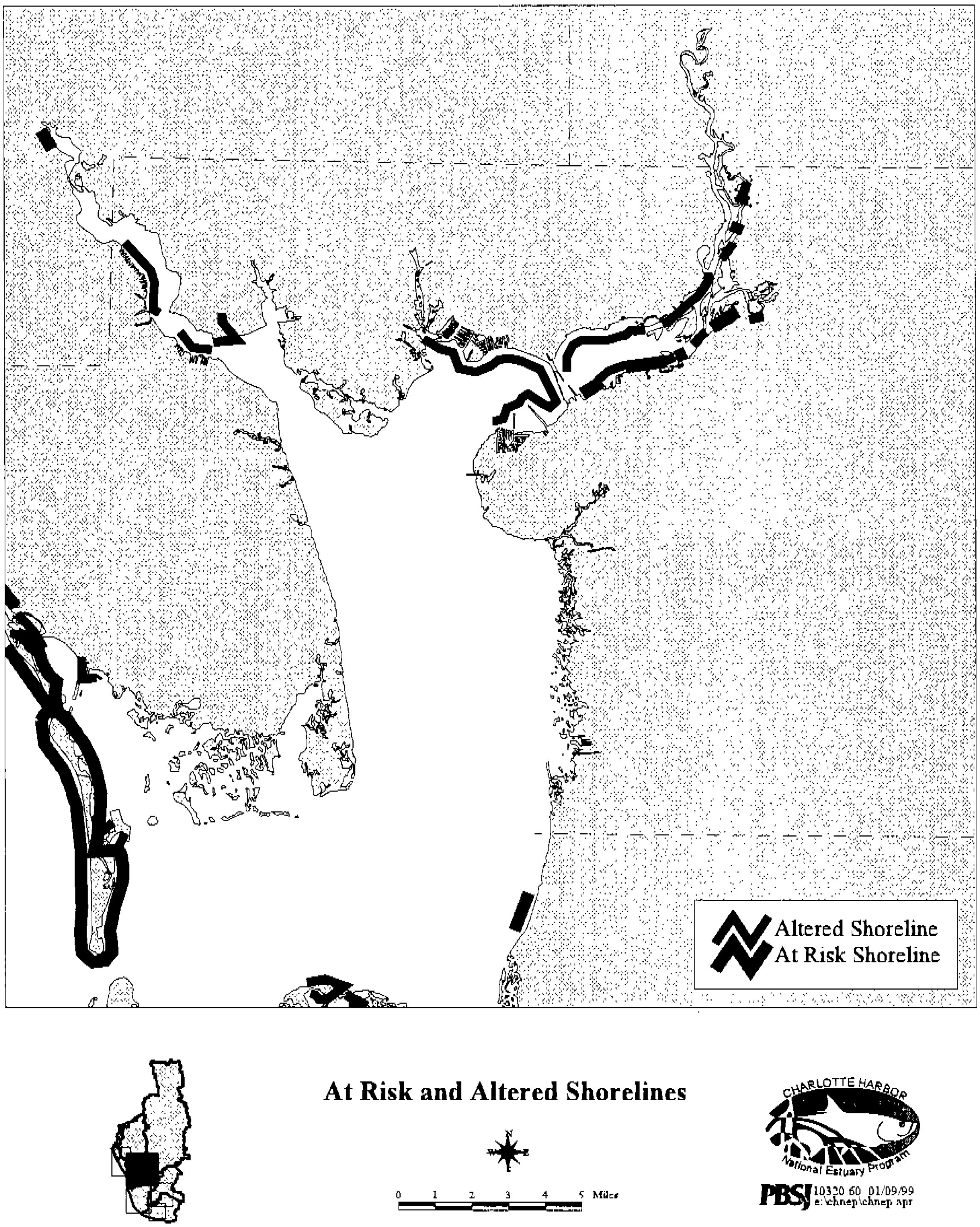


Figure 10-31. Altered and at risk shorelines in the Charlotte Harbor region.

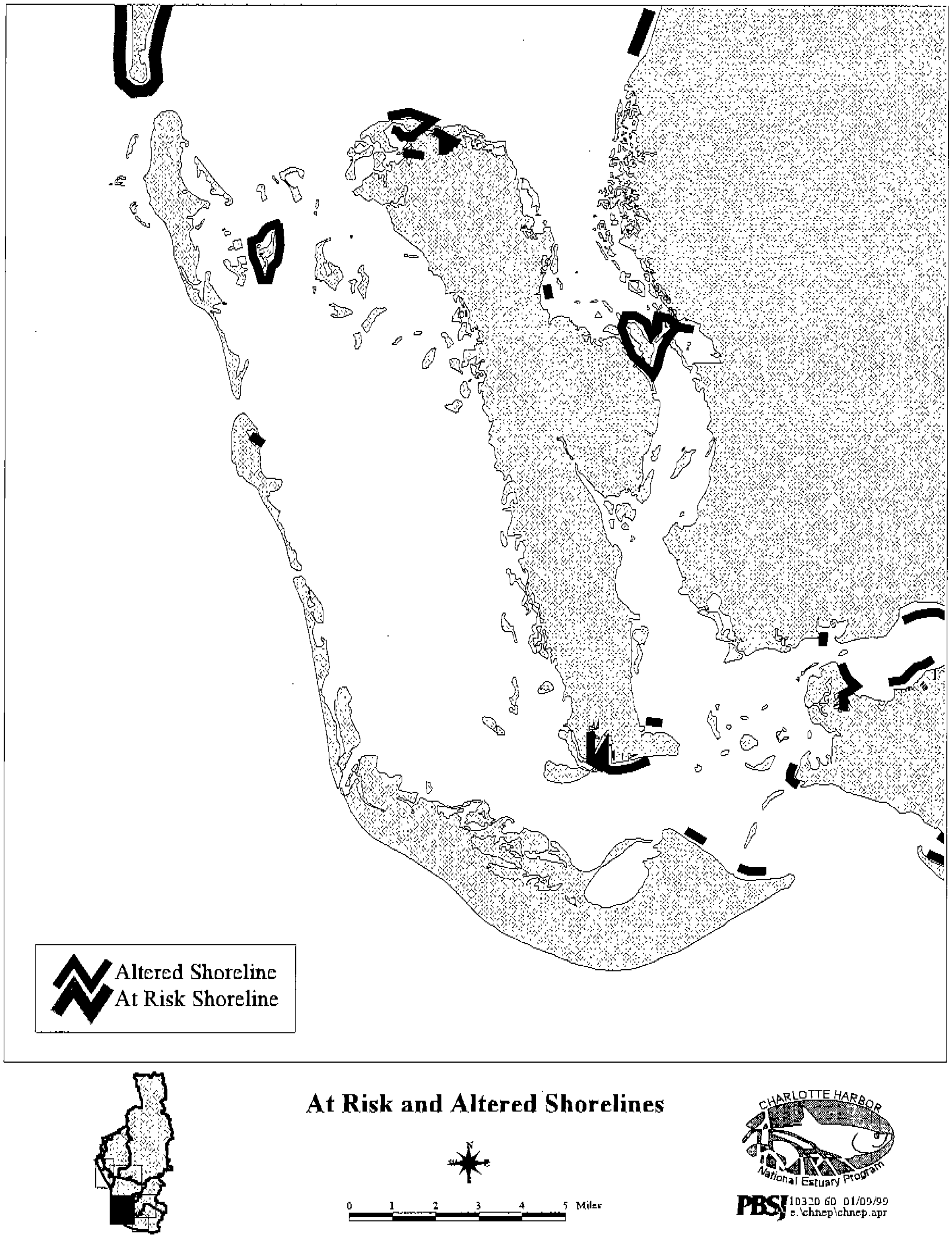


Figure 10-32. Altered and at risk shorelines in the Pine Island Sound and Matlacha Pass region.

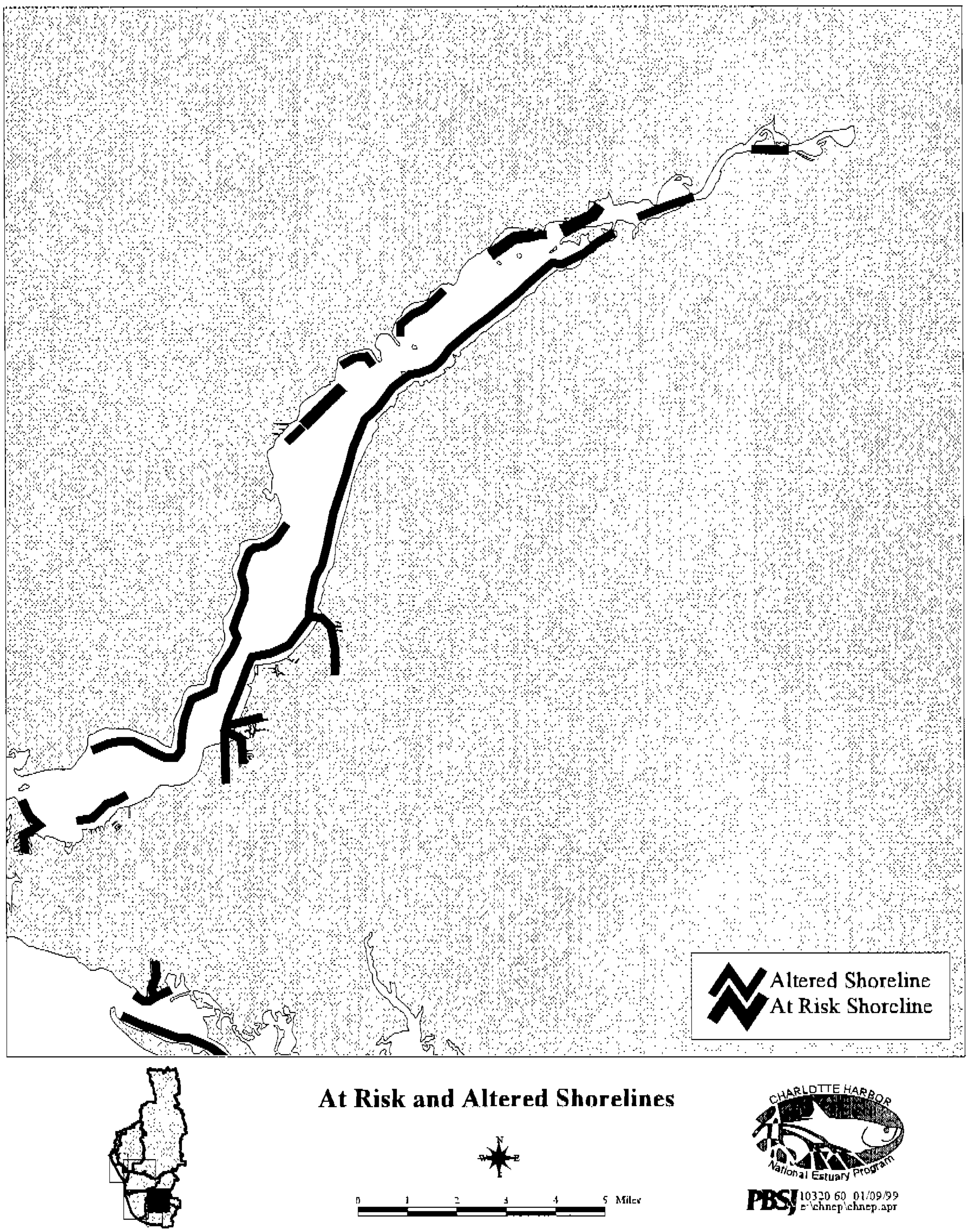


Figure 10-33. Altered and at risk shorelines in the Caloosahatchee River region.

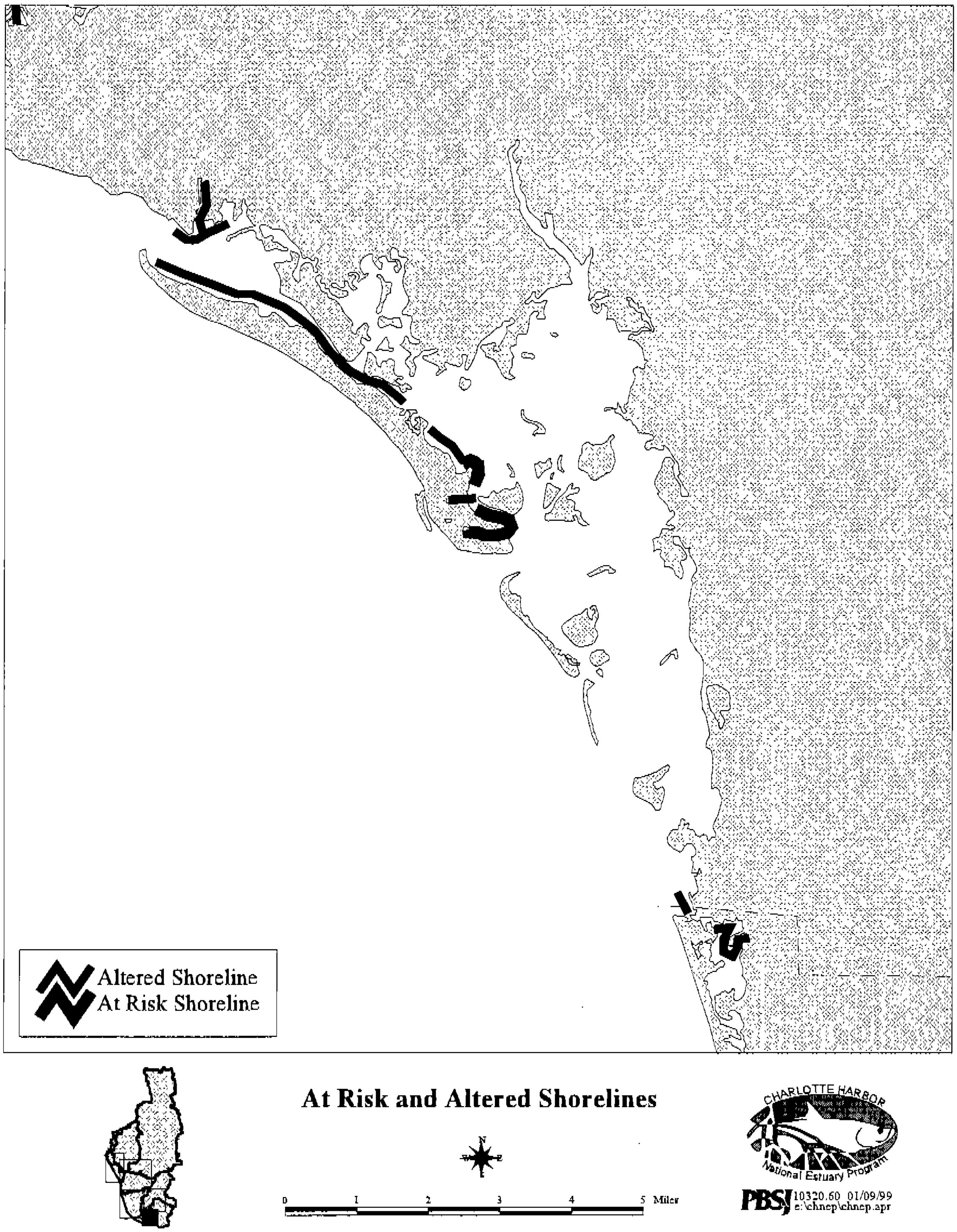


Figure 10-34. Altered and at risk shorelines in the Estero Bay region.

The shorelines on the Gulf Coast are primarily recreational beaches on Sanibel Island, and the shorelines of the interiors of the region are primarily mangrove forests as previously discussed. The altered shoreline shown at the south tip of Pine Island is the settlement of St. James City.

Distribution in the Caloosahatchee River

In contrast to the Charlotte Harbor Proper region, the shores of the Caloosahatchee River have been almost entirely altered due to development. The altered shorelines of the Caloosahatchee River are presented in Figure 10-33. These shorelines are the result of the relatively large urban areas of Cape Coral, Fort Myers, and North Fort Myers that were constructed on its shores. The few remaining unaltered shores of this portion of the river are primarily located in the north on the Caloosahatchee National Wildlife Refuge.

Distribution in Estero Bay

The Estero Bay altered shorelines are presented in Figure 10-34. The majority of the shorelines of Estero Bay are protected in conjunction with the buffer zones for the Estero Bay Aquatic Preserve. The altered shorelines of Estero Bay are almost entirely associated with the fully developed shores of the barrier island, Estero Island.

10.3 Critical Harbor Habitats

Many of the waters of the Charlotte Harbor NEP area are currently protected as Aquatic Preserves, while many natural shoreline habitats have been altered and are considered to be at risk. Each of these is discussed below.

10.3.1 Aquatic Preserves

Most of the water area of the Charlotte Harbor NEP study area is currently protected as a state Aquatic Preserve. The Aquatic Preserves of the study area are summarized in Figure 10-35. In Charlotte Harbor Proper these areas include the Charlotte Harbor/Gasparilla Sound Aquatic Preserve that totals 79,168 acres, and the Cape Haze Aquatic Preserve which totals 11,284 acres. The Lemon Bay Aquatic Preserve totals 7,667 acres. The Pine Island Sound Aquatic Preserve totals 54,176 acres, and the Matlacha Pass Aquatic Preserve totals 12,511 acres. Lastly, the Estero Bay Aquatic Preserve totals 9,834 acres.

In addition to the Aquatic Preserves, the State of Florida has designated State Buffer Preserves to protect the shorelines of the Aquatic Preserves from development pressures. These State Buffer Preserves are also depicted in Figure 10-36. They include 5,940 acres at Cape Coral; 11,168 acres at Cape Haze (including Cape Cave and Myakka estuaries); 4,515 acres at Pine Island, 6,677 acres at Port Charlotte; 5,494 acres at Estero Bay. The Estero Bay State Buffer Preserve is associated with an additional 640 acres of protected buffer land that is currently owned by the Nature Conservancy.

10.3.2 Shoreline Habitats at Risk

A number of factors combine to put at risk currently natural shoreline areas within the Charlotte Harbor NEP. The root cause of such potential threats to natural shorelines come from intense development pressure along the barrier islands and other coastal areas. Historically, within certain areas of the Charlotte Harbor NEP, natural shorelines were altered to reduce erosion by various hardened techniques including, seawalls, rock rubble and rip-rap. Such hardened shorelines generally provide shoreline habitats of less biological value since the amount and diversity of physical variation is reduced.

Because of regulatory changes made during the 1970's and 1980's permitted shoreline hardening has become far less common. In fact compared to many other developed areas of the state, the natural shorelines within southwest Florida remain relatively intact. However, as coastal development continues to rapidly expand throughout the area pressures will intensify to modify natural shorelines. Such activities can be expected to include:

- the trimming of existing mangrove fringes to provide both residential access and enhanced views,
- construct boat docks and access points, and
- stabilization of beaches, passes and navigation.

Potential areas where such activities may be expected to occur are indicated in Figures 10-31 through 10-34.

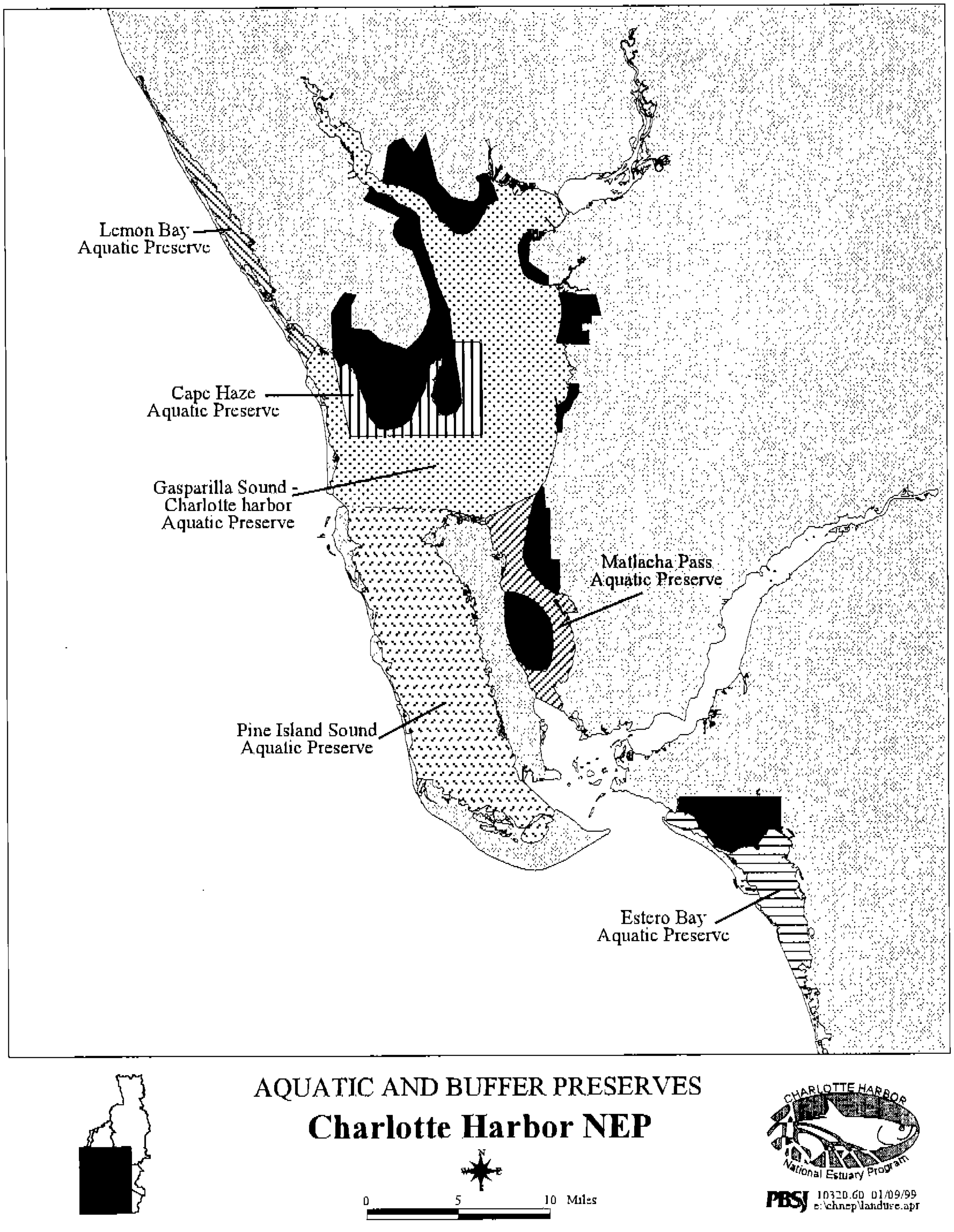


Figure 10-35. Aquatic Preserves and State Buffer Preserves in the Charlotte Harbor NEP study area.

11. Inland Habitats

Inland habitats of ecological significance to the Charlotte Harbor NEP estuarine system are discussed in this section. The focus of this chapter is on habitats that define the most important interactions between the estuary and inland resources and habitats. These critical habitats include the following:

- wetland habitats that provide water quality benefits and habitat for important species;
- habitats that serve as nesting, breeding, and feeding grounds for important species;
- riverine habitats; and
- critical habitats for listed species.

Because water flows from the inland habitats into the rivers and estuaries of the Charlotte Harbor NEP, impacts to water quality, hydrology, and habitats of inlands can impact those of coastal areas. Changes in river flows and water quality may alter freshwater flows and nutrient inputs to the coastal areas and impacts on inland habitat may fragment and disrupt habitat and migratory corridors used by wildlife. The major basins within the Charlotte Harbor NEP encompass a variety of land cover types and habitats. Some of the more common are discussed briefly below.

Swamps are broadly defined as forested wetlands (Myers and Ewel, 1990). Although more than half of Florida was originally wetland (swamp and marsh), it has been estimated that more than half of that coverage has been lost. Wooded swampland still comprises approximately 10% of Florida's land cover. In the Charlotte Harbor NEP area, swamps comprised of cypress and mixed hardwoods are distributed adjacent to lakes and rivers, in sloughs, and in shallow ponds. The upper Myakka River and the Peace River both support extensive swamp fringes.

Six-mile Swamp, south of the Caloosahatchee River is a major southern cypress stand within the Charlotte Harbor NEP area, and is at the northern end of the swamp system that includes Corkscrew Swamp, Big Cypress Swamp, and Fakahatchee Strand and extends south to Florida Bay.

Wetlands provide a variety of benefits to both the natural communities and human oriented activities of the Charlotte Harbor NEP area. Wetlands provide a buffer between uplands and open water and remove pollutants from runoff, retain surface water for flood attenuation, and provide bank and shoreline stabilization. Surface water/groundwater interactions are also enhanced by wetlands, which often provide conduits for groundwater recharge. Swamps and marshes are also critical habitats for numerous important species. Breeding, nesting, and feeding activities of many beneficial and listed species occur in wetlands. The distribution of forested and non-forested freshwater wetlands and open water habitats in the Charlotte Harbor NEP major basins are discussed below.

Marshes, or non-forested wetlands, make up about one-third of all wetlands in Florida and are well-represented in the Charlotte Harbor NEP area. However, most of the marshes in the Charlotte Harbor watersheds are small. These small marsh areas, characterized as seasonal ponds, extend throughout the pine flatwoods of the system. The only major expanses of marsh in the study area are along the Myakka River, which are considered highland marshes. Highland marshes are formed through an interaction of topography and geologic solution features, and can be unstable. Marshes provide all of the water quality, water quantity, and habitat benefits of forested wetlands, as listed above.

Lakes are not common in the Charlotte Harbor NEP watersheds, with the exception of the extreme headwaters of the Peace River. Lakes Hancock, Parker, and the Lakeland "Chain of Lakes" are at the northern extent of the peninsular Florida lake district. Florida lakes can include a diversity of habitats because of the range in sizes, shoreline convolutions, and variations in water chemistry (Myers and Ewel, 1990). Many of the lakes in the upper Peace River Basin are in or near urban areas, and support much recreational use. Also, there are many lakes in this basin that have been created through phosphate mining operations.

Riverine habitats provide a linkage between the estuary and inland areas. River channels and associated fringe wetlands are very important habitats for birds, mammals, and other native biota. Pollutant assimilation, floodwater attenuation, and groundwater recharge also occur in riverine systems. Major rivers of the Charlotte Harbor NEP include the Peace, Myakka, and Caloosahatchee, as well as the smaller coastal rivers including the Orange, Estero, Imperial, and others.

The ***pine flatwood*** is the most extensive type of terrestrial ecosystem in Florida (Myers and Ewel, 1990). It typically has acidic, sandy soil, is poorly drained, and has a low, flat topography. Pine flatwoods extend over most of the Charlotte Harbor NEP area, from just inland of coastal systems to the river headwaters. Pine flatwood represents by far the most common land cover of upland, non-urban lands. Humans have had a significant effect on pine flatwoods, clearing vast acreages for timber. The resulting prairies have become a stable land cover in themselves.

Scrub and high pine habitats are uncommon, and are best represented in the Charlotte Harbor NEP watersheds along reaches of the Peace River and towards the Highlands Ridge area, which is near the southernmost extent of these areas. Scrub and high pine are characterized by tall, twisted sand pines, scrub oaks, and an understory of shrubs and vines, with dry, sandy soil (Myers and Ewel, 1990). Like pine flatwood, scrub and high pine depend on periodic fire to maintain their viability.

11.1 Critical Inland Habitats

The following sections describe important and critical habitats of the inland portions of the major basins of the Charlotte Harbor NEP. Maps of Strategic Habitat Conservation Areas (SHCA maps) and biodiversity "hot spots" are identified for several species in this chapter.

Using habitat and distribution maps, public land boundaries, and literature-based density estimates, the individual maps of under-represented species were merged into a single statewide map of *proposed strategic habitat conservation areas (SHCAs).* Conservation areas were identified for rare communities (e.g. scrub, pine rocklands), rare plants, wading birds, and bat caves and were included in the strategic habitat conservation areas. Strategic habitat conservation areas show lands needed to meet minimum conservation goals (FGFWFC, 1994).

Regional maps of hot spots of biodiversity have been mapped by FGFWFC (1994). Individual habitat maps for 44 focal species and rare natural communities highlight potential habitat and records from FNAI, FGFWFC, and other sources were added for other natural resources. Finally, boundaries of public lands were added to show relationships between natural resources and distribution of public ownerships. The 44 focal species serve as indicator species of biological diversity in Florida.

Much of the data used in identifying "hot spots" and SHCAs relied on Landsat satellite data collected in 30 m square "pixels" (0.25 acre cells). In addition, the Atlas of Florida Breeding Birds (Kale *et al.,*1992) references breeding locations in 7.5 minute quadrangle maps, an area of about 7,600 acres. Habitat of broad-ranging animals, such as bald eagles and panthers, was based on vegetation cover type. As a result of the artificial boundaries described above, some maps have "square" boundaries which coincide with quadrangle maps or other delineated areas.

11.1.1 Wetlands

Wetlands provide water quality improvement, flood attenuation, bank and shoreline stabilization, and habitat. Forested, non-forested freshwater wetlands, and open water habitats are discussed below, by major basin. The distribution and extent of forested and non-forested wetlands and open water habitat in the Charlotte Harbor NEP area are summarized in Table 11.

Some important issues in the Charlotte Harbor NEP area include distribution and abundance of remaining wetlands and the potential loss of wetlands because of overdrainage or filling. Acres of hydric soils (as contained in the SWFWMD and SFWMD GIS coverages) that currently have no wetland vegetation on the GIS coverages provide an estimate of land that was likely historically wetlands, but is now either excessively-well drained, or has been cleared for urban or agricultural use.

Peace River

The Peace River Basin contains large areas of open water (46,969 acres), as well as forested (131,607 acres) and non-forested (95,283 acres) wetlands. The highest acreage of open water (32,559 acres) is located in the Peace River at Bartow Subbasin, as described above. Forested wetlands are most expansive in the Charlie Creek Subbasin (26,642 acres), and the three upper

Peace River Subbasins (Bartow, Zolfo Springs, and Arcadia). Shell Creek, to the south, contains the most non-forested wetlands (30,537 acres). Examination of the entire Charlotte Harbor NEP study area shows that forested wetlands are most common in the Peace River Basin. Most forested wetlands in the basin fringe the main river channel.

Table 11. Wetland and open water habitat in the Charlotte Harbor NEP area.

Major Basin	Subbasin	Open Water (acres)	Forested Freshwater Wetlands (acres)	Nonforested Freshwater Wetlands (acres)
Myakka River	Upper Myakka	2,264	16,625	12,058
	Coastal Lower Myakka	3,269	17,492	31,848
Peace River	Peace at Bartow	32,559	19,378	11,908
	Peace at Zolfo Springs	3,364	18,119	6,520
	Peace at Arcadia	656	20,424	7,524
	Payne Creek	1,033	6,599	2,534
	Charlie Creek	1,275	26,642	11,880
	Joshua Creek	348	2,848	5,056
	Horse Creek	294	15,044	9,461
	Shell Creek	1,048	6,698	30,537
	Coastal Lower Peace	6,392	15,855	9,863
Coastal Harbor Proper		3,120	6,429	23,557
Lemon Bay		1,139	1,552	1,989
Pine Island Sound/ Matlacha Pass		4,502	1,652	2,415
Tidal Caloosahatchee River	Telegraph Swamp	0	7,041	7,469
	Orange River	211	1,054	1,358
	Lower Caloosahatchee	1,487	479	17,966
Estero Bay		2,059	41,029	16,790
Coastal Venice		1,494	4,234	5,706

Myakka River

The Coastal Lower Myakka River contains large expanses of non-forested wetlands (31,848 acres) in relation to the overall basin size, as discussed above. The watershed also supports substantial forested wetlands (17,492 acres), but less open water (3,269 acres). Upper Lake Myakka and Lower Lake Myakka are the primary open water habitats in this watershed.

Coastal Harbor Proper

The coastal drainage areas of the Charlotte Harbor NEP contain modest amounts of forested wetlands (6,429 acres) and open water (3,120 acres), but do include a large expanse of non-forested freshwater wetland, in addition to the substantial saltwater wetlands present. A total of 23,557 acres (almost 40 square miles) of non-forested wetlands exist in the near-harbor areas.

Coastal Venice

The Coastal Venice basin has approximately 18 square miles of freshwater wetlands and open water. Forested and non-forested wetlands share similar overall areas (4,234 and 5,706 acres, respectively), with less open water (1,494 acres).

Lemon Bay

The Lemon Bay major basin includes two to three square miles each of open water, and forested and non-forested wetlands. Many of these areas are along creeks east of Englewood.

Pine Island Sound/Matlacha Pass

This basin has more open water (4,502 acres) than either forested (1,652 acres) or non-forested (2,415 acres) wetlands. Freshwater wetlands occur on the mainland and Pine and Little Pine islands.

Caloosahatchee River

The Caloosahatchee River basin has extensive non-forested wetlands (26,788 acres), much of which is in the Lower Caloosahatchee subbasin. Telegraph Swamp, to the north of the river, contains most of the forested wetlands and a similar amount of non-forested wetlands, but no reported open water.

Estero Bay

The Estero Bay major basin includes expansive forested wetlands, and also large non-forested areas, located just east of the Corkscrew Swamp. Over 64 square miles (41,029 acres) of forested swamp, and over 26 square miles (16,790 acres) of non-forested marsh exist east of Estero Bay. These are very important wetland habitats, and are located at the northern edge of the swamp system that extends south to Florida Bay, as discussed above.

11.1.2 Breeding and Feeding Grounds

As discussed above, one of the functions that upland habitats can provide is to support the breeding and feeding of desirable estuarine species that depend on these areas to complete their life cycles. Inland habitats that are crucial for ibis, egrets, roseate spoonbill, brown pelicans, osprey, and eagles are discussed below.

Migratory species also occur throughout the Charlotte Harbor NEP study area, although habitat for these species is not included in the present discussion. Maps of Strategic Habitat Conservation Areas (SHCA) (FGFWC, 1994) for selected wading birds are presented in the following sections. These maps are based on the likelihood of occurrence of that species in a particular habitat or vegetation cover.

Resolution and the size of the units (pixels) used to generate the maps affect the way habitat distributions appear in the Figures.

Ibis

The white ibis is widely distributed throughout Florida, but is very common in south Florida's wetlands. Ibis use several inland habitats for feeding, including wet prairies, freshwater marshes, shallow lakes, and swamps. Nesting often takes place in mangroves. They also frequent agricultural areas, especially pastures and rangeland. Most of these habitat types are widely distributed throughout the major basins of the Charlotte Harbor NEP. Extensive wet prairies, rangeland, marshes, and riverine fringe swamps exist in the Peace River, Myakka River, Coastal Harbor Proper, Estero Bay, and Caloosahatchee River major basins. Less extensive feeding and nesting areas are found in the Lemon Bay, Coastal Venice, and Pine Island Sound/Matlacha Pass basins. Strategic Habitat Conservation Areas for white ibis, as defined by FGFWFC (1994) appear in Figures 11-1 through 11-5.

Egret

Egrets have feeding and nesting requirements similar to Ibis. Egrets feed in wet prairies, freshwater marshes, and swamps. They also frequent agricultural areas, especially pastures and rangeland, as well as vegetated dunes and salt marshes. As with white ibis, the most favored habitats of egrets are widespread in the Charlotte Harbor NEP major basins. The larger riverine basins provide the most extensive habitat while smaller, coastal, more urbanized basins offer less opportunity for feeding and nesting. Wading bird biodiverstiy "hot spots", as defined by FGFWFC (1994) are presented in Figures 11-1 through 11-5.

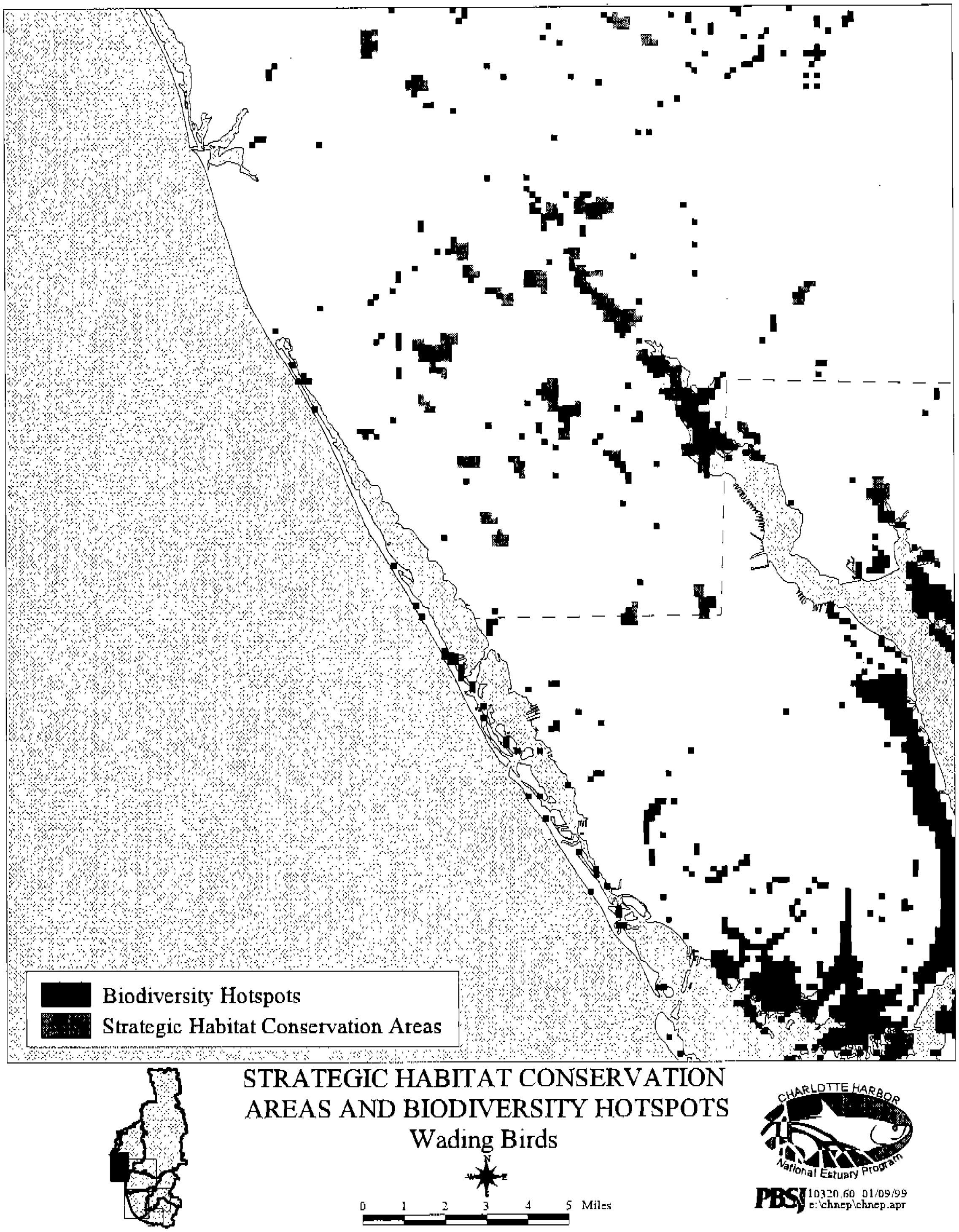


Figure 11-1. Strategic Habitat Conservation Areas (SHCA) for white ibis and wading bird biodiversity "Hot Spots" for Lemon Bay and the lower Myakka River area (after FGFWC, 1994).

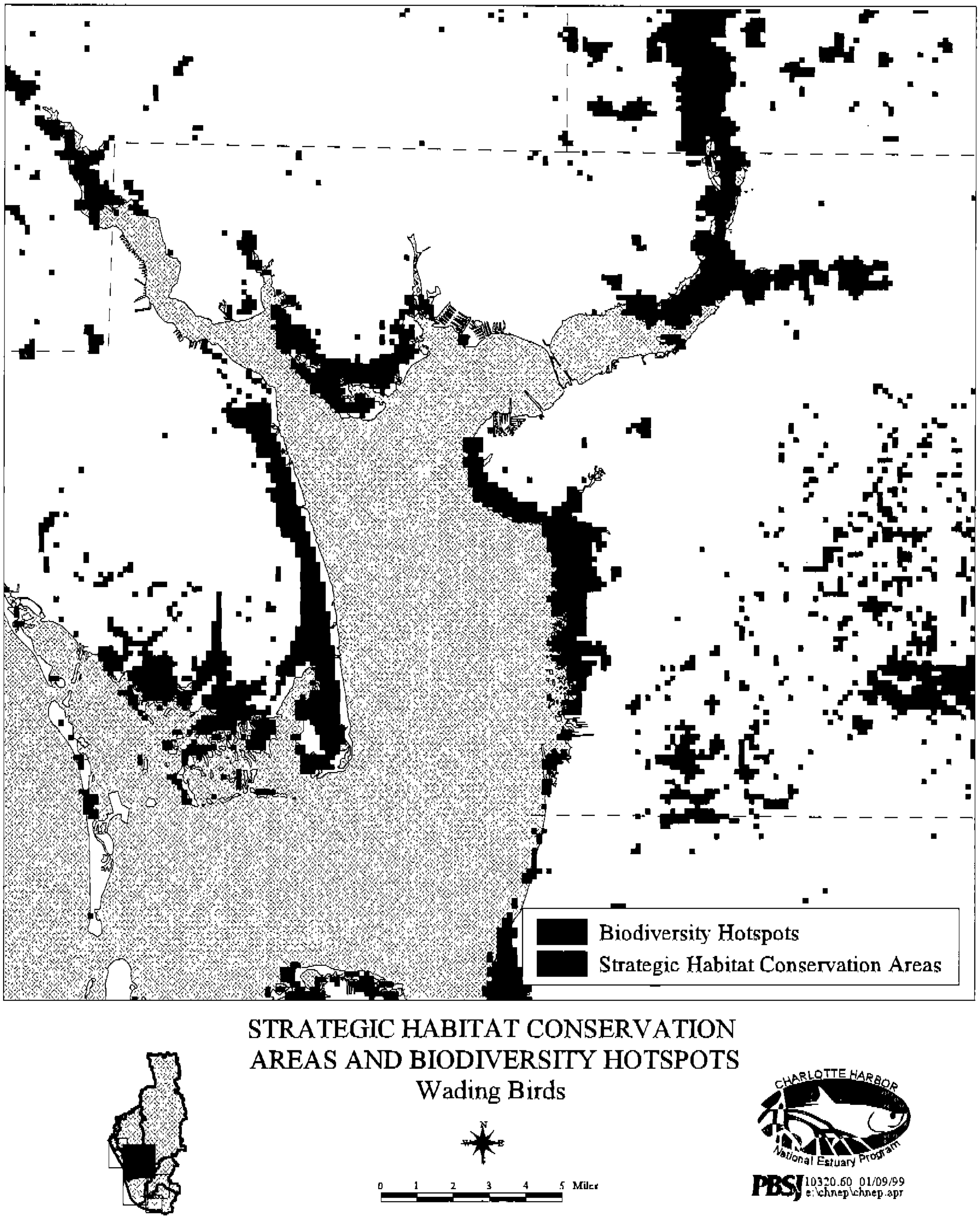


Figure 11-2. Strategic Habitat Conservation Areas (SHCA) for white ibis and wading bird biodiversity "Hot Spots" for Charlotte Harbor area (after FGFWC, 1994).

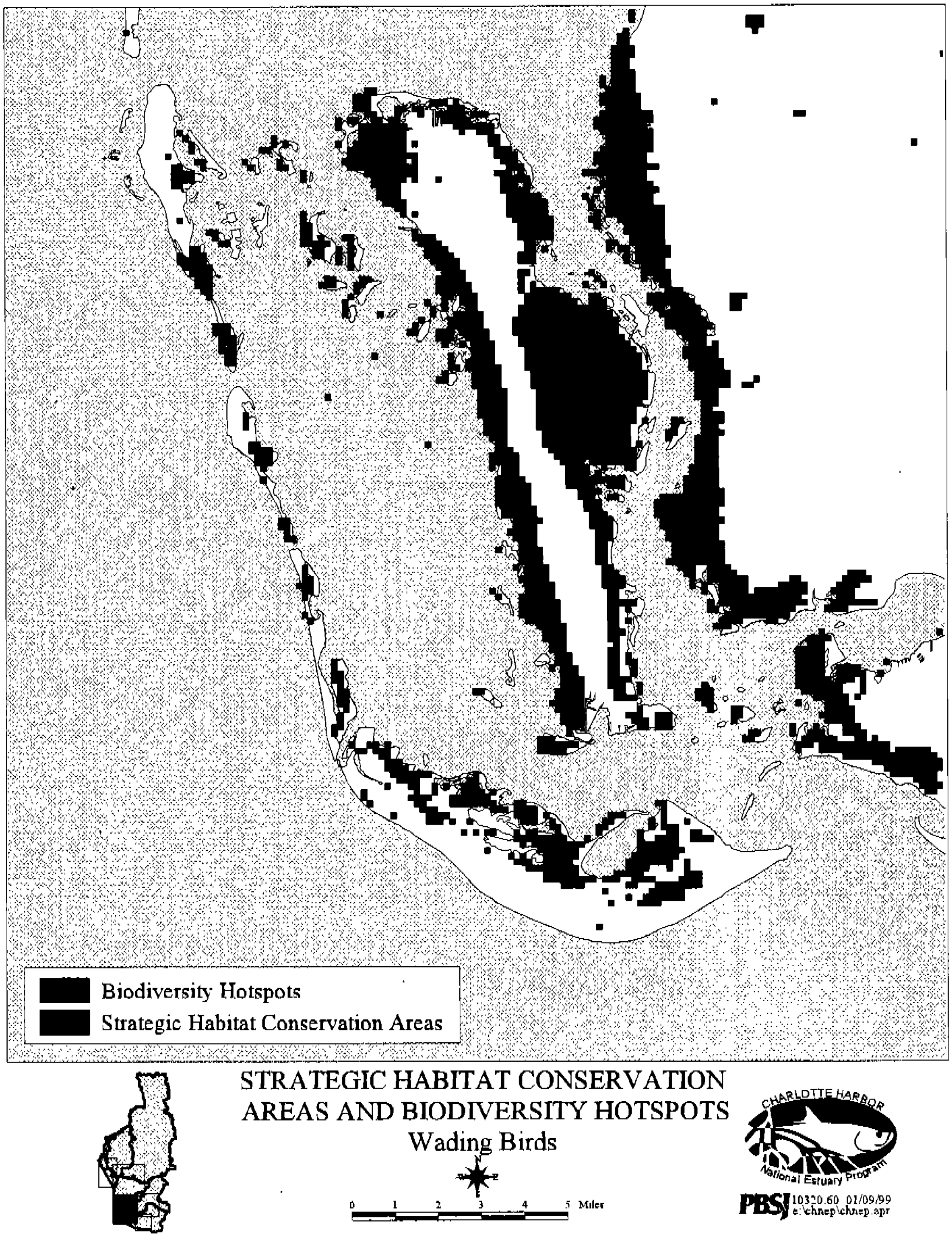


Figure 11-3. Strategic Habitat Conservation Areas (SHCA) for white ibis and wading bird biodiversity "Hot Spots" for Pine Island Sound and Matlacha Pass area (after FGFWC, 1994).

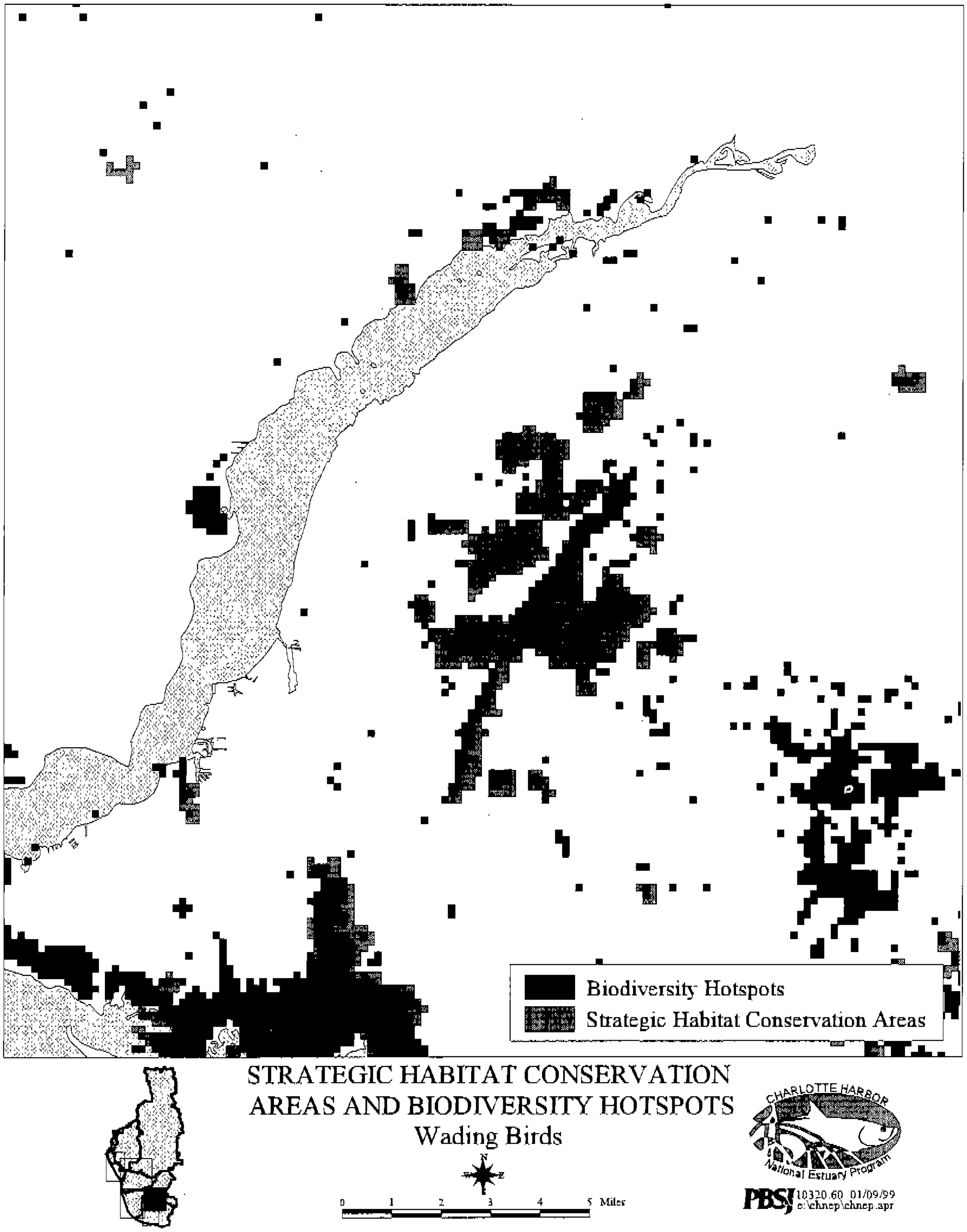


Figure 11-4. Strategic Habitat Conservation Areas (SHCA) for white ibis and wading bird biodiversity "Hot Spots" for the Caloosahatchee River area (after FGFWC, 1994).

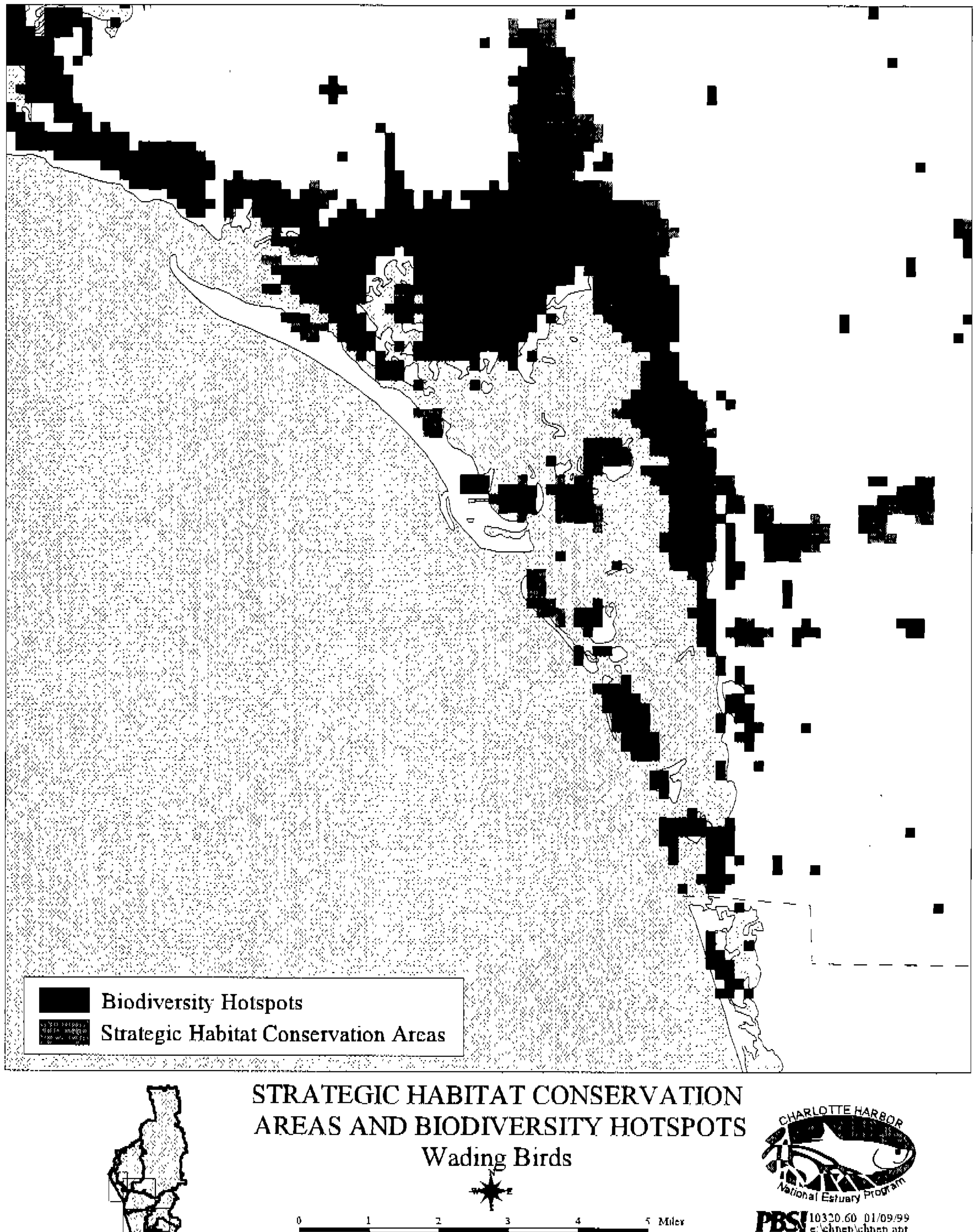


Figure 11-5. Strategic Habitat Conservation Areas (SHCA) for white ibis (shaded areas) for Estero Bay area (after FGFWC, 1994).

Roseate Spoonbill

Roseate spoonbills are primarily coastal birds, although they frequent south Florida's coastal and freshwater wetlands. Spoonbills nest in mangroves, often with heron or ibis colonies, and feed in shallow estuarine mud flats, coastal bays, lakes, and less frequently in freshwater marshes. Roseate spoonbills are frequently found in the Estero Bay, Coastal Harbor Proper, and Myakka and Peace river major basins.

Brown Pelican

Brown pelicans nest in coastal mangrove islands, and feed in offshore, estuarine, or freshwater open water. Fewer than 50 islands throughout Florida are used by brown pelicans for nesting. Most of the pelican's life is spent along the coastline, but they may be seen flying up-river in search of feeding grounds. Additionally, pelicans have been observed using phosphate pits for feeding. Brown pelican habitat, as defined by FGFWFC (1994), is shown in Figures 11-6 through 11-10.

Osprey

Ospreys are widespread in Florida, largely because of extensive open water habitats in which they feed. Ospreys feed in both estuarine and freshwater water bodies. Eggs are usually laid in nests in tall, living or dead cypress, pine, hardwood, or mangrove trees near aquatic food sources. Ospreys may also use man-made structures such as utility poles, radio towers, or other tall objects for nesting. Nesting may occur in groups if food is particularly abundant. Some of the largest concentrations of nesting in Florida occur in south Florida between Florida Bay and Ten-Thousand Islands, but osprey are very common throughout the Charlotte Harbor NEP coastal areas.

Eagle

Florida has the largest resident population of bald eagles in the continental United States, in spite of habitat loss and environmental contamination. A riparian bird, eagle nests are often built in tall pine trees near lakes, marshes, or along coastlines. Some inland pairs may build a nest far from open water, over marshes or dry prairies. Immatures may fly far inland at night to roost away from coastal nesting areas. A diet of fish and large wetland birds such as coots, grebes, and egrets ensures that any nearby eagles will be found near estuarine or freshwater bodies. Map of FGFWFC Strategic Habitat Conservation Areas for the bald eagle are also shown in Figures 11-11 through 11-15.

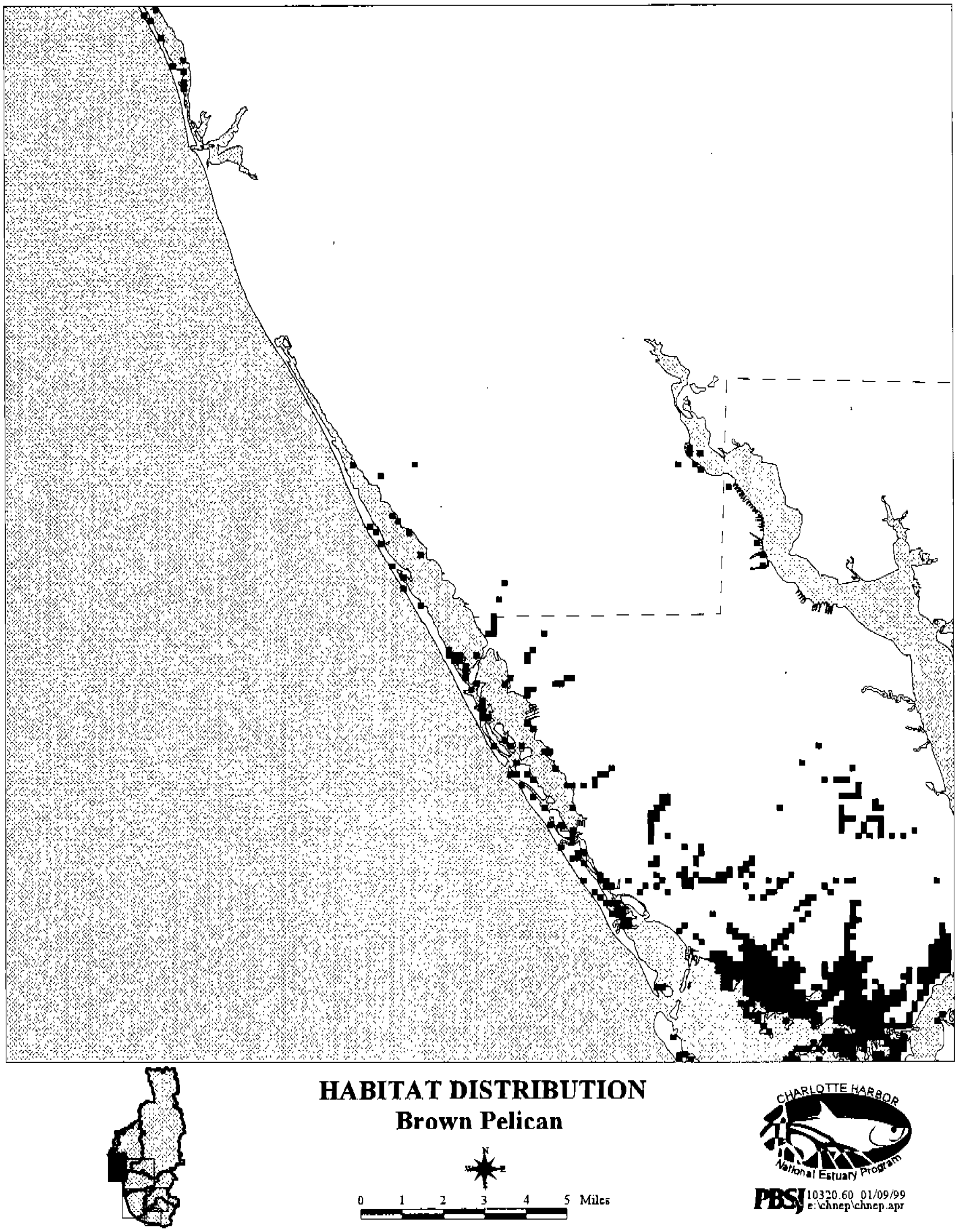


Figure 11-6. Brown pelican habitat (shaded areas) in Lemon Bay area (after FGFWC, 1994).

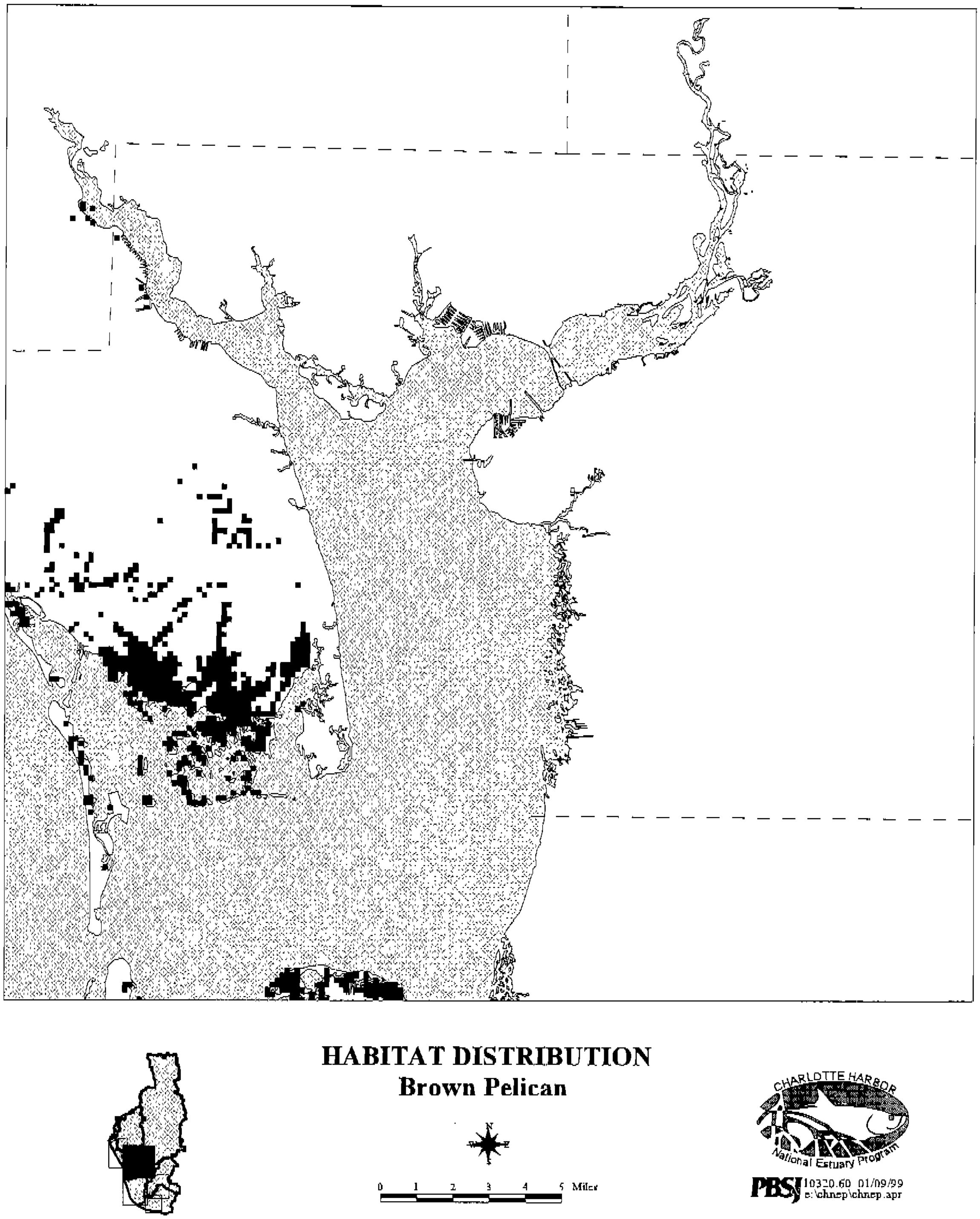


Figure 11-7. Brown pelican habitat (shaded areas) in Charlotte Harbor area (after FGFWC, 1994).

Figure 11-8. Brown pelican habitat (shaded areas) in Pine Island Sound and Matlacha Pass area (after FGFWC, 1994).

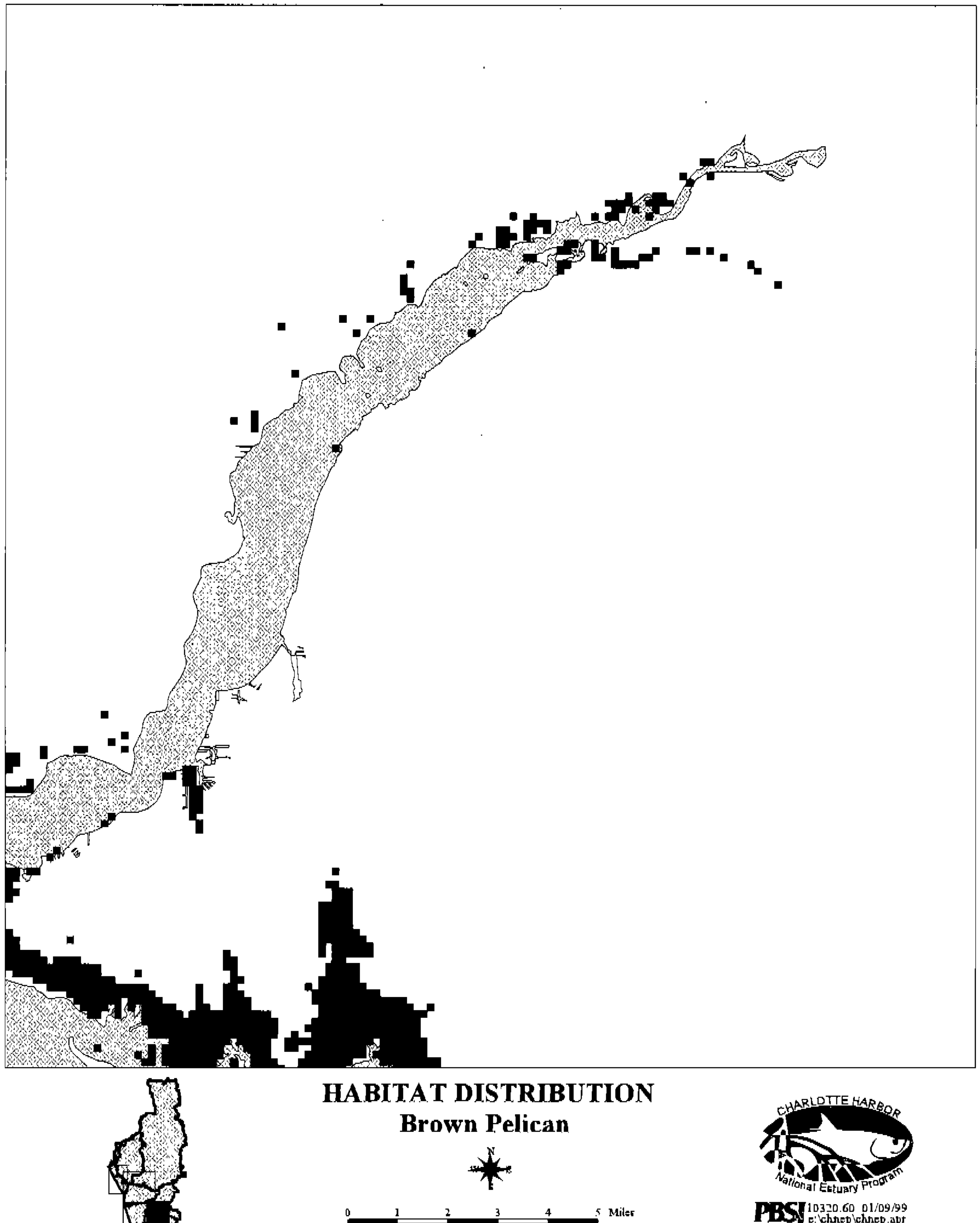


Figure 11-9. Brown pelican habitat (shaded areas) in the Caloosahatchee River area (after FGFWC, 1994).

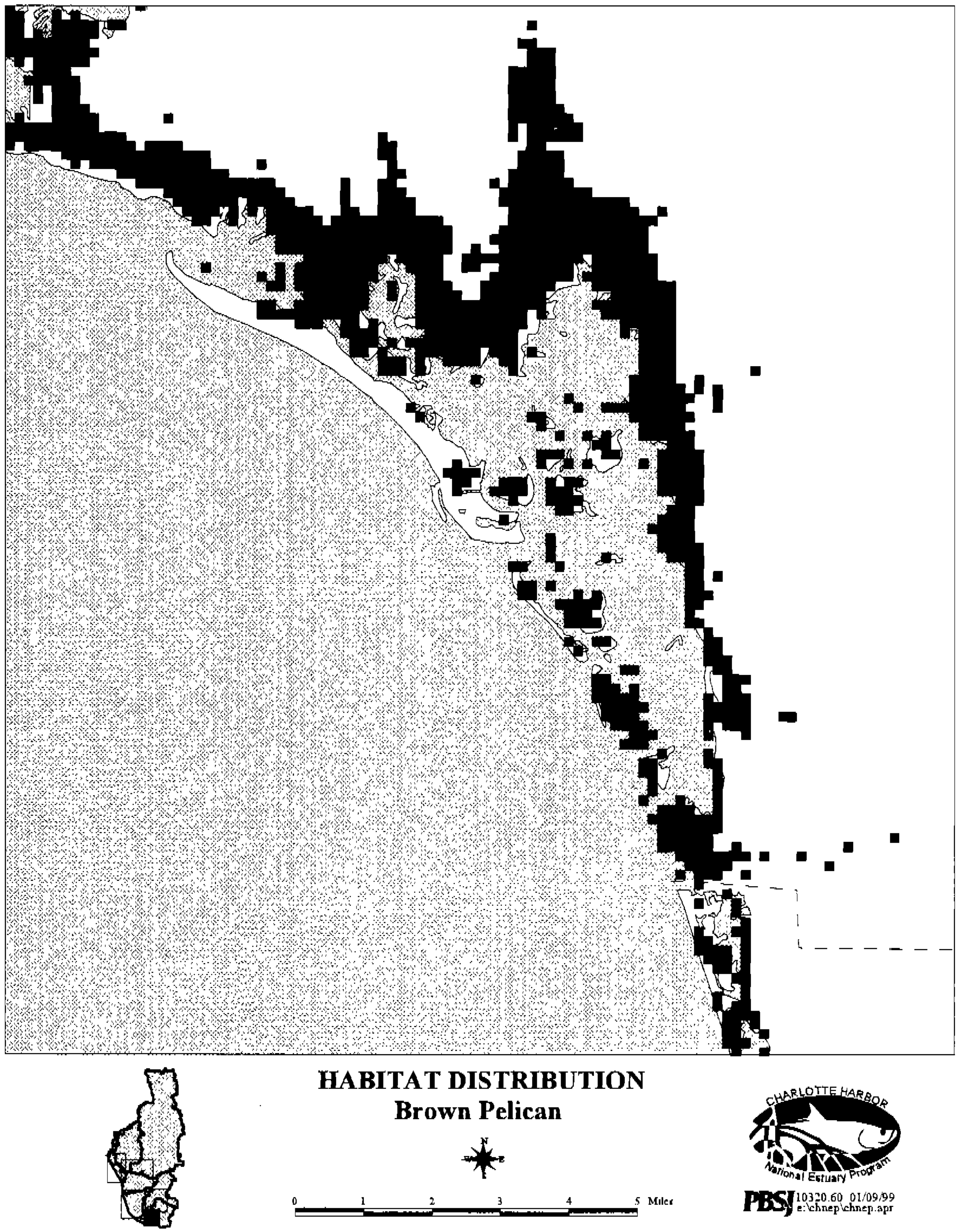


Figure 11-10. Brown pelican habitat (shaded areas) in Estero Bay area (after FGFWC, 1994).

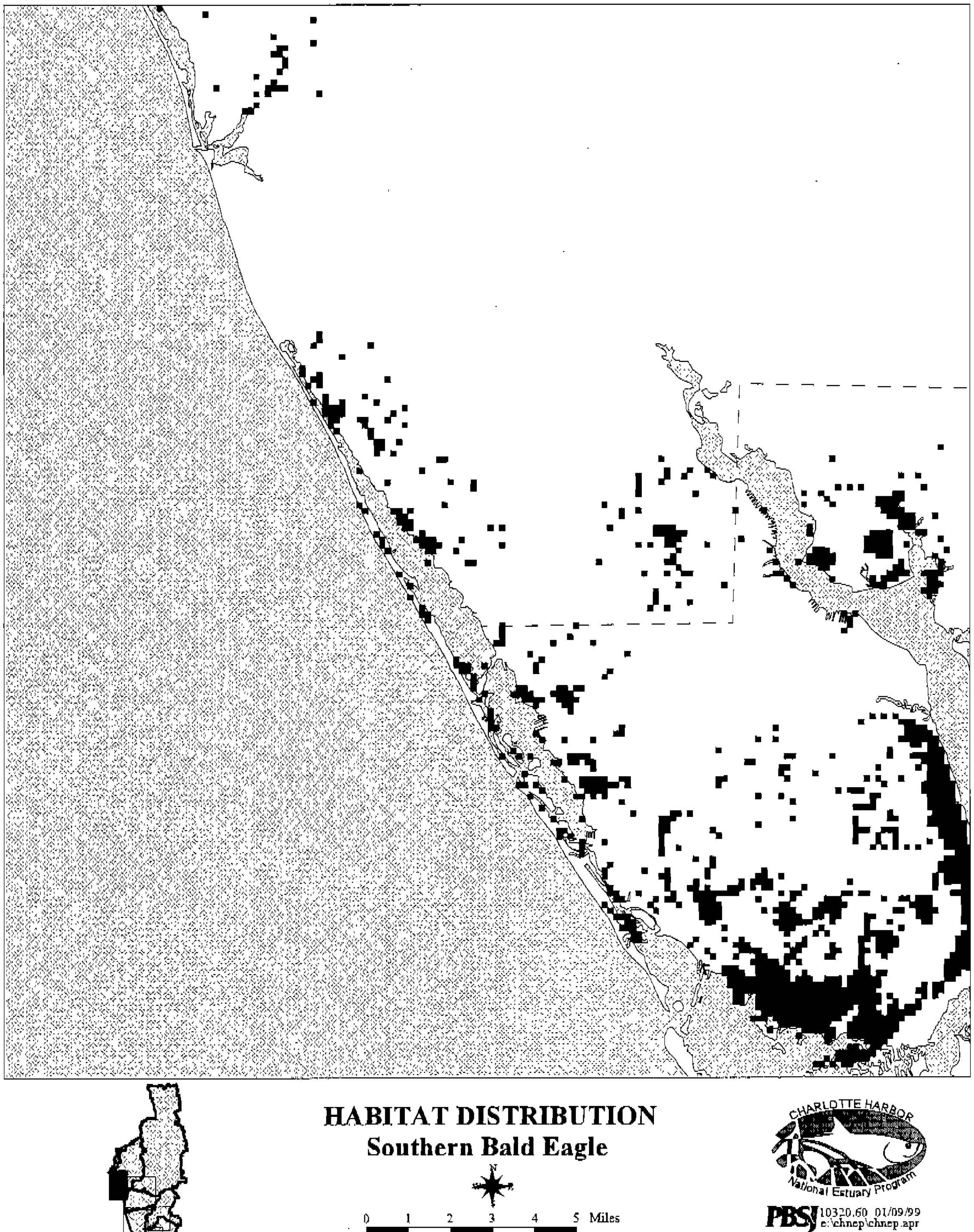


Figure 11-11. Strategic Habitat Conservation Areas (SHCAs) for the bald eagle in Lemon Bay area (shaded areas) (after FGFWC, 1994).

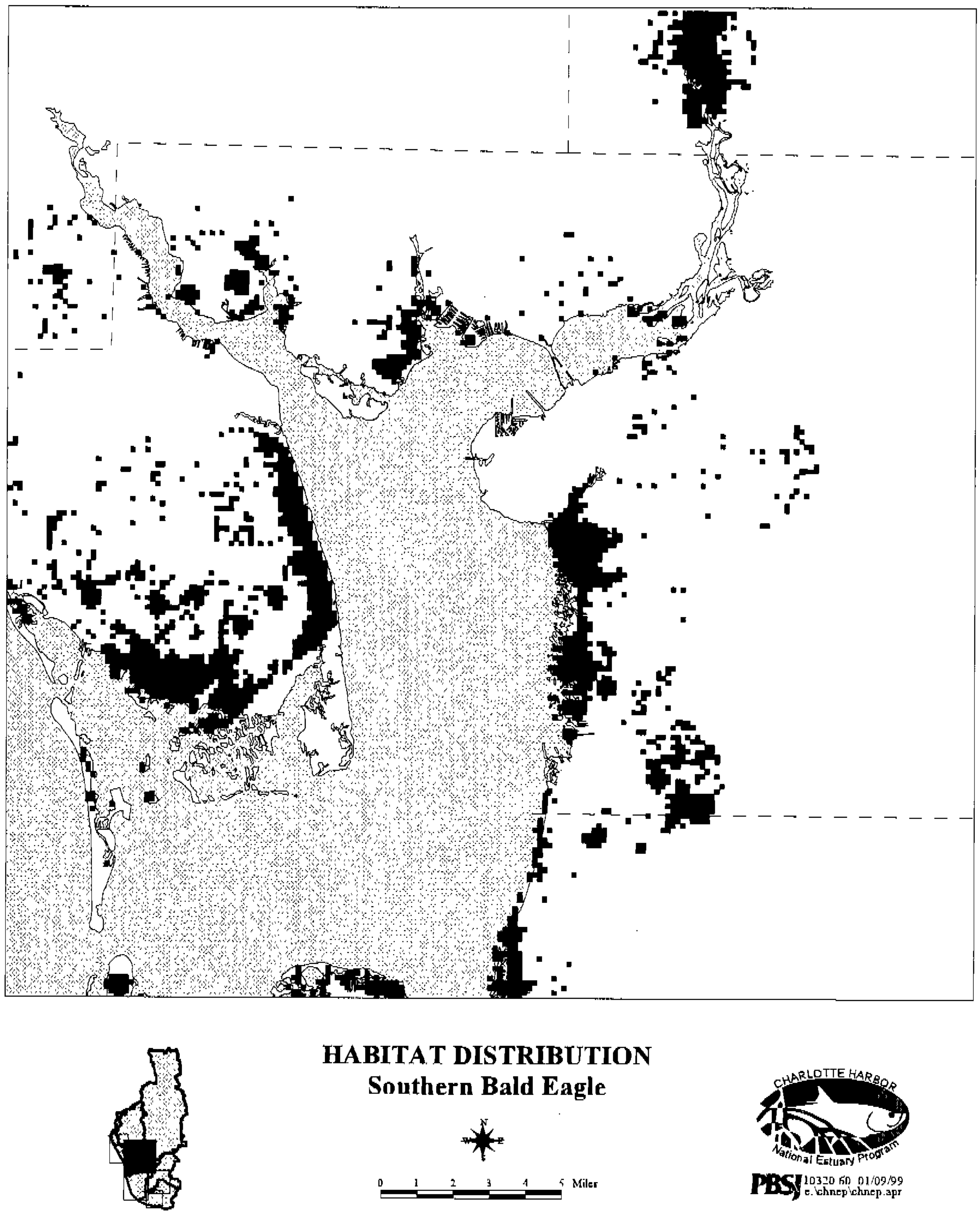


Figure 11-12. Strategic Habitat Conservation Areas (SHCAs) for the bald eagle in Charlotte Harbor area (shaded areas) (after FGFWC, 1994).

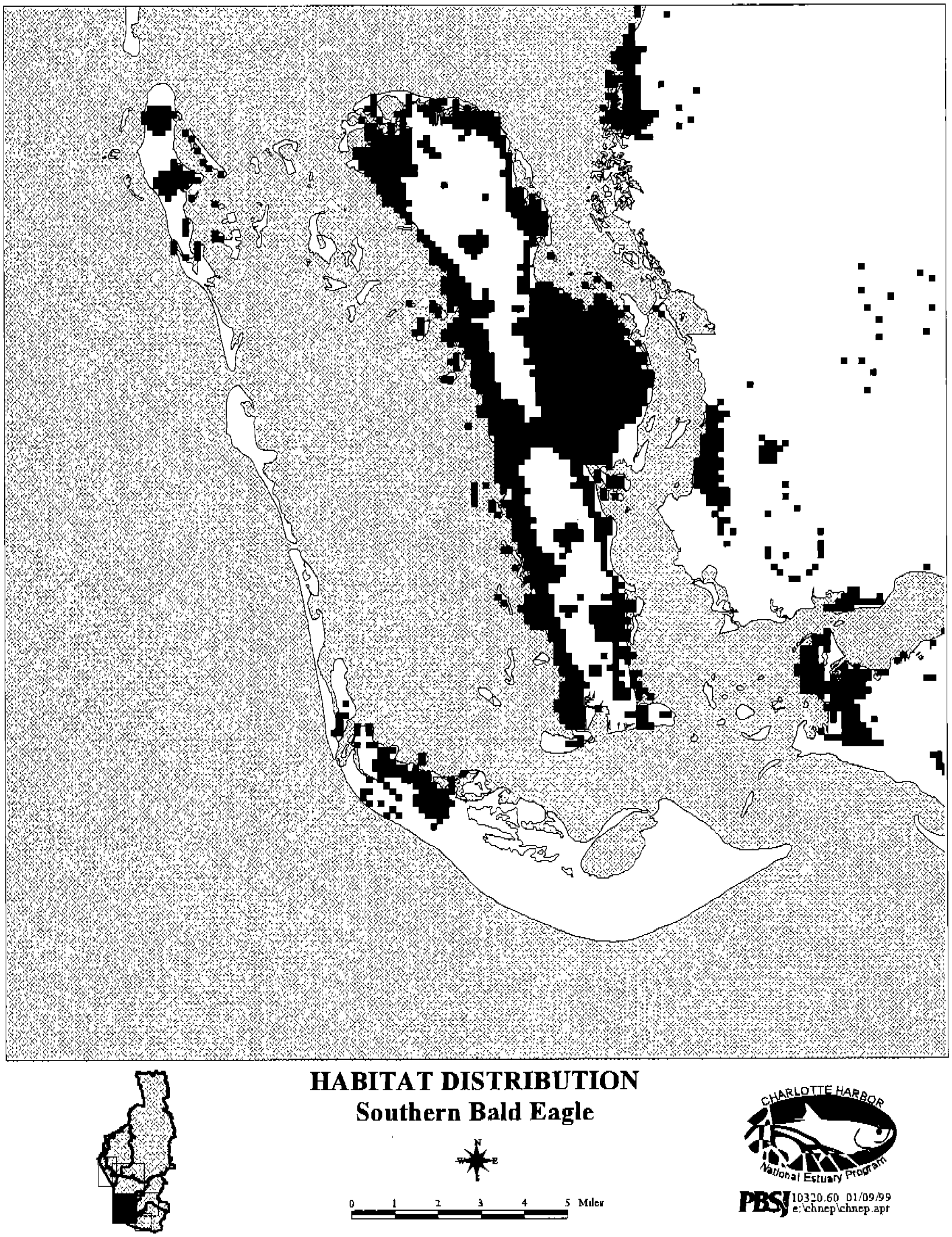


Figure 11-13. Strategic Habitat Conservation Areas (SHCAs) for the bald eagle in Pine Island Sound and Matlacha Pass area (shaded areas) (after FGFWC, 1994).

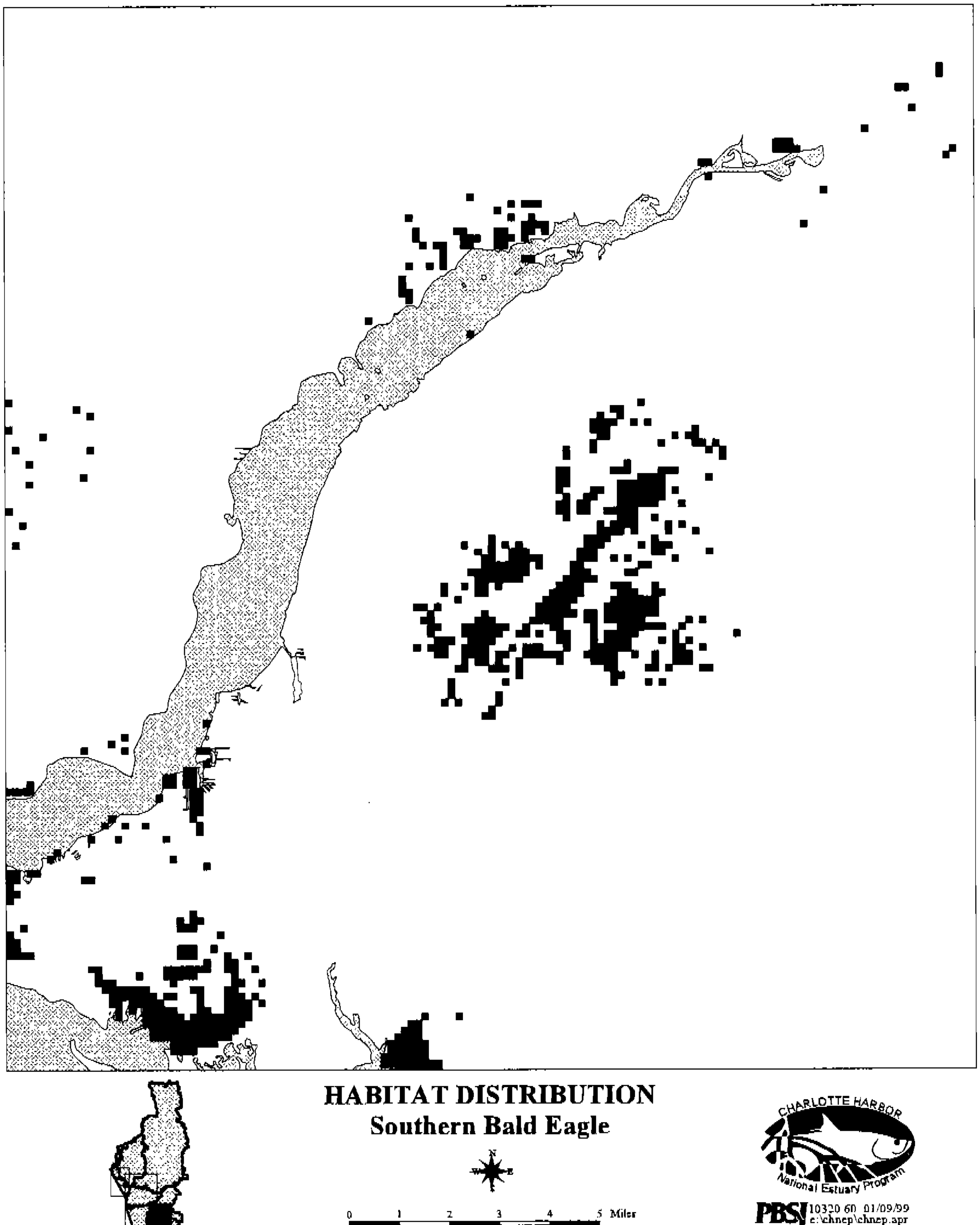


Figure 11-14. Strategic Habitat Conservation Areas (SHCAs) for the bald eagle in the Caloosahatchee River area (shaded areas) (after FGFWC, 1994).

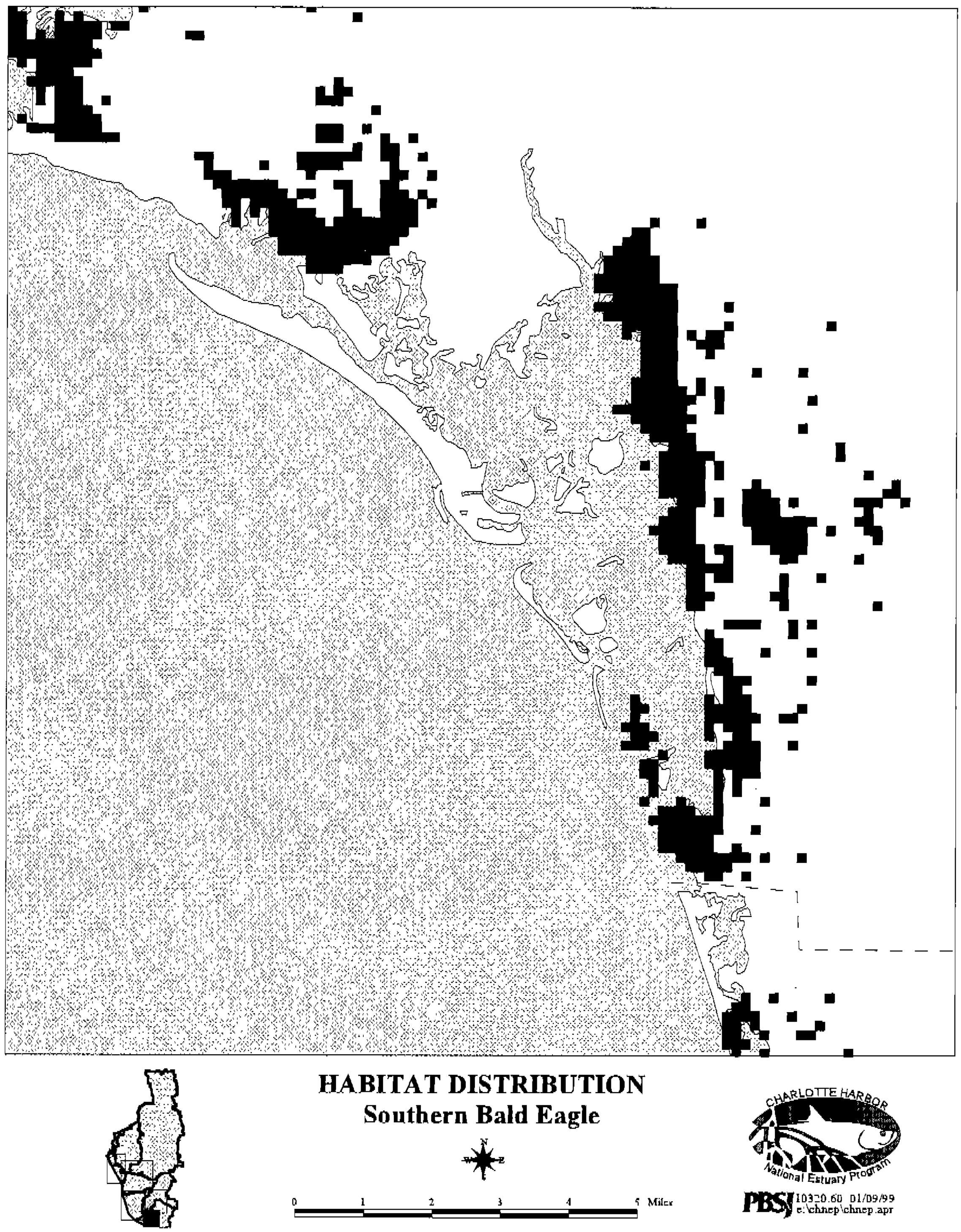


Figure 11-15. Strategic Habitat Conservation Areas (SHCAs) for the bald eagle in the Estero Bay area (shaded areas) (after FGFWC, 1994).

There are several marine fishes which use the freshwater rivers above the tidal influence in the Charlotte Harbor complex. The hogchoker, as a juvenile, is an obligate user of freshwater rivers. They may be found on sandy bottoms many miles upstream. As they grow, the larger individuals move downstream to the upper ends of estuarine systems where the adults live and spawn. Juvenile American eels ascend rivers in Florida to live and grow for six to twenty years before returning to the sea. Females move far inland and males remain in the estuary. All three river systems, the Myakka, Peace, and Caloosahatchee, support both the hogchoker and American eel species.

The gulf sturgeon, a subspecies of the Atlantic sturgeon, has been recorded in Charlotte Harbor both as an adult and as a juvenile. Adult gulf sturgeon are believed to spawn in rocky areas in rivers such as the Suwanee River several 100 miles to the north. Just above Arcadia, a rocky area exists that may provide suitable habitat. Neither the Myakka nor the Caloosahatchee rivers has such an area. The Charlotte Harbor complex is at the southern end of this sturgeon's range and it may not commonly occur here.

The bull shark is famous world-wide for swimming far upstream in rivers. Female bull sharks give birth near the headwaters of estuaries. These young sharks prefer to remain in freshwater. Young sharks have been taken from the Hog Island area in the summer. Such fish could be expected to be found occasionally well up the rivers.

Snook, tarpon, and mullet are well-known to penetrate far upstream in Florida rivers. None of these fish spawn in freshwater. This habitat is used, among many habitats, as a forage area. Smaller fish, young of the year and juveniles, can be found in the smaller tributaries to rivers and larger fish in the main stem of all three rivers in the Charlotte Harbor NEP complex. All three species, snook, tarpon, and mullet, reach Lake Okeechobee and have been recorded far upstream in the Myakka and Peace rivers.

11.1.4 Listed Species Habitats

The following section discusses critical habitat for two listed species in the Charlotte Harbor NEP area -- Florida panther and Florida scrub jay.

Florida Panther

The presence of Florida Panthers was recorded soon after Hernando deSoto landed in Tampa Bay in 1539. However, hunting pressure along with habitat loss from the expanding Florida population over the past centuries are largely responsible for decline in the panther population. SHCA areas for the Florida panther are shown in Figures 11-16 through 11-19.

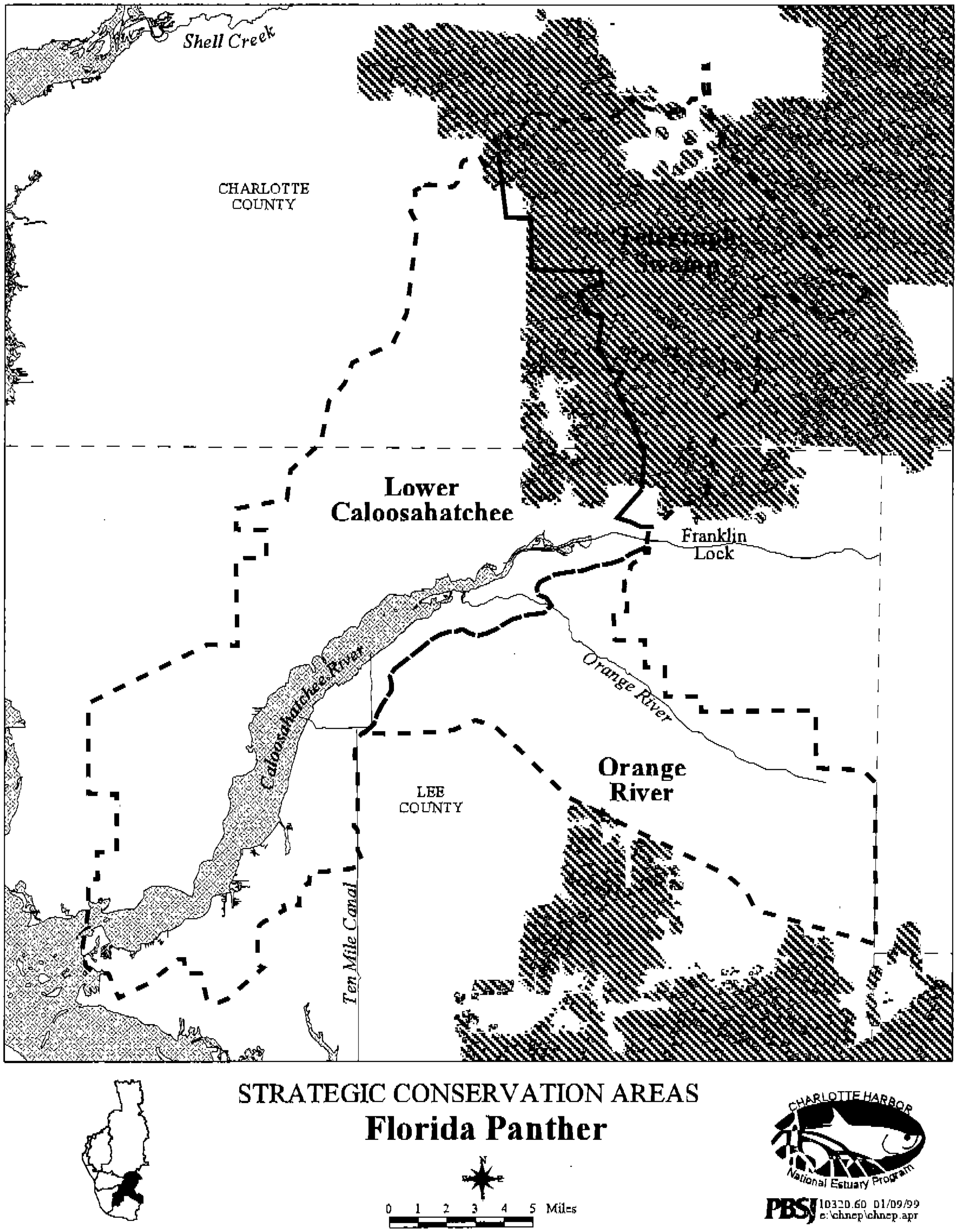


Figure 11-16. Strategic Habitat Conservation Areas (SHCAs) for the Florida Panther in the Caloosahatchee River area (shaded areas) (after FGFWC, 1994).

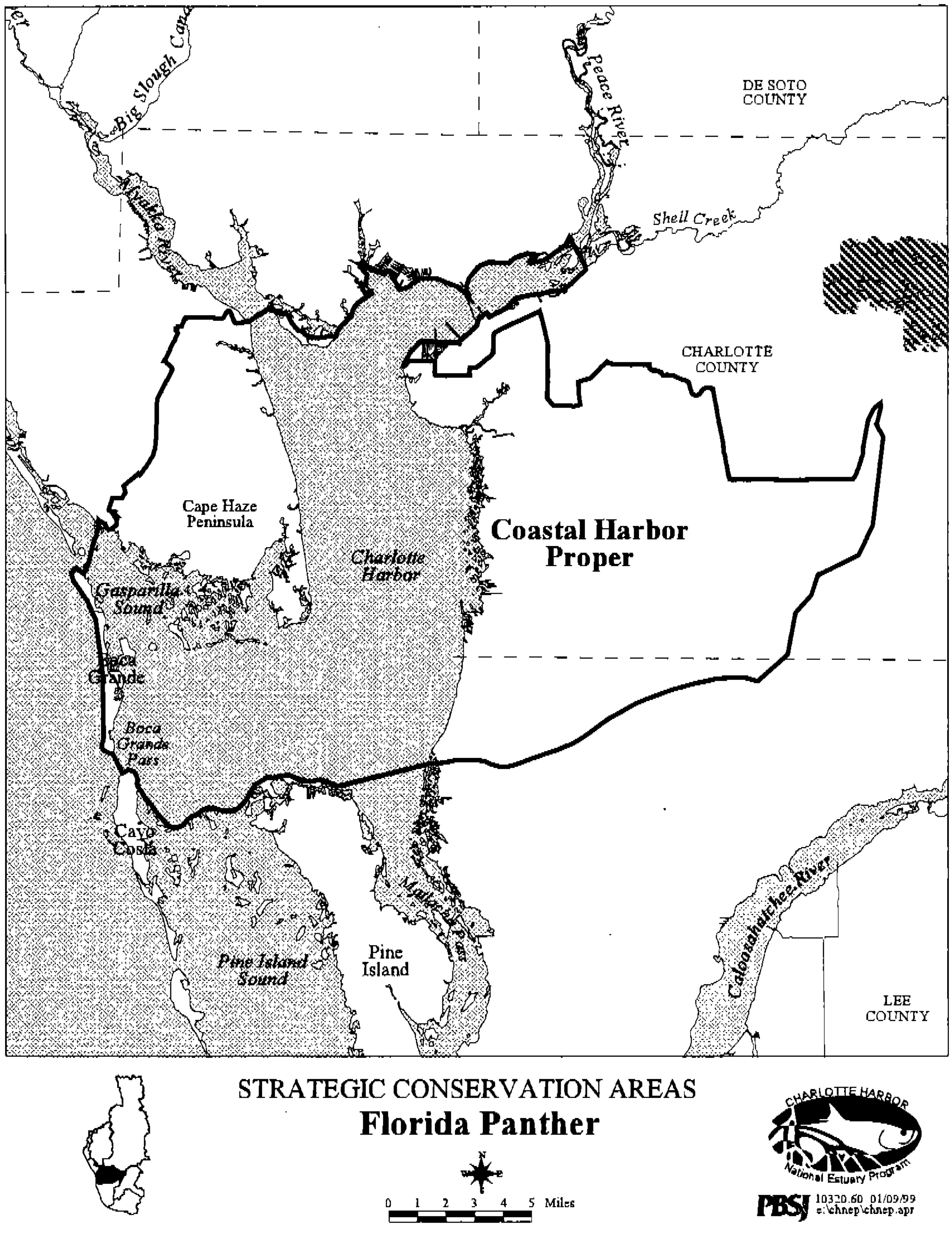


Figure 11-17. Strategic Habitat Conservation Areas (SHCAs) for the Florida Panther in the Charlotte Harbor area (shaded areas) (after FGFWC, 1994).

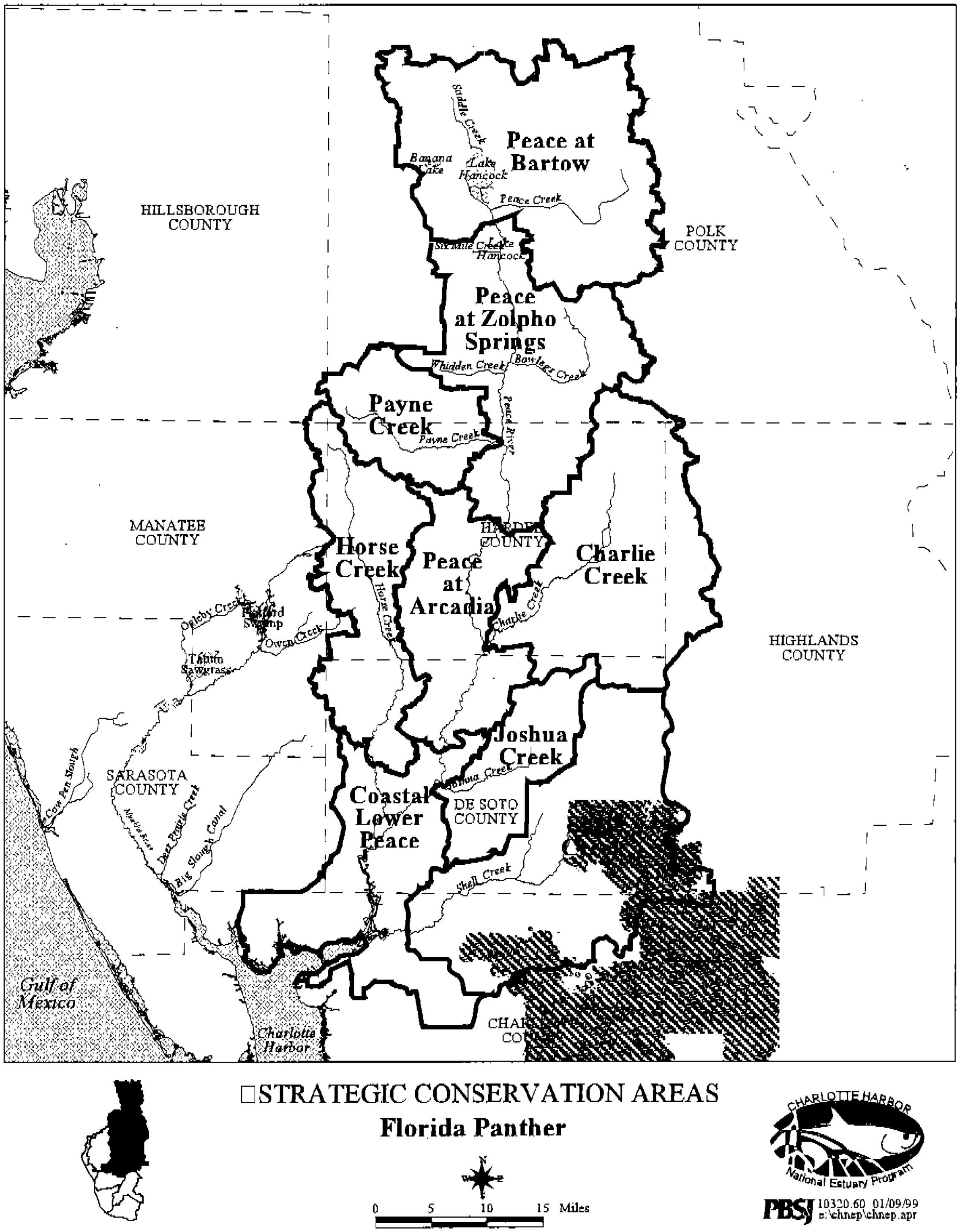


Figure 11-18. Strategic Habitat Conservation Areas (SHCAs) for the Florida Panther in the lower Peace River area (shaded areas) (after FGFWC, 1994).

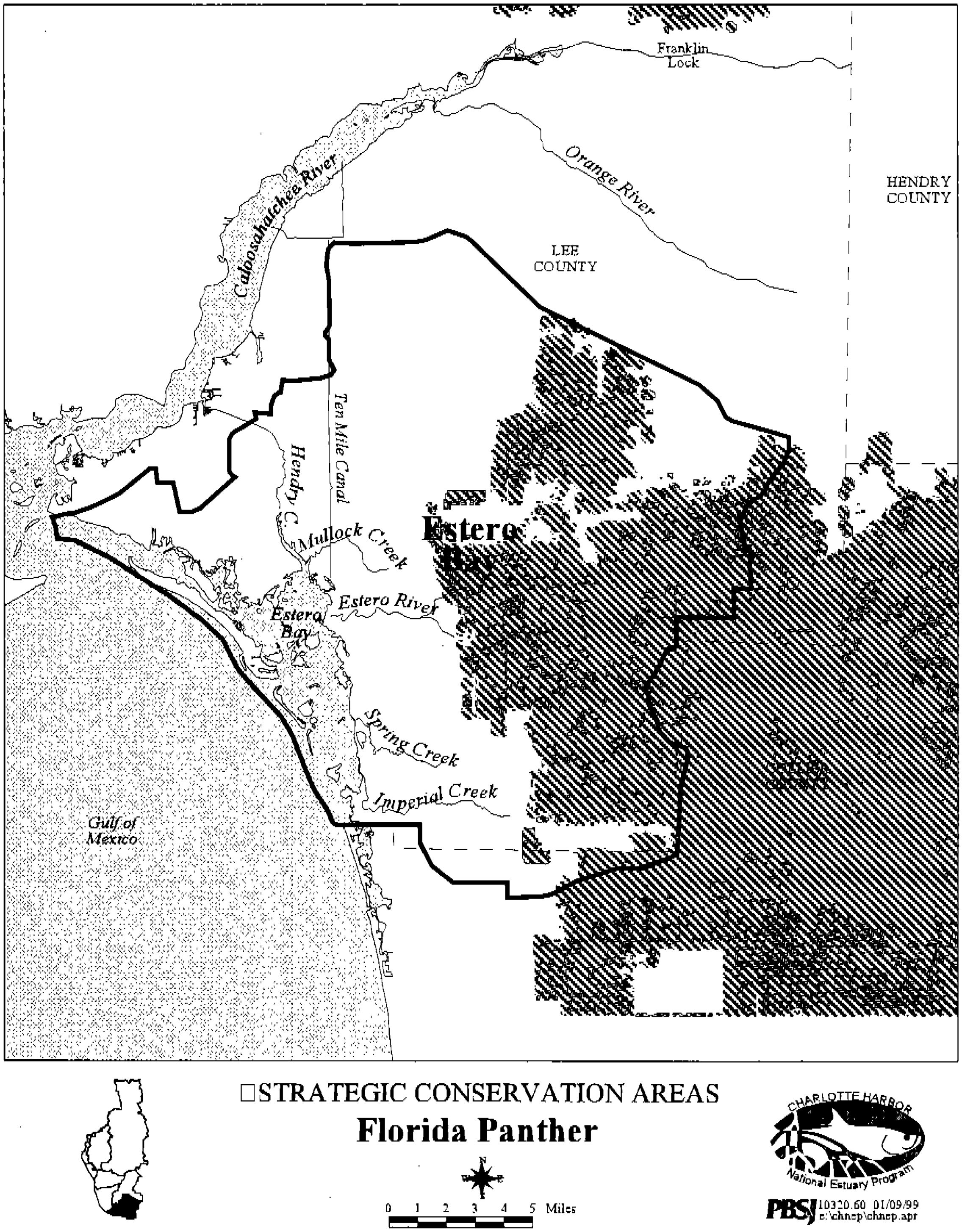


Figure 11-19. Strategic Habitat Conservation Areas (SHCAs) for the Florida Panther in the Estero Bay area (shaded areas) (after FGFWC, 1994).

Now only an estimated 30 to 50 animals remain in the wild in south Florida. Further decline through genetic defects from inbreeding, mercury poisoning through the food chain, and pressure from human expansion, this endangered species has been elevated to the forefront of public awareness.

Florida Panthers are solitary with a relatively large home range, which makes maintaining adequate size habitats a challenge. Panther habitat consists of large expanses of mixed cypress swamp, hardwood swamp, dry prairie and pineland. A male panther home range averages 275 square miles and usually overlaps with smaller ranges of females with whom they periodically mate. Boundaries are maintained by scent marking and usually only vacated upon the death of the occupant.

Adequate food supplies affect the productivity of the population and its density (Alvarez, 1993). The preferred prey are deer and feral hog. In some areas panthers subsist on small mammals such as armadillo and racoon. In these cases, the female panthers are often in poor physical condition and have a low rate of productivity, if any at all. If a predator's food supply is diminished, the younger animals will initially become a smaller percentage of the total population.

Through the use of road kills, panther signs verified by wildlife biologists, and radiotelemetry, the primary public tracts of land that support the remaining breeding population appear to be the Everglades National Park, Big Cypress National Preserve, Fakahatchee Strand State Preserve, Big Cypress Seminole Indian Reservation, and the Florida Panther National Wildlife Refuge. The Charlotte Harbor NEP abuts these lands to the north, and can be expected to support a panther population, especially in the southern basins such as the Estero Bay Basin.

In south Florida, panthers have been found in most types of vegetation including tropical hammocks, pine flatwoods, cabbage palm forests, mixed swamp, cypress swamp, live-oak hammocks, saw grass marshes, and Brazilian pepper thickets. Open agricultural lands are common around most publicly owned land in southern Florida and receive some use by panthers if cover nearby is adequate.
The fragmentation of native forests may have reduced suitability of many areas for panther habitat.

Scrub Jay

The Florida scrub jay is the only bird species restricted to Florida. The species is geographically isolated and genetically distinct from other species of scrub jays found in Mexico and the western United States. It is non-migratory, extremely sedentary, and has very specific habitat requirements. The primary habitat for the Florida scrub jay is the xeric oak ecosystem on well-drained sand, but scrub jays will also use other suitable habitats for foraging. In southwest Florida, scrub jays usually reside in areas dominated by scrub oaks *(Quercus geminata, Q. myrtifolia,* and *Q. chapmanii).* They develop well-defined territories for families within these areas. Preferred nesting habitat is usually in scrub oaks no taller than three meters, interspersed with patches of bare sand.

Florida scrub jays are monogamous and remain mated throughout the year. The offspring generally stay with the parents for at least one year, forming a family group of three or more members. These helpers assist the breeding pair in territorial and breeding activities except for nest-construction, egg-laying and incubation. The family group resides in a territory with a well-defined boundary, defended by all group members.

Florida scrub jays have been observed using both the scrub habitat as well as non-scrub habitat in the Charlotte Harbor NEP area. A large remnant area of scrub oak in the Charlotte Harbor NEP area includes a strand extending to the south from the Estero Bay Watershed. However, the Florida Natural Areas Inventory (FNAI) shows reports of scrub jays sightings to be most common in northeast Lee County along the Caloosahatchee River, and along the gulf coast from Gasparilla Sound north through Lemon Bay to Sarasota Bay, with only a few sightings near Estero Bay.

The oak scrub can be delineated into three categories (Types I, II and III) using FGFWFC guidelines for the Florida scrub jay (FGFWFC, 1991). Differentiation between the categories is based on the coverage of oak scrub species, which provide a principal food for the scrub jay. These categories are indicative of habitat quality, with Type I providing the highest quality habitat and Type III the lowest.

> Type I habitat comprises areas with greater than 15 percent coverage by oak scrub species,
>
> Type II habitat comprises land with greater than zero but less than 15-percent coverage.
>
> Type III is any upland or seasonally dry wetland within one-quarter mile of any area designated as Type I or Type II habitat.

Past scrub jay surveys have documented the presence of Florida scrub jays and provided biologists with a consistent pattern of scrub jay family distribution, the number of family groups and the location of territories. Official surveys have been conducted in portions of the Charlotte Harbor area by wildlife biologists in 1991, 1995, and 1996.

Habitat preservation for the Florida scrub jay is recommended by FGFWFC guidelines wherever jays exist on-site. Habitat preservation is recommended even if jays do not exist on site but are within five miles of Type I habitat. There are large tracts of non-scrub acreage on airport property that can be developed while preserving the largest, most contiguous areas of oak scrub.

As a general guideline, for land development purposes, FGFWFC has issued the following:

1A. *Number of Acres Preserved for Territory Refuges*

Preserved acres = (# scrub jay groups on site) x 25

1B. *Number of acres to be preserved for Satellite Refuges: Type I habitat to be used only*

Preserved acres = (total acres Type I habitat on-site) - (# acres 1A) x 0.25 or 0, whichever is greater

Total Preservation Acres = 1A + 1B

11.2 Inland Habitats at Risk

Many regions within the Charlotte Harbor NEP have experienced increasing development over the past few decades. In many of these areas, the extent and rate of this growth is projected to continue to increase. The development which is occurring within these regions of the Charlotte Harbor NEP can be generally divided into three different types, each of which poses to some degree its own unique forms of potential risks to inland habitats.

Population Growth and Associated Residential and Commercial Development

The rapid rates of population growth, especially in coastal areas surrounding the bays and estuaries within the Charlotte Harbor NEP continue to negatively impact critical inland habitats. During the 1960's and 1970's a number of very large residential communities, covering many square miles, were planned and constructed in Southwest Florida. These included: the City of Cape Coral in Lee County; the urban areas of Port Charlotte, South Gulf Cove, Gulf Cove, Rotonda and Punta Gorda Isles in Charlotte County; and, the City of North Port in Sarasota County. While each of these previous large scale developments had significant effects on both wetlands and uplands, much of the current threat is associated with the cumulative impacts of rapid incremental growth. Often, the individual impacts associated with smaller residential developments by themselves may be relatively limited. However, the magnitude of ongoing development and the cumulative needs from infrastructure, have resulted in placing many critical inland habitats currently at risk.

Agricultural Development

Not only has agricultural development expanded in many regions of the Charlotte Harbor NEP, but in numerous instances the uses of previously existing agricultural lands has changed. Historically, there has been a pattern of expanding acreages in citrus and row crop lands within the Charlotte Harbor NEP. In some instances these increases have been attributed to periods of expansion following hard freezes further north. The expansion of agriculture in other areas can be directly related to the greater availability of surface and groundwater when compared to areas to the north. Converting new areas to agriculture requires removing existing vegetation over large tracts of land. In other instances, agricultural expansion entails the transformation of previously less intensely used range lands. The potential exists in both cases to reduce or fragment existing critical inland habits.

Expanded Mining Operations

Rock/gravel and phosphate are the two forms of mining common within the Charlotte Harbor NEP. Because of the scale and aerial extent of the typical phosphate mining operation, such practices potentially pose significant impacts to inland habitats. Current regulatory permitting requirements combined with advancement in reclamation practices by the industry have resulted in significant improvements in the creation of both wetlands and forested areas following excavation. Nevertheless, large scale mining by its very nature poses substantial near-term risks to inland habitats.

11.2.1 Wetlands

Under current Federal, State, Water Management District, and County rules and regulations, wetlands are provided far more protection than during previous decades. However, even though development may not directly impact a particular area of wetlands, the functional aspects of many such areas are often compromised by surrounding activities. Usually such impacts result from alterations of the normal hydroperiod, resulting in either too much or not enough water seasonally being delivered from the surrounding uplands. Not only is the normal dependency of a wetland area on the associated uplands altered, but the resulting changes in nutrient budgets and hydroperiods often result in alterations of the vegetation communities within such wetlands. This in turn may negatively affect the wetlands habitat value for those species which use it for nesting and/or feeding. Further, waters leaving such impacted wetlands to riverine/estuarine systems are often degraded with regard to nutrients and other pollutants.

11.2.2 Uplands

Development has resulted in a number of unique habitats and critical areas used by threatened and endangered species to be at risk. While this discussion emphasizes habitats used by two listed species within the inland areas of the Charlotte Harbor NEP, development poses similar risks for many other species.

Florida Scrub Jay

The greatest threat posed by development to the Florida Scrub Jay has been caused by the dramatic reduction within areas of the Charlotte Harbor NEP in the particular type of scrub habitats critical to the species nesting and feeding success. Historically, much of the coastal residential development which occurred in Sarasota, Charlotte, and Lee Counties took place in the higher, well drained sandy ridges which were covered with the unique vegetation assemblages which comprise scrub oak communities. It is exactly this type of habitat to which the Florida Scrub Jay is both adapted and which it requires to survive. As wetlands gained greater protection during the 1970's , there was a further emphasis on expanding development in such dry, "easily permittable", upland areas. As a result, only isolated, fragmented remnants of these once common coastal ridge scrub oak communities remain. In more inland areas, the high, well drained sandy soils characteristically covered by scrub oak were also found to be ideal for growing citrus. The combined pressures of both residential and agricultural development have resulted in the loss of much of the Florida Scrub Jay's historic habitat within the Charlotte Harbor NEP. Such areas continue to be at risk, and prudence suggests a high premium on the conservation and maintenance of the remaining larger tracts of existing scrub habitat.

Florida Panther

Florida Panthers are solitary animals requiring large expanses of mixed cypress and hardwood swamp, dry prairie and pinelands for their home ranges. This species is thought to have once occurred throughout much of Florida. However, as with most large terrestrial predators their numbers and ranges have historically declined with the steady increase in the human population. Long-term residential and agricultural growth within Florida have resulted in a reduction in the species available range and diminished food supplies. In recent times, the Florida Panther has been forced into smaller increasingly poorer or marginal habitats. Within the Charlotte Harbor NEP, the State's proposed strategic habitat conservation areas for the Florida panther include portions of southeastern DeSoto County, and eastern portions of both Charlotte and Lee counties.

11.2.3 Riverine and Lake Systems

Development has resulted in a number of freshwater habitats within the Charlotte Harbor NEP being placed at risk. Two causes of such threats to freshwater systems are hydrologic alterations and anthropogenic eutrophication. Examples of each can be found within the upper Peace River Basin.

Upper Peace River

In the 1970's the State passed strict rules governing the phosphate industry to prevent future spills. In many instances this resulted in the cessation of almost all historic drainage to the Peace River from many mined subbasins. The combined effects of such hydrologic alterations have been significant. Currently SWFWMD, the State and the phosphate industry are investigating possible methods to reconnect such isolated basins back into their historic drainages.

Lake Hancock

A long history of wastewater discharges (which have been removed) and agricultural runoff have resulted in Lake Hancock's current highly eutrophic state. At this time, there are an estimated 12,000 acre-feet of unconsolidated organic muck covering the lake's bottom. The condition and discharges from Lake Hancock are postulated by many as being a primary cause of the periodic, extreme high blue-green algae levels observed throughout the Peace River and downstream to below the Peace River/Manasota Regional Water Supply Facility.

12. Management Options

This chapter presents potential management options which will address priority problems identified for each major basin. These potential management options will be addressed more specifically for the Action Plans and Quantifiable Objectives to be developed during other projects, as will the effects of each of the options on the primary criteria of the study, such as flow management, pollutant load reduction, and nutrient load reduction.

Management options for water quality, hydrologic alteration, and fish and wildlife habitat loss are listed in Tables 12-1 through 12-24 for each of the nine major basins:

- Myakka River,
- Peace River,
- Charlotte Harbor Proper,
- Lemon Bay/Gasparilla Sound/Cape Haze Complex,
- Pine Island Sound/ Matlacha Pass,
- Tidal Caloosahatchee River,
- Estero Bay, and
- Coastal Venice.

Potential management options are specific for each priority basin. For each management option, the objective of the option, the principle behind the option, the basin-specific application of the option are included in this section, constraints to implementation, potential benefits, and the geographic extent of each potential option are included.

Table 12-1. Identification of Management Options for Water Quality for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Provide treatment for runoff from developed public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
2) Provide vegetated buffers adjacent to river	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering river	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Near river and tributaries
3) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide

Table 12-1. Identification of Management Options for Water Quality for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
4) Investigate atmospheric deposition's role in surface water quality	Atmospheric deposition; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
5) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
7) Increase level of reuse for landscape irrigation	Stormwater runoff;	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide
8) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide

Table 12-1. Identification of Management Options for Water Quality for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Extend sanitary sewer to coastal areas now served by septic tank systems	Groundwater contamination	Removing wastewater effluent from near river reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tank systems	Near river and other surface water bodies
10) Develop program to monitor septic tank system operation and efficiency		Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank system operations and efficiency	Basin-wide
11) Promote the use of agricultural BMPs and development of NRCS Conservation Plans	Stormwater runoff; Uplands and wetlands to agriculture	BMPs provide water quality treatment to agri. runoff	Cost, farmers' acceptance or regulatory and enforcement	Reduced nutrient and contaminant loads, and enhanced freshwater flow rates from agricultural lands	Basin-wide

Table 12-1. Identification of Management Options for Water Quality for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
12) Promote integrated pest management (IPM) for farms and landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide
13) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
14) Promote compact urban growth	Wetland and upland to urban land use; stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide
15) Coordinate water quality monitoring programs to protect Outstanding Florida Water status		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-2. Identification of Management Options for Hydrologic Alterations for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Re-establish more natural annual flow hydrographs in streams	Hydrologic alteration	Return streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows to the river	Basin-wide
4) Increase stormwater runoff storage	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows to river.	Basin-wide
5) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide

Table 12-2. Identification of Management Options for Hydrologic Alterations for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
6) Re-establish hydrologic connection for mined areas	Shell and fill mining	Increases areas that contribute stormwater runoff to the river	Physical, cost	Improve freshwater inflows to river	Basin-wide
7) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and outfalls to river
8) Utilize agricultural BMPs to manage amount of irrigation return water	Wetlands and uplands to agriculture land use	Managing agri. Irrigation return flows through permitting, BMPs	Cost, farmers acceptance	Maintain more natural freshwater flow characteristics in river basin	Basin-wide

Table 12-2. Identification of Management Options for Hydrologic Alterations for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water and groundwater systems	Cost, technical analysis	Maintaining acceptable freshwater inflow rates to the river	Basin-wide

Table 12-3. Identification of Management Options for Habitat Loss for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in river watershed	Basin-wide
3) Manage public access to natural areas	Wetlands to urban land use	Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts on riverine resources	Along river
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts on natural systems	Basin-wide

Table 12-3. Identification of Management Options for Habitat Loss for the Myakka River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for river	Main river and tributaries
6) Re-establish more natural annual flow hydrographs in river and tributaries	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for living resources.	Main river and tributaries
7) Establish greenways and wildlife corridors between large natural areas	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide
8) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water and groundwater systems	Cost, technical analysis	Improving habitat values for living resources of the river	Basin-wide

Table 12-4. Identification of Management Options for Water Quality for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Provide treatment for runoff from developed public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
2) Provide vegetated buffers adjacent to river	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering river	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Near river and tributaries
3) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide

Table 12-4. Identification of Management Options for Water Quality for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
4) Investigate atmospheric deposition's role in surface water quality	Atmospheric deposition; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
5) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
6) Increase level of reuse for landscape irrigation	Stormwater runoff;	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide
7) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide

Table 12-4. Identification of Management Options for Water Quality for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
8) Extend sanitary sewer to coastal areas now served by septic tank systems	Groundwater contamination	Removing wastewater effluent from near river reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tank systems	Near river and other surface water bodies
9) Develop program to monitor septic tank operation and efficiency		Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank operations and efficiency	Basin-wide
10) Promote the use of agricultural BMPs and development of NRCS Conservation Plans	Stormwater runoff; Uplands and wetlands to agriculture	BMPs provide water quality treatment to agri. runoff	Cost, farmers' acceptance or regulatory and enforcement	Reduced nutrient and contaminant loads, and enhanced freshwater flow rates from agricultural lands	Basin-wide

Table 12-4. Identification of Management Options for Water Quality for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
11) Promote integrated pest management (IPM) for farms and landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide
12) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
13) Promote compact urban growth	Wetland and upland to urban land use; stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide
14) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-5. Identification of Management Options for Hydrologic Alterations for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Re-establish more natural annual flow hydrographs in streams	Hydrologic alteration	Return streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows to the river	Basin-wide
4) Increase stormwater runoff storage	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows to river.	Basin-wide

Table 12-5. Identification of Management Options for Hydrologic Alterations for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
6) Re-establish hydrologic connection for mined areas	Phosphate mining	Increases areas that contribute stormwater runoff to the river	Physical, cost	Improve freshwater inflows to river	Basin-wide
7) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and outfalls to river
8) Establish environmentally appropriate operating schedule for Shell Creek	Hydrologic alteration; Urban infrastru. - dams and locks	Determine optimal range and timing for water releases from dam	Cost, public and private acceptance, technical analysis	Re-establishing acceptable freshwater inflow rates to lower river	Shell Creek

Table 12-5. Identification of Management Options for Hydrologic Alterations for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Utilize agricultural BMPs to manage amount of irrigation return water	Wetlands and uplands to agriculture land use	Managing agri. Irrigation return flows through permitting, BMPs	Cost, farmers acceptance	Maintain more natural freshwater flow characteristics in river basin	Basin-wide
10) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water and groundwater systems	Cost, technical analysis	Maintaining acceptable freshwater inflow rates to the river	Basin-wide

Table 12-6. Identification of Management Options for Habitat Loss for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in river watershed	Basin-wide
3) Manage public access to natural areas	Wetlands to urban land use	Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to riverine resources	Along river
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts to natural systems	Basin-wide

Table 12-6. Identification of Management Options for Habitat Loss for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for river	Main river and tributaries
6) Re-establish more natural annual flow hydrographs in river and tributaries	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for living resources.	Main river and tributaries
7) Establish greenways and wildlife corridors between large natural areas	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-6. Identification of Management Options for Habitat Loss for the Peace River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
8) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water and groundwater systems	Cost, technical analysis	Improving habitat values for living resources of the river	Basin-wide

Table 12-7. Identification of Management Options for Water Quality for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Enhance circulation in residential canals	Urban infrastru. - canals; Stormwater runoff	Flushing improves water quality	Physical (right-of-way requirements), social	Increased water quality in coastal residential areas.	Coastal lands and tidal river reaches
2) Provide treatment for runoff from developed public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
3) Provide vegetated buffers adjacent to estuary	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering estuary	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Coastal fringe and along tidal creeks

Table 12-7. Identification of Management Options for Water Quality for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
4) Improve circulation through passes and causeways	Urban infrastru. - roads/bridges; Shoreline alteration; Dredging	Flushing improves water quality in estuary	Physical (right-of-way requirements), social	Increased water quality in coastal areas	Coastal lands and tidal river reaches
5) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide
6) Investigate atmospheric deposition's role in surface water quality	Atm. Dep.; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide

Table 12-7. Identification of Management Options for Water Quality for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
7) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
8) Increase level of reuse for landscape irrigation	Stormwater runoff;	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide
9) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide
10) Extend sanitary sewer to coastal areas now served by septic tank system	Groundwater contamination	Removing wastewater effluent from coastal areas reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tank system	Coastal areas and near other surface water bodies

Table 12-7. Identification of Management Options for Water Quality for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
11) Develop program to monitor septic tank system operation and efficiency		Improved monitoring will reduce potential for impacts from septic tank system	Cost, public acceptance	Improvements in septic tank system operations and efficiency	Basin-wide
12) Promote the use of agricultural BMPs and development of NRCS Conservation Plans	Stormwater runoff; Uplands and wetlands to agriculture	BMPs provide water quality treatment to agri. runoff	Cost, farmers' acceptance or regulatory and enforcement	Reduced nutrient and contaminant loads, and enhanced freshwater flow rates from agricultural lands	Basin-wide
13) Promote integrated pest management (IPM) for farms and landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide
14) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide

Table 12-7. Identification of Management Options for Water Quality for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
15) Promote compact urban growth	Wetland and upland to urban land use; stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide
16) Develop Master Plan for Spill Response	Rec. and comm. boating	Master Plan would reduce impacts from spill	Cost, public, government, and private participation	Reduced impacts from spills in harbor	Coastal areas in within harbor
17) Improve boat head and bilge pumping, and refueling practices	Rec. and comm. boating	Pump heads/bilges to appropriate destination, use spill-reducing fueling methods	Cost, public acceptance	Reduction of human waste and contaminants to surface waters	Coastal lands, within harbor
18) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-8. Identification of Management Options for Hydrologic Alterations for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Investigate alternate sources such as desalinization.	Urban water supply	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces demands on groundwater and surface water for potable use	Mainly coastal areas
4) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas

Table 12-8. Identification of Management Options for Hydrologic Alterations for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Increase stormwater runoff storage near coast	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas
6) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
7) Re-establish hydrologic connection for mined areas.	Shell and fill mining	Increases areas that contribute stormwater runoff to estuary	Physical, cost	Improve freshwater inflows to estuary	Basin-wide
8) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and coastal outfalls

Table 12-8. Identification of Management Options for Hydrologic Alterations for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Establish environmentally appropriate operating schedule for dams and locks	Hydrologic alteration; Urban infrastru. - dams and locks	Determine optimal range and timing for water releases from locks and dams	Cost, public and private acceptance, technical analysis	Re-establishing acceptable freshwater inflow rates to estuary	Basin-wide
10) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water, and groundwater systems	Cost, technical analysis	Re-establishing acceptable freshwater inflow rates to estuary	Basin-wide

Table 12-9. Identification of Management Options for Habitat Loss for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
3) Manage public access to coastal areas		Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to shoreline and estuarine resources	Coastal areas
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts on natural systems	Basin-wide

Table 12-9. Identification of Management Options for Habitat Loss for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for estuary	Coastal areas
6) Investigate alternate water sources such as desalinization.	Over-use of surface and ground water	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces potential impacts to natural systems from over use as potable source	Basin-wide
7) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for estuarine living resources.	Coastal areas and tidal creeks
8) Establish greenways and wildlife corridors between large natural areas.	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-9. Identification of Management Options for Habitat Loss for the Coastal Charlotte Harbor Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and protect areas subject to prop scarring	Rec. and comm. boating; Rec. and comm. fishing	Reduces impacts to seagrass meadows by limiting motor boat access to areas	Cost, regulatory/ enforcement, public acceptance	Improves quality of estuarine habitat	Within Charlotte Harbor
10) Provide protection for manatees in areas of their congregation	Rec. and comm. boating; Rec. and comm. fishing	Reduces manatee mortality by slowing boats or limiting access to some areas	Cost, regulatory/ enforcement, public acceptance	Reduced manatee mortality	Within Charlotte Harbor and coastal canals and streams
11) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water, and groundwater systems	Cost, technical analysis	Improving habitat values for living resources of the estuary	Basin-wide
12) Assess cumulative impacts of entrainment on living resources of estuary		Determine the degree of mortality to living resources from entrainment	Cost, industry participation	Better understanding of impacts of entrainment	Coastal areas

Table 12-10. Identification of Management Options for Water Quality for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Enhance circulation in residential canals	Urban infrastru. - canals; Stormwater runoff	Flushing improves water quality	Physical (right-of-way requirements), social	Increased water quality in coastal residential areas.	Coastal lands and tidal river reaches
2) Provide stormwater treatment for runoff from developed public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
3) Provide vegetated buffers adjacent to estuary	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering estuary	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Coastal fringe and along tidal creeks
4) Improve circulation through passes, causeways, and the Intercoastal Water Way	Urban infrastru. - roads/bridges; Shoreline alteration; Dredging	Flushing improves water quality in estuary	Physical (right-of-way requirements), social	Increased water quality in coastal areas	Coastal lands and tidal river reaches

Table 12-10. Identification of Management Options for Water Quality for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide
6) Investigate atmospheric deposition's role in surface water quality	Atmospheric deposition; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
7) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
8) Increase level of reuse for landscape irrigation	Stormwater runoff	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide

Table 12-10. Identification of Management Options for Water Quality for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide
10) Extend sanitary sewer to coastal areas now served by septic tanks	Groundwater contamination	Removing wastewater effluent from coastal areas reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tanks	Coastal areas and near other surface water bodies
11) Develop program to monitor septic tank operation and efficiency	Lower density to higher density urban land use	Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank operations and efficiency	Basin-wide
12) Promote integrated pest management (IPM) for landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide

Table 12-10. Identification of Management Options for Water Quality for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
13) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
14) Promote compact urban growth	Wetland and upland to urban land use; Stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide
15) Develop Master Plan for Spill Response	Rec. and comm. boating	Master Plan would reduce impacts from spill	Cost, public, government, and private participation	Reduced impacts from spills in harbor	Coastal areas in within harbor
16) Improve boat head and bilge pumping, and refueling practices	Rec. and comm. boating	Pump heads/bilges to appropriate destination, use spill-reducing fueling methods	Cost, public acceptance	Reduction of human waste and contaminants to surface waters	Coastal lands, within harbor

Table 12-10. Identification of Management Options for Water Quality for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
17) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-11. Identification of Management Options for Hydrologic Alterations for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Re-establish more natural annual flow hydrographs in coastal streams	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas
4) Increase stormwater runoff storage near coast	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas

Table 12-11. Identification of Management Options for Hydrologic Alterations for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
6) Re-establish hydrologic connection for mined areas.	Shell and fill mining	Increases areas that contribute stormwater runoff to estuary	Physical, cost	Improve freshwater inflows to estuary	Basin-wide
7) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and coastal outfalls
8) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water, and groundwater systems	Cost, technical analysis	Re-establishing acceptable freshwater inflow rates to estuary	Basin-wide

Table 12-12. Identification of Management Options for Habitat Loss for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
3) Manage public access to coastal areas	Wetlands to urban land use	Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to shoreline and estuarine resources	Coastal areas
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts to natural systems	Basin-wide

Table 12-12. Identification of Management Options for Habitat Loss for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for estuary	Coastal areas
6) Investigate alternate water sources such as desalinization.	Over-use of surface and ground water	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces potential impacts to natural systems from over use as potable source	Basin-wide
7) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for estuarine living resources.	Coastal areas and tidal creeks
8) Establish greenways and wildlife corridors between large natural areas.	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-12. Identification of Management Options for Habitat Loss for the Lemon Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and protect areas subject to prop scarring	Rec. and comm. boating; Rec. and comm. fishing	Reduces impacts to seagrass meadows by limiting motor boat access to areas	Cost, regulatory/ enforcement, public acceptance	Improves quality of estuarine habitat	Within Charlotte Harbor
10) Provide protection for manatees in areas of their congregation	Rec. and comm. boating; Rec. and comm. fishing	Reduces manatee mortality by slowing boats or limiting access to some areas	Cost, regulatory/ enforcement, public acceptance	Reduced manatee mortality	Within Charlotte Harbor and coastal canals and streams

Table 12-13. Identification of Management Options for Water Quality for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Enhance circulation in residential canals	Urban infrastru. - canals; Stormwater runoff	Flushing improves water quality	Physical (right-of-way requirements), social	Increased water quality in coastal residential areas.	Coastal lands and tidal river reaches
2) Provide treatment for runoff from public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
3) Provide vegetated buffers adjacent to estuary	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering estuary	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Coastal fringe and along tidal creeks
4) Improve circulation through passes and causeways	Urban infrastru. - roads/bridges; Shoreline alteration; Dredging	Flushing improves water quality in estuary	Physical (right-of-way requirements), social	Increased water quality in coastal areas	Coastal lands and tidal river reaches

Table 12-13. Identification of Management Options for Water Quality for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide
6) Investigate atmospheric deposition's role in surface water quality	Atmospheric deposition; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
7) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
8) Increase level of reuse for landscape irrigation	Stormwater runoff;	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide

Table 12-13. Identification of Management Options for Water Quality for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide
10) Extend sanitary sewer to coastal areas now served by septic tanks	Groundwater contamination	Removing wastewater effluent from coastal areas reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tanks	Coastal areas and near other surface water bodies
11) Develop program to monitor septic tank operation and efficiency		Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank operations and efficiency	Basin-wide

Table 12-13. Identification of Management Options for Water Quality for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
12) Promote the use of agricultural BMPs and development of NRCS Conservation Plans	Stormwater runoff; Uplands and wetlands to agriculture	BMPs provide water quality treatment to agri. runoff	Cost, farmers' acceptance or regulatory and enforcement	Reduced nutrient and contaminant loads, and enhanced freshwater flow rates from agricultural lands	Basin-wide
13) Promote integrated pest management (IPM) for farms and landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide
14) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
15) Promote compact urban growth	Wetland and upland to urban land use; Stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide

Table 12-13. Identification of Management Options for Water Quality for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
16) Develop Master Plan for Spill Response	Rec. and comm. boating	Master Plan would reduce impacts from spill	Cost, public, government, and private participation	Reduced impacts from spills in harbor	Coastal areas in within harbor
17) Improve boat head and bilge pumping, and refueling practices	Rec. and comm. boating	Pump heads/bilges to appropriate destination, use spill-reducing fueling methods	Cost, public acceptance	Reduction of human waste and contaminants to surface waters	Coastal lands, within harbor
18) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-14. Identification of Management Options for Hydrologic Alterations for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Investigate alternate sources such as desalinization	Urban water supply	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces demands on groundwater and surface water for potable use	Mainly coastal areas
4) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas

Table 12-14. Identification of Management Options for Hydrologic Alterations for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Increase stormwater runoff storage near coast	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas
6) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
7) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and coastal outfalls

Table 12-15. Identification of Management Options for Habitat Loss for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
3) Manage public access to coastal areas	Wetland to urban land use	Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to shoreline and estuarine resources	Coastal areas
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts to natural systems	Basin-wide

Table 12-15. Identification of Management Options for Habitat Loss for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for estuary	Coastal areas
6) Investigate alternate water sources such as desalinization	Over-use of surface and ground water	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces potential impacts to natural systems from over use as potable source	Basin-wide
7) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for estuarine living resources.	Coastal areas and tidal creeks
8) Establish greenways and wildlife corridors between large natural areas.	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-15. Identification of Management Options for Habitat Loss for the Pine Island Sound Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and protect areas subject to prop scarring	Rec. and comm. boating; Rec. and comm. fishing	Reduces impacts to seagrass meadows by limiting motor boat access to areas	Cost, regulatory/ enforcement, public acceptance	Improves quality of estuarine habitat	Within Charlotte Harbor
10) Provide protection for manatees in areas of their congregation	Rec. and comm. boating; Rec. and comm. fishing	Reduces manatee mortality by slowing boats or limiting access to some areas	Cost, regulatory/ enforcement, public acceptance	Reduced manatee mortality	Within Charlotte Harbor and coastal canals and streams
11) Assess cumulative impacts of entrainment of living resources of estuary		Determine how many living resources are killed through entrainment	Cost, industry participation	Better understanding of impacts of entrainment	Coastal areas

Table 12-16. Identification of Management Options for Water Quality for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Enhance circulation in residential canals	Urban infrastru. - canals; Stormwater runoff	Flushing improves water quality	Physical (right-of-way requirements), social	Increased water quality in coastal residential areas.	Coastal lands and tidal river reaches
2) Improve circulation through passes and causeways	Urban infrastru. - roads/bridges; Shoreline alteration; Dredging	Flushing improves water quality in estuary	Physical (right-of-way requirements), social	Increased water quality in coastal areas	Coastal lands and tidal river reaches
3) Provide treatment for runoff from developed public lands.	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
4) Provide vegetated buffers adjacent to estuary.	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering estuary	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Coastal fringe and along tidal creeks

Table 12-16. Identification of Management Options for Water Quality for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property.	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide
6) Investigate atmospheric deposition's role in surface water quality	Atm. Dep.; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
7) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
8) Increase level of reuse for landscape irrigation	Stormwater runoff;	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide

Table 12-16. Identification of Management Options for Water Quality for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality probiems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide
10) Extend sanitary sewer to coastal areas served by septic tanks	Groundwater contamination	Removing effluent from coastal areas reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tanks	Coastal areas and near other surface water bodies
11) Develop program to monitor septic tank operation and efficiency		Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank operations and efficiency	Basin-wide

Table 12-16. Identification of Management Options for Water Quality for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
12) Promote the use of agricultural BMPs and development of NRCS Conservation Plans	Stormwater runoff; Uplands and wetlands to agriculture	BMPs provide water quality treatment to agri. runoff	Cost, farmers' acceptance or regulatory and enforcement	Reduced nutrient and contaminant loads, and enhanced freshwater flow rates from agricultural lands	Basin-wide
13) Promote integrated pest management (IPM) for farms and landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide
14) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
15) Promote compact urban growth	Wetland and upland to urban land use; stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide

Table 12-16. Identification of Management Options for Water Quality for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
16) Develop Master Plan for Spill Response	Rec. and comm. boating	Master Plan would reduce impacts from spill	Cost, public, government, and private participation	Reduced impacts from spills in river	Coastal areas in within lower river
17) Improve boat head and bilge pumping, and refueling practices	Rec. and comm. boating	Pump heads/bilges to appropriate destination, use spill-reducing fueling methods	Cost, public acceptance	Reduction of human waste and contaminants to surface waters	Coastal lands, within lower river
18) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-17. Identification of Management Options for Hydrologic Alterations for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Investigate alternate sources such as desalinization.	Urban water supply	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces demands on groundwater and surface water for potable use	Mainly coastal areas
4) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows to lower river	Coastal and inland areas

Table 12-17. Identification of Management Options for Hydrologic Alterations for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Establish environmentally appropriate operating schedule for Franklin lock	Hydrologic alteration; Urban infrastru. - dams and locks	Determine optimal range and timing for water releases from lock	Cost, public and private acceptance, technical analysis	Re-establishing acceptable freshwater inflow rates to lower river	Basin-wide
6) Increase stormwater runoff storage near coast	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows for lower river	Coastal and inland areas
7) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
8) Re-establish hydrologic connection for mined areas.	Shell and fill mining	Increases areas that contribute stormwater runoff to estuary	Physical, cost	Improve freshwater inflows to estuary	Basin-wide

Table 12-17. Identification of Management Options for Hydrologic Alterations for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and outfalls to river

Table 12-18. Identification of Management Options for Habitat Loss for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in river and watershed	Basin-wide, or within river only
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in river and watershed	Basin-wide, or within river only
3) Manage public access to coastal areas	Wetlands to urban land use	Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to shoreline and estuarine resources	River shoreline areas
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts to natural systems	Basin-wide

Table 12-18. Identification of Management Options for Habitat Loss for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for estuary	River shoreline areas
6) Investigate alternate water sources such as desalinization.	Over-use of surface and ground water	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces potential impacts to natural systems from over use as potable source	Basin-wide
7) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for estuarine living resources.	Coastal areas and tidal creeks
8) Establish greenways and wildlife corridors between large natural areas.	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-18. Identification of Management Options for Habitat Loss for the Caloosahatchee River Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and protect areas subject to prop scarring	Rec. and comm. boating; Rec. and comm. fishing	Reduces impacts to seagrass meadows by limiting motor boat access to areas	Cost, regulatory/ enforcement, public acceptance	Improves quality of estuarine habitat	Within lower river
10) Provide protection for manatees in areas of their congregation	Rec. and comm. boating; Rec. and comm. fishing	Reduces manatee mortality by slowing boats or limiting access to some areas	Cost, regulatory/ enforcement, public acceptance	Reduced manatee mortality	Within lower river and coastal canals and streams
11) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water, and groundwater systems	Cost, technical analysis	Improving habitat values for living resources of the estuary	Basin-wide
12) Assess cumulative impacts of entrainment of living resources of the lower river		Determine degree of mortality of living resources due to entrainment	Cost, industry participation	Better understanding of impacts of entrainment	Within river

Table 12-19. Identification of Management Options for Water Quality for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Enhance circulation in residential canals	Urban infrastru. - canals; Stormwater runoff	Flushing improves water quality	Physical (right-of-way requirements), social	Increased water quality in coastal residential areas.	Coastal lands and tidal river reaches
2) Provide treatment for runoff from developed public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
3) Provide vegetated buffers adjacent to estuary	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering estuary	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Coastal fringe and along tidal creeks
4) Improve circulation through passes and causeways	Urban infrastru. - roads/bridges; Shoreline alteration; Dredging	Flushing improves water quality in estuary	Physical (right-of-way requirements), social	Increased water quality in coastal areas	Coastal lands and tidal river reaches

Table 12-19. Identification of Management Options for Water Quality for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide
6) Investigate atmospheric deposition's role in surface water quality	Atmospheric deposition; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
7) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
8) Increase level of reuse for landscape irrigation	Stormwater runoff	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide

Table 12-19. Identification of Management Options for Water Quality for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide
10) Extend sanitary sewer to coastal areas now served by septic tanks	Groundwater contamination	Removing wastewater effluent from coastal areas reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tanks	Coastal areas and near other surface water bodies
11) Develop program to monitor septic tank operation and efficiency	Uplands to urban land use	Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank operations and efficiency	Basin-wide

Table 12-19. Identification of Management Options for Water Quality for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
12) Promote the use of agricultural BMPs and development of NRCS Conservation Plans	Stormwater runoff; Uplands and wetlands to agriculture	BMPs provide water quality treatment to agri. runoff	Cost, farmers' acceptance or regulatory and enforcement	Reduced nutrient and contaminant loads, and enhanced freshwater flow rates from agricultural lands	Basin-wide
13) Promote integrated pest management (IPM) for farms and landscaping	Stormwater runoff; Uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide
14) Reduce extent of unnecessary paved surfaces	Stormwater runoff; Wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
15) Promote compact urban growth	Wetland and upland to urban land use; Stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide

Table 12-19. Identification of Management Options for Water Quality for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
16) Develop Master Plan for Spill Response	Rec. and comm. boating	Master Plan would reduce impacts from spill	Cost, public, government, and private participation	Reduced impacts from spills in harbor	Coastal areas in within harbor
17) Improve boat head and bilge pumping, and refueling practices	Rec. and comm. boating	Pump heads/bilges to appropriate destination, use spill-reducing fueling methods	Cost, public acceptance	Reduction of human waste and contaminants to surface waters	Coastal lands, within harbor
18) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-20. Identification of Management Options for Hydrologic Alterations for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Investigate alternate sources such as desalinization	Urban water supply	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces demands on groundwater and surface water for potable use	Mainly coastal areas
4) Re-establish more natural annual flow hydrographs in coastal streams	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas

Table 12-20. Identification of Management Options for Hydrologic Alterations for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Increase stormwater runoff storage near coast	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas
6) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
7) Re-establish hydrologic connection for mined areas	Shell and fill mining	Increases areas that contribute stormwater runoff to estuary	Physical, cost	Improve freshwater inflows to estuary	Basin-wide
8) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics (ie. Imperial River)	Inland basins and coastal outfalls

Table 12-20. Identification of Management Options for Hydrologic Alterations for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water, and groundwater systems	Cost, technical analysis	Re-establishing acceptable freshwater inflow rates to estuary	Basin-wide

Table 12-21. Identification of Management Options for Habitat Loss for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
3) Manage public access to coastal areas		Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to shoreline and estuarine resources	Coastal areas
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts to natural systems	Basin-wide

Table 12-21. Identification of Management Options for Habitat Loss for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for estuary	Coastal areas
6) Investigate alternate water sources such as desalinization	Over-use of surface and ground water	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces potential impacts to natural systems from over use as potable source	Basin-wide
7) Re-establish more natural annual flow hydrographs in coastal streams	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for estuarine living resources.	Coastal areas and tidal creeks
8) Establish greenways and wildlife corridors between large natural areas	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-21. Identification of Management Options for Habitat Loss for the Estero Bay Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and protect areas subject to prop scarring	Rec. and comm. boating; Rec. and comm. fishing	Reduces impacts to seagrass meadows by limiting motor boat access to areas	Cost, regulatory/ enforcement, public acceptance	Improves quality of estuarine habitat	Within Charlotte Harbor
10) Provide protection for manatees in areas of their congregation	Rec. and comm. boating; Rec. and comm. fishing	Reduces manatee mortality by slowing boats or limiting access to some areas	Cost, regulatory/ enforcement, public acceptance	Reduced manatee mortality	Within Charlotte Harbor and coastal canals and streams
11) Determine and achieve minimum flows and levels for freshwater systems	Hydrologic alteration; Urban and agri. water supply	Determine optimal range, timing, and levels surface water, and groundwater systems	Cost, technical analysis	Improving habitat values for living resources of the estuary	Basin-wide

Table 12-22. Identification of Management Options for Water Quality for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Enhance circulation in residential canals	Urban infrastru. - canals; Stormwater runoff	Flushing improves water quality	Physical (right-of-way requirements), social	Increased water quality in coastal residential areas.	Coastal lands and tidal river reaches
2) Provide treatment for runoff from developed public lands	Urban infrastru. - roads and bridges; Stormwater runoff	Treatment improves stormwater quality from roads, other public lands	Financial, physical (land requirements)	Decreased pollutant loadings from stormwater	Basin-wide
3) Provide vegetated buffers adjacent to estuary	Stormwater runoff; Wetland to urban land use	Buffers will filter runoff prior to entering estuary	Regulatory (rules not in place or not enforced)	Decreased pollutant loadings from stormwater	Coastal fringe and along tidal creeks
4) Improve circulation through passes and causeways	Urban infrastru. - roads/bridges; Shoreline alteration; Dredging	Flushing improves water quality in estuary	Physical (right-of-way requirements), social	Increased water quality in coastal areas	Coastal lands and tidal river reaches

Table 12-22. Identification of Management Options for Water Quality for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Promote Florida Yards & Neighbor. measures for source reduction for residences, businesses, and public property	Stormwater Runoff	Reducing irrigation, fertilization and pesticide applic. decreases loadings from urban lands.	Lack of public knowledge	Decreased nutrient and contaminant loadings from residential areas	Basin-wide
6) Investigate atmospheric deposition's role in surface water quality	Atmospheric deposition; Stormwater runoff	Atm. deposition contributes to nutrient and contaminant loading from runoff	Cost, technical analysis	Identifying atm. dep.'s role in water quality will allow management options to be developed.	Basin-wide
7) Promote energy conservation	Atmospheric deposition	Using less energy reduces stationary and mobile air emissions	Cost, public and industry acceptance, technical	Reduced atm. dep. contribution to water quality impacts	Basin-wide
8) Increase level of reuse for landscape irrigation	Stormwater runoff;	Reuse reduces landscape nutrient loading needs	Reuse distribution system, social (public acceptance)	Decreases fertilizer contribution to nutrient loading	Basin-wide

Table 12-22. Identification of Management Options for Water Quality for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Ensure that current monitoring of WWTP effluent disposal is adequate	Point source discharges	Monitoring should be adequate to indicate water quality problems	Cost, WWTP operators' acceptance	Reduced water quality impacts from WWTP	Basin-wide
10) Extend sanitary sewer to coastal areas now served by septic tanks	Groundwater contamination	Removing wastewater effluent from coastal areas reduces chances of water quality impacts	Cost, public acceptance	Reduced nutrient and contaminant loading from septic tanks	Coastal areas and near other surface water bodies
11) Develop program to monitor septic tank operation and efficiency		Improved monitoring will reduce potential for impacts from septic tanks	Cost, public acceptance	Improvements in septic tank operations and efficiency	Basin-wide
12) Promote integrated pest management (IPM) for landscaping	Stormwater runoff, uplands to agriculture	IPM reduces amount of pesticide applied to land	Education efforts, farmers' and landscapers' acceptance	Reduced contaminants in stormwater	Basin-wide

Table 12-22. Identification of Management Options for Water Quality for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
13) Reduce unnecessary paved surfaces	Stormwater runoff; wetland and upland to urban land use	Reduced pavement reduces runoff quantity and improves quality	Cost, regulatory/ enforcement	Improved surface water quality from urban runoff	Basin-wide
14) Promote compact urban growth	Wetland and upland to urban land use; stormwater runoff	Minimizing urban sprawl reduces spatial extent of impact	Regulatory, public acceptance	Reduced extent of water quality impacts	Basin-wide
15) Develop Master Plan for Spill Response	Rec. and comm. boating	Master Plan would reduce impacts from spill	Cost, public, government, and private participation	Reduced impacts from spills in harbor	Coastal areas in within harbor
16) Improve boat head and bilge pumping, and refueling practices	Rec. and comm. boating	Pump heads/bilges to appropriate destination, use spill-reducing fueling methods	Cost, public acceptance	Reduction of human waste and contaminants to surface waters	Coastal lands, within harbor

Table 12-22. Identification of Management Options for Water Quality for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
17) Coordinate water quality monitoring programs		Coordinated monitoring will better characterize surface and groundwater	Cost	Better understanding of trends in water quality in basin	Basin-wide

Table 12-23. Identification of Management Options for Hydrologic Alterations for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Increase level of reuse for landscape irrigation	Urban water supply	Reuse reduces additional water use and nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water.	Basin-wide
2) Promote use of water-saving appliances and fixtures	Urban water supply	Reduces rate of potable water use	Public acceptance, distribution of hardware	Reduces per capita potable water use	Basin-wide
3) Investigate alternate sources such as desalinization	Urban water supply	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces demands on groundwater and surface water for potable use	Mainly coastal areas
4) Re-establish more natural annual flow hydrographs in coastal streams	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas

Table 12-23. Identification of Management Options for Hydrologic Alterations for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Increase stormwater runoff storage near coast	Hydrologic alteration	Surface water is stored and gradually released	Cost, land requirements	Ensures stable, natural freshwater inflows for coastal estuary.	Coastal and inland areas
6) Provide for sheet flow of surface water past roads and utility corridors	Urban infrastru. - roads & utility corridors; Wetlands to urban; Uplands to urban	Improves surface water flow patterns and rates	Cost, regulatory/ enforcement	Improved surface water flow regime	Basin-wide
7) Identify and correct significant and unnecessary inter-basin transfers	Inter-basin transfer of water	Route surface water and ground-water to natural outfalls	Cost, land requirements	Improved freshwater inflow characteristics	Inland basins and coastal outfalls

Table 12-24. Identification of Management Options for Habitat Loss for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
1) Develop and implement Master Plan for habitat protection and restoration	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Coordinated Master Plan will make habitat enhancement efforts more effective	Cost, regulatory format	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
2) Establish and implement mitigation criteria	Wetlands and uplands to agriculture and urban; Hydrologic alter.	Developing criteria will improve habitat protection and enhancement	Cost, regulatory format, public and private acceptance	Improved habitat in Charlotte Harbor and watershed	Basin-wide, or estuary only
3) Manage public access to coastal areas	Wetland to urban land use	Management will limit impacts to habitats	Cost, enforcement, public acceptance	Reduced impacts to shoreline and estuarine resources	Coastal areas
4) Increase level of reuse for landscape irrigation	Wetlands to urban and agriculture	Reuse reduces additional demands on freshwater, and reduces nutrient loading	Reuse distribution system, social (public acceptance)	Reduces demands on potable water, which reduces potential impacts to natural systems	Basin-wide

Table 12-24. Identification of Management Options for Habitat Loss for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
5) Encourage waterfront property owners to enhance shoreline habitats	Wetland to urban land use	Shoreline enhancement will improve habitat values	Public awareness, cost	Improved habitat values for estuary	Coastal areas
6) Investigate alternate water sources such as desalinization	Over-use of surface and ground water	Process sea water into potable water through physical and chemical means	Public acceptance, cost	Reduces potential impacts to natural systems from over use as potable source	Basin-wide
7) Re-establish more natural annual flow hydrographs in coastal streams.	Hydrologic alteration	Return coastal streams to more natural systems	Cost, land requirements	Ensures stable, natural rates of freshwater inflow for estuarine living resources.	Coastal areas and tidal creeks
8) Establish greenways and wildlife corridors between large natural areas	Wetlands to urban and agriculture; Uplands to urban and agriculture; Low density to high density land use	Provides upland and wetland connections between large natural habitat areas	Cost, land availability	Provides contiguous system of uplands and wetlands for habitat	Basin-wide

Table 12-24. Identification of Management Options for Habitat Loss for the Coastal Venice Basin.

Management Option	Issues Addressed	Mode of Operation	Constraints to Implementing	Potential Benefits	Geographic Area of Use
9) Identify and protect areas subject to prop scarring	Rec. and comm. boating; Rec. and comm. fishing	Reduces impacts to seagrass meadows by limiting motor boat access to areas	Cost, regulatory/ enforcement, public acceptance	Improves quality of estuarine habitat	Within Charlotte Harbor
10) Provide protection for manatees in areas of their congregation	Rec. and comm. boating; Rec. and comm. fishing	Reduces manatee mortality by slowing boats or limiting access to some areas	Cost, regulatory/ enforcement, public acceptance	Reduced manatee mortality	Within Charlotte Harbor and coastal canals and streams
11) Assess cumulative impacts of entrainment of living resources of estuary	Wetlands to urban land use	Determine how many living resources are killed through entrainment	Cost, industry participation	Better understanding of impacts of entrainment	Coastal areas

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SYNTHESIS OF TECHNICAL INFORMATION

Volume 2:
APPENDICES

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for the

Charlotte Harbor National Estuary Program

- *Peace River & Watershed* • *Myakka River & Watershed*
- *Coastal Venice/Lemon Bay/Gasparilla Sound/Cape Haze*
- *Charlotte Harbor Proper* • *Pine Island Sound/Matlacha Pass*
- *Estero Bay & Watershed* • *Tidal Caloosahatchee River & Watershed*

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INTRODUCTION

This report "Synthesis of Existing Information, Volume II," contains the following information:

- Total annual and mean monthly rainfall plots for basins.
- Total annual and mean monthly streamflow.
- Surface water quality summaries for basins within the Charlotte Harbor NEP study area.
- Pollution potential model for basins within the Charlotte Harbor NEP study area.
- Land use data from SWFWMD based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III for the Charlotte Harbor NEP study area.

This second volume supplements Volume I that characterizes and analyzes the program's three priority problems in the greater Charlotte Harbor watershed. These problems are:

1) **Hydrologic Alterations** - adverse changes to amounts, locations, and timing of freshwater flows, hydrologic function of floodplain systems, and natural river flows.

2) **Water Quality Degradation** - including but not limited to pollution from agricultural and urban runoff, point source discharges, septic tank system loadings, atmospheric deposition, and groundwater.

3) **Fish and Wildlife Habitat Loss** - degradation and elimination of headwater streams and other habitats caused by development, conversion of natural shorelines, cumulative impacts of docks and boats, invasion of exotic species, and cumulative and future impacts.

Addressing elements of the three identified priority problems as they relate to each of these major basins will be a primary focus in development of the Charlotte Harbor NEP CCMP. To accomplish this, the Synthesis of Existing Information seeks to:

- identify and compile relevant sources of information;

- to assess trends in the estuary's water quality, natural resources, and uses;

- to assess pollution loadings to the estuary and relate them to observed changes in water quality, natural resources, and land use; and

- to identify potential environmental problems.

List of Appendices

Appendix A:

Total annual and mean monthly rainfall plots for basins

Appendix A: (continued)

Appendix A: (continued)

Appendix A: (continued)

Appendix A: (continued)

Appendix A: (continued)

Appendix B:

Total annual and mean monthly streamflow

Appendix B: (continued)

Appendix B: (continued)

Appendix B: (continued)

Appendix B: (continued)

Appendix B: (continued)

Appendix B: (continued)

Appendix D: (continued)

Appendix B: (continued)

Appendix C:

Surface water quality summaries for basins within the Charlotte Harbor Study Area

Appendix A

Total annual and mean monthly rainfall plots for basins within the Charlotte Harbor Study Area

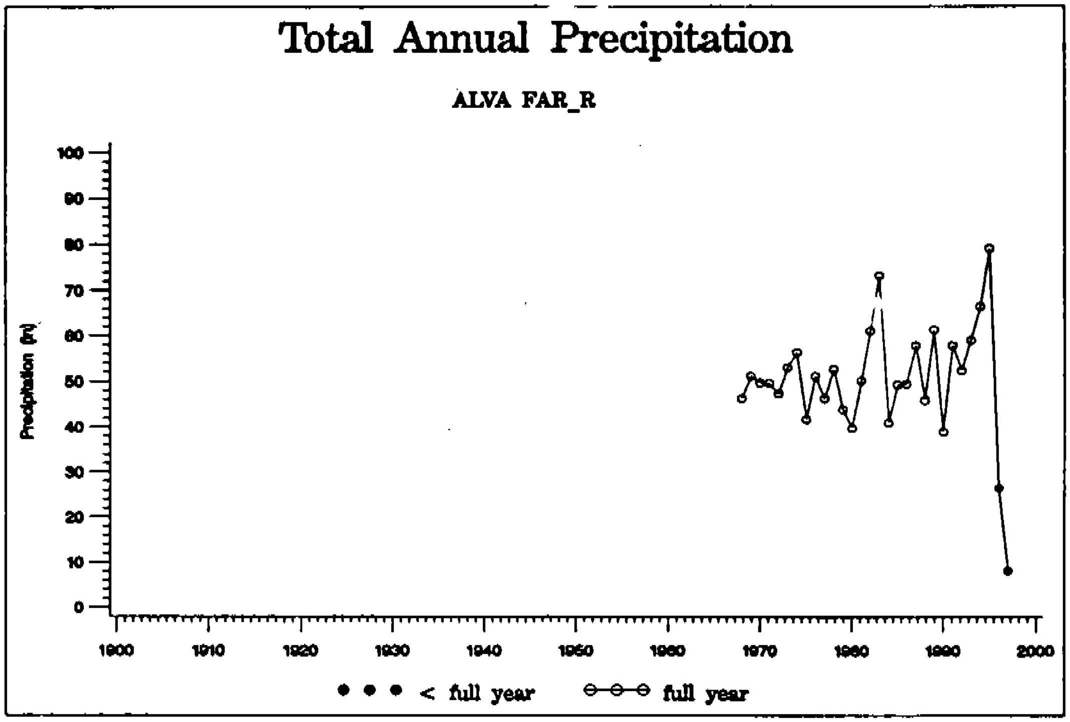
Myakka River Basin
Peace River Basin
Charlotte Harbor Basin
Pine Island/ Matlacha Pass Basin
Caloosahatchee River Basin
Estero Bay Basin
Coastal Venice Basin

NWS Station Number	Longitude	Latitude	NWS Station Name
80228	81.85000	27.23333	ARCADIA
80236	81.35000	27.18333	ARCHBOLD BIOLOGICAL
80369	81.53333	27.60000	AVON PARK 2 W
80390	81.51667	27.85000	BABSON PARK 1 ENE
80478	81.85000	27.90000	BARTOW
80520	82.50000	28.06667	BAY LAKE
80887	81.75000	26.33333	BONITA SPRINGS 2 MI
80945	82.46667	27.45000	BRADENTON 5 ESE
80940	82.55000	27.48333	BRADENTON EXPERIMENT
81046	82.36667	28.61667	BROOKSVILLE CHIN HIL
81310	82.18333	26.53333	CAPTIVA
81632	82.76667	27.96667	CLEARWATER
81869	81.16667	27.40000	CORNWELL 4 NW
82288	81.51667	27.36667	DE SOTO CITY 8 SW
82298	81.13333	26.60000	DEVILS GARDEN
83153	82.13333	27.56667	FORT GREEN 12 WSW
83186	81.86667	26.60000	FORT MYERS PAGE FLD
83986	82.23333	28.15000	HILLSBOROUGH RVR SP
84210	81.43333	26.46667	IMMOKALEE 3 NNW
84242	81.33333	27.80000	INDIAN LAKE ESTATES
84625	81.41667	28.28333	KISSIMMEE 2
84620	81.41667	28.30000	KISSIMMEE CITY HALL
84662	81.43333	26.75000	LA BELLE
84707	81.71667	28.10000	LAKE ALFRED EXP STN
84845	81.38333	27.28333	LAKE PLACID 2 SW
84866	81.48333	26.43333	LAKE TRAFFORD
84797	81.91667	28.01667	LAKELAND
85124	82.65000	27.41667	LONGBOAT KEY
85895	81.08333	26.83333	MOORE HAVEN LOCK 1
85973	81.60000	27.93333	MOUNTAIN LAKE
86065	82.31667	27.23333	MYAKKA RIVER STATE P
86078	81.78333	26.16667	NAPLES
86251	81.00000	27.93333	NITTAW 1 S
86880	82.43333	27.56667	PARRISH
87205	82.13333	28.01667	PLANT CITY
87395	82.05000	26.93333	PUNTA GORDA
87397	82.00000	26.91667	PUNTA GORDA 4 ESE
88021	82.53333	27.35000	SARASOTA
88024	82.46667	27.33333	SARASOTA 5 E
87851	82.26667	28.33333	ST LEO
87886	82.63333	27.76667	ST PETERSBURG WHITTD
88788	82.53333	27.96667	TAMPA INTL ARPT
88824	82.75000	28.15000	TARPON SPNGS SWG PLT
89176	82.43333	27.10000	VENICE
89401	81.80000	27.55000	WAUCHULA
89707	81.73333	28.01667	WINTER HAVEN

SFWMD Rain Monitoring Station	Longitude	Latitude
TAMIAMI_R	81.25833	25.88611
BARRON_R	81.35000	25.96667
FAKAHAT_R	81.40833	25.97889
FAKA_R	81.50972	25.96028
L TRAFFO_R	81.48333	26.43333
HENDER_R	81.68694	26.09944
GORDON_R	81.78500	26.17250
GOLD.W1_R	81.76806	26.16750
COCOH.WB_R	81.76417	26.27250
SITE3_R	81.52361	26.06167
SITE2_R	81.67139	26.19667
SITE4 2_R	81.52389	26.27111
SITE1_R	81.56167	26.27833
C-296_R	81.34528	26.11111
C-54_R	80.88389	26.17167
JUNGLE L_R	81.79000	26.16778
USDA IMM_R	81.43750	26.46111
CORK.HQ_R	81.58333	26.38333
BAY WEST_R	81.70250	26.27472
VICTORIA_R	81.77083	26.26111
NAPLES C_R	81.75000	26.12694
MARCO FI_R	81.70056	25.92972
COLLIER_R	81.65833	26.15639
CCWWTP_R	81.78694	26.26806
ROYAL HA_R	81.59167	25.99028
IMMOKALE_R	81.40722	26.39278
SILVER S_R	81.43861	26.29667
FAKAHATC_R	81.36139	26.16694
CCWWTP2_R	81.67500	26.24167
GOLD.WP_R	81.70000	26.18333
GOLD.WP2_R	81.70417	26.16667
IMMOKA 2_R	81.41667	26.40694
MONROE T_R	81.10694	25.85833
MARCO TO_R	81.58333	26.00000
MILES CI_R	81.34667	26.18417
COPELAND_R	81.36028	25.95000
NAPLES T_R	81.75917	26.15361
L TRAFFO_R	81.48333	26.43333
NAPLES_R	81.79000	26.16778
EVERGL 2_R	81.38722	25.84500
IMMOKA 3_R	81.43750	26.46111
MILES 2_R	81.34583	26.19583
SITE #1_R	81.68333	26.15000
SITE #2_R	81.30000	25.88333
SIX L.7_R	81.62333	26.02028
CCWTP_R	81.78333	26.26667
SDS_R	81.70250	26.27472
KANTORS_R	81.69500	26.19111
L TRAFFO_R	81.48333	26.43333

SFWMD Rain Monitoring Station	Longitude	Latitude
MARCO FI_R	81.70056	25.92972
KANTORS_R	81.69500	26.19111
USDA IMM_R	81.43750	26.46111
EVERGL 2_R	81.38722	25.84500
CORK.HQ_R	81.58333	26.38333
CORK.LCI_R	81.57167	26.40833
CORK.CP_R	81.61639	26.40722
CORK.SD_R	81.64083	26.36278
DUDA.NAP_R	81.65333	26.03056
GOLD.FS_R	81.70472	26.18250
CORK.HQ_E	81.58333	26.38333
IMMOKALE_R	81.40722	26.39278
IMMOKA 3_R	81.43750	26.46111
MARCO FI_R	81.70056	25.92972
EVERGL 2_R	81.38722	25.84500
NAPLES_R	81.79000	26.16778
RACOON PT	81.31667	25.96667
GOLDFS2	81.63222	26.22806
ASGROW	81.70833	26.27083
BCBNAPLE_R	81.80833	26.22500
COLLISEM	81.59167	25.99028
EAGLECRK	81.70694	26.05167
GOLD75	81.52083	26.15778
NNAPFS42	81.72583	26.27194
CORKISL	81.59222	26.36417
COLLICTY	81.68806	26.16944
STEPHAN	81.68806	26.16944
951EXT_R	81.68861	26.30222
COCO1_R	81.78000	26.27250
IMMOKALE_R	81.40722	26.39278
GOLDFS2	81.63222	26.22806
BCBNAPLE_R	81.80833	26.22500
COLLISEM	81.59167	25.99028
COLGOV_R	81.76278	26.12944
DANHP_R	81.48111	25.97833
LEHIGH 1_R	81.65000	26.60667
LEHIGH_R	81.65000	26.60667
S79_R	81.69861	26.72361
CAPECOR1_R	82.01528	26.58972
CAPECOR2_R	81.96361	26.57889
LEHIGH 2_R	81.66000	26.65167
LEHIGH 3_R	81.56778	26.62361
LEHIGH 4_R	81.60667	26.55667
LEHIGH 5_R	81.70528	26.60417
ALVA FAR_R	81.63000	26.71222
LEHIGH 1_R	81.65000	26.60667
LEHIGH_R	81.65000	26.60667
S79_R	81.69861	26.72361

SFWMD Rain Monitoring Station	Longitude	Latitude
CAPECOR1_R	82.01528	26.58972
CAPECOR2_R	81.96361	26.57889
LEHIGH 2_R	81.66000	26.65167
LEHIGH 3_R	81.56778	26.62361
LEHIGH 4_R	81.60667	26.55667
LEHIGH 5_R	81.70528	26.60417
ALVA FAR_R	81.63000	26.71222
FORT MEY_R	81.86667	26.58333
L.B.MINO_R	81.59944	26.74306
LEHIGH E_R	81.71667	26.55000
LEHIGH 6_R	81.73333	26.61667
LEHIGH W_R	81.65000	26.60694
CORK.TOW_R	81.58333	26.52278
ESTERO T_R	81.83833	26.47361
SLEE_R	81.77722	26.69556
CAPTIVA_R	82.18333	26.53333
BONITA S_R	81.75000	26.33333
FT MEYER_R	81.86444	26.58056
SR_R	81.86667	26.58333
CORK.TOW_R	81.58333	26.52278
FT MEYER_R	81.86444	26.58056
SR_R	81.86667	26.58333
CAPECOR2_R	81.96361	26.57889
FORT MEY_R	81.86667	26.58333
S79_R	81.69861	26.72361
LEHIGH W_R	81.65000	26.60694
S79_R	81.69861	26.72361
S79_R	81.69861	26.72361
FORT MEY_R	81.86667	26.58333
BONITA S_R	81.75000	26.33333
CORK_R	81.57889	26.42194


Total Annual Precipitation
ALVA FAR_R
Precipitation (in)
100
90
80
70
60
50
40
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20
10
0
1900
1910
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1930
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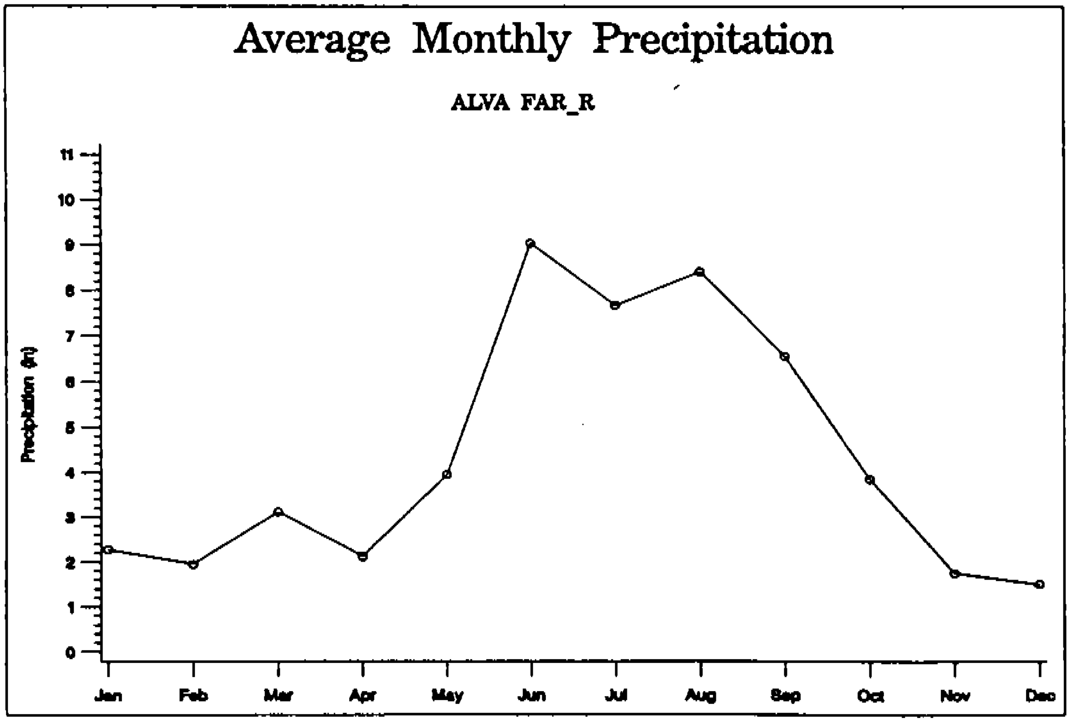
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
ALVA FAR_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
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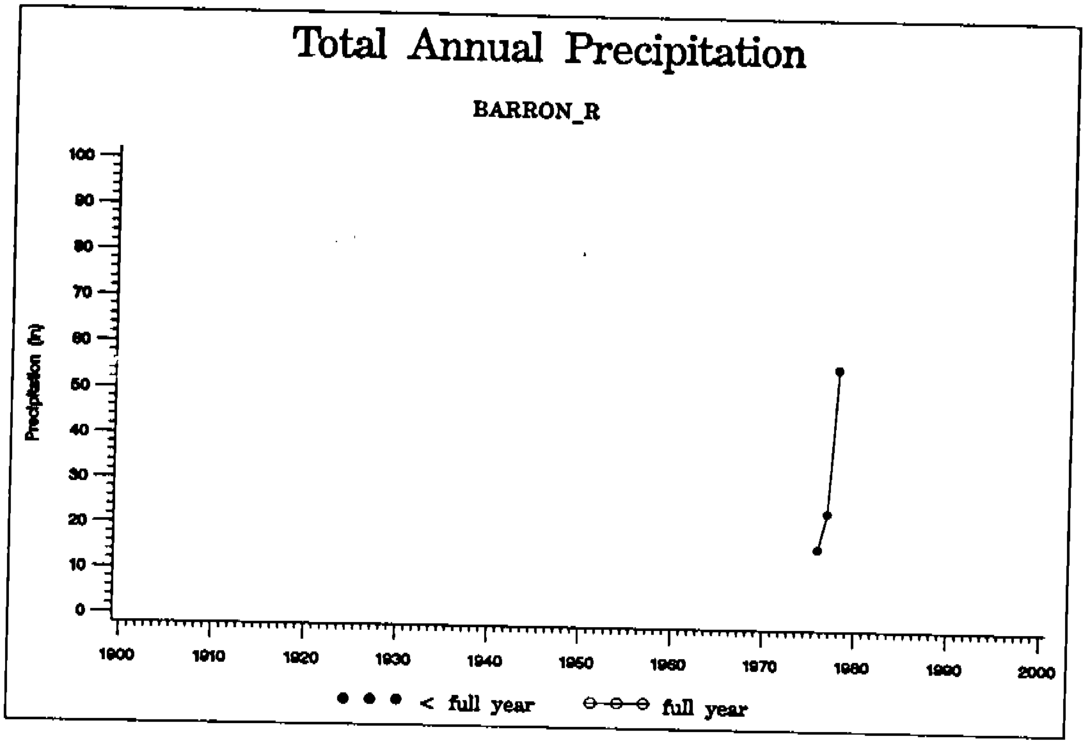
Total Annual Precipitation
BARRON_R
Precipitation (in)
0
10
20
30
40
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70
80
90
100
1900
1910
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1950
1960
1970
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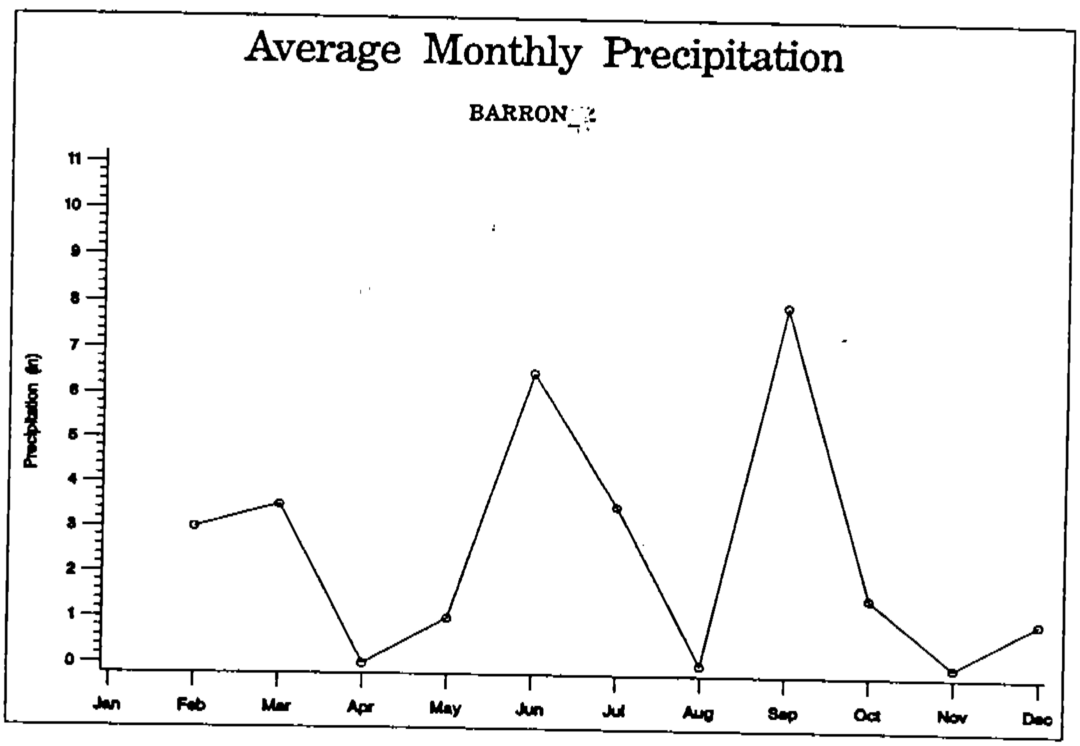
2000
< full year
full year


Average Monthly Precipitation
BARRON
Precipitation (in)
0
1
2
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4
5
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8
9
10
11
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Sep
Oct
Nov
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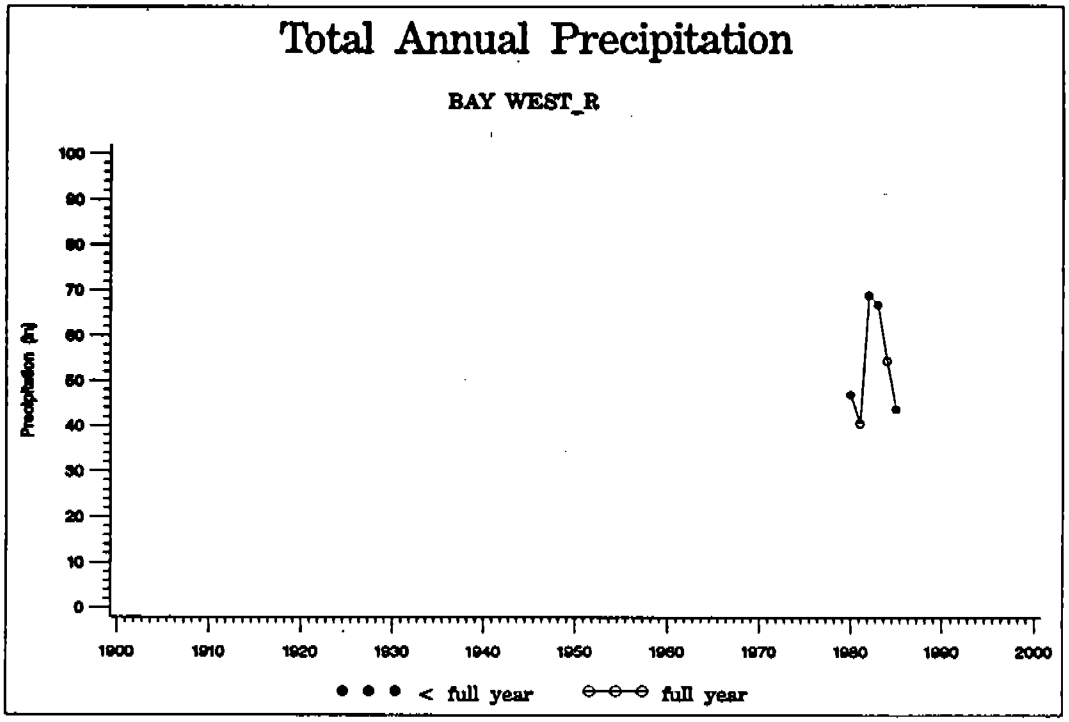
Total Annual Precipitation
BAY WEST_R
Precipitation (in)
100
90
80
70
60
50
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30
20
10
0
1900
1910
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1990
2000
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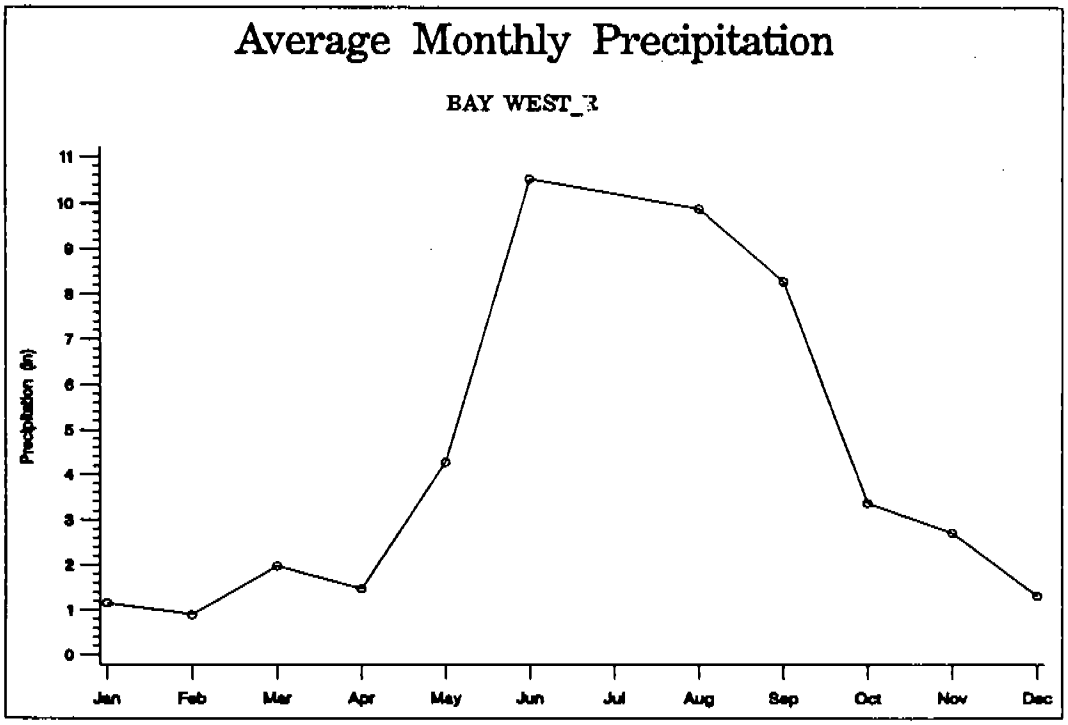
full year


Average Monthly Precipitation
BAY WEST_R
Precipitation (in)
11
10
9
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6
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0
Jan
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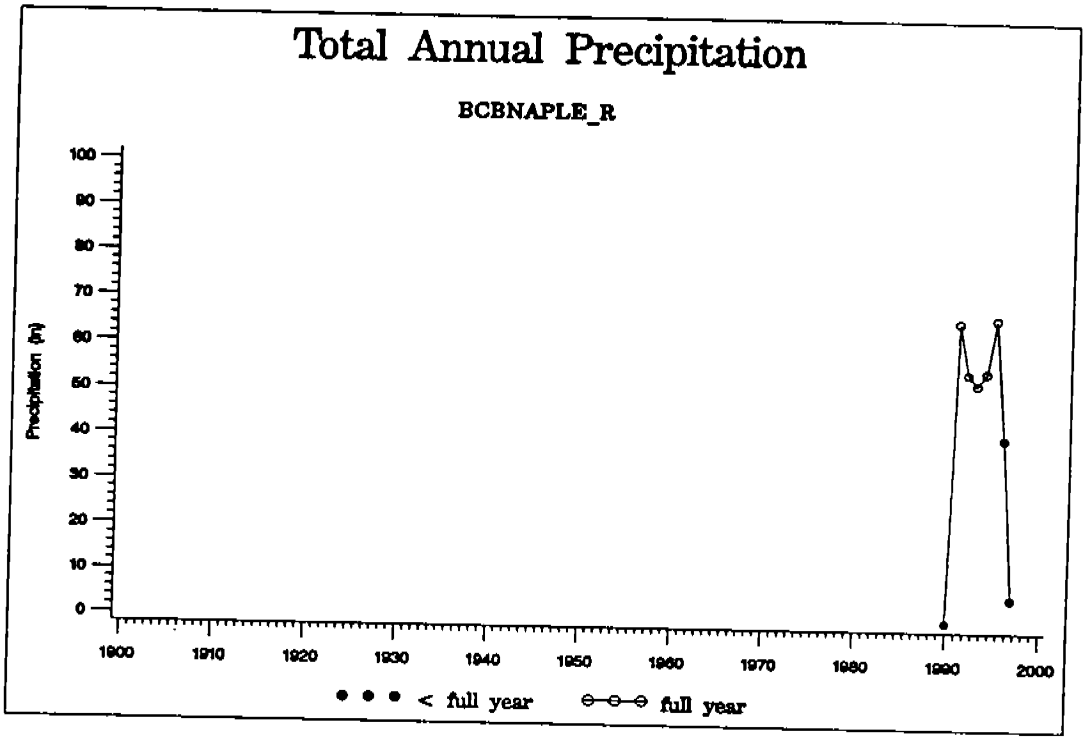
Total Annual Precipitation
BCBNAPLE_R
Precipitation (in)
100
90
80
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60
50
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1910
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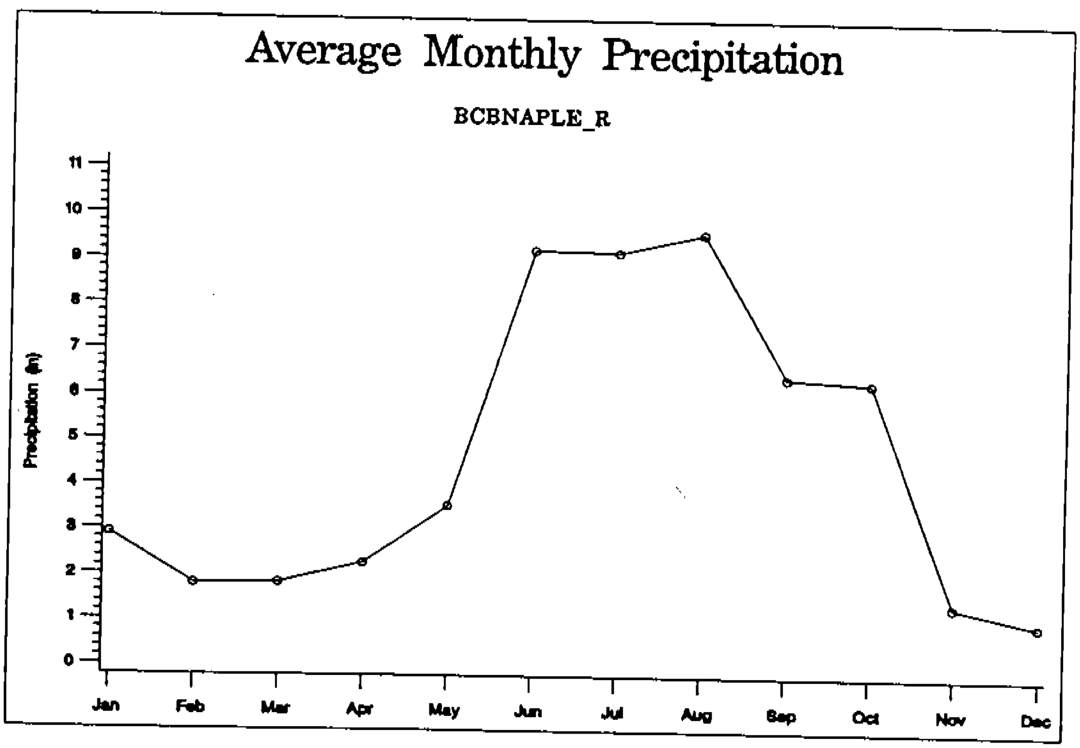
< full year
full year


Average Monthly Precipitation
BCBNAPLE_R
Precipitation (in)
11
10
9
8
7
6
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4
3
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0
Jan
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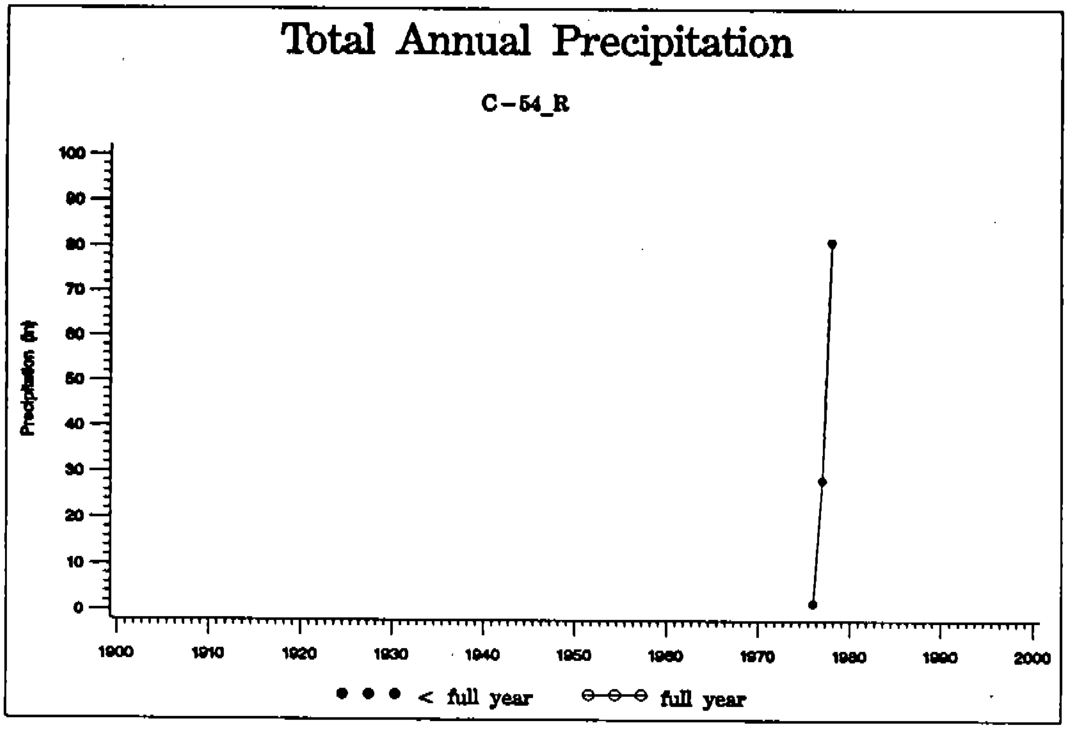
Total Annual Precipitation
C-54_R
Precipitation (in)
0
10
20
30
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100
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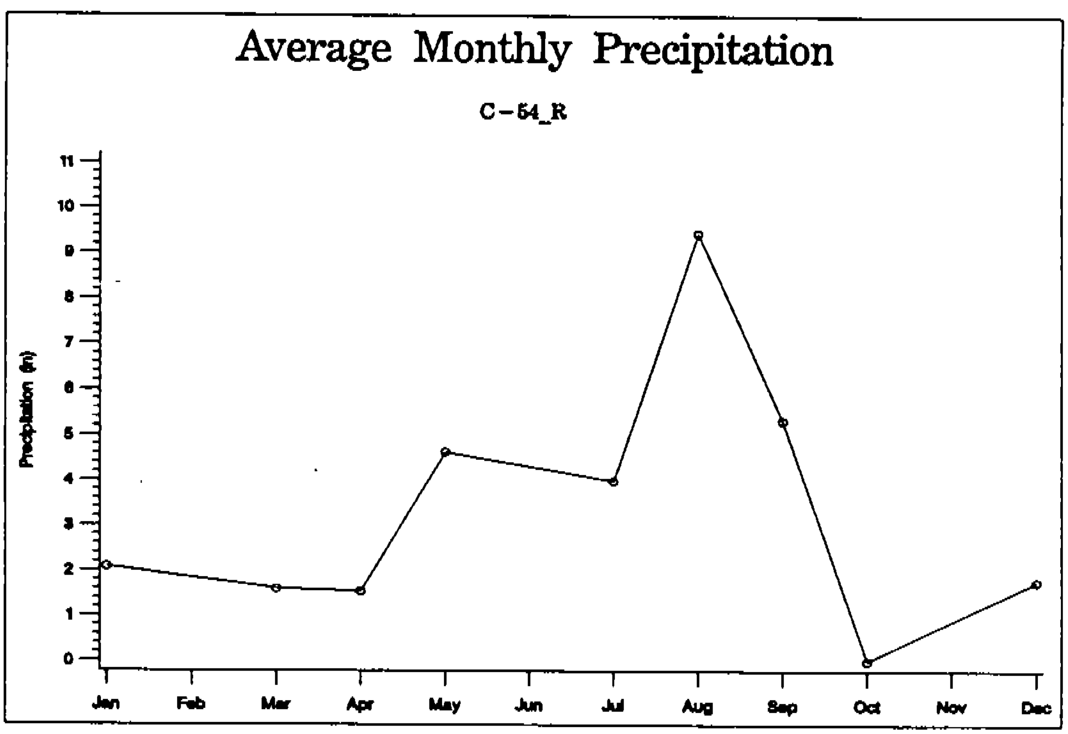
< full year
full year


Average Monthly Precipitation
C-54_R
Precipitation (in)
0
1
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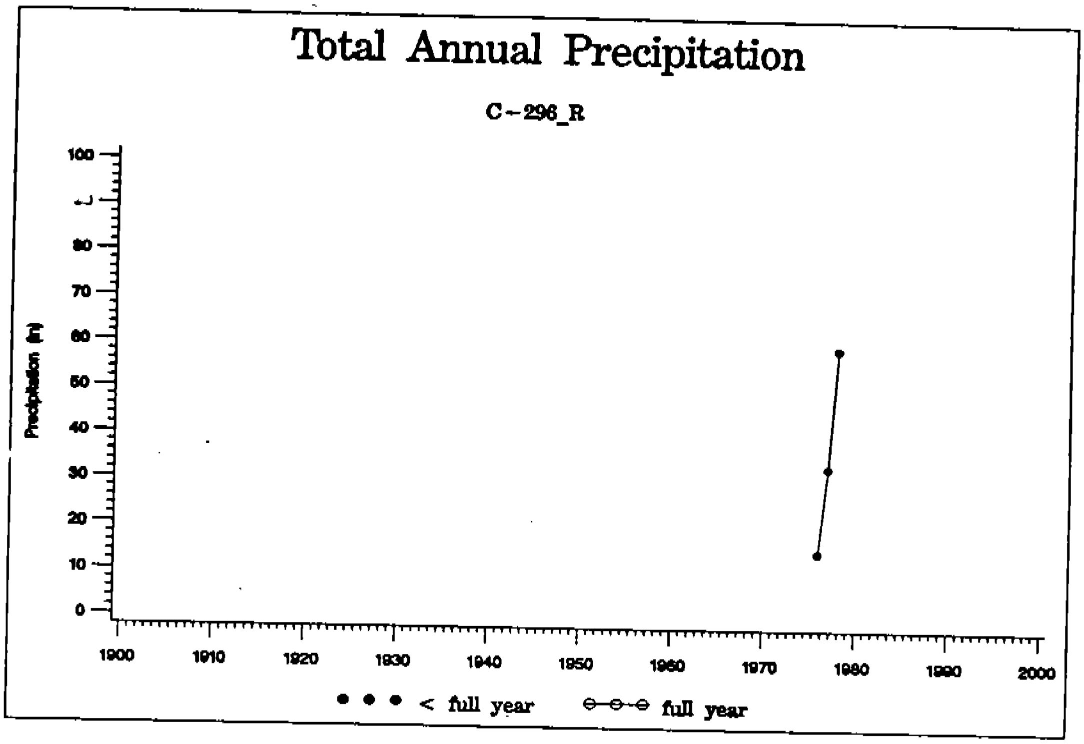
Total Annual Precipitation
C-296_R
Precipitation (in)
0
10
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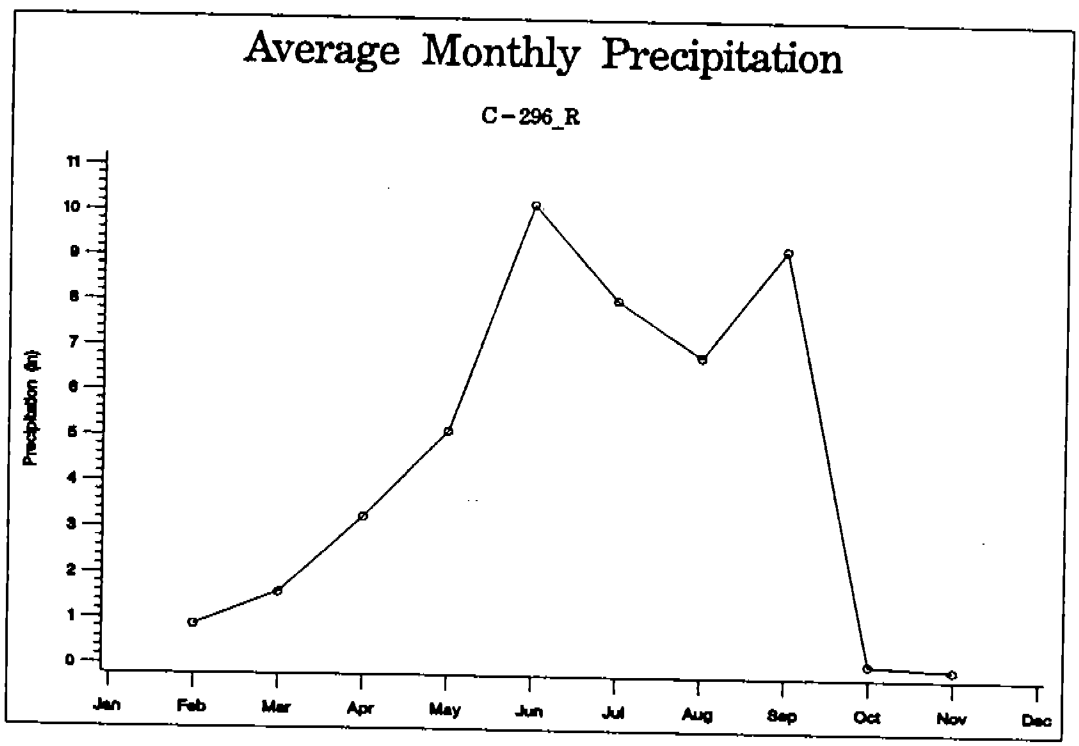
● ● ● < full year
⊖-⊖-⊖ full year


Average Monthly Precipitation
C-296_R
Precipitation (in)
0
1
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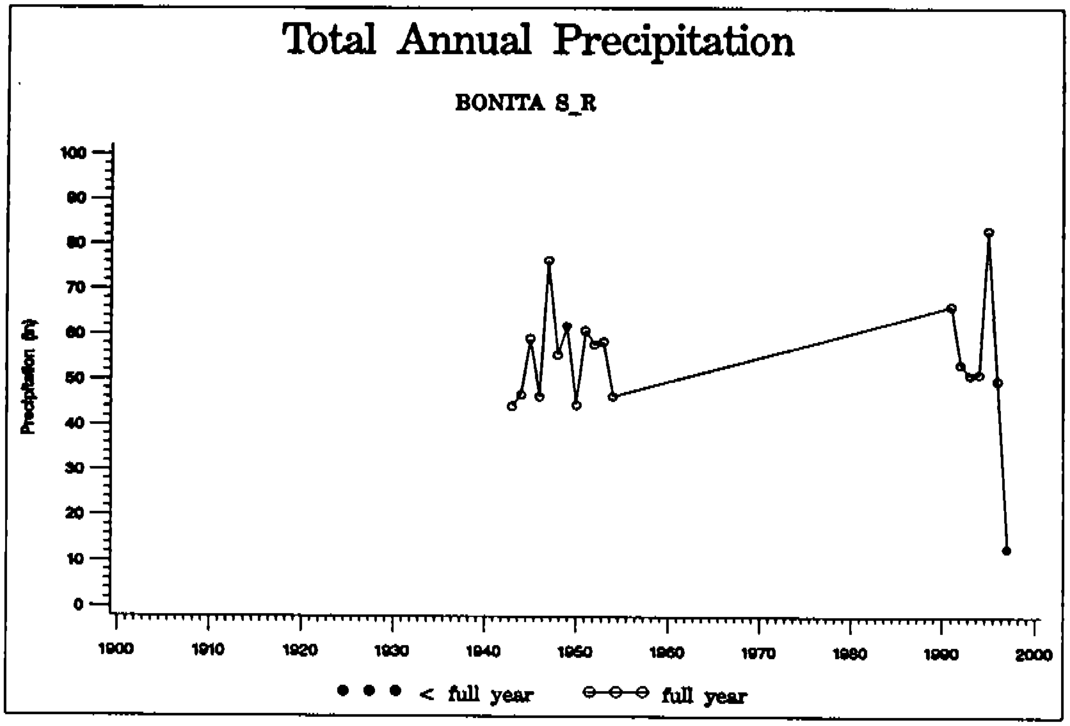
Total Annual Precipitation
BONITA S_R
Precipitation (in)
0
10
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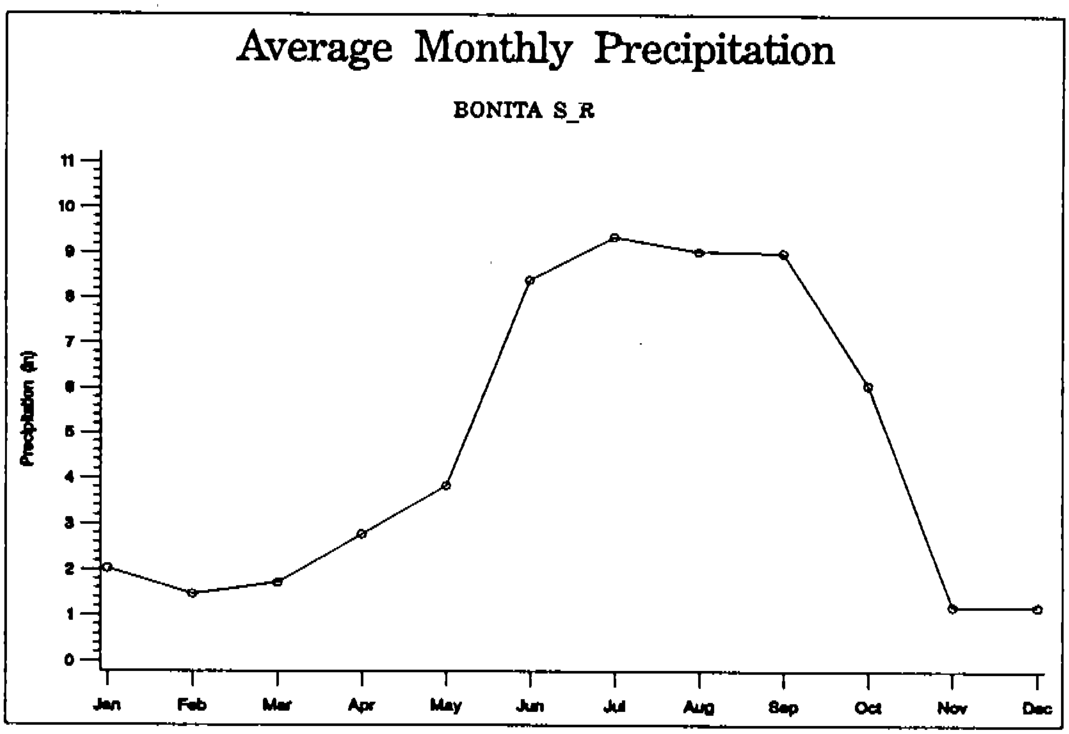
full year


Average Monthly Precipitation
BONITA S_R
Precipitation (in)
0
1
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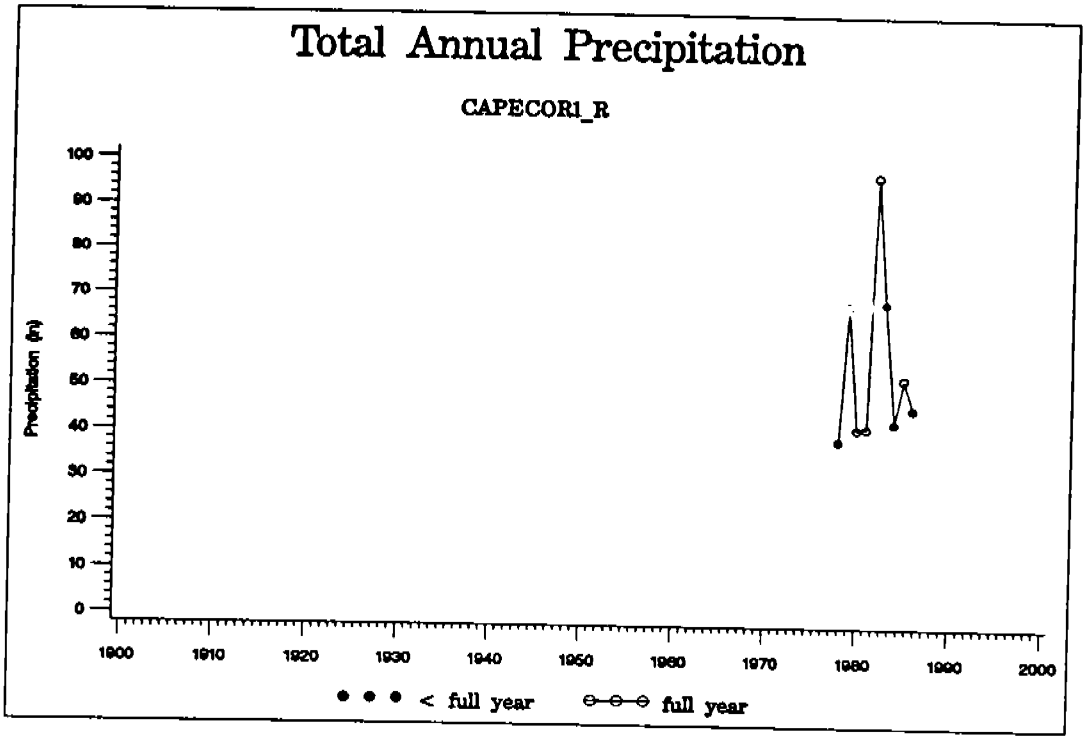
Total Annual Precipitation
CAPECOR1_R
Precipitation (in)
0
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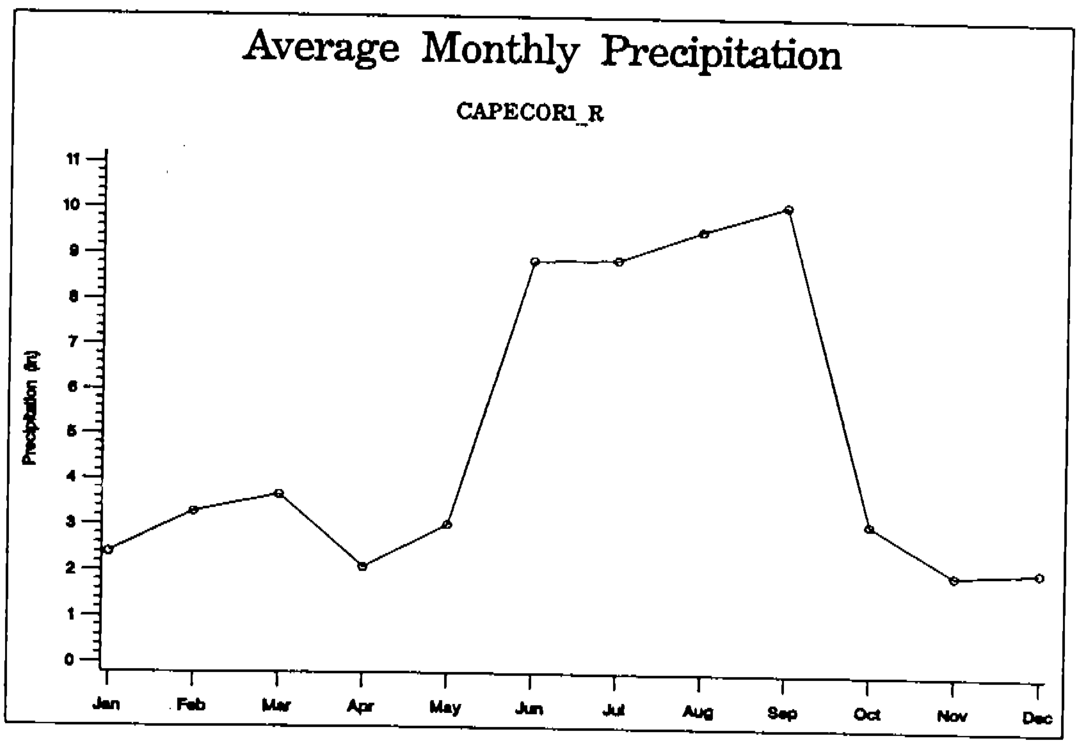
full year


Average Monthly Precipitation
CAPECOR1_R
Precipitation (in)
0
1
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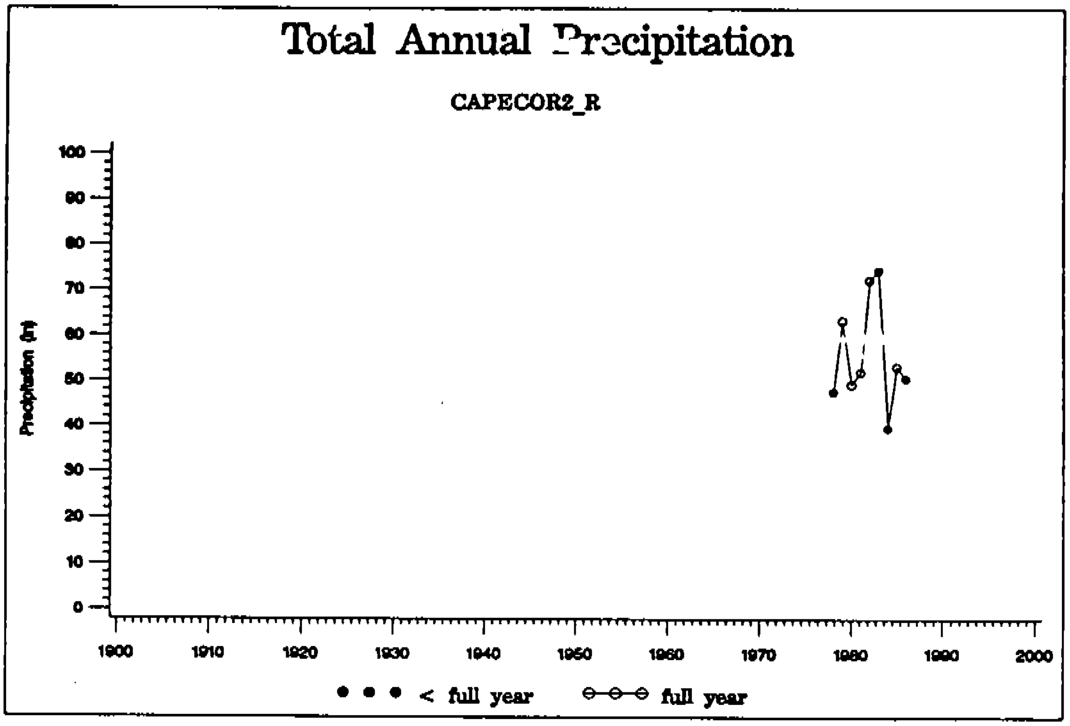
Total Annual Precipitation
CAPECOR2_R
Precipitation (in)
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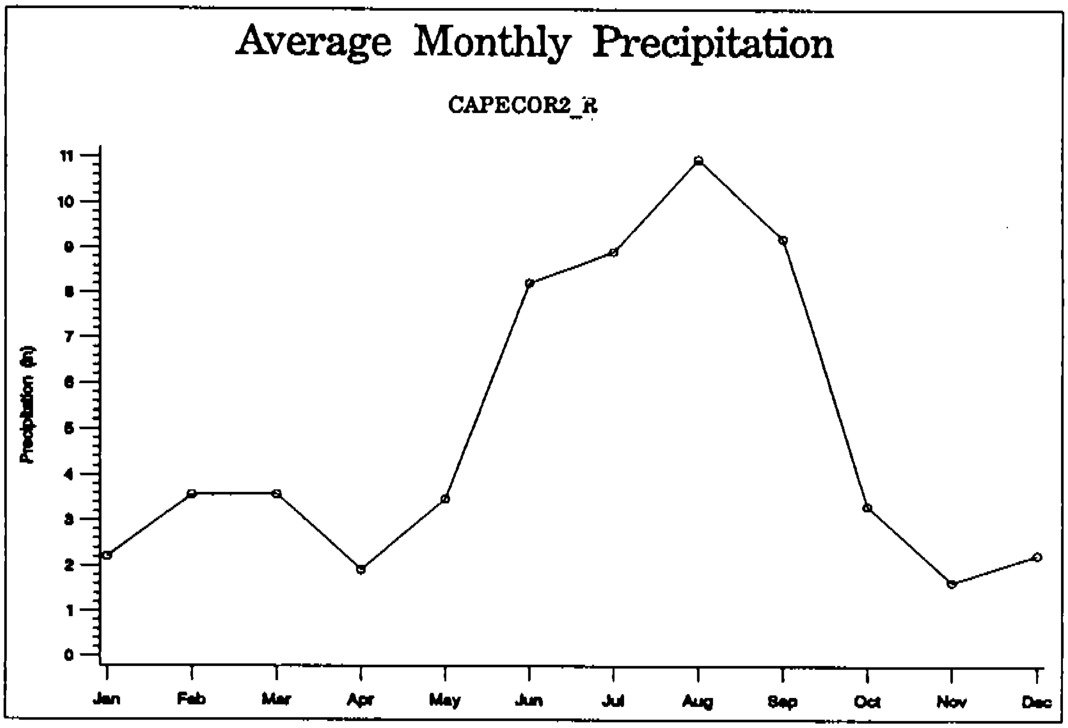
full year


Average Monthly Precipitation
CAPECOR2_R
Precipitation (in)
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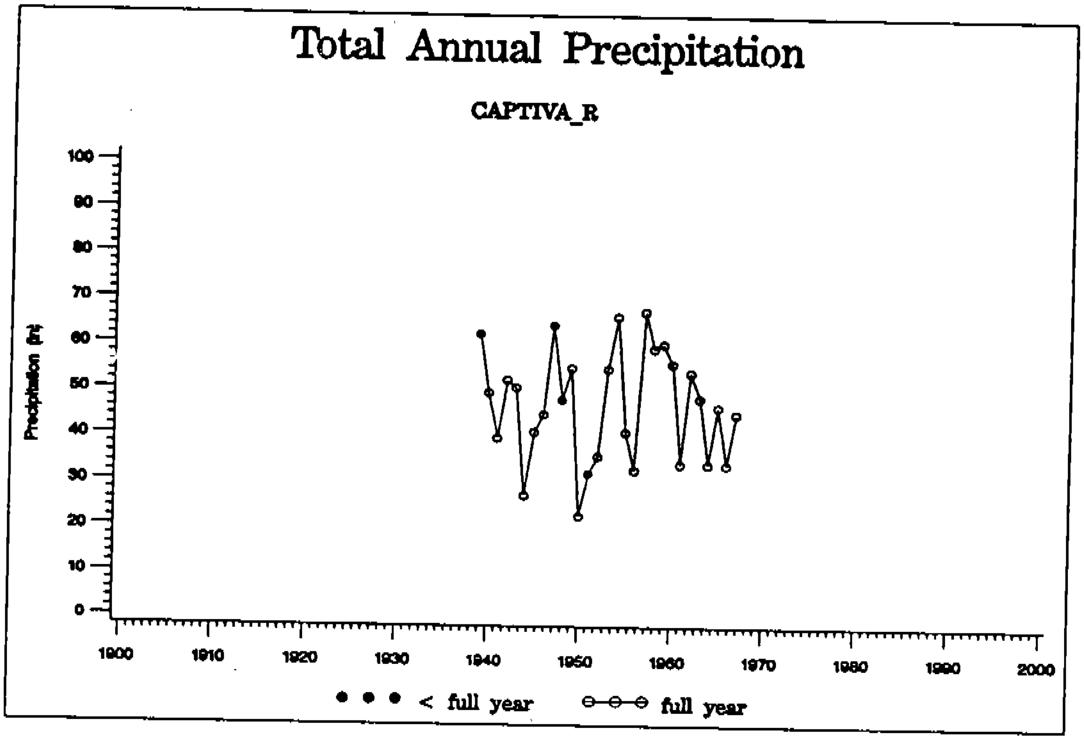
Total Annual Precipitation
CAPTIVA_R
Precipitation (in)
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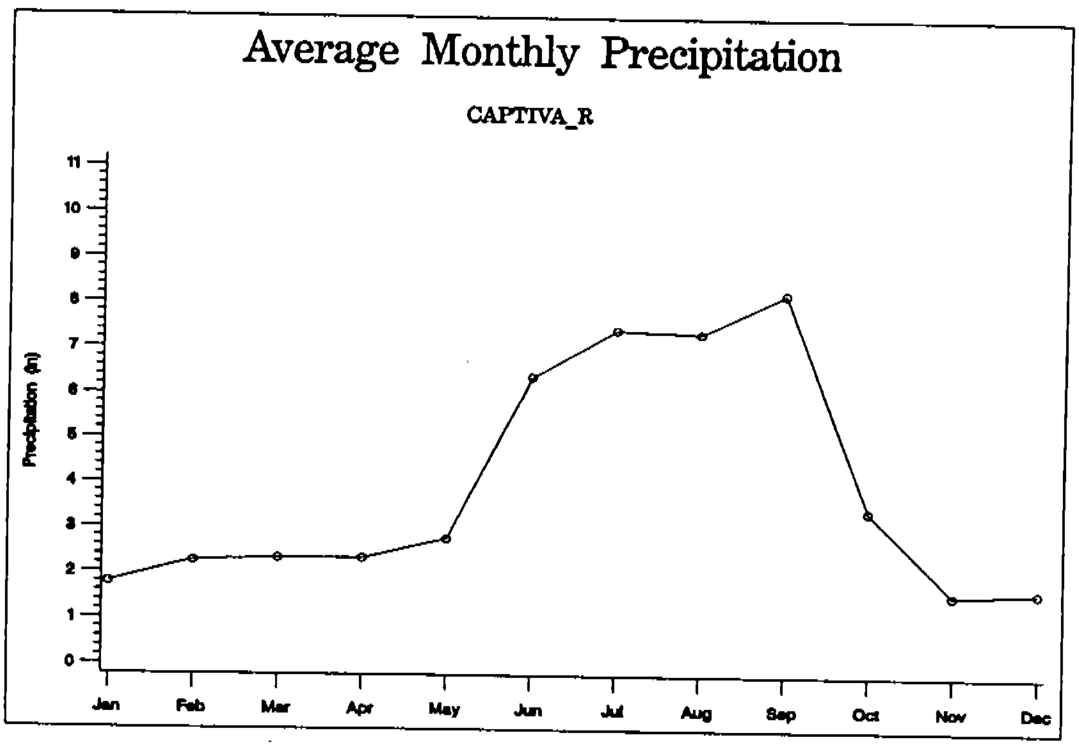
Average Monthly Precipitation
CAPTIVA_R
Precipitation (in)
0
1
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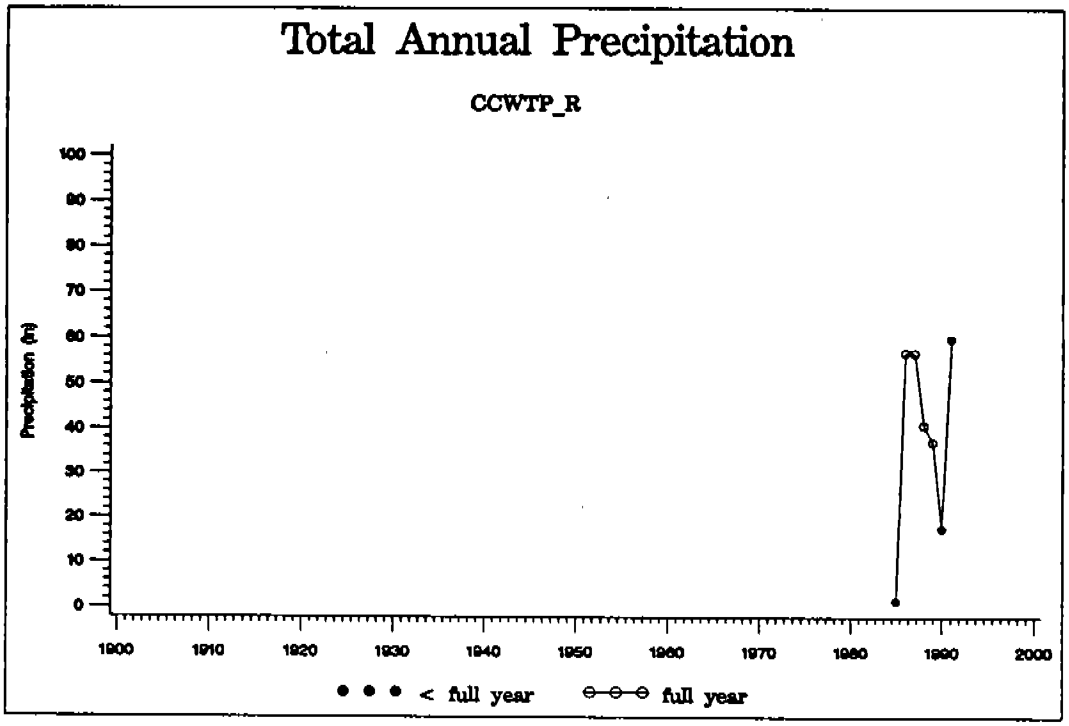

Total Annual Precipitation
CCWTP_R
Precipitation (in)
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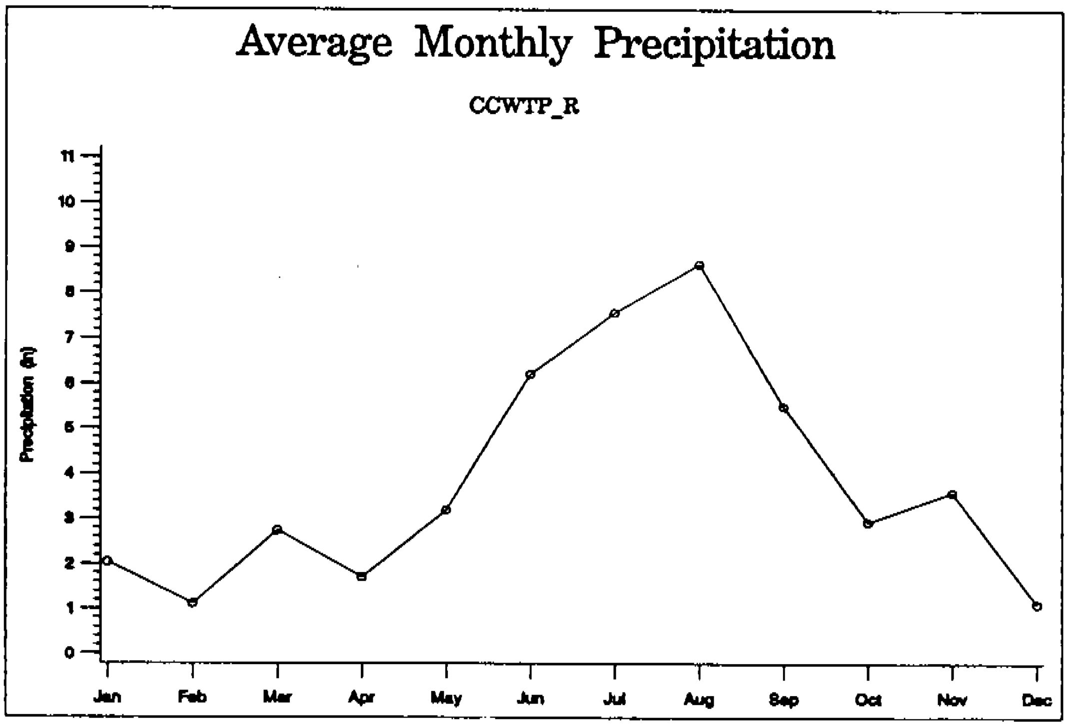
full year



Average Monthly Precipitation
CCWTP_R
Precipitation (in)
0
1
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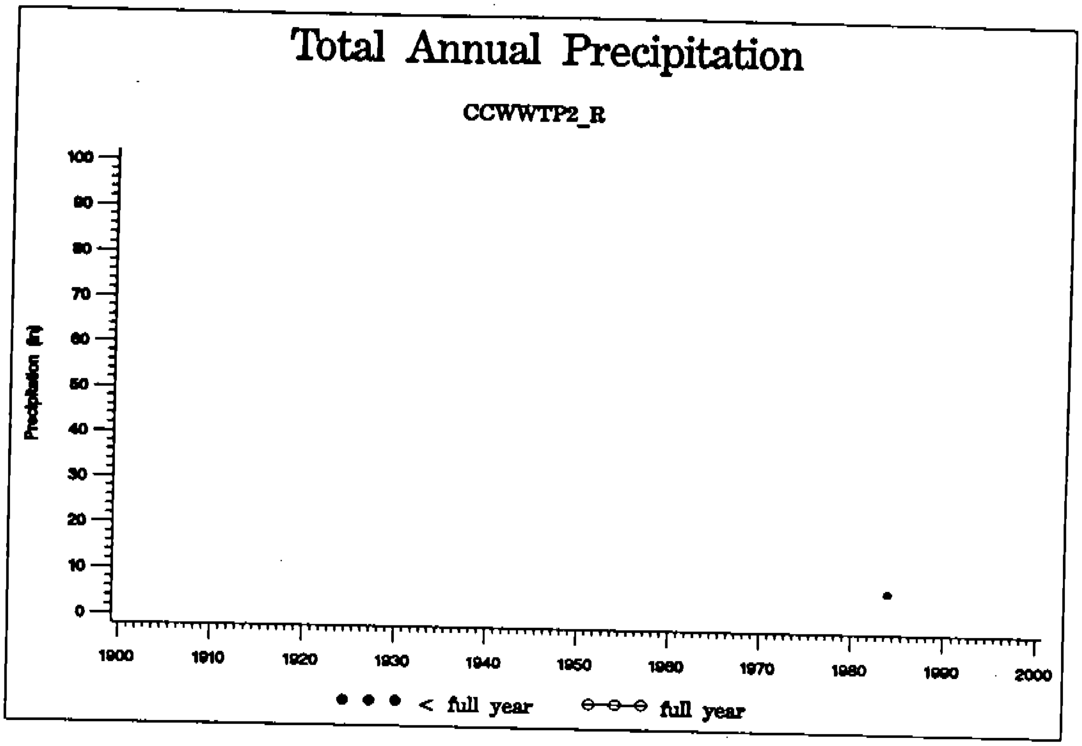
Total Annual Precipitation
CCWWTP2_R
Precipitation (in)
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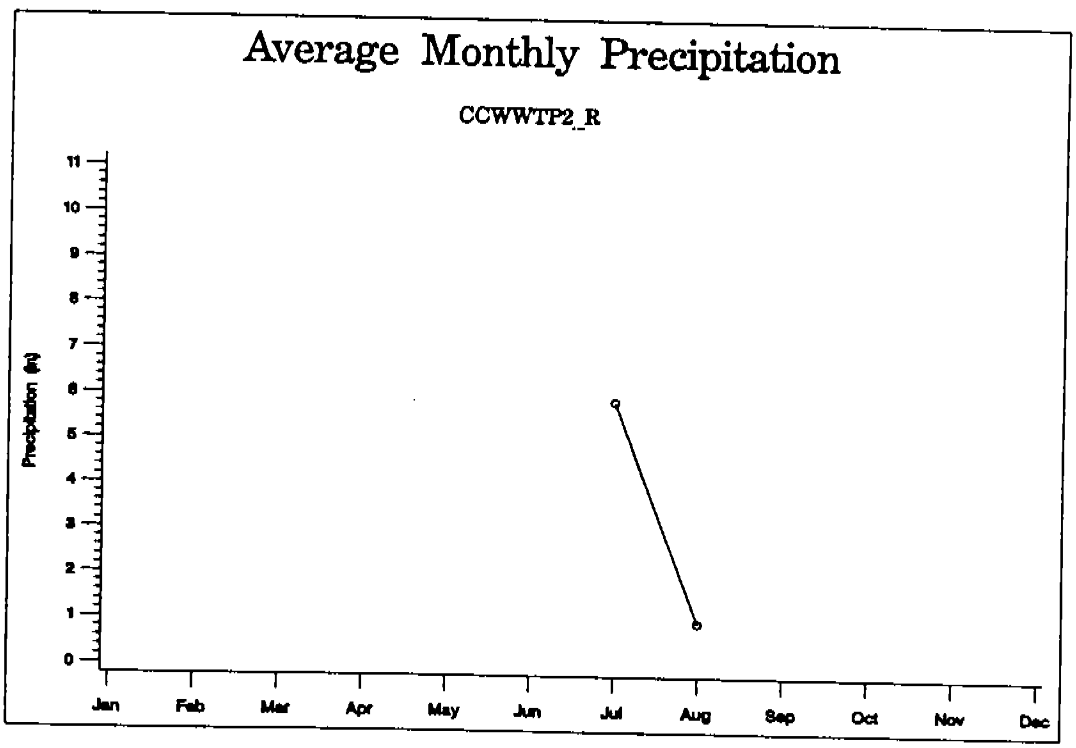
full year


Average Monthly Precipitation
CCWWTP2_R
Precipitation (in)
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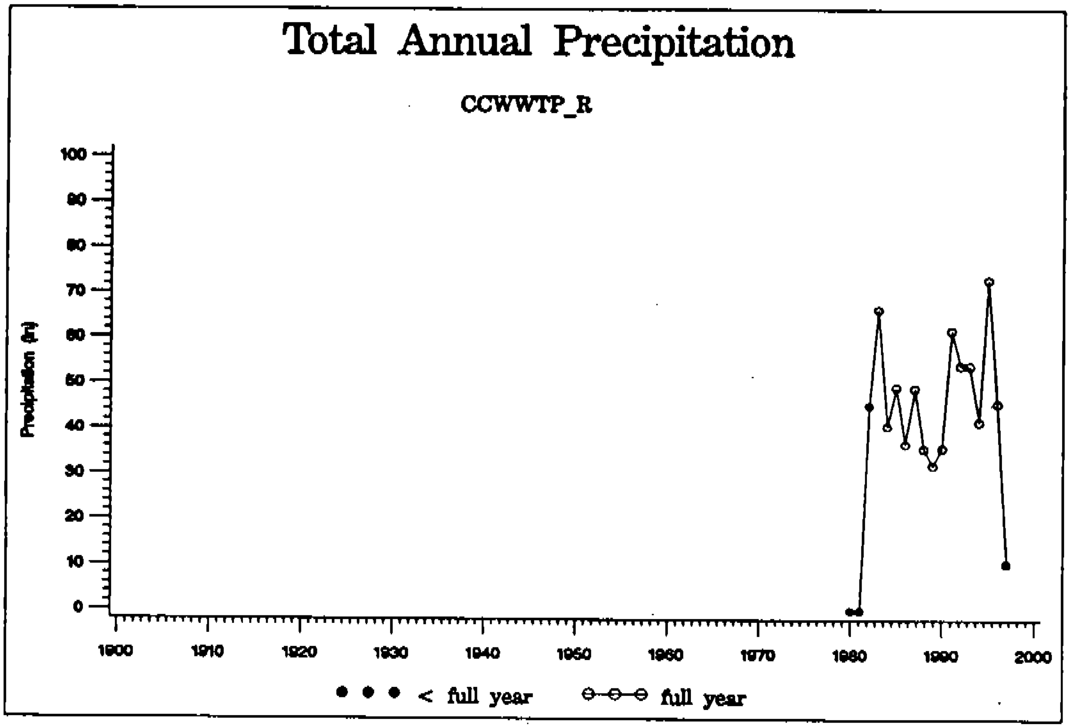
Total Annual Precipitation
CCWWTP_R
Precipitation (in)
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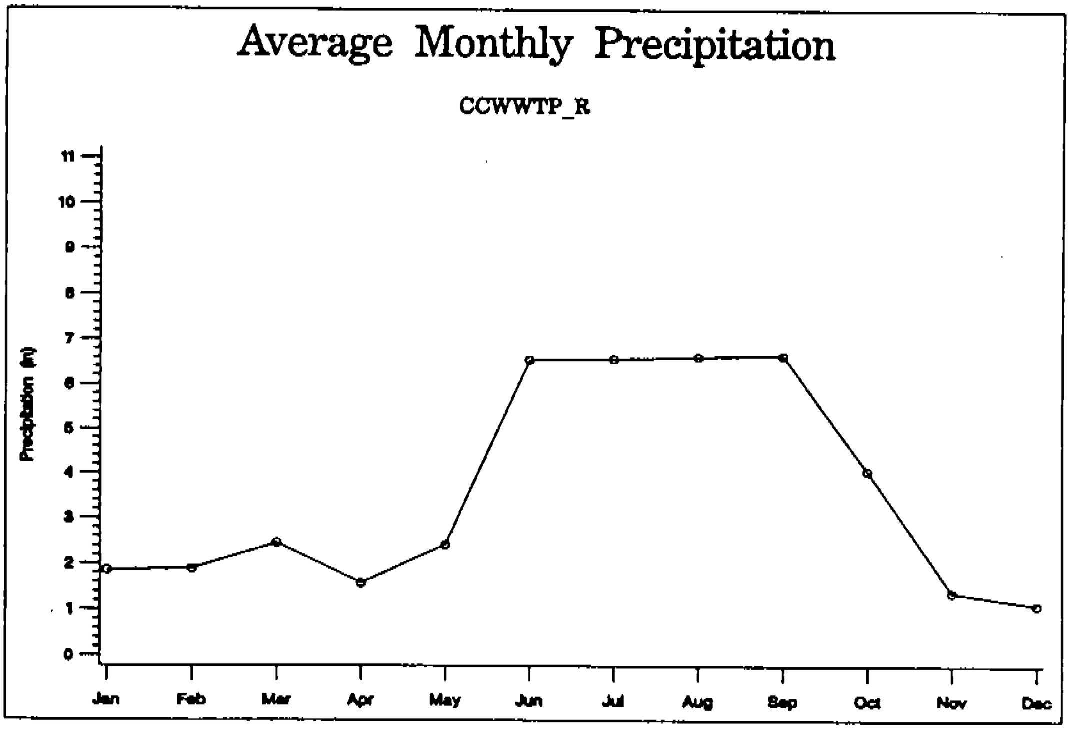
Average Monthly Precipitation
CCWWTP_R
Precipitation (in)
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Jan
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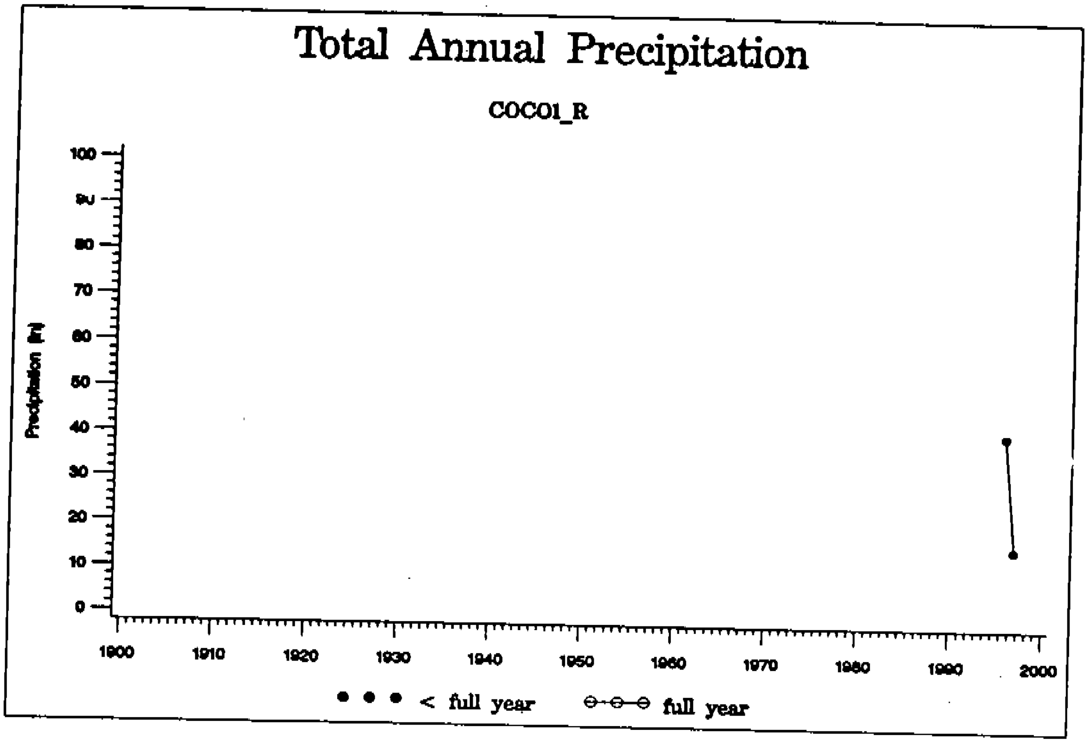
Total Annual Precipitation
COCO1_R
Precipitation (in)
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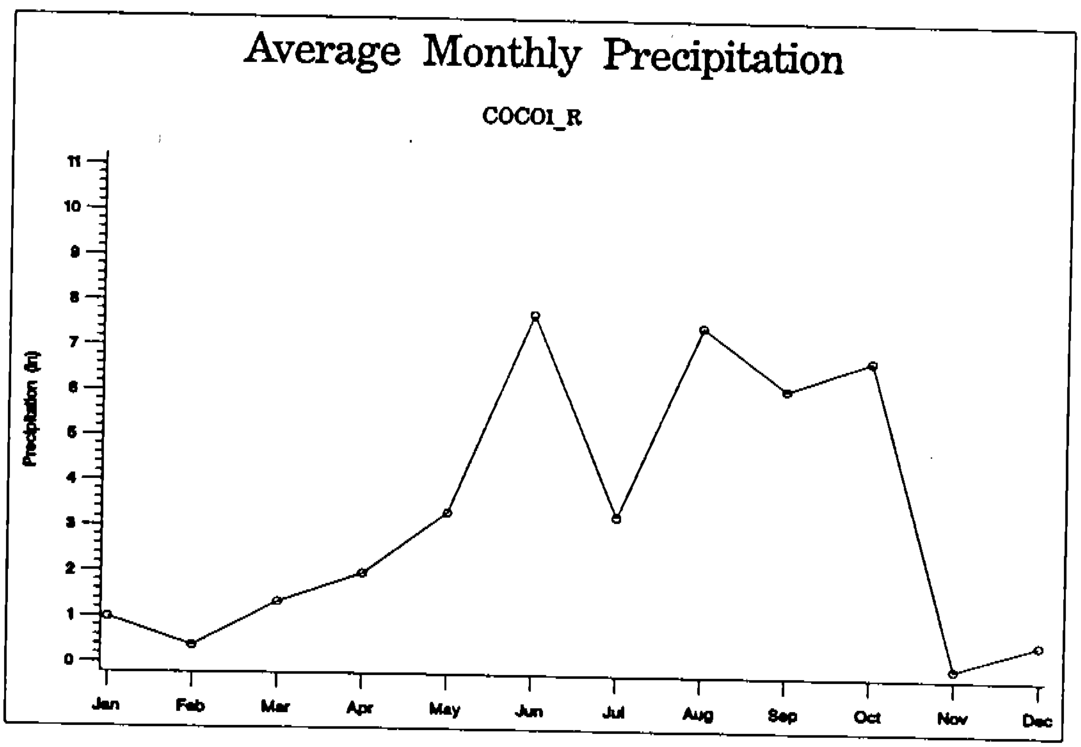
full year


Average Monthly Precipitation
COCO1_R
Precipitation (in)
11
10
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Jan
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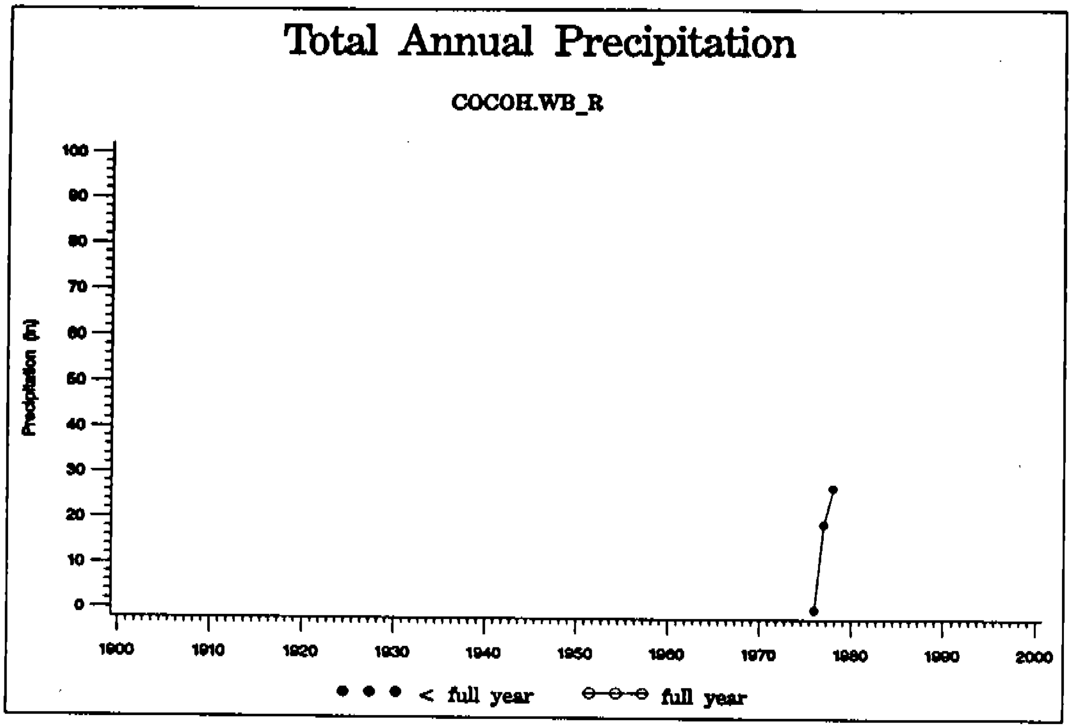
Dec


Total Annual Precipitation
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Precipitation (in)
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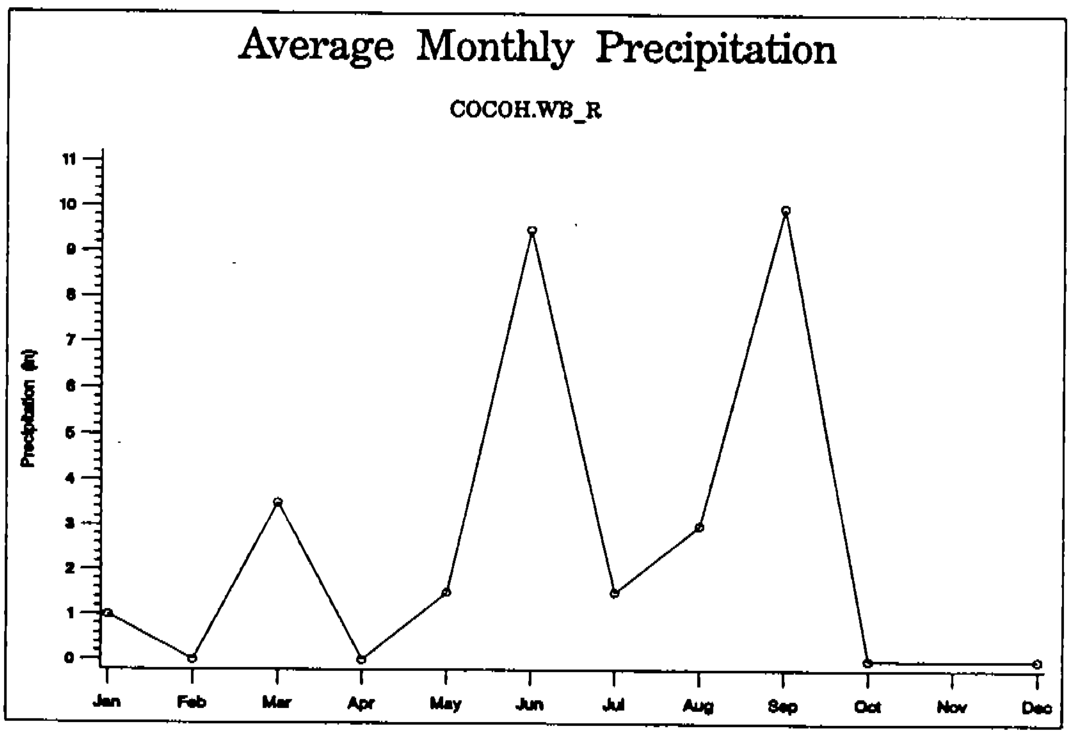
full year


Average Monthly Precipitation
COCOH.WB_R
Precipitation (in)
11
10
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2
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0
Jan
Feb
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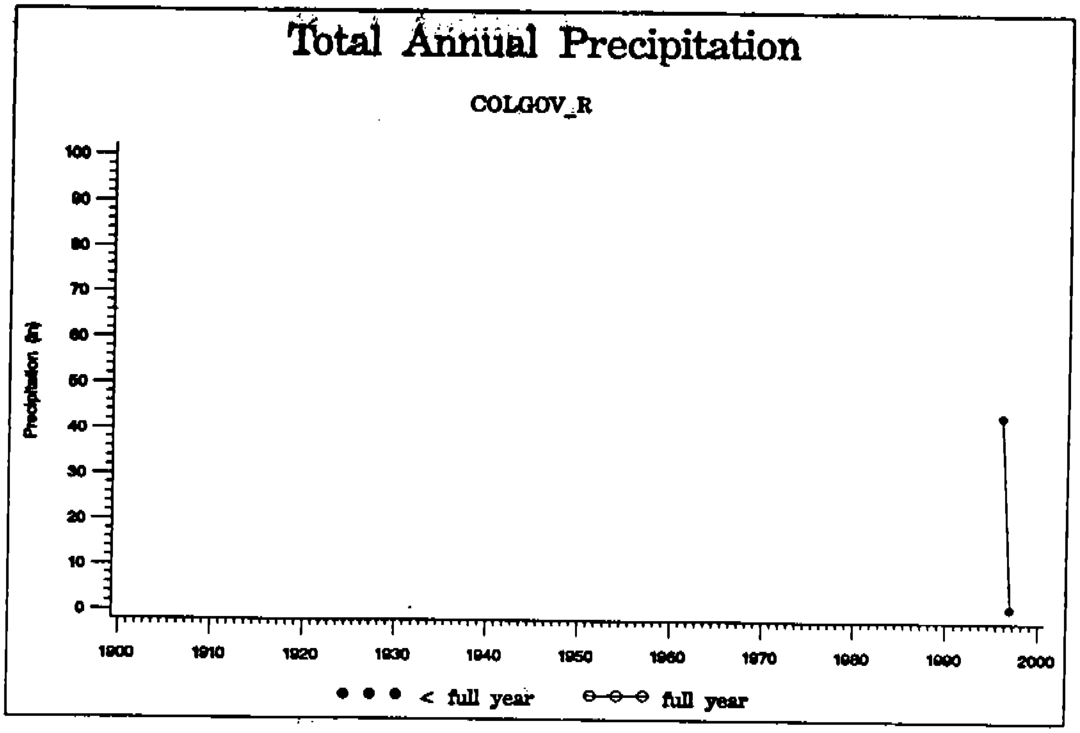
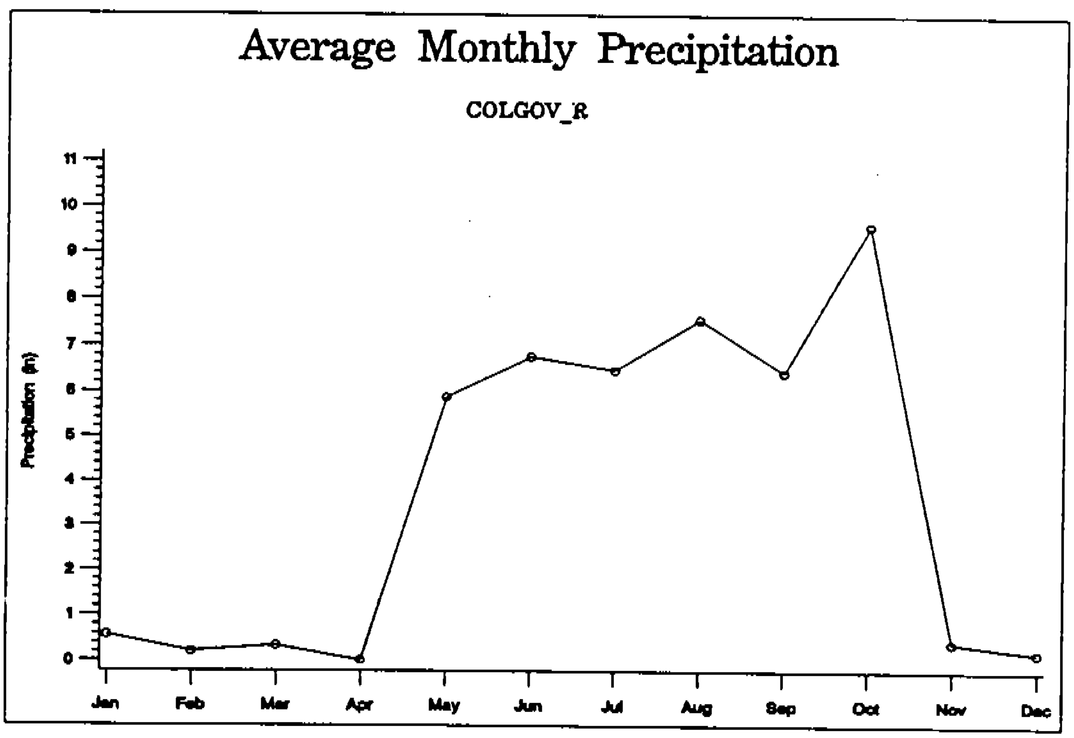
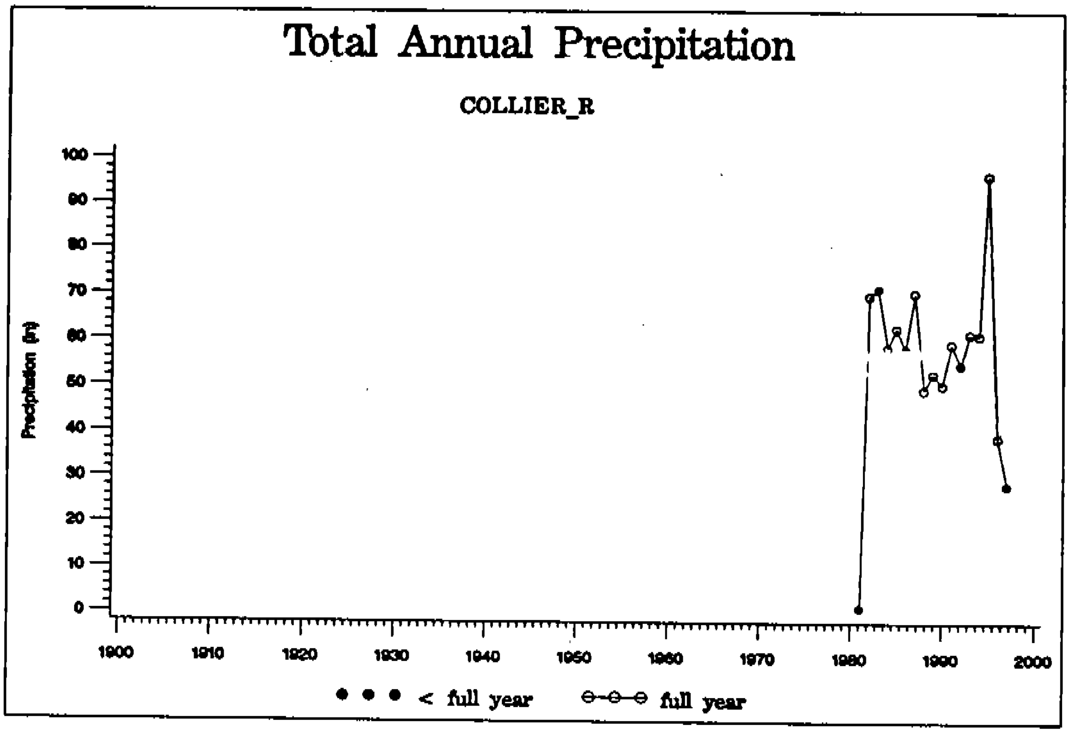
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
COLGOV_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
COLGOV_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
COLLIER_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
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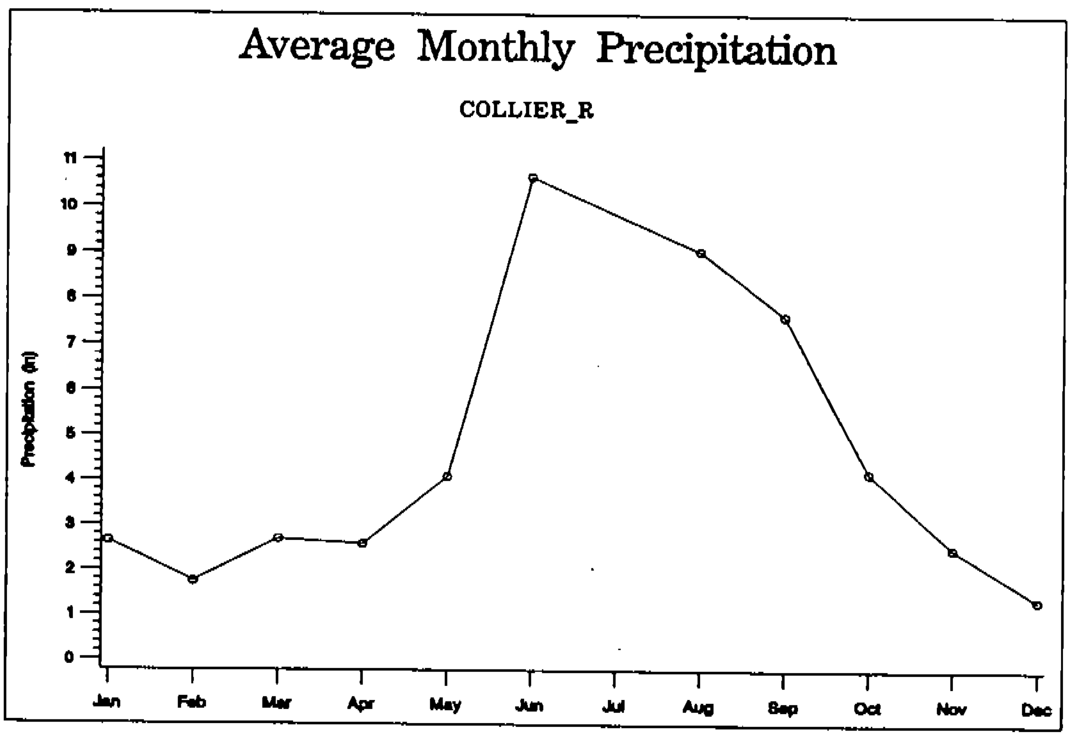
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Precipitation
COLLIER_R
Precipitation (in)
11
10
9
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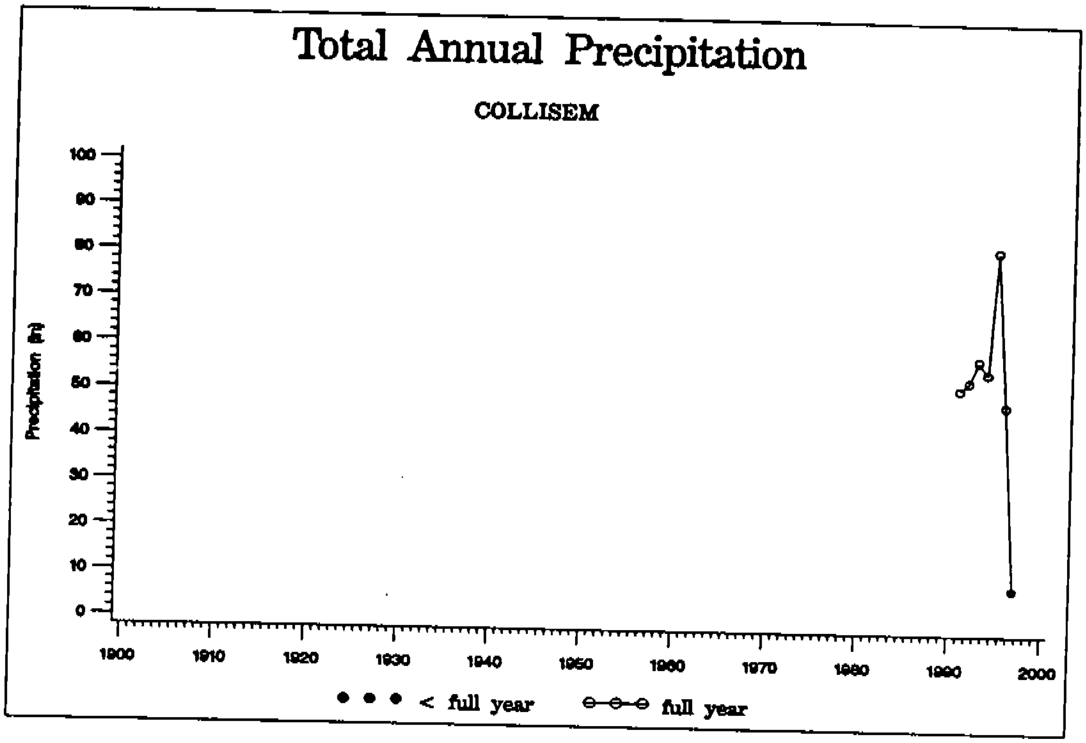
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
COLLISEM
Precipitation (in)
100
90
80
70
60
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1900
1910
1920
1930
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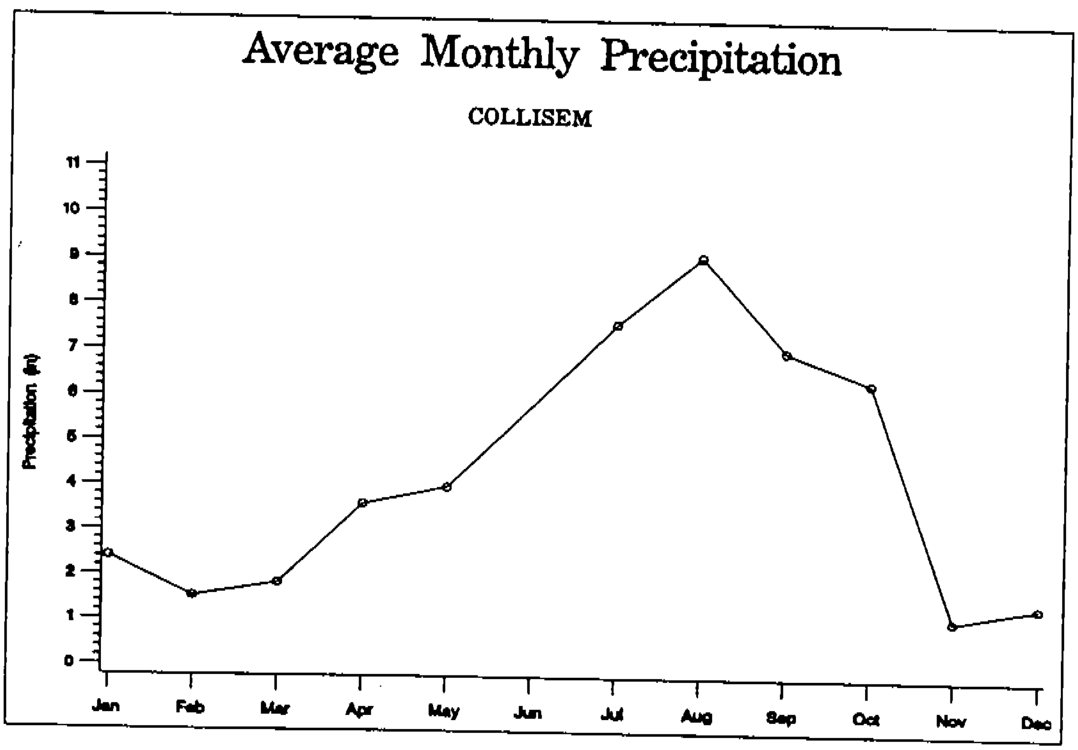
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Precipitation
COLLISEM
Precipitation (in)
11
10
9
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6
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4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
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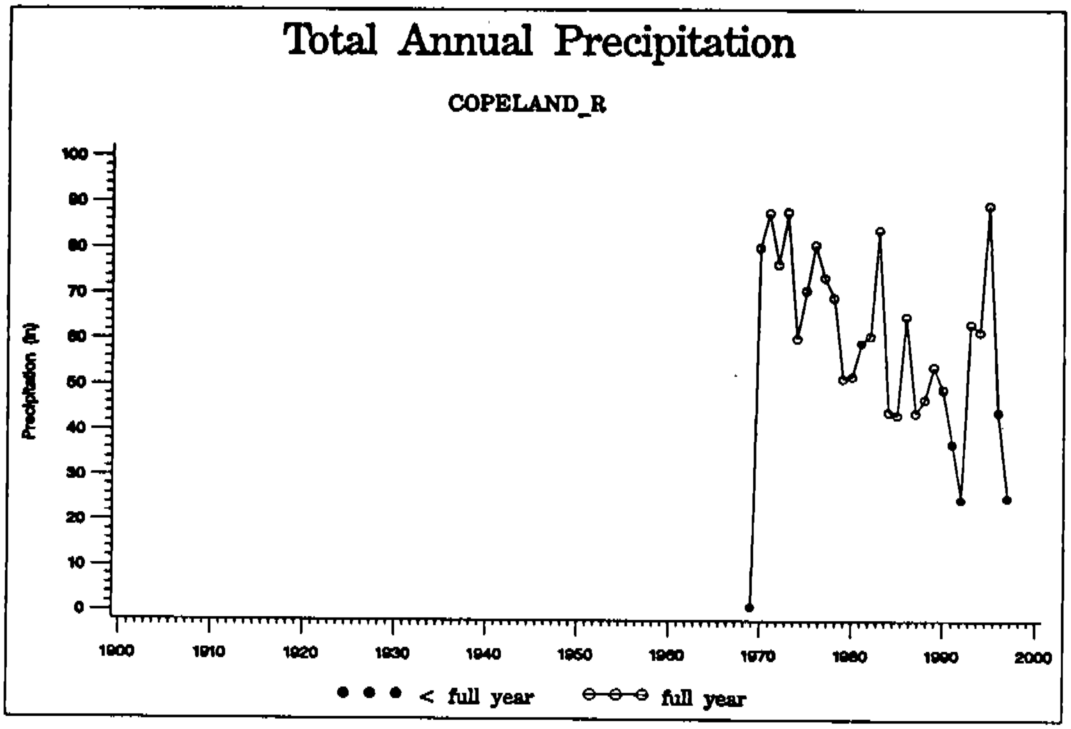
Sep
Oct
Nov
Dec


Total Annual Precipitation
COPELAND_R
Precipitation (in)
0
10
20
30
40
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1900
1910
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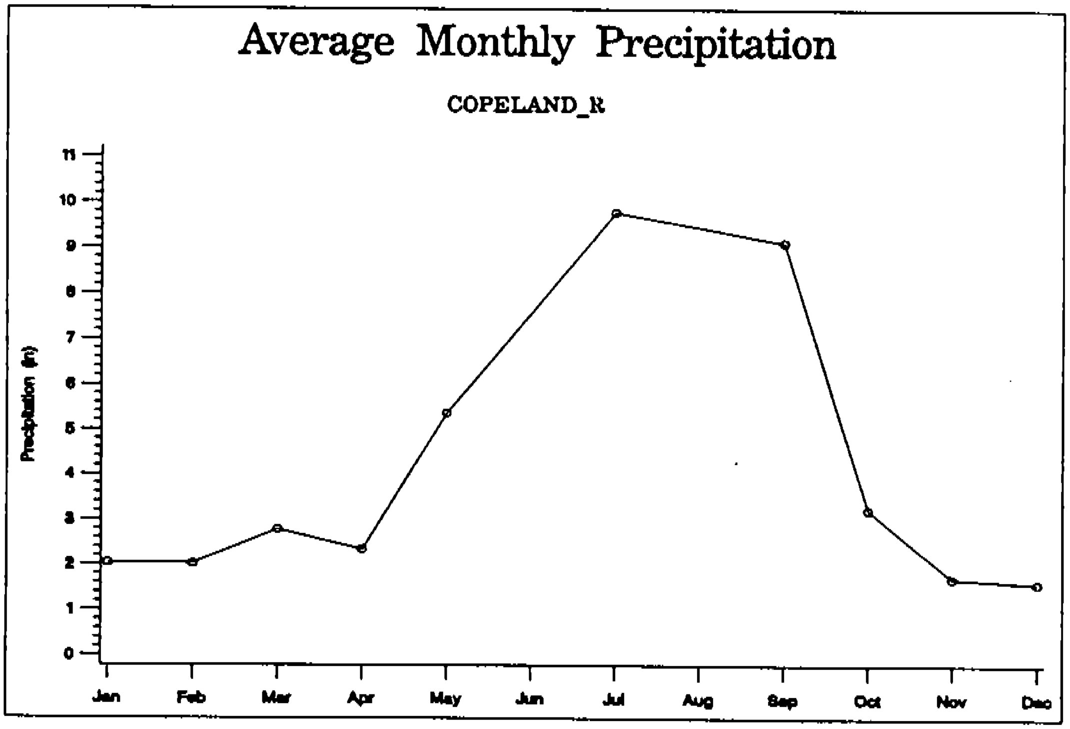
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
COPELAND_R
Precipitation (in)
0
1
2
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8
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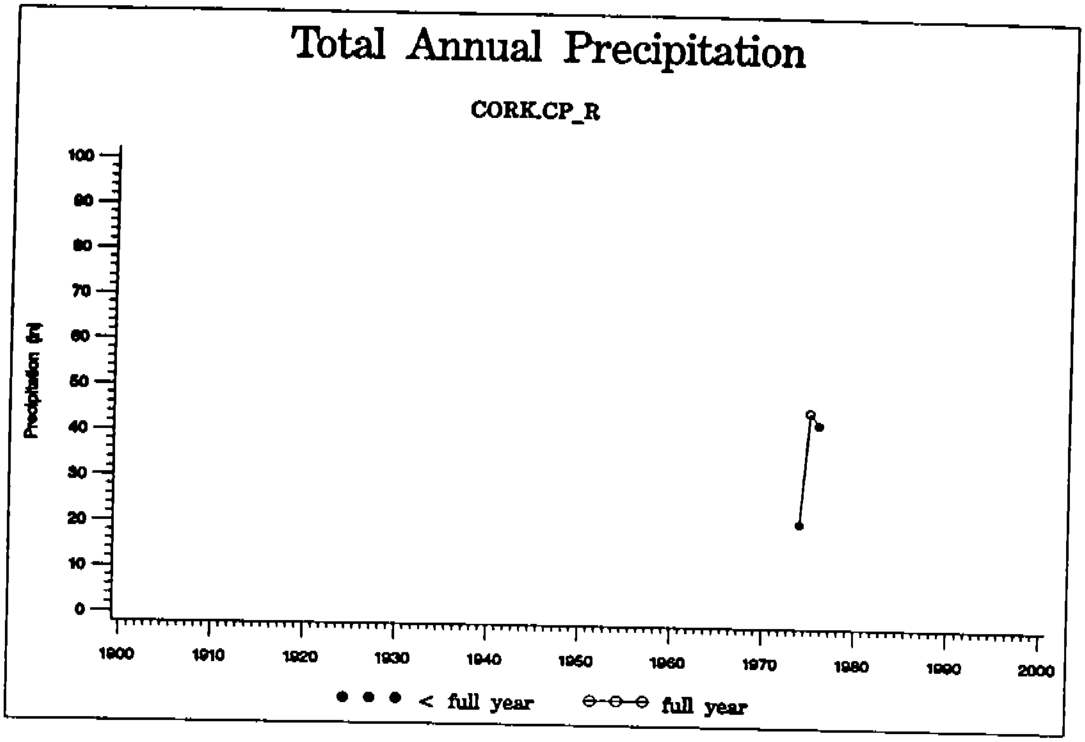
Nov
Dec


Total Annual Precipitation
CORK.CP_R
Precipitation (in)
100
90
80
70
60
50
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1910
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1950
1960
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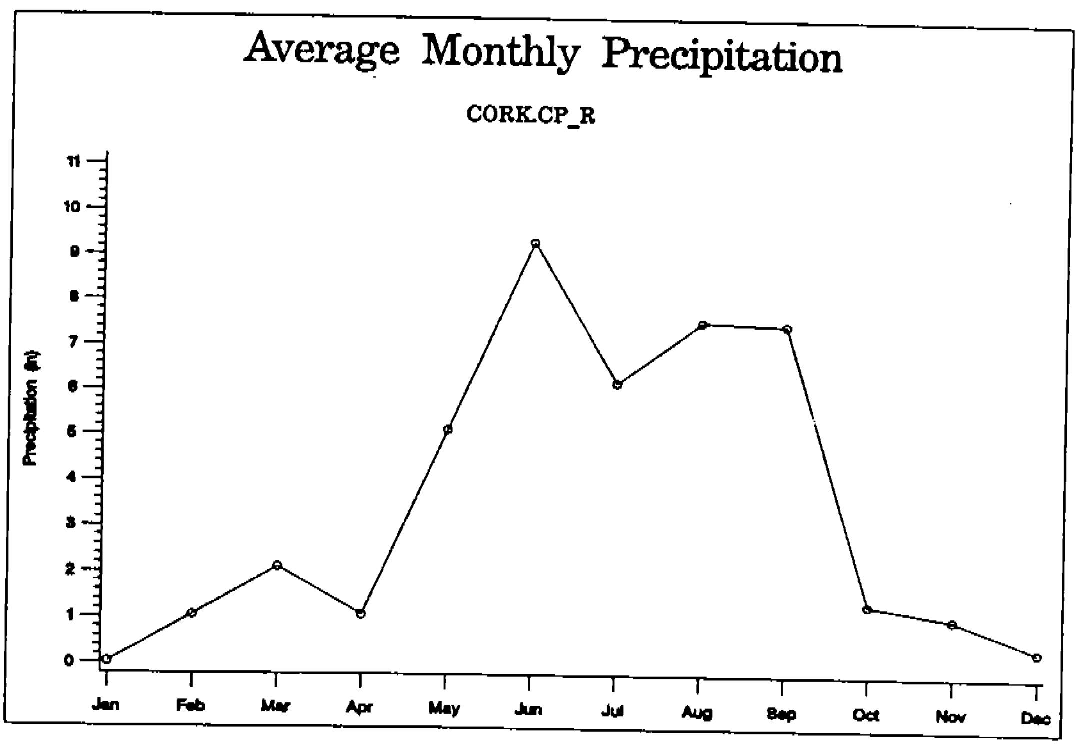
1990
2000
< full year
full year


Average Monthly Precipitation
CORK.CP_R
Precipitation (in)
11
10
9
8
7
6
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4
3
2
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0
Jan
Feb
Mar
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May
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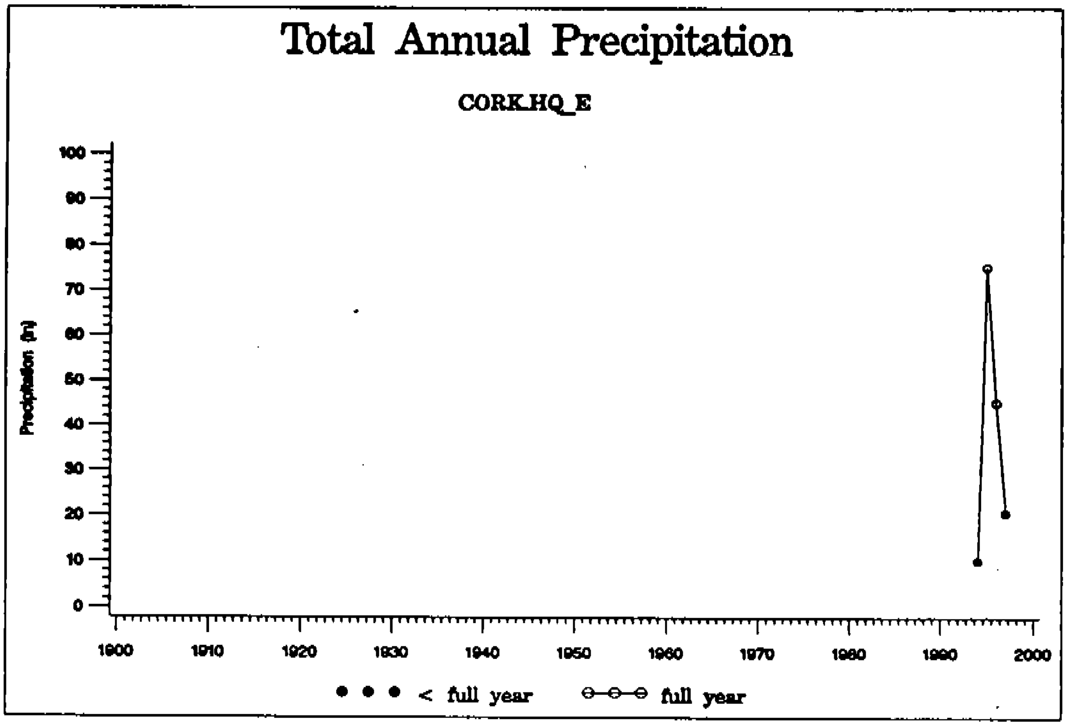
Oct
Nov
Dec



Total Annual Precipitation
CORK.HQ_E
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
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1940
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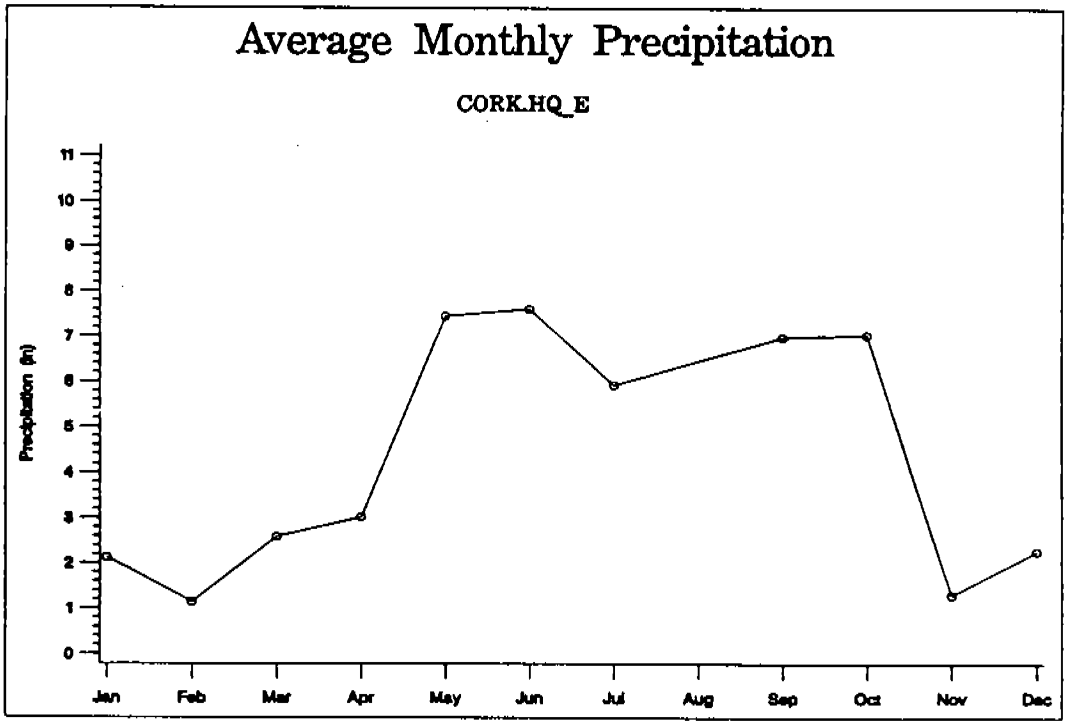
1960
1970
1980
1990
2000
● ● ● < full year
⊖-⊖-⊖ full year



Average Monthly Precipitation
CORK.HQ_E
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
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Jan
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Mar
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May
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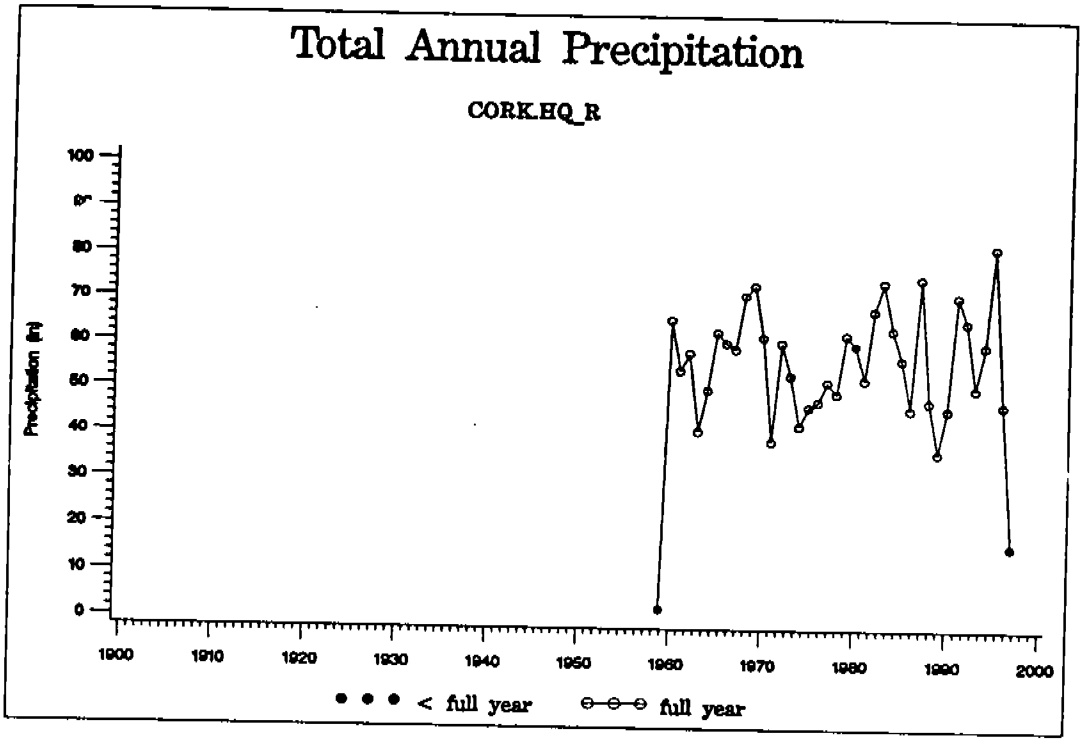
Sep
Oct
Nov
Dec


Total Annual Precipitation
CORK.HQ_R
Precipitation (in)
100
80
70
60
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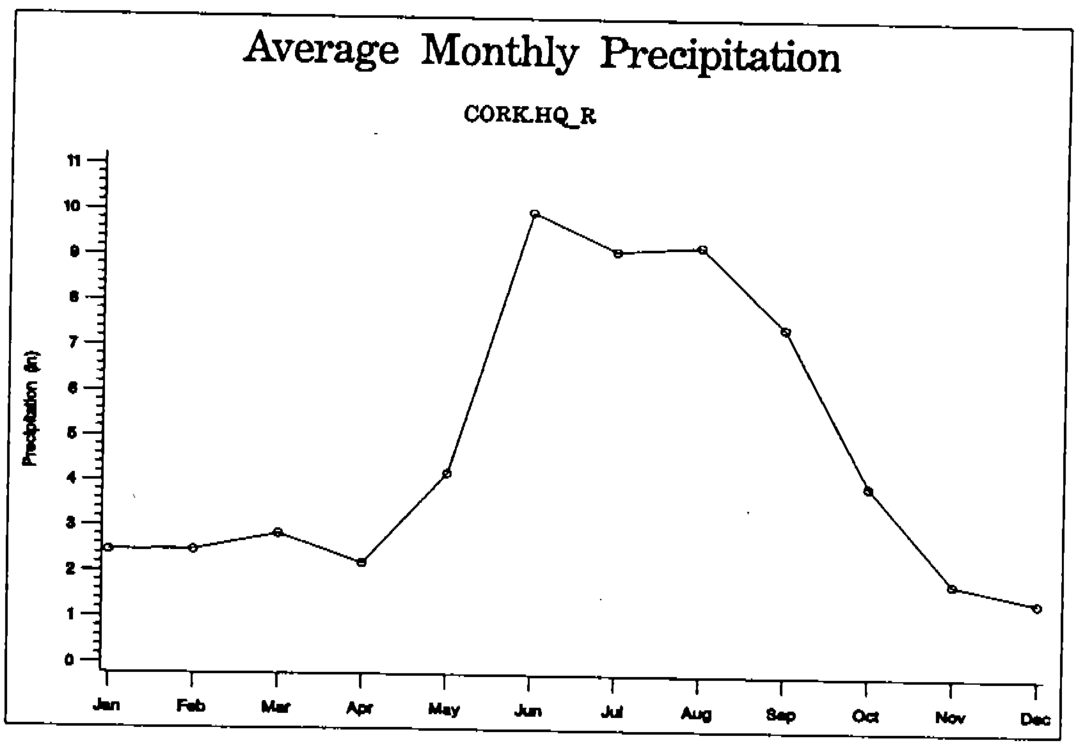
2000
< full year
full year


Average Monthly Precipitation
CORK.HQ_R
Precipitation (in)
11
10
9
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Jan
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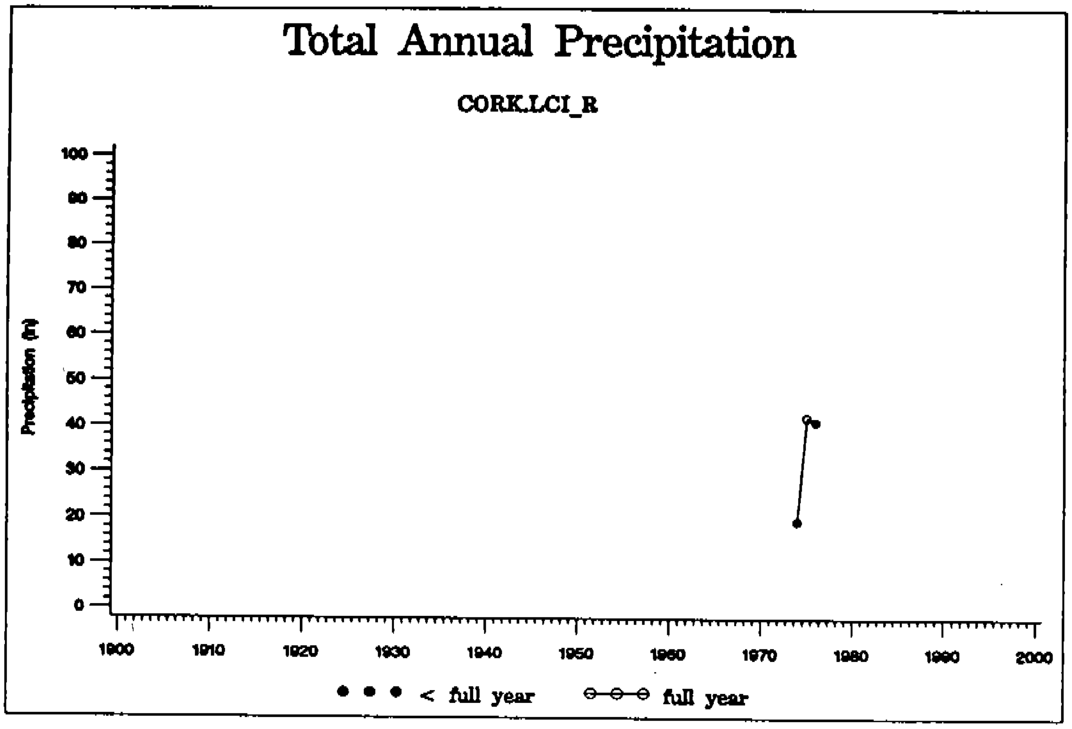
Total Annual Precipitation
CORK.LCI_R
Precipitation (in)
100
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60
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1960
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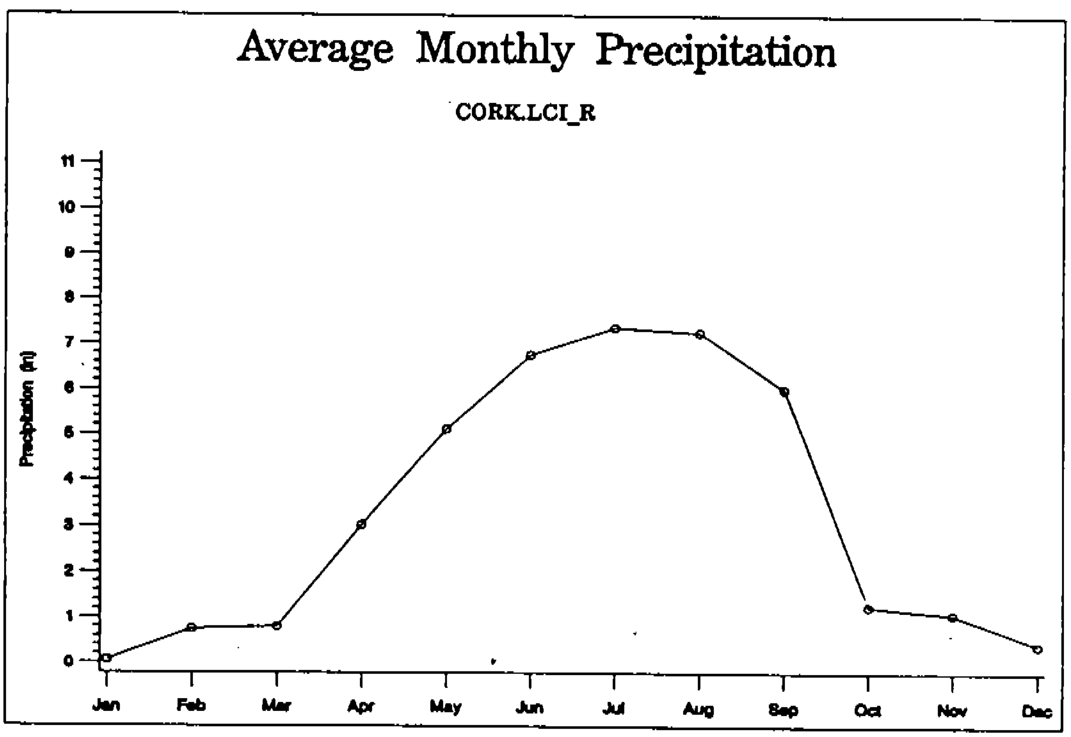
2000
< full year
full year


Average Monthly Precipitation
CORK.LCI_R
Precipitation (in)
11
10
9
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7
6
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4
3
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Jan
Feb
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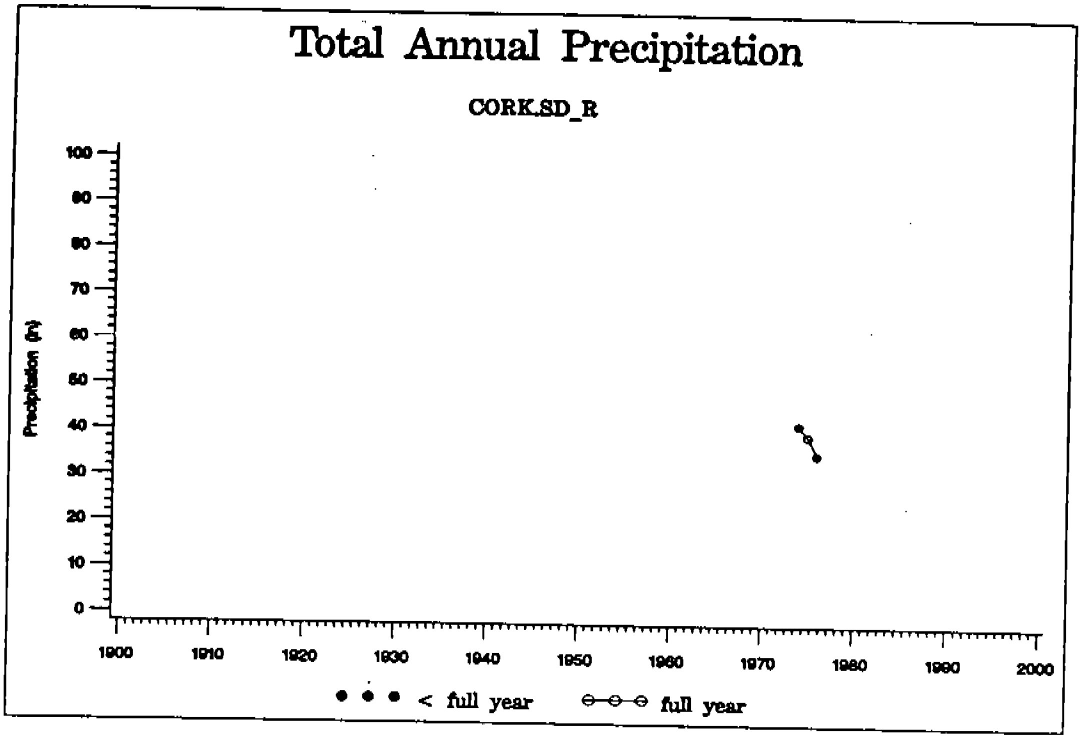
Dec


Total Annual Precipitation
CORK.SD_R
Precipitation (in)
100
90
80
70
60
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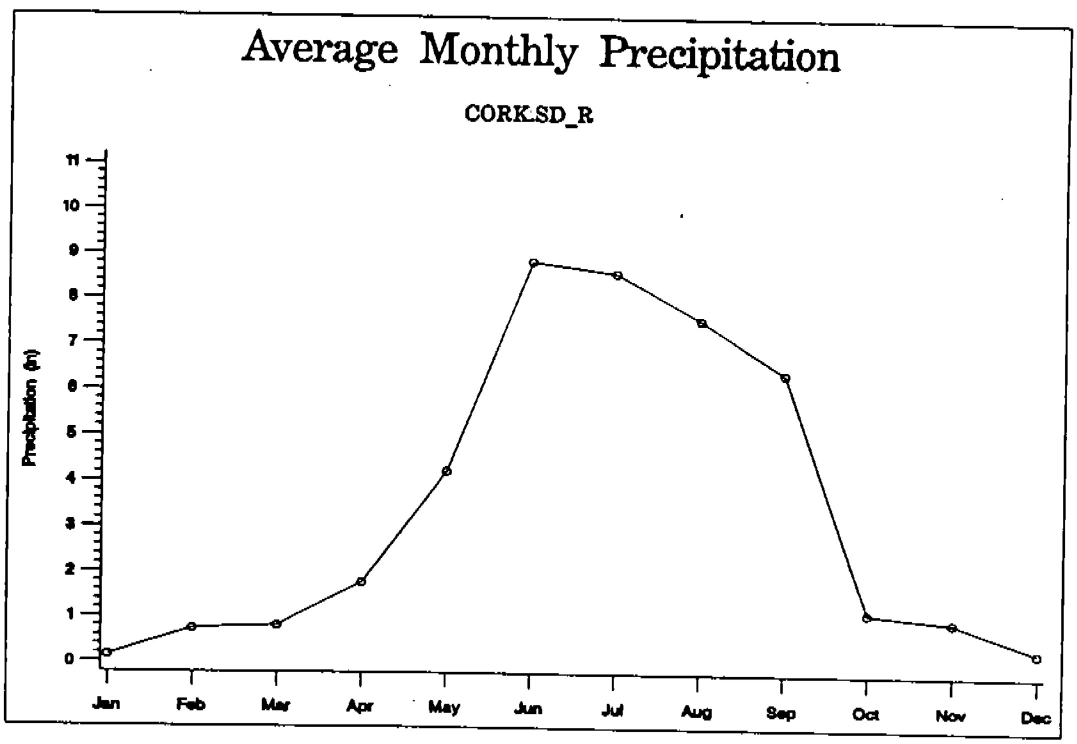
< full year
full year


Average Monthly Precipitation
CORK.SD_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
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1
0
Jan
Feb
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May
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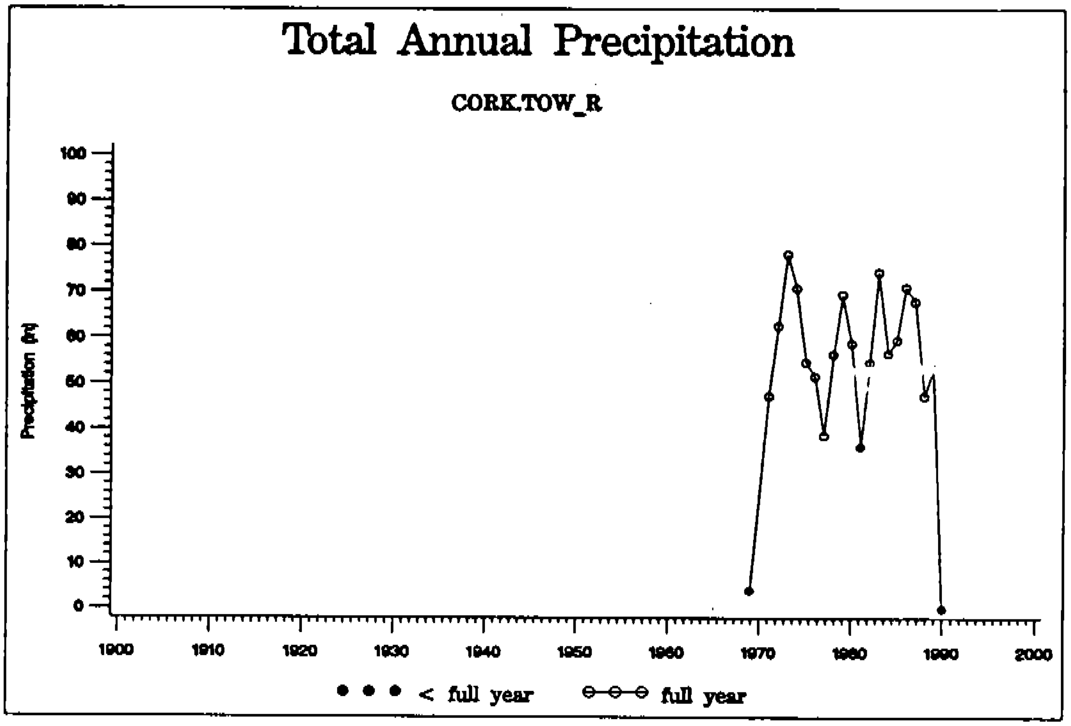
Nov
Dec


Total Annual Precipitation
CORK.TOW_R
Precipitation (in)
0
10
20
30
40
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90
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1960
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1990
2000
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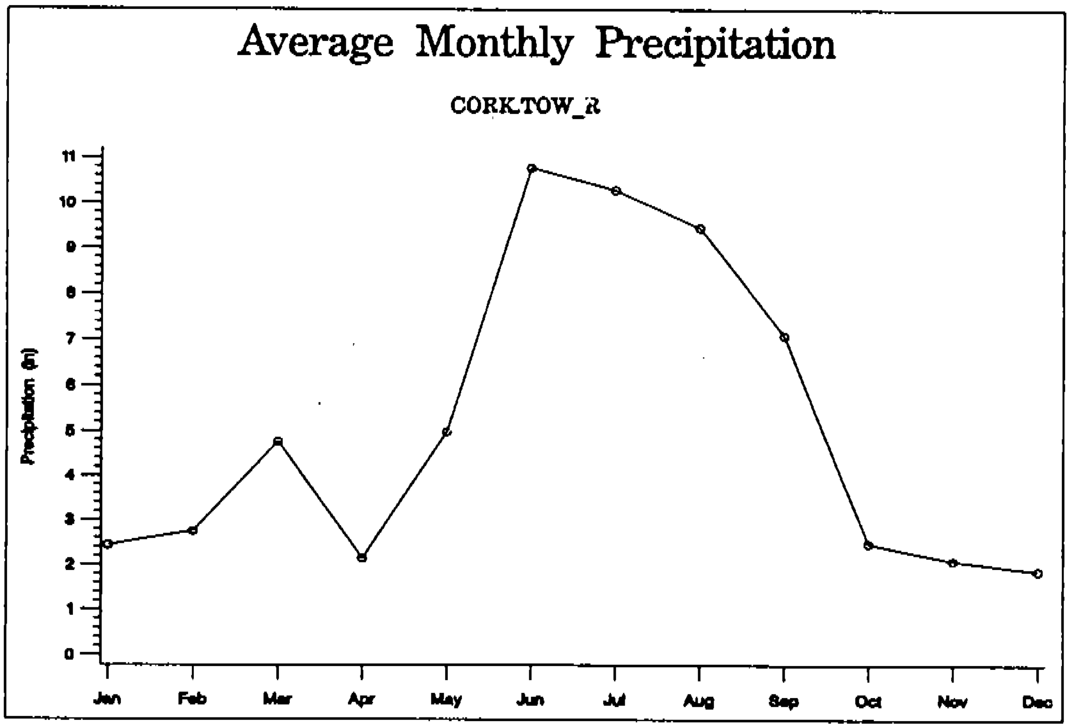
full year


Average Monthly Precipitation
CORK.TOW_R
Precipitation (in)
0
1
2
3
4
5
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8
9
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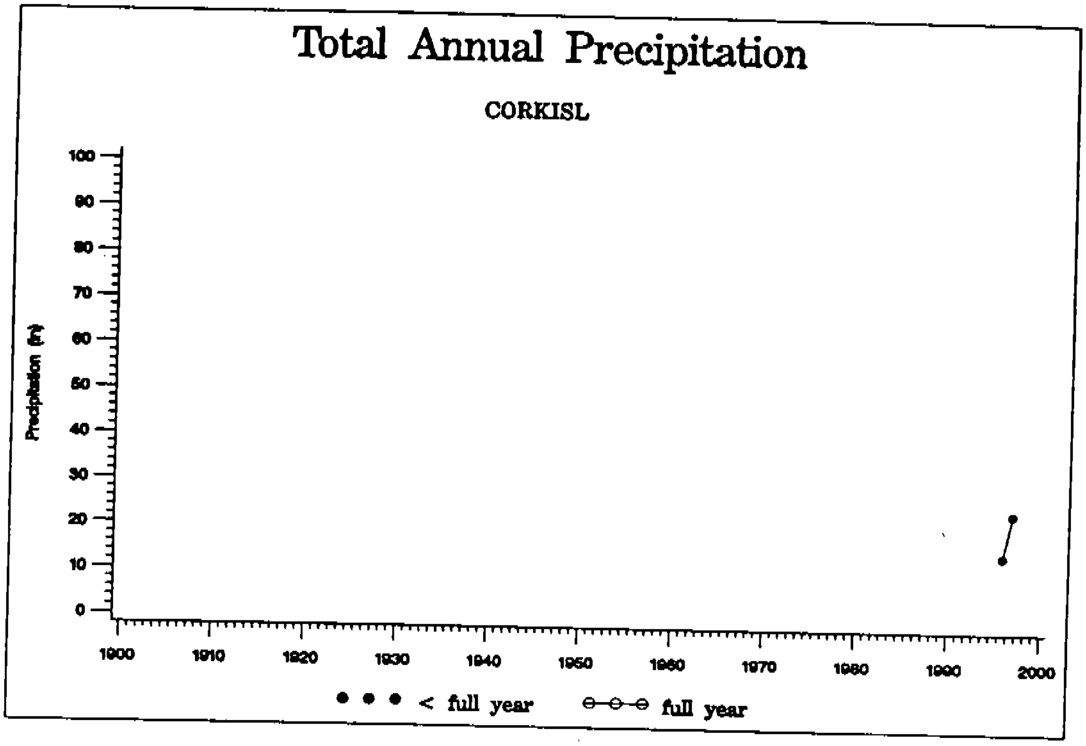
Total Annual Precipitation
CORKISL
Precipitation (in)
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20
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40
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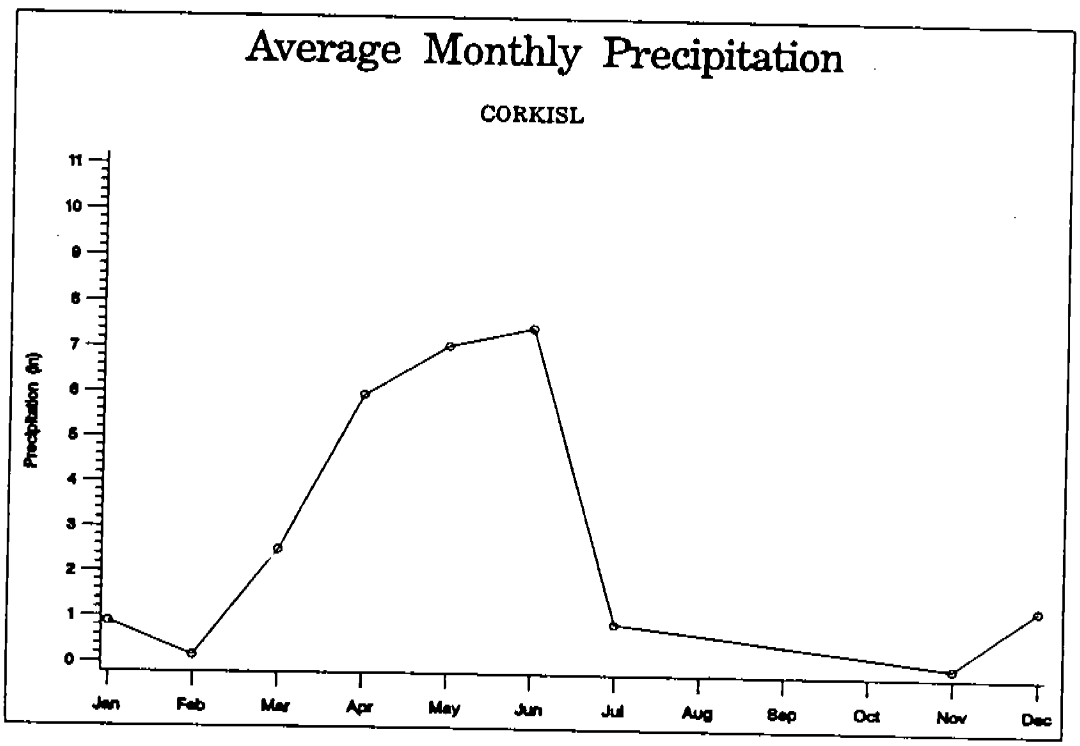
full year


Average Monthly Precipitation
CORKISL
Precipitation (in)
0
1
2
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4
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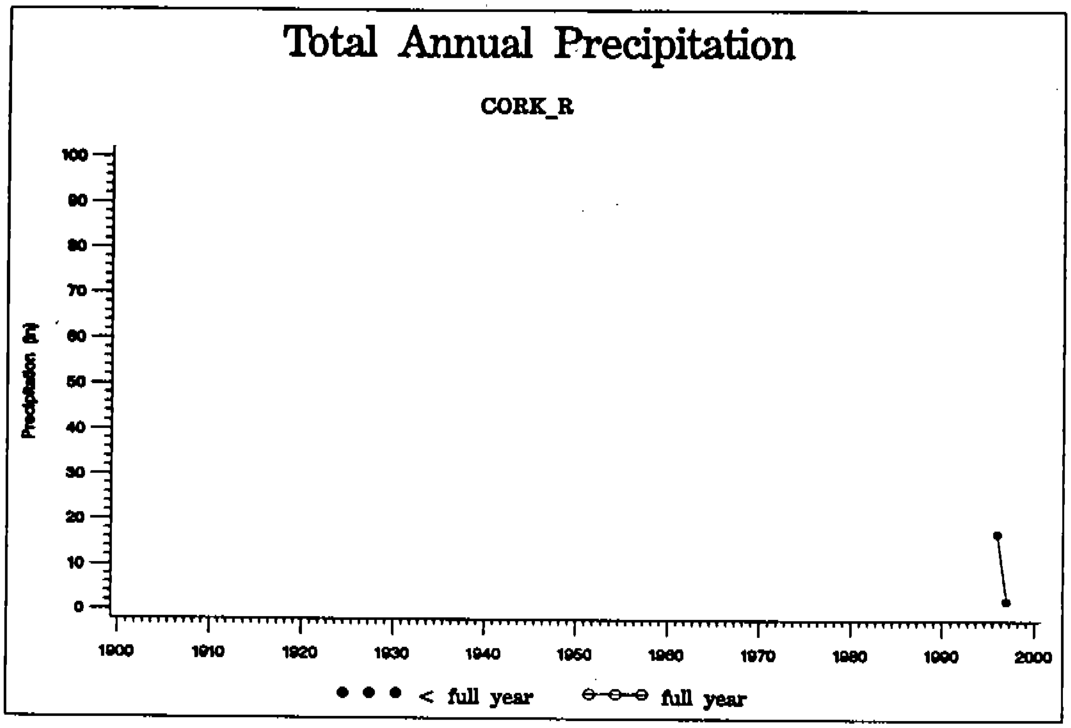
Dec


Total Annual Precipitation
CORK_R
Precipitation (in)
100
90
80
70
60
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2000
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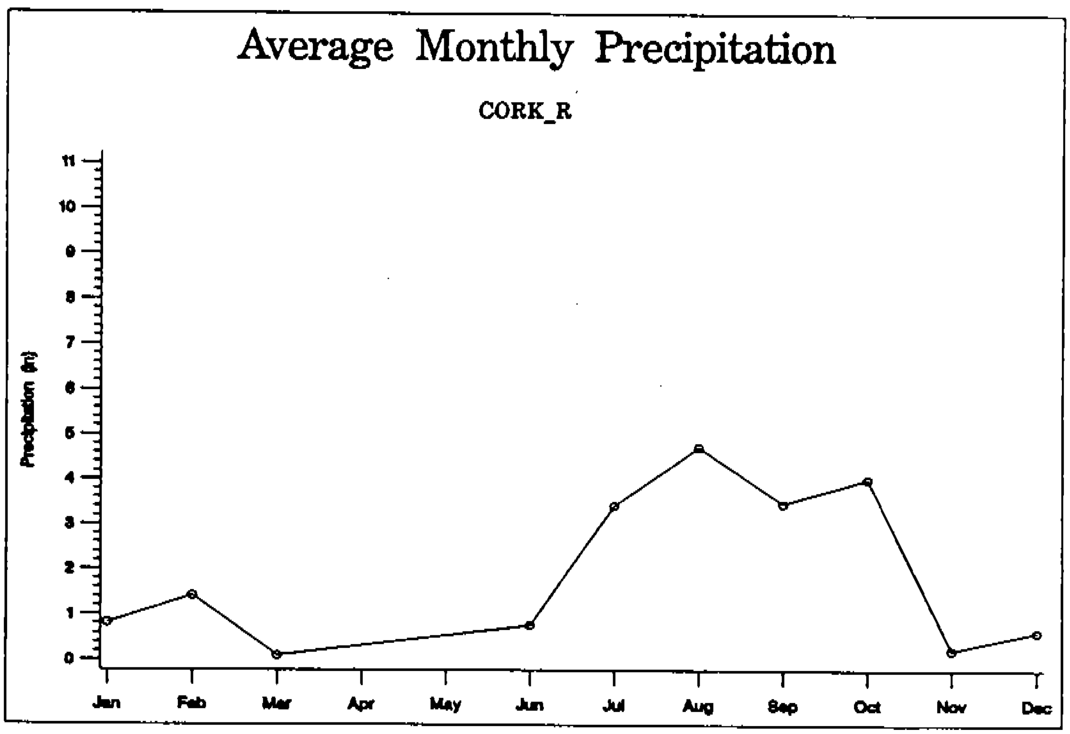
full year


Average Monthly Precipitation
CORK_R
Precipitation (in)
11
10
9
8
7
6
5
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3
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1
0
Jan
Feb
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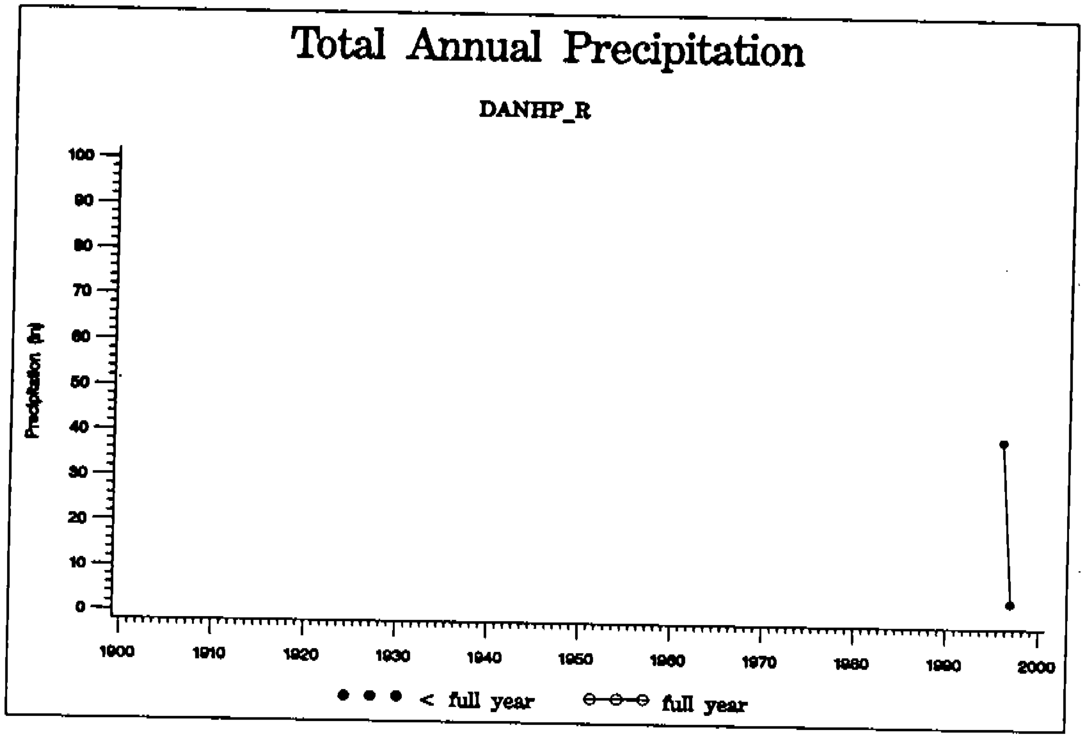
Dec


Total Annual Precipitation
DANHP_R
Precipitation (in)
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70
60
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2000
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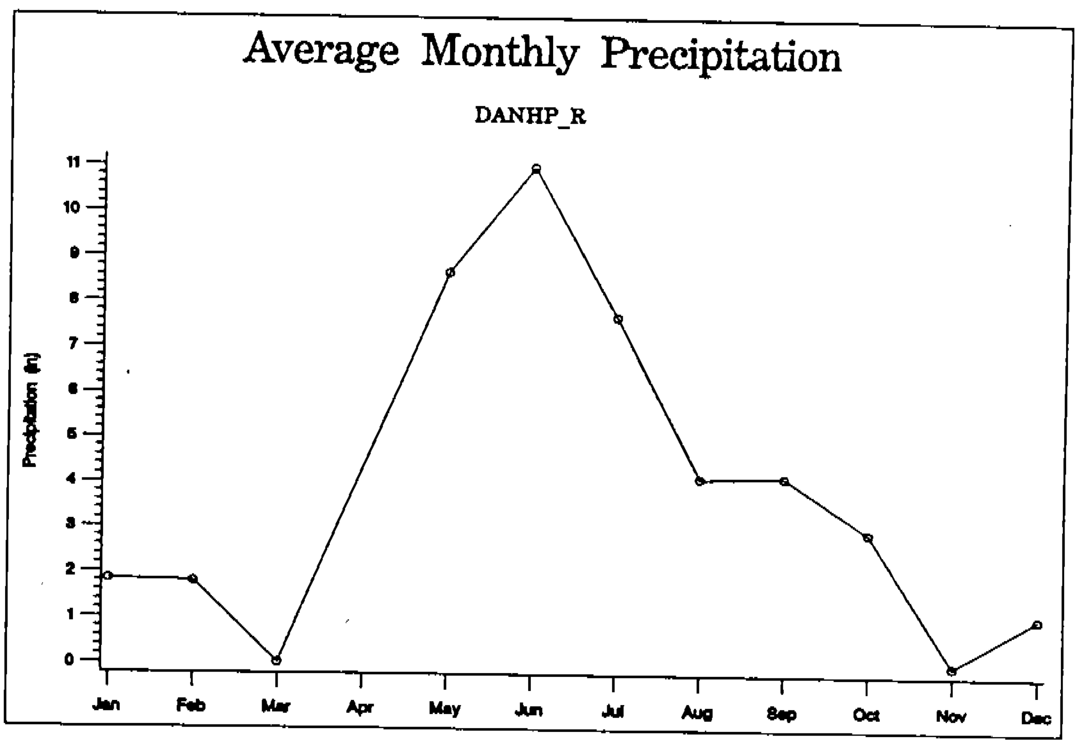
full year


Average Monthly Precipitation
DANHP_R
Precipitation (in)
11
10
9
8
7
6
5
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3
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0
Jan
Feb
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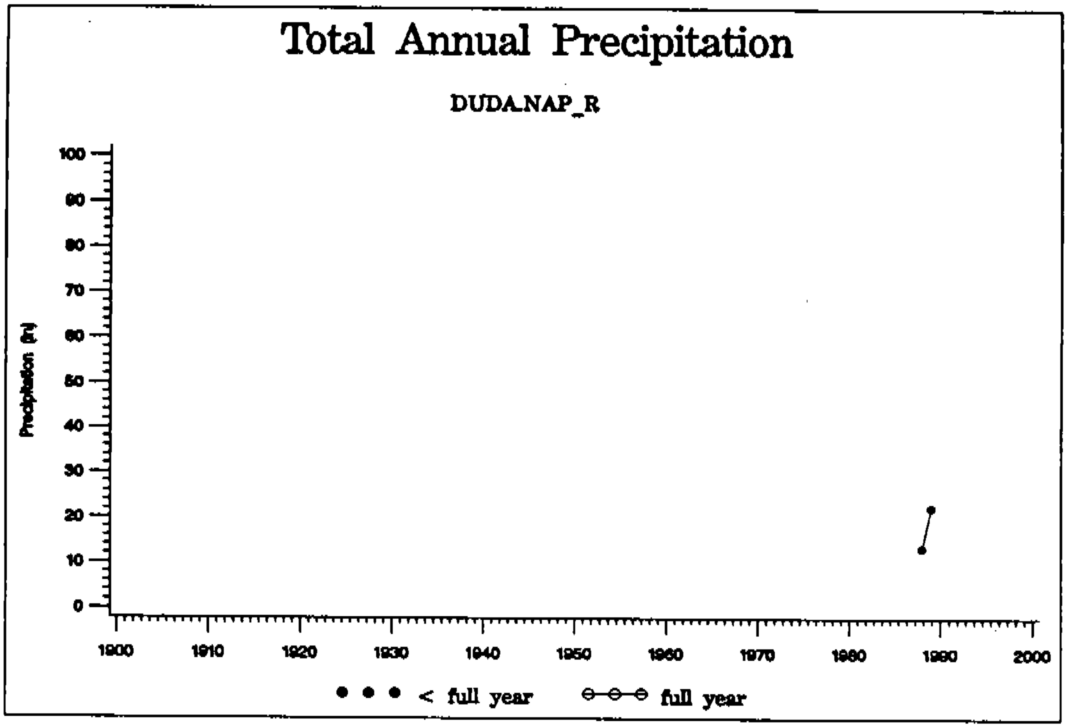
Oct
Nov
Dec


Total Annual Precipitation
DUDA.NAP_R
Precipitation (in)
100
90
80
70
60
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1910
1920
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1960
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1990
2000
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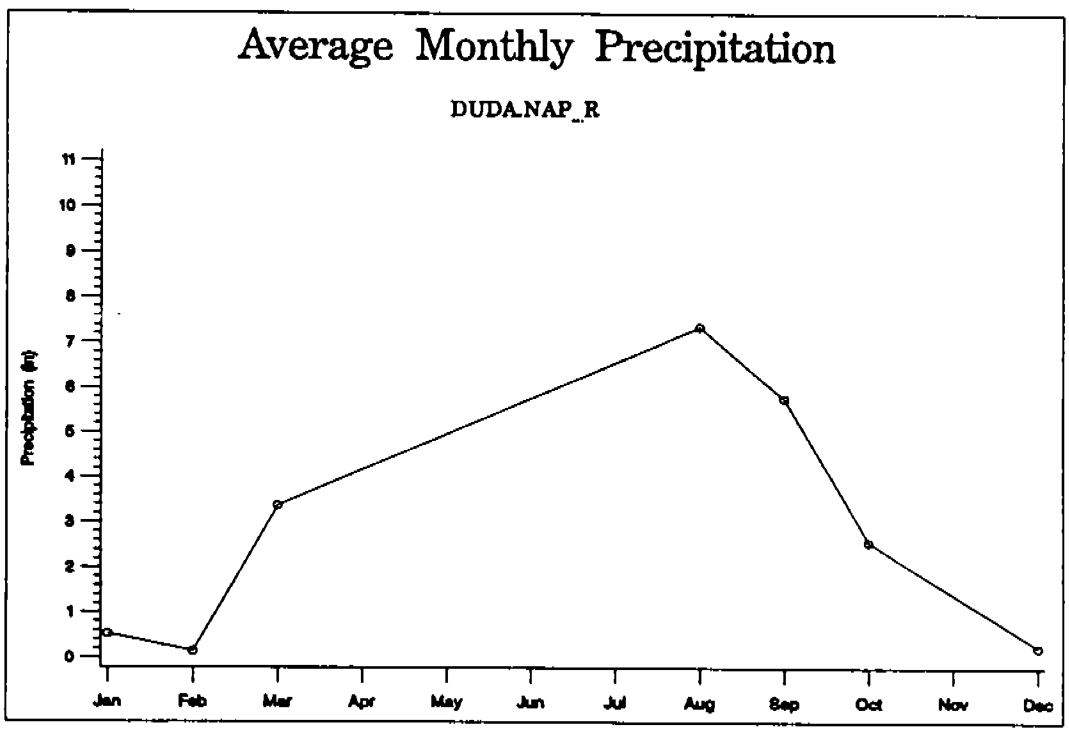
full year


Average Monthly Precipitation
DUDA.NAP_R
Precipitation (in)
11
10
9
8
7
6
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4
3
2
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0
Jan
Feb
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May
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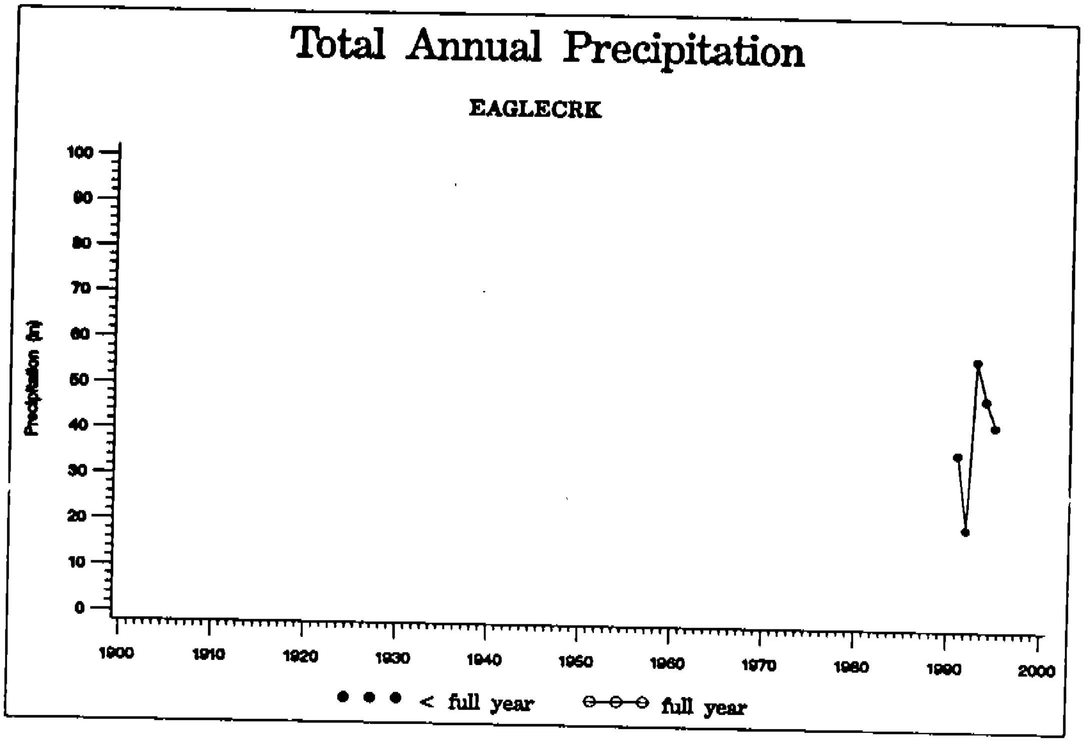
Nov
Dec


Total Annual Precipitation
EAGLECRK
Precipitation (in)
0
10
20
30
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1960
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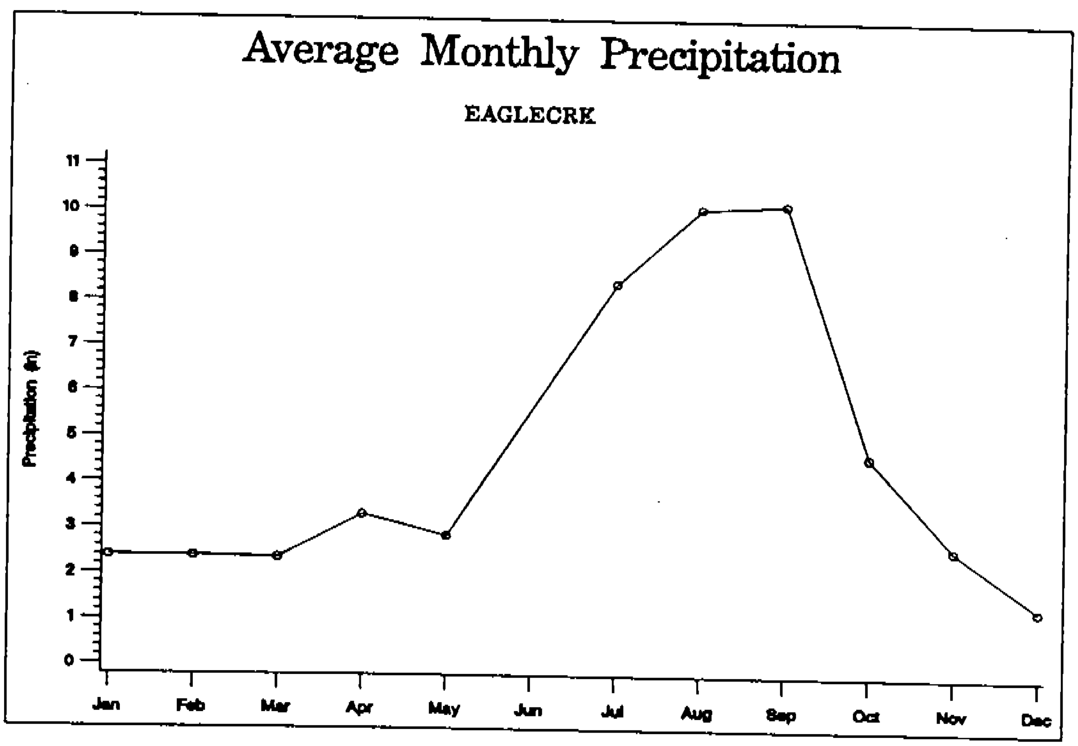
1990
2000
< full year
full year


Average Monthly Precipitation
EAGLECRK
Precipitation (in)
0
1
2
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4
5
6
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8
9
10
11
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Oct
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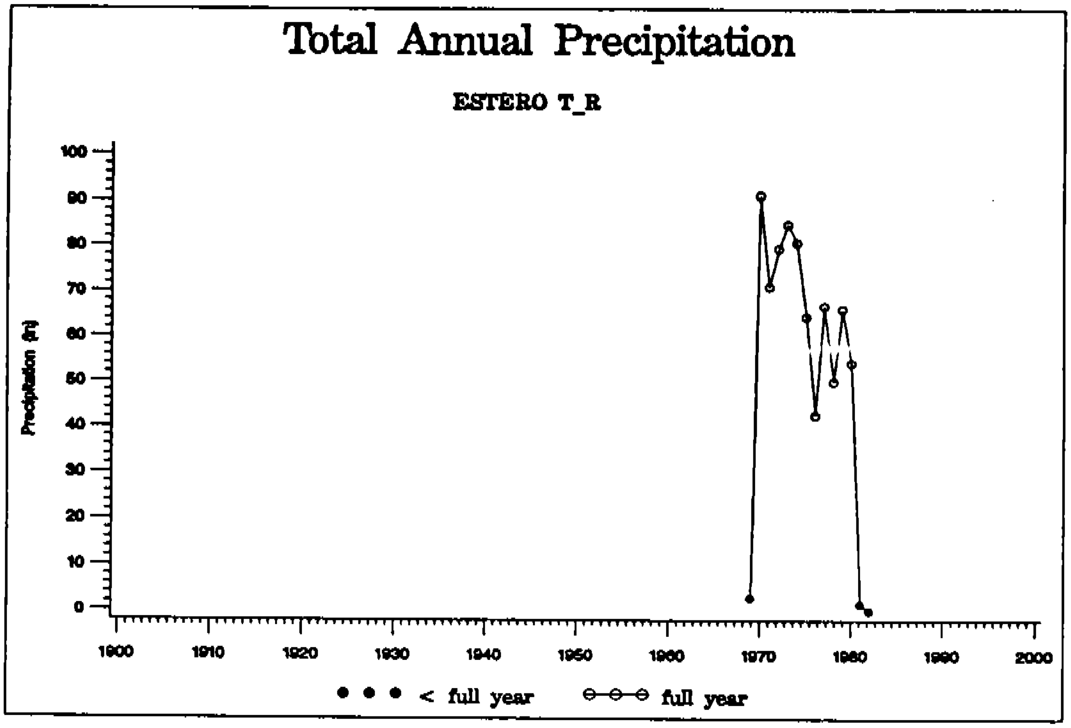
Dec



Total Annual Precipitation
ESTERO T_R
Precipitation (in)
100
90
80
70
60
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0
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1910
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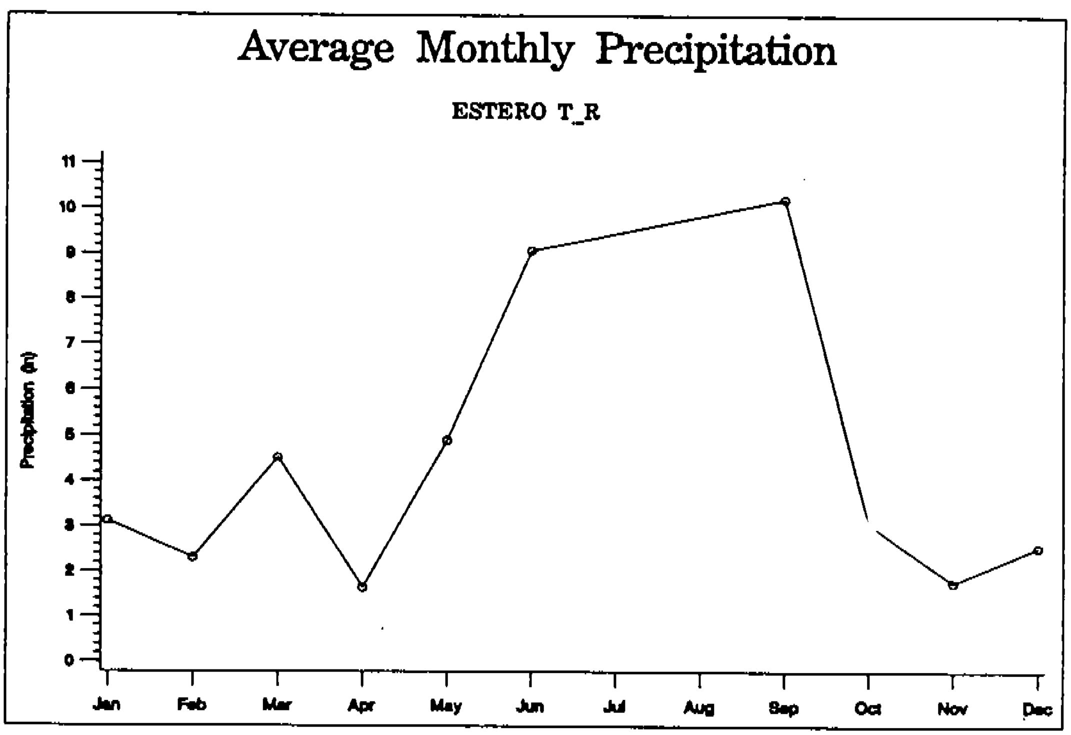
1990
2000
< full year
full year



Average Monthly Precipitation
ESTERO T_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
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May
Jun
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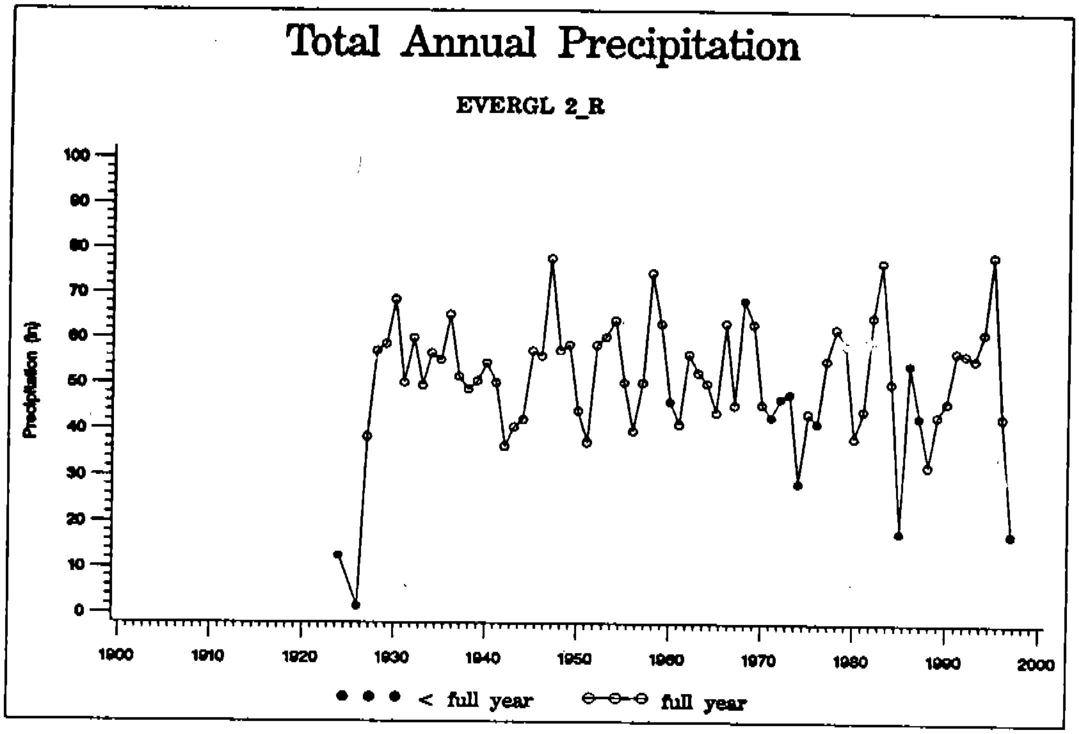
Nov
Dec


Total Annual Precipitation
EVERGL 2_R
Precipitation (in)
100
90
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60
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1910
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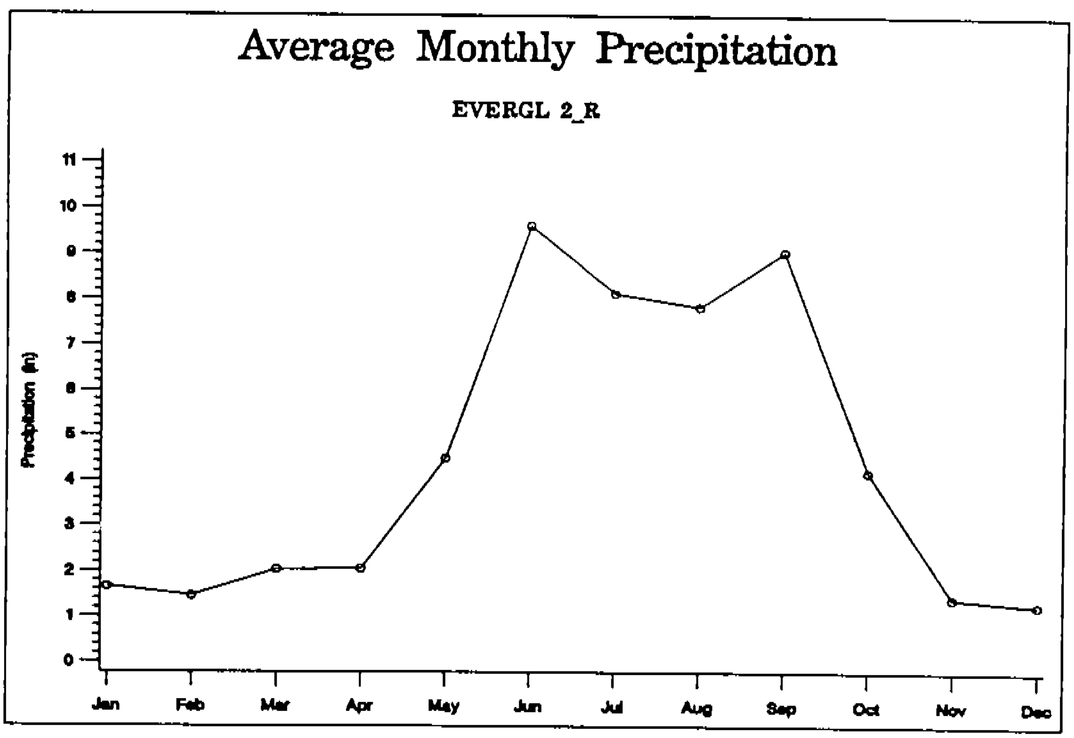
full year


Average Monthly Precipitation
EVERGL 2_R
Precipitation (in)
11
10
9
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6
5
4
3
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1
0
Jan
Feb
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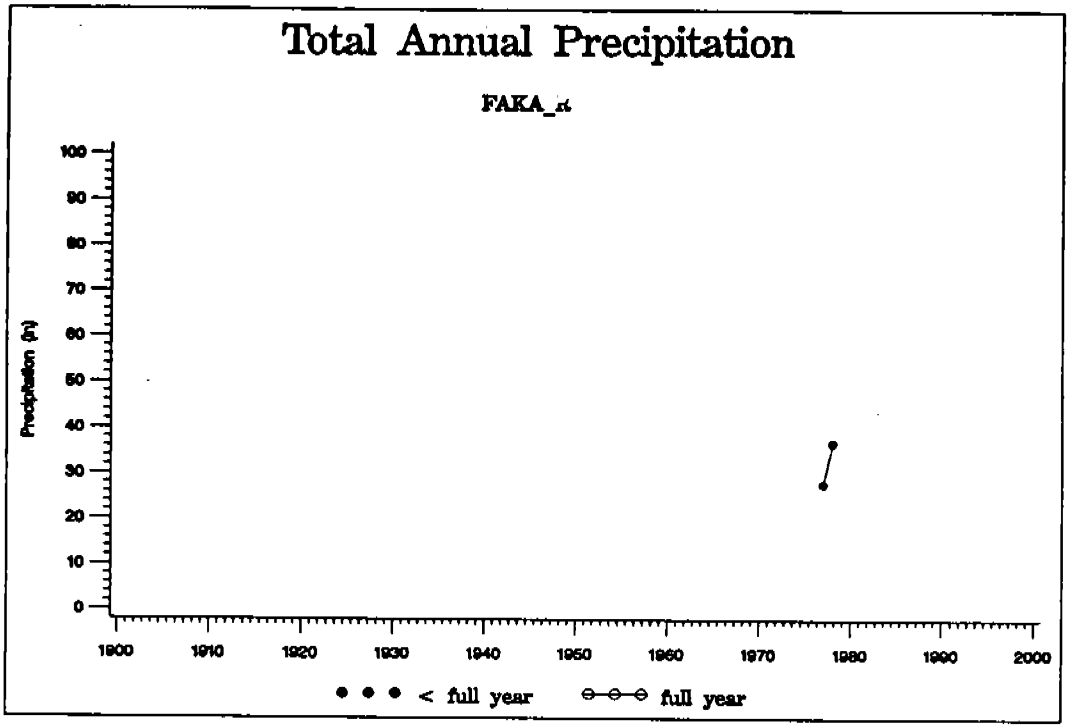
Dec


Total Annual Precipitation
FAKA_R
Precipitation (in)
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10
20
30
40
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1960
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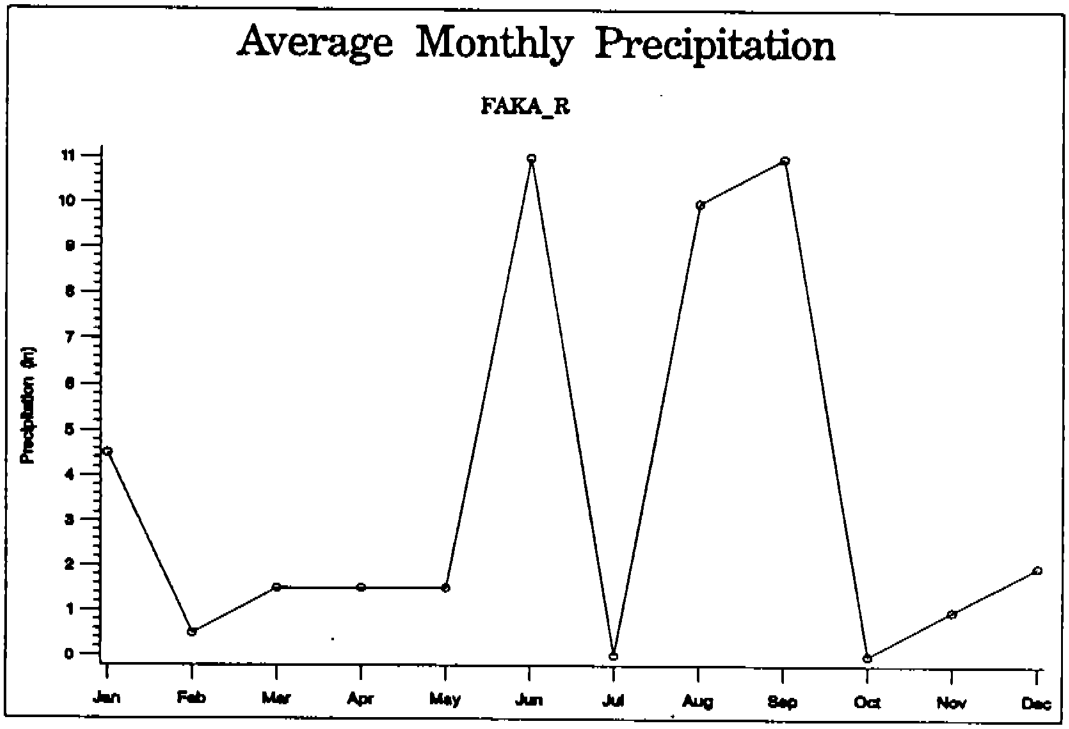
1990
2000
< full year
full year


Average Monthly Precipitation
FAKA_R
Precipitation (in)
0
1
2
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4
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Jan
Feb
Mar
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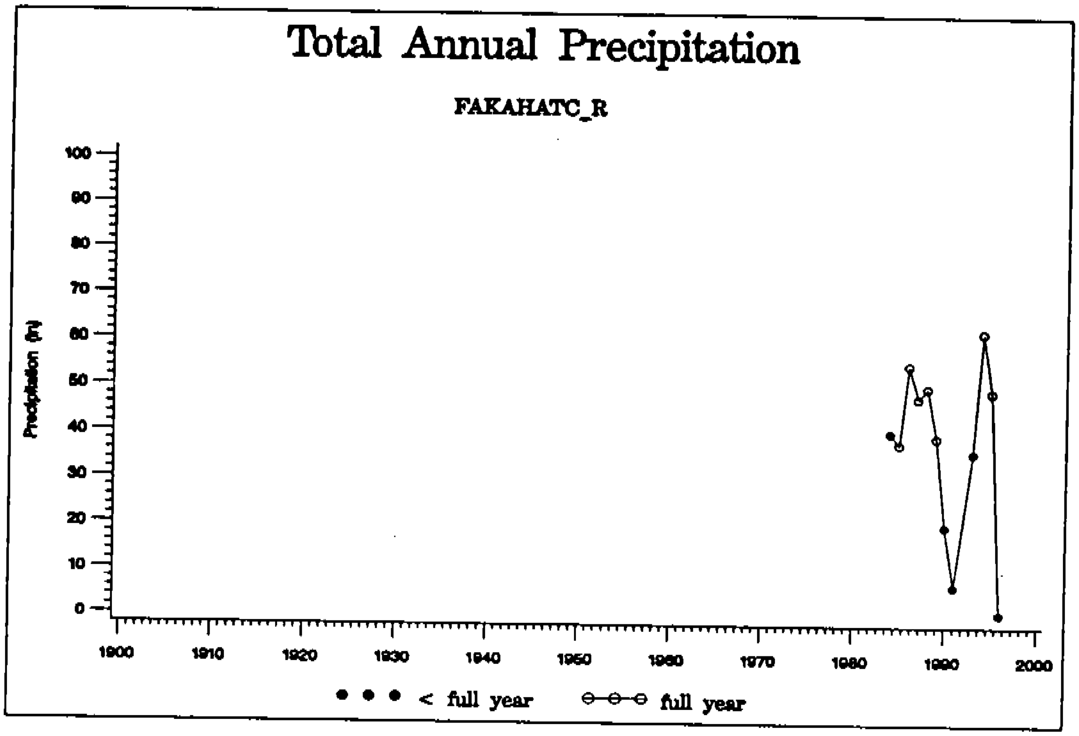
Dec


Total Annual Precipitation
FAKAHATC_R
Precipitation (in)
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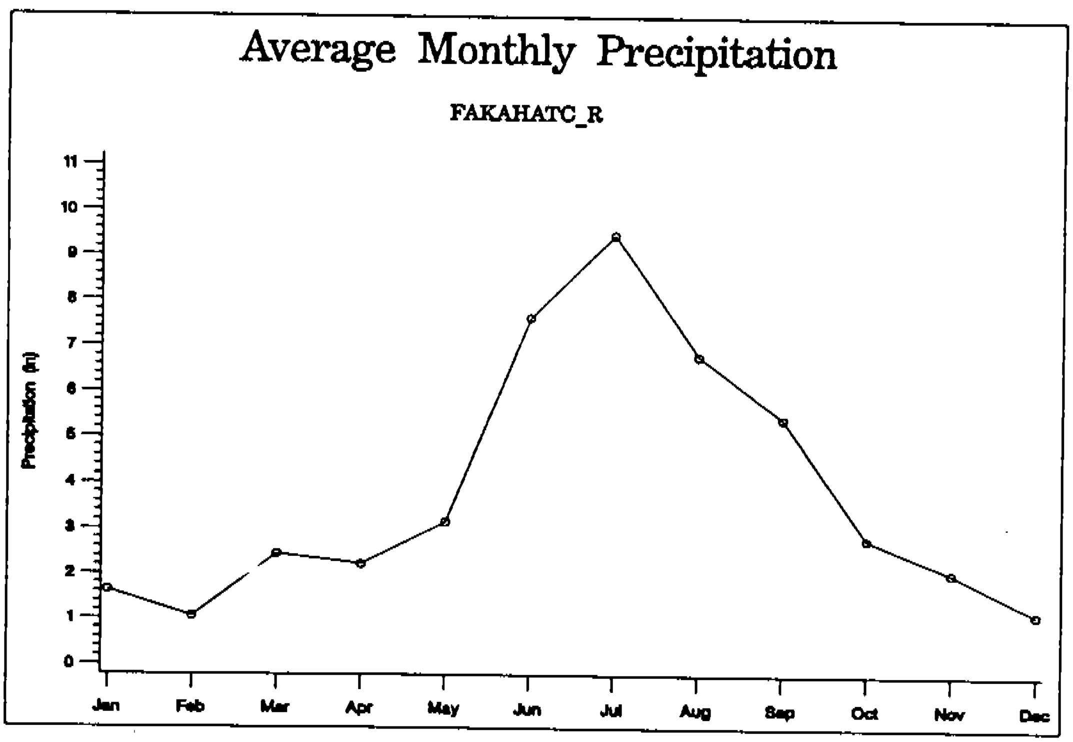
full year


Average Monthly Precipitation
FAKAHATC_R
Precipitation (in)
11
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Nov
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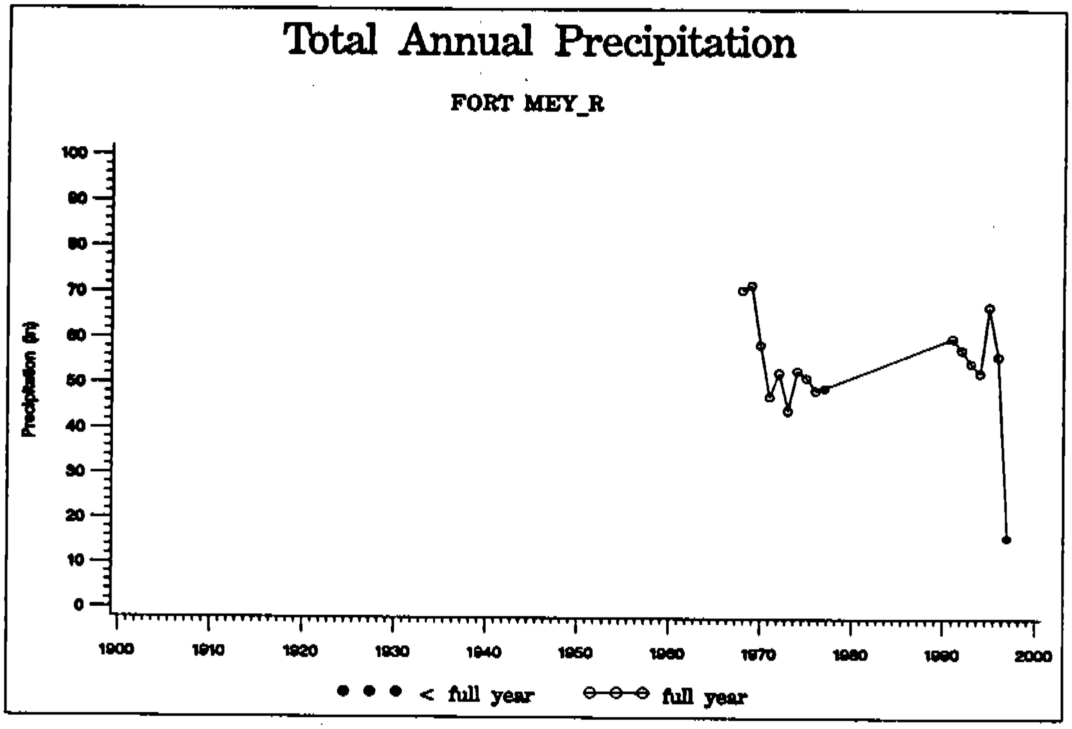

Total Annual Precipitation
FORT MEY_R
Precipitation (in)
100
90
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70
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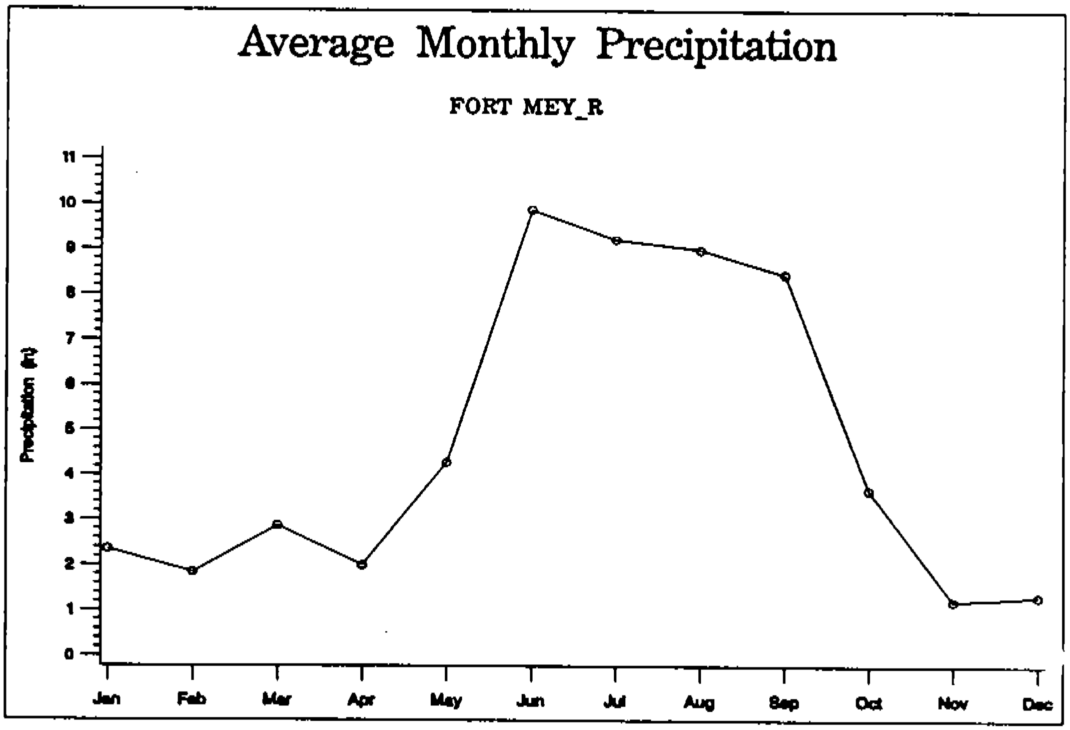
full year



Average Monthly Precipitation
FORT MEY_R
Precipitation (in)
11
10
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Jan
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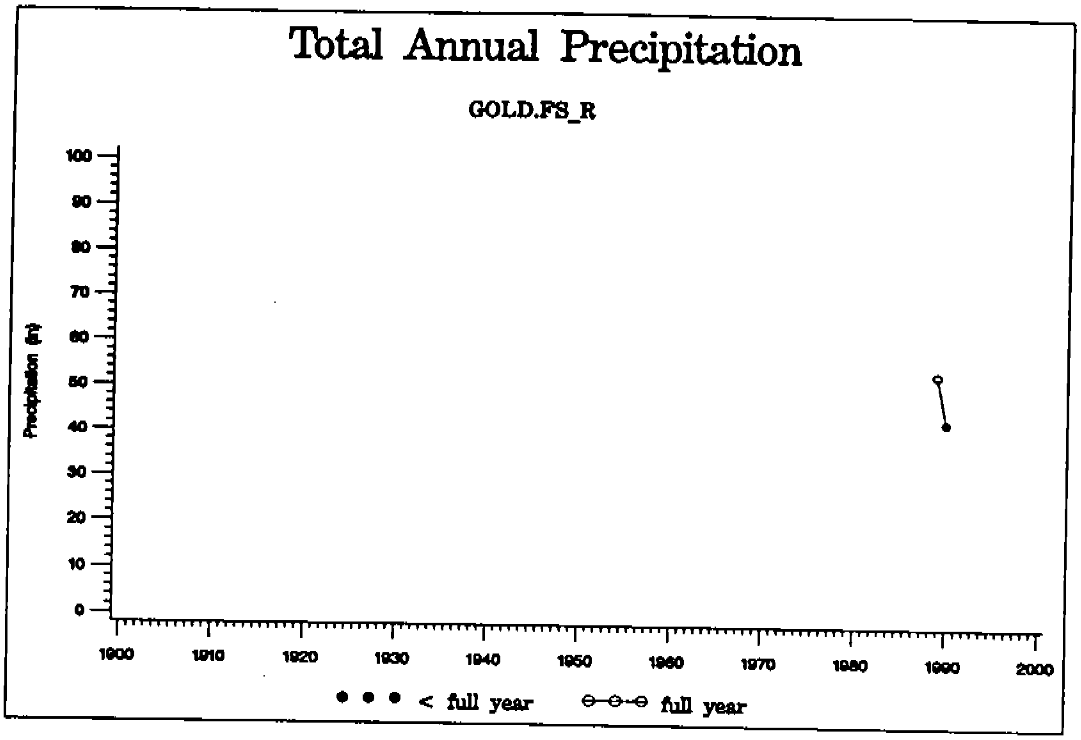
Nov
Dec


Total Annual Precipitation
GOLD.FS_R
Precipitation (in)
100
90
80
70
60
50
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10
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1900
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1920
1930
1940
1950
1960
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1980
1990
2000
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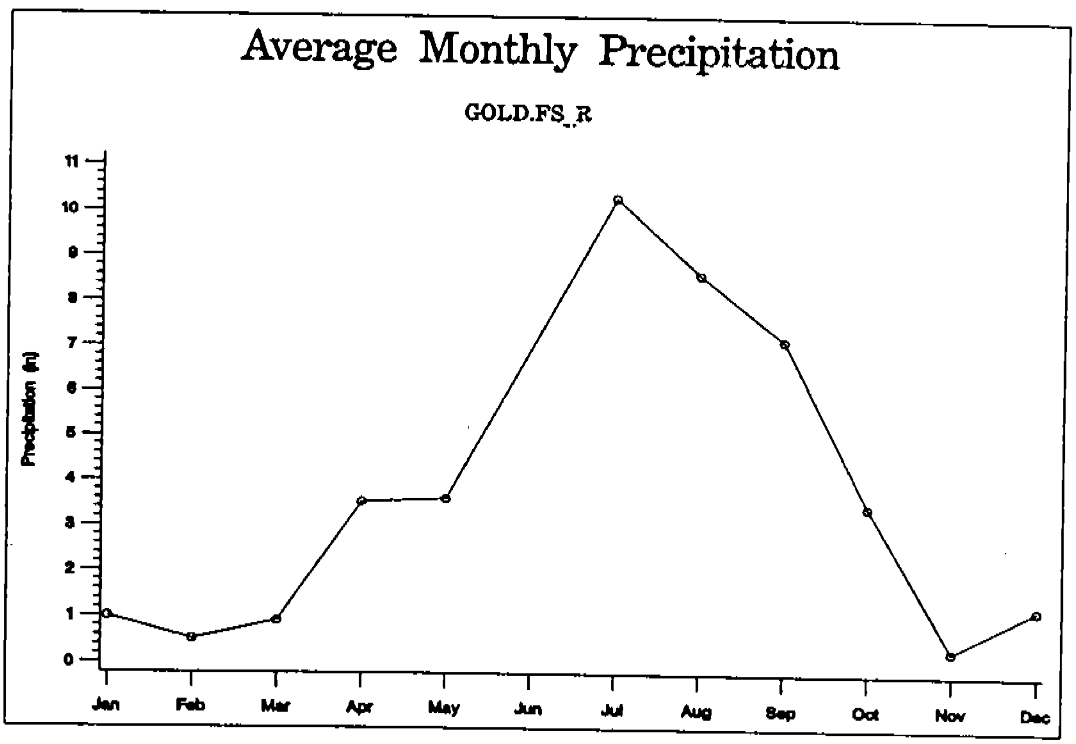
full year


Average Monthly Precipitation
GOLD.FS_R
Precipitation (in)
11
10
9
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6
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Jan
Feb
Mar
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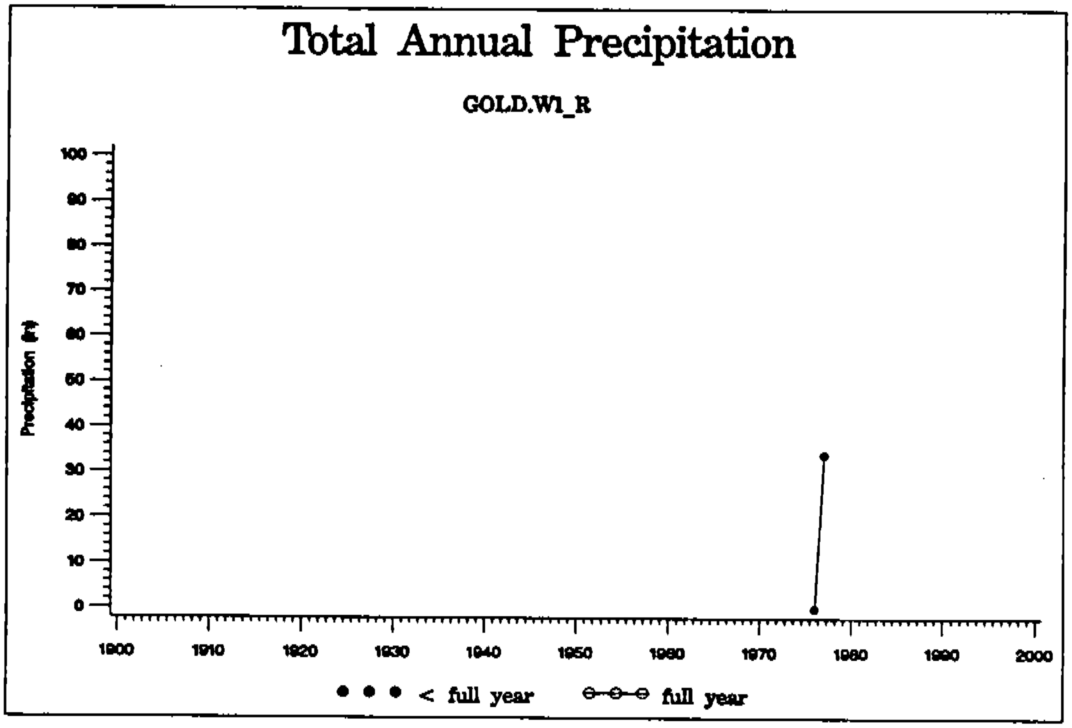
Total Annual Precipitation
GOLD.W1_R
Precipitation (in)
0
10
20
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1970
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1990
2000
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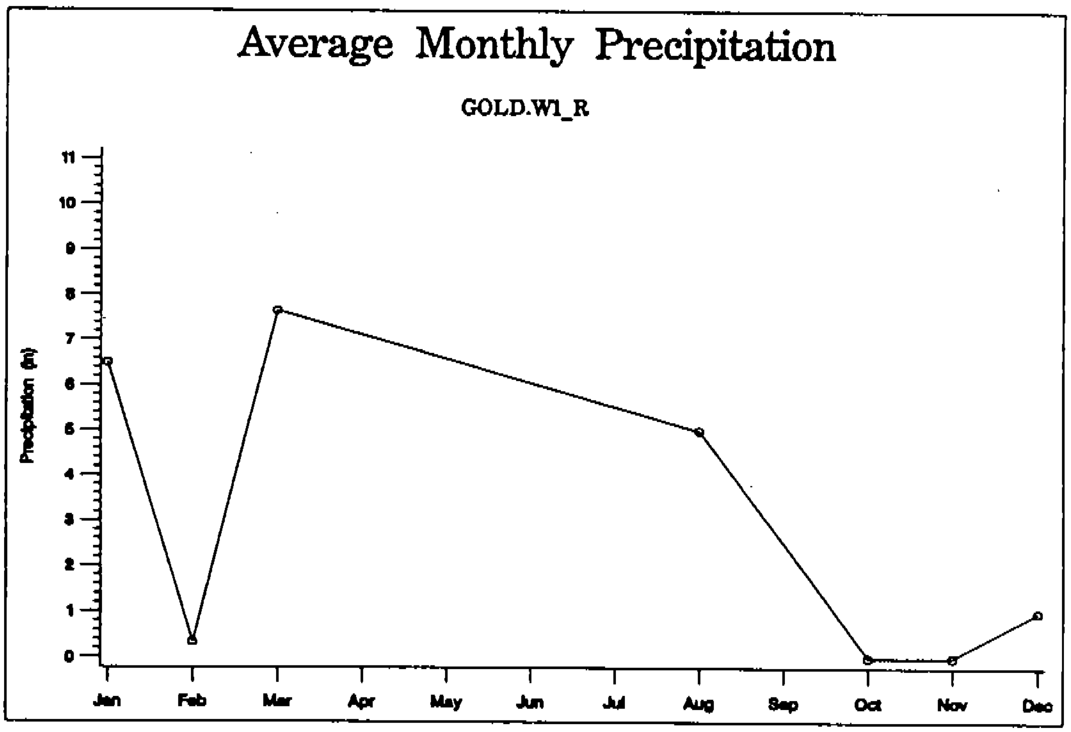
full year


Average Monthly Precipitation
GOLD.W1_R
Precipitation (in)
0
1
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Jan
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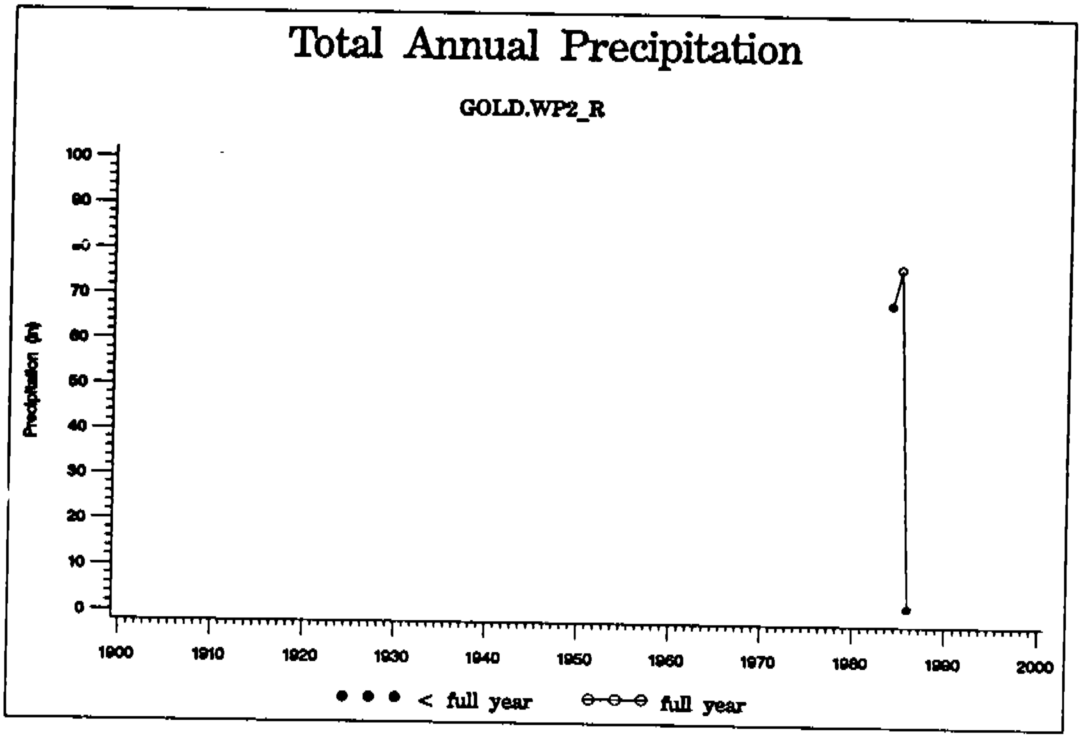
Total Annual Precipitation
GOLD.WP2_R
Precipitation (in)
100
90
70
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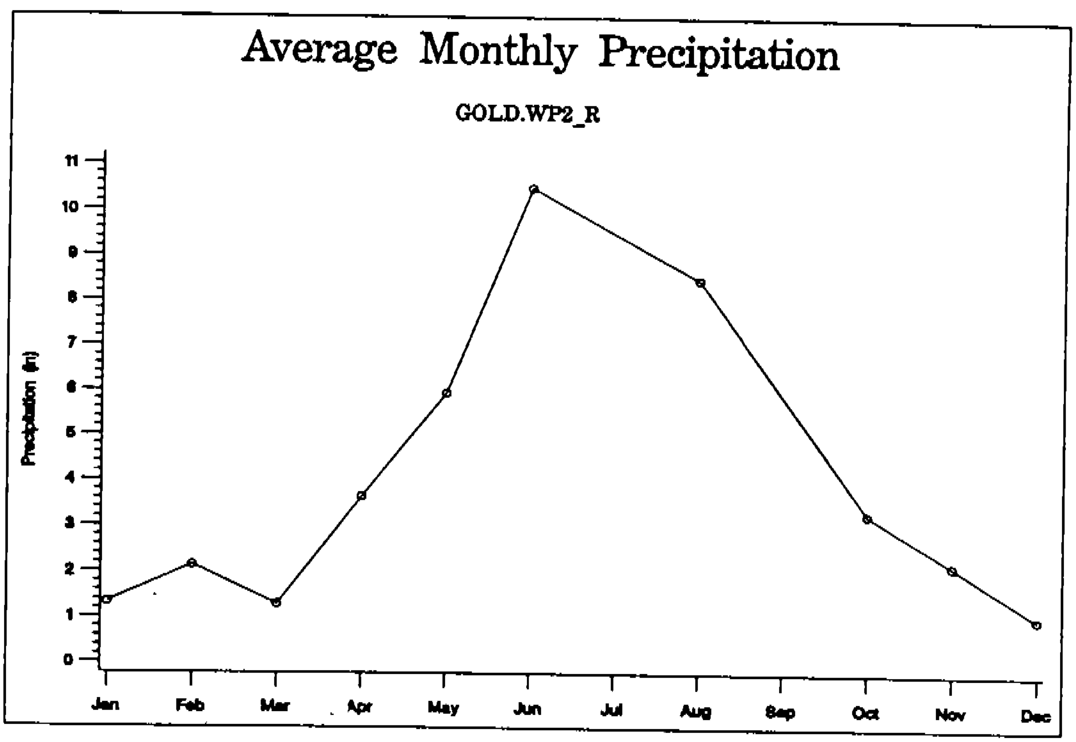
< full year
full year


Average Monthly Precipitation
GOLD.WP2_R
Precipitation (in)
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10
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Jan
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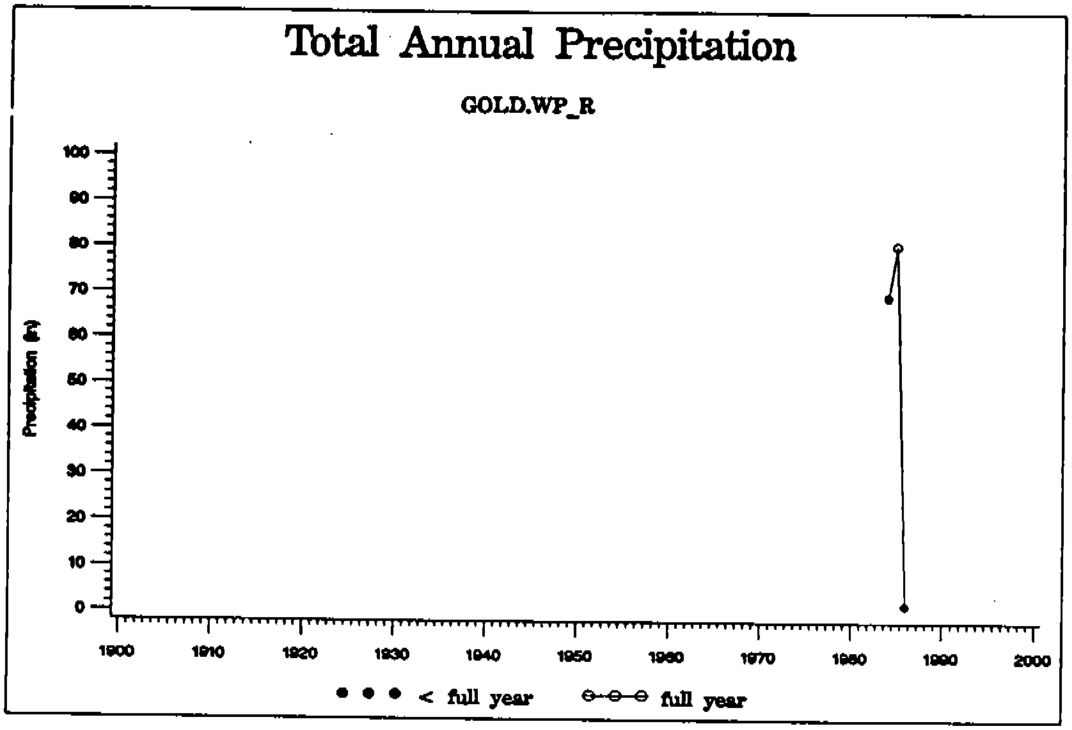
Total Annual Precipitation
GOLD.WP_R
Precipitation (in)
0
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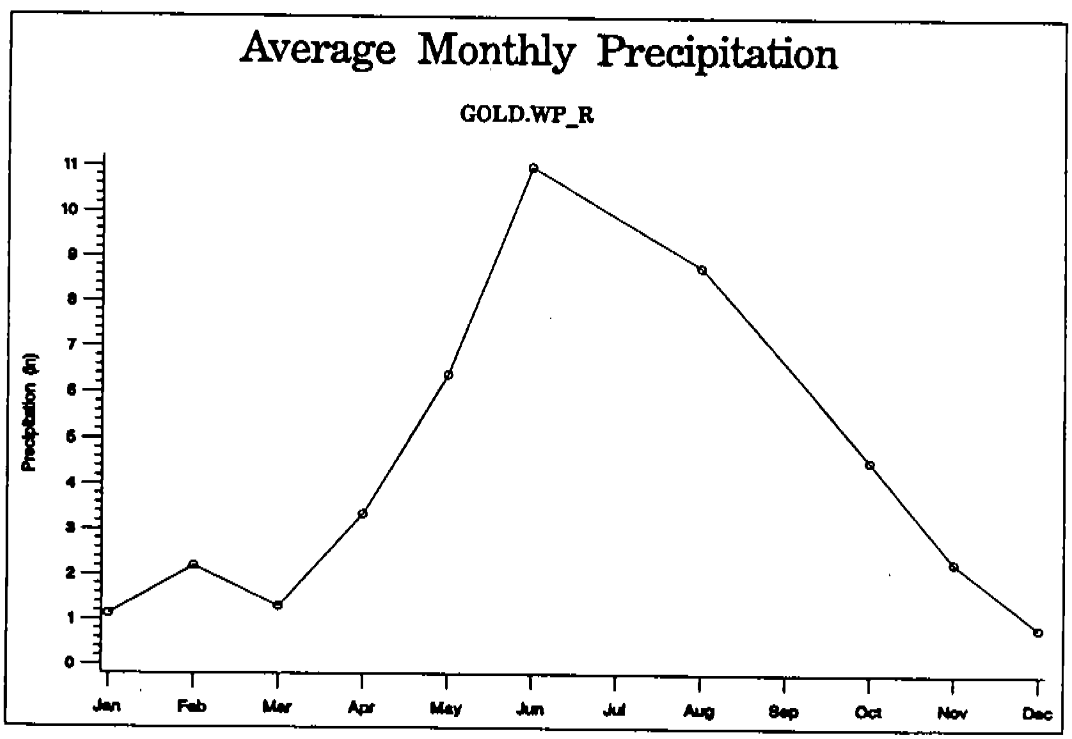
Average Monthly Precipitation
GOLD.WP_R
Precipitation (in)
0
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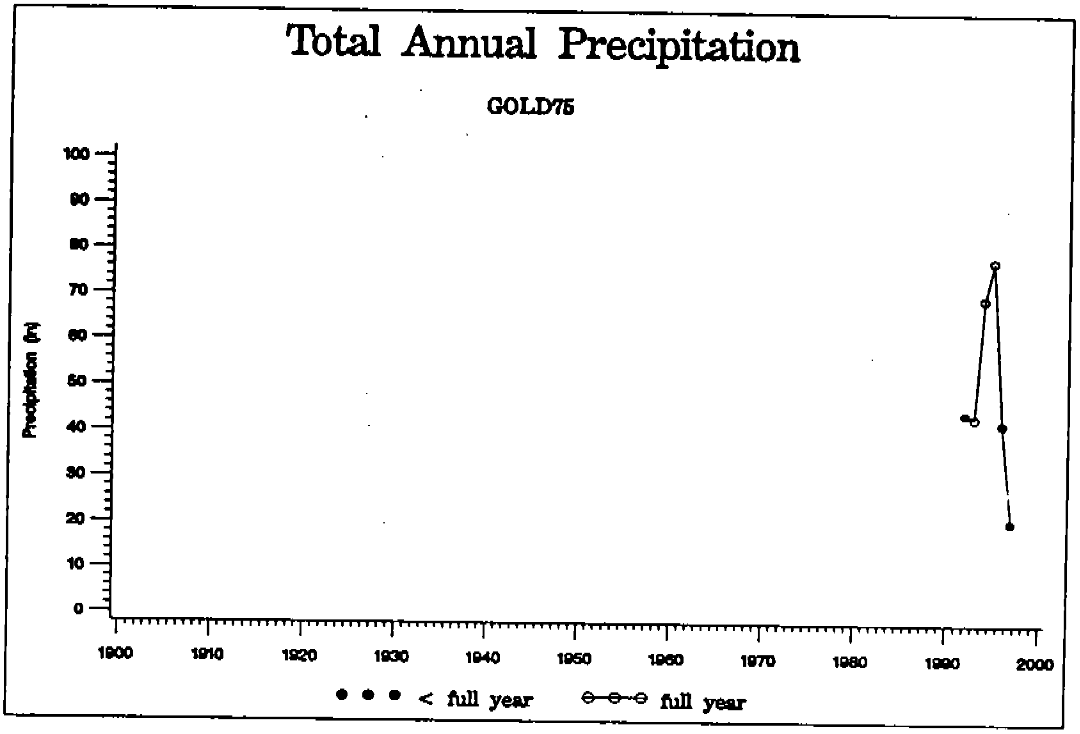
Total Annual Precipitation
GOLD75
Precipitation (in)
0
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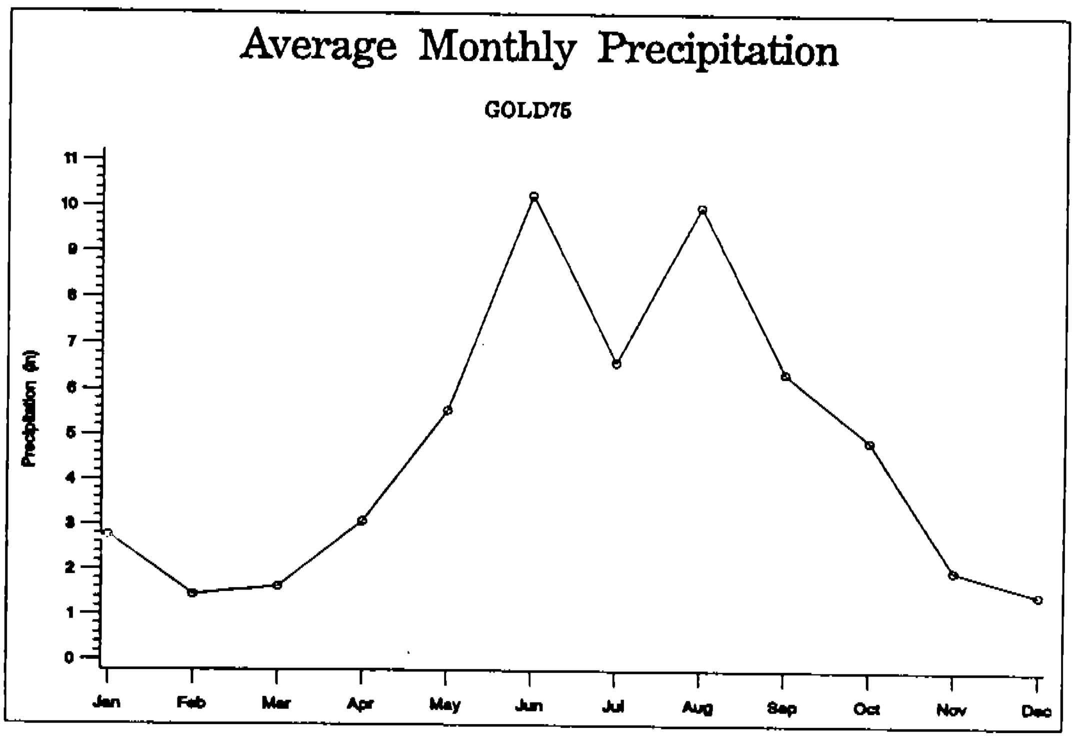
Average Monthly Precipitation
GOLD75
Precipitation (in)
0
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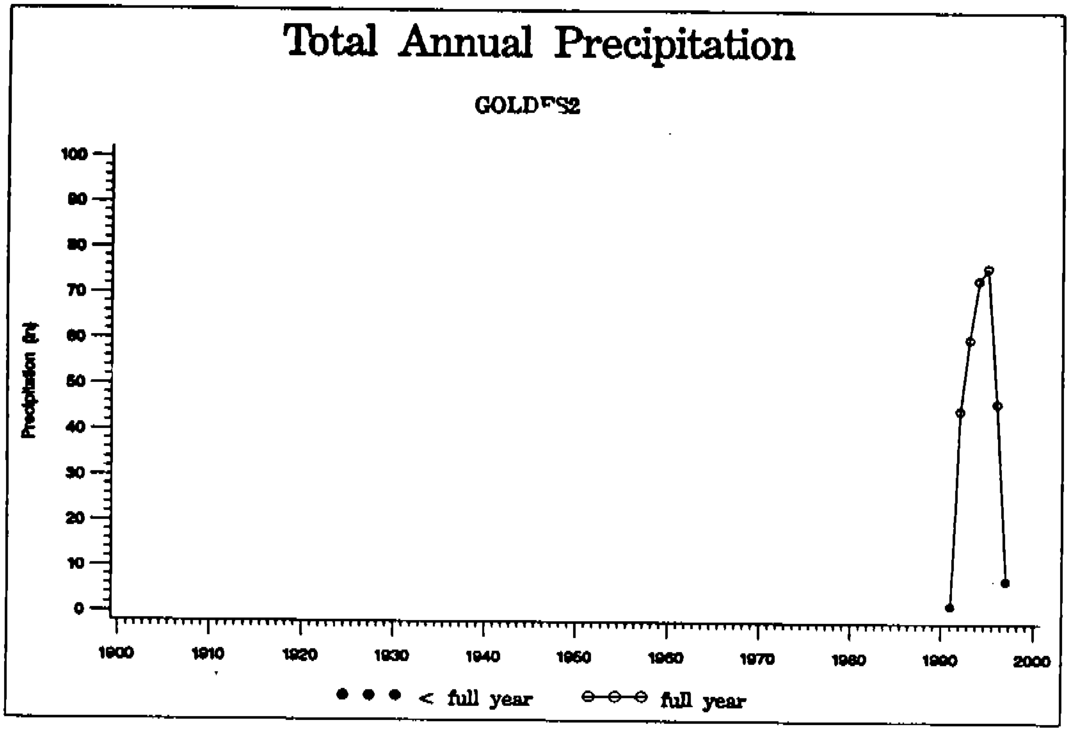
Total Annual Precipitation
GOLD"S2
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Precipitation (in)
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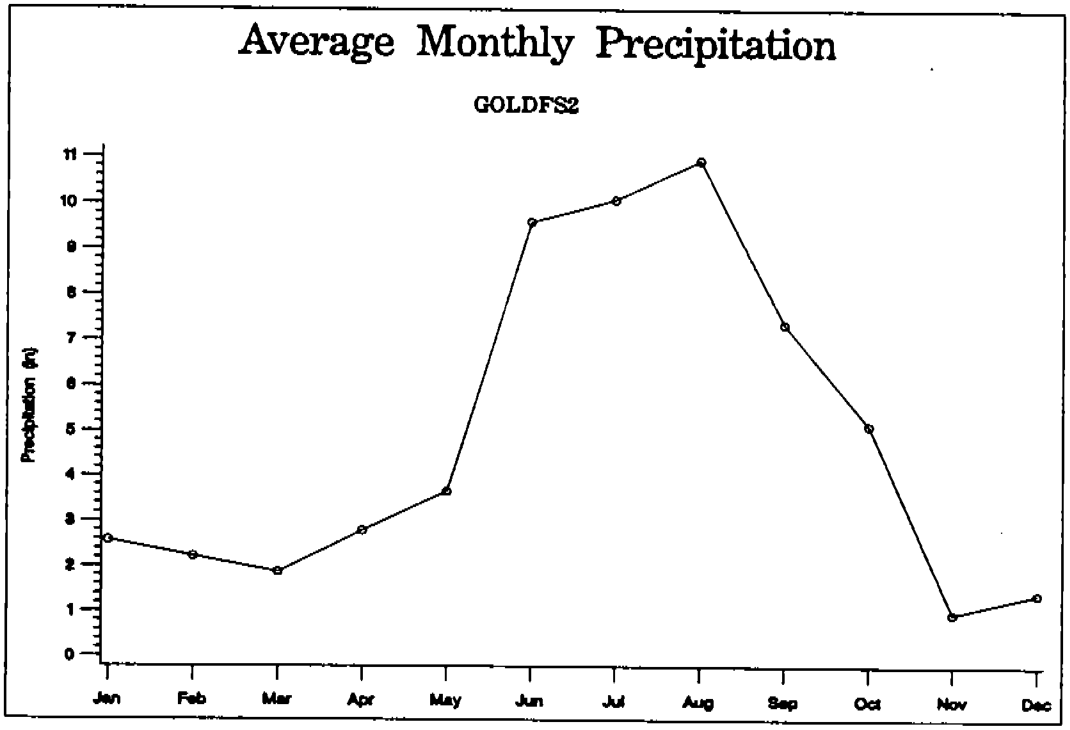
Average Monthly Precipitation
GOLDFS2
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Precipitation (in)
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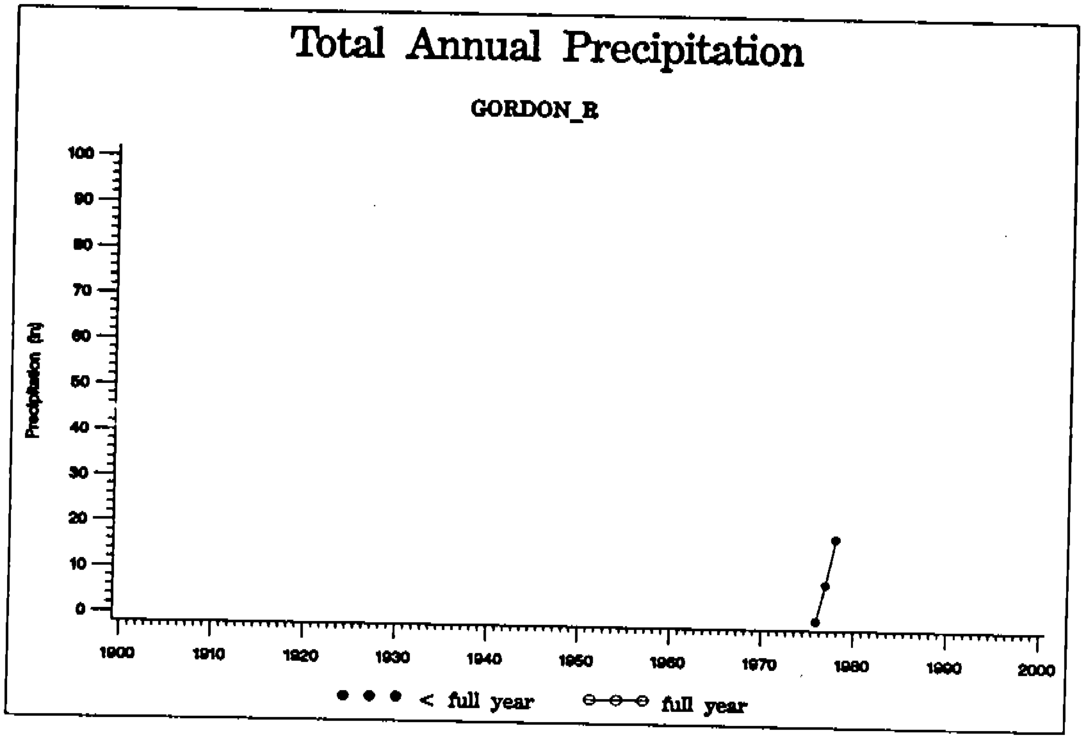
Total Annual Precipitation
GORDON_R
Precipitation (in)
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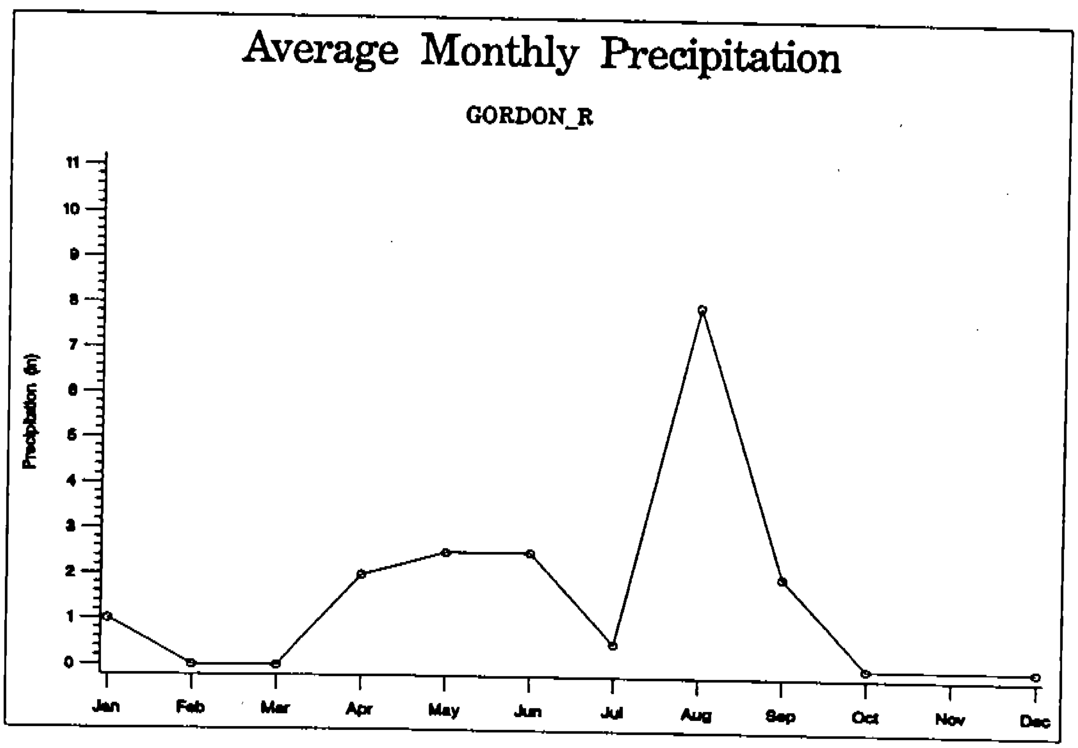
Average Monthly Precipitation
GORDON_R
Precipitation (in)
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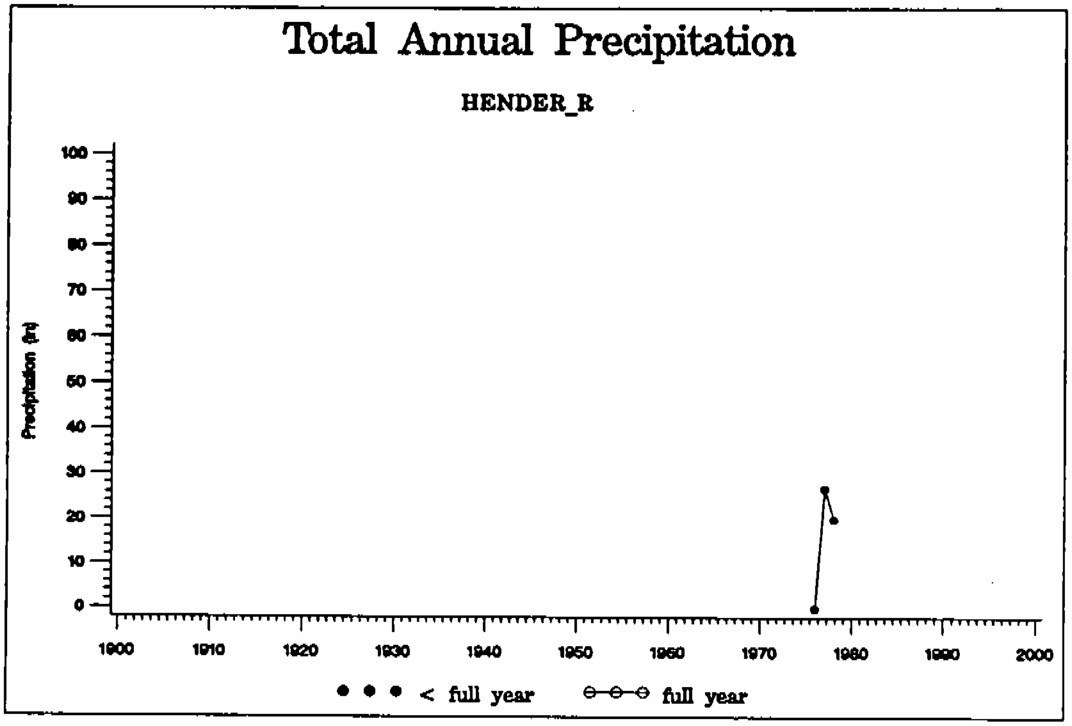
Total Annual Precipitation
HENDER_R
Precipitation (in)
100
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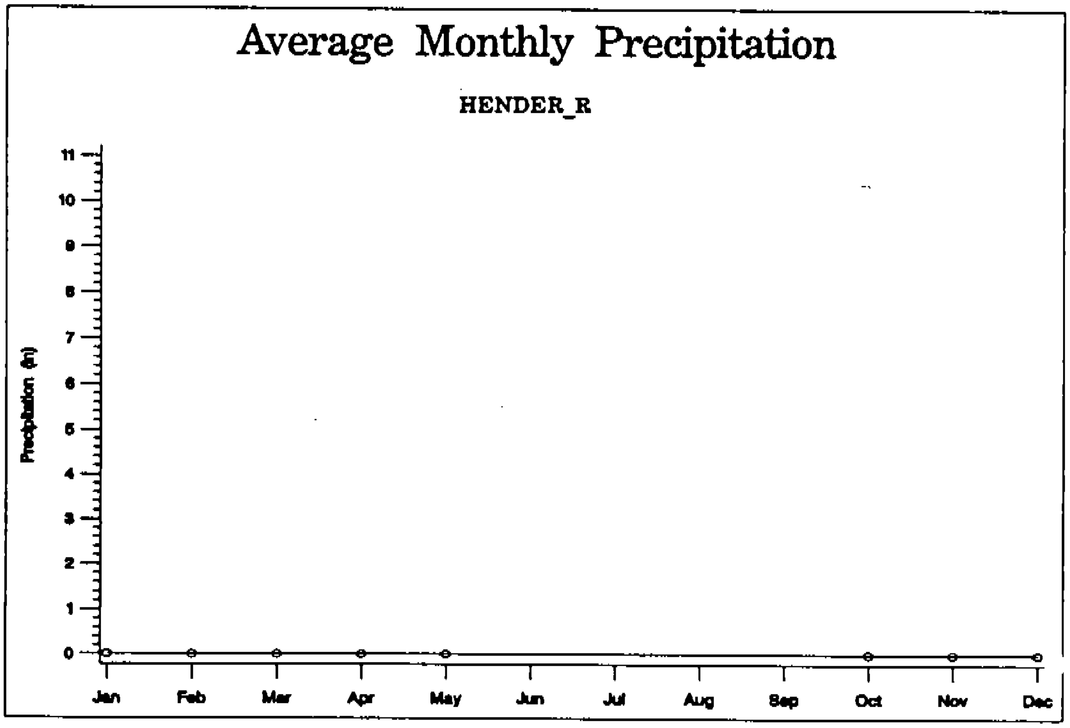
Average Monthly Precipitation
HENDER_R
Precipitation (in)
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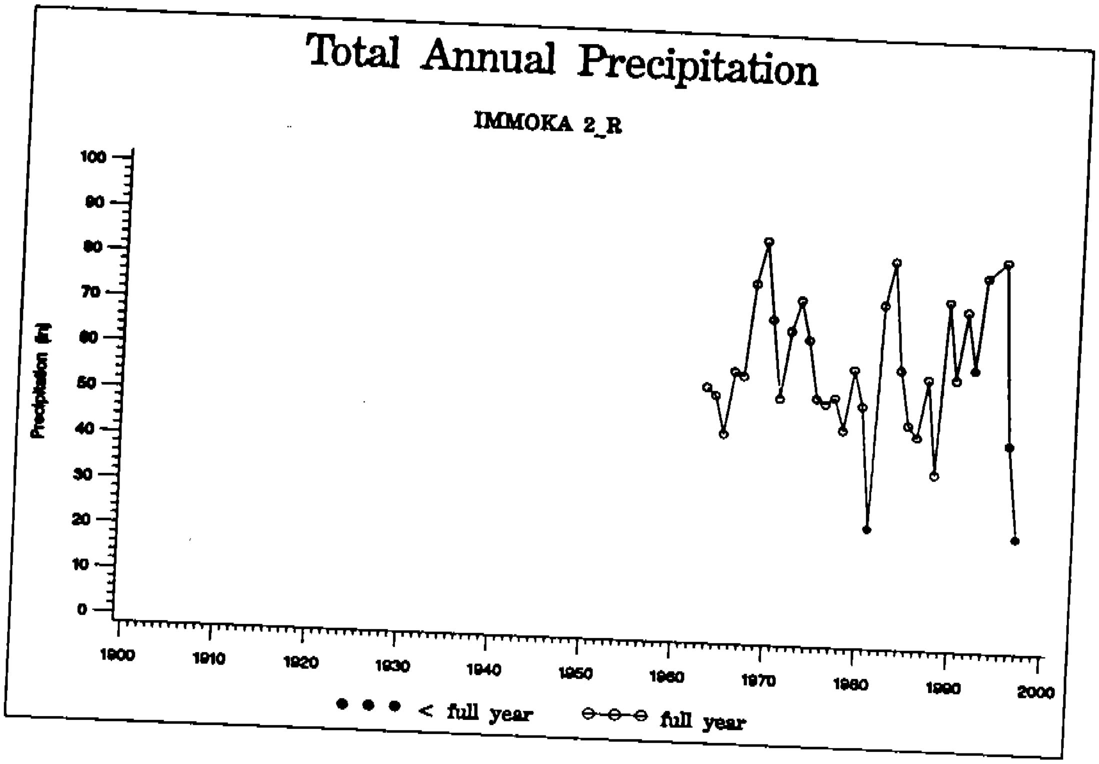

Total Annual Precipitation
IMMOKA 2_R
Precipitation (in)
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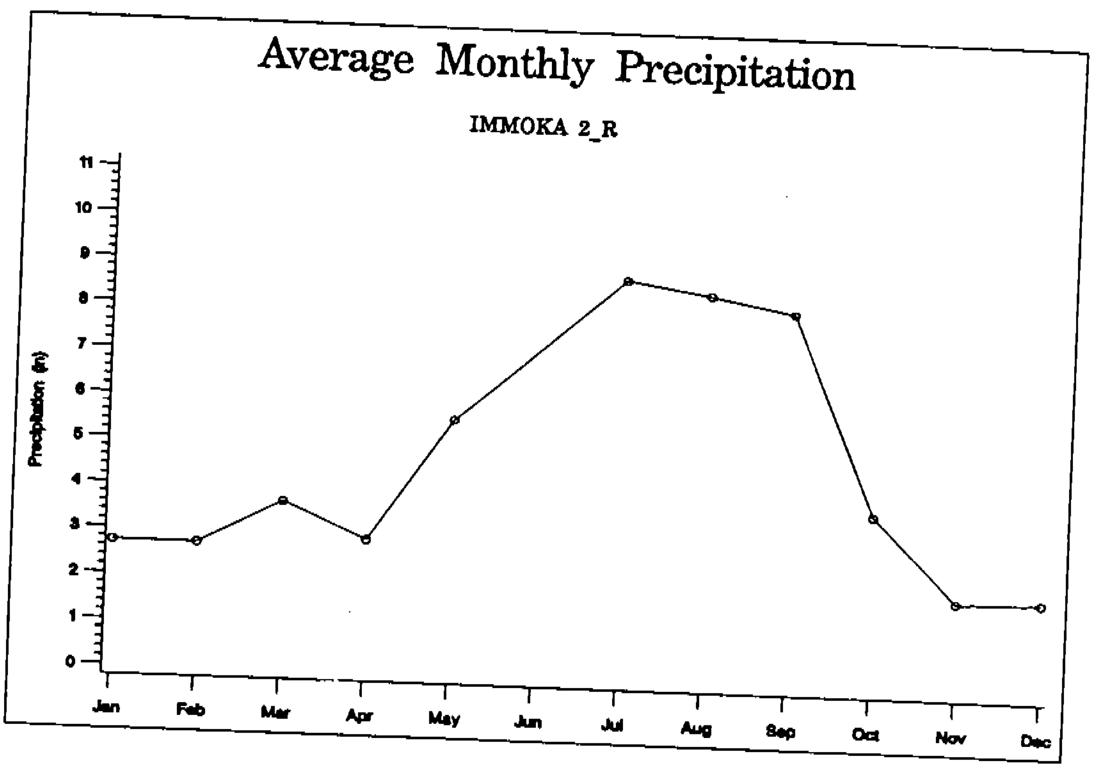

Average Monthly Precipitation
IMMOKA 2_R
Precipitation (in)
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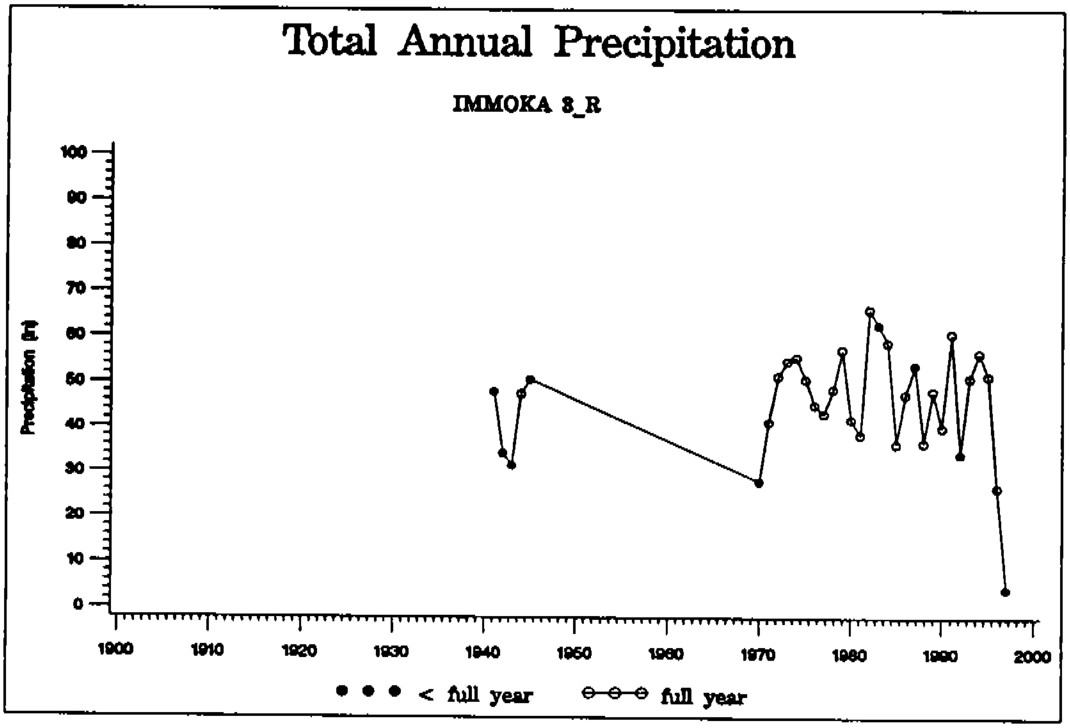
Total Annual Precipitation
IMMOKA 3_R
Precipitation (in)
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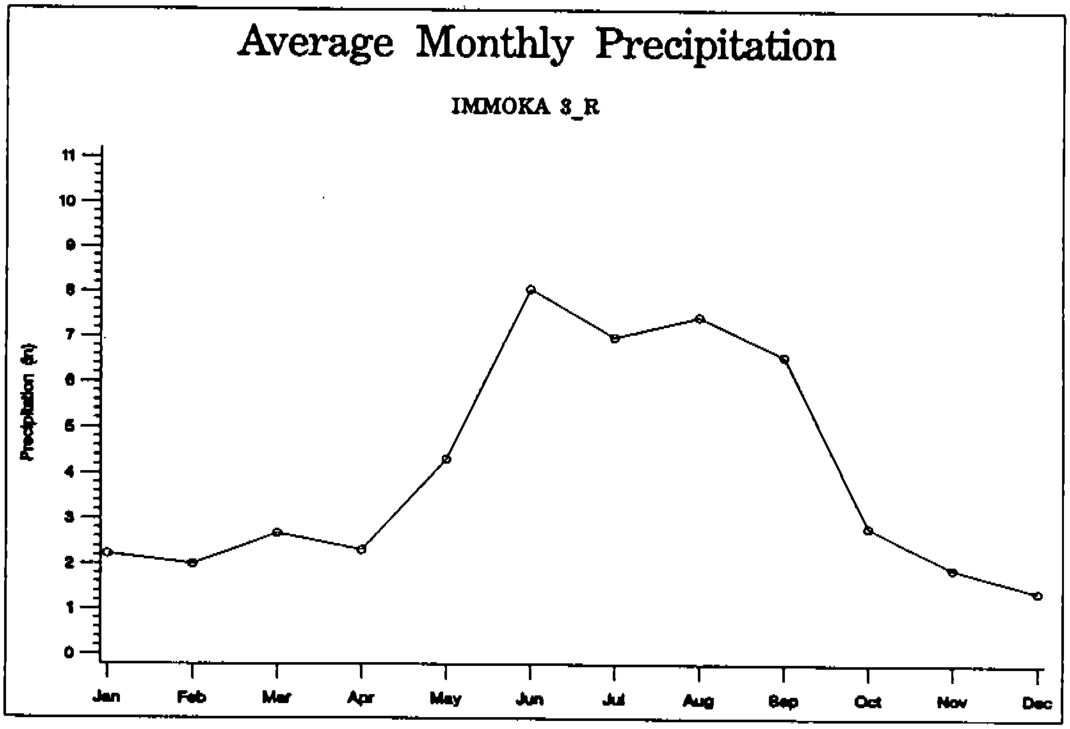
Average Monthly Precipitation
IMMOKA 3_R
Precipitation (in)
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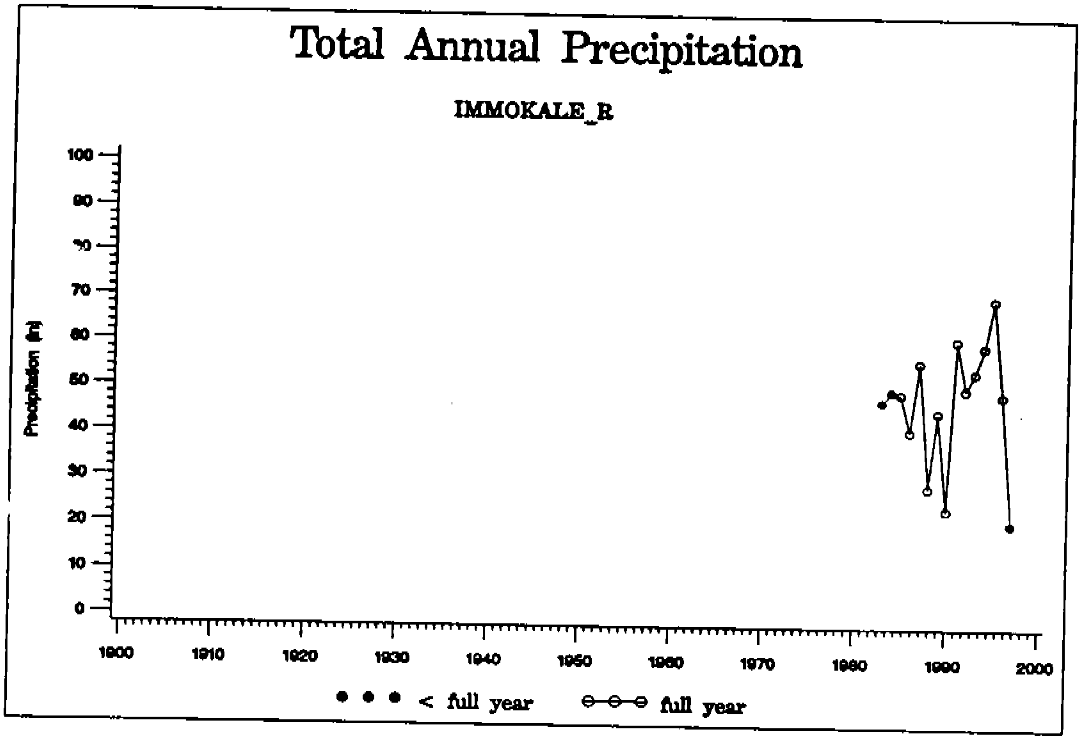
Total Annual Precipitation
IMMOKALE_R
Precipitation (in)
100
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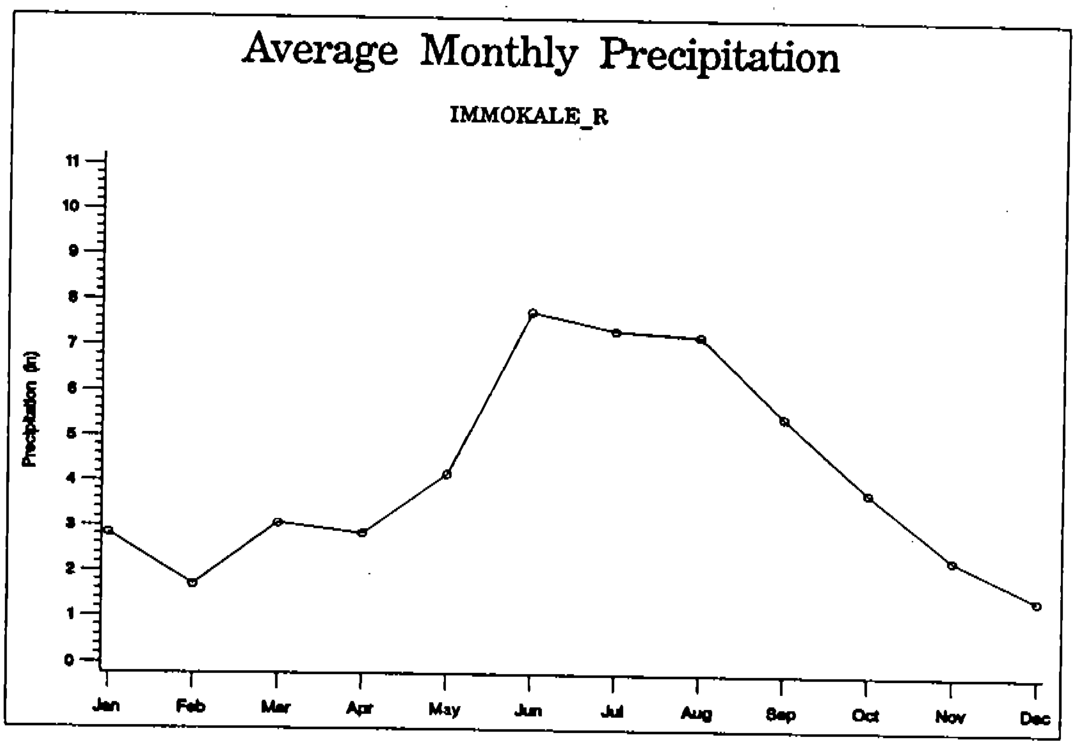
Average Monthly Precipitation
IMMOKALE_R
Precipitation (in)
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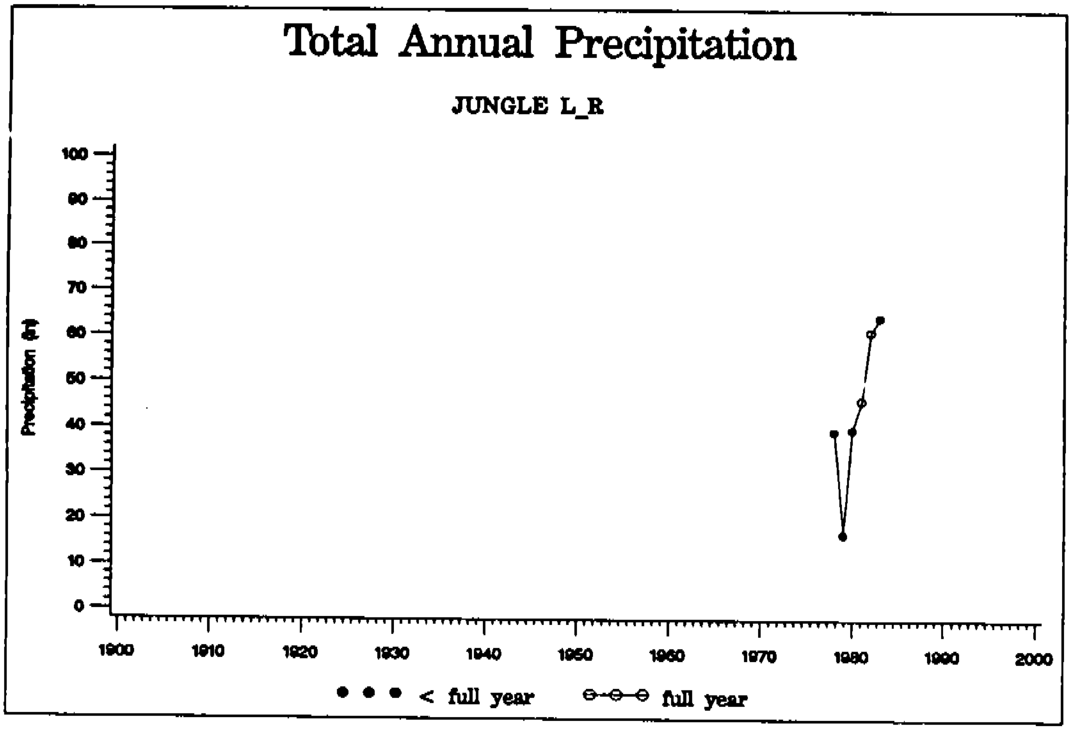

Total Annual Precipitation
JUNGLE L_R
Precipitation (in)
0
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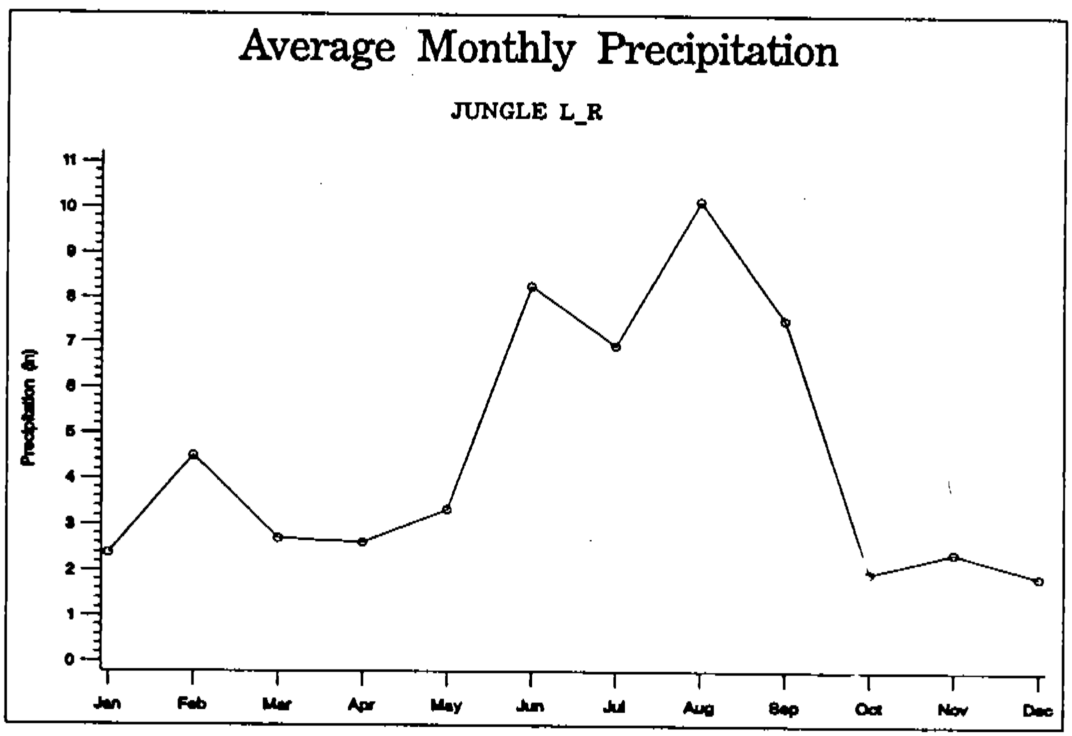

Average Monthly Precipitation
JUNGLE L_R
Precipitation (in)
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Jan
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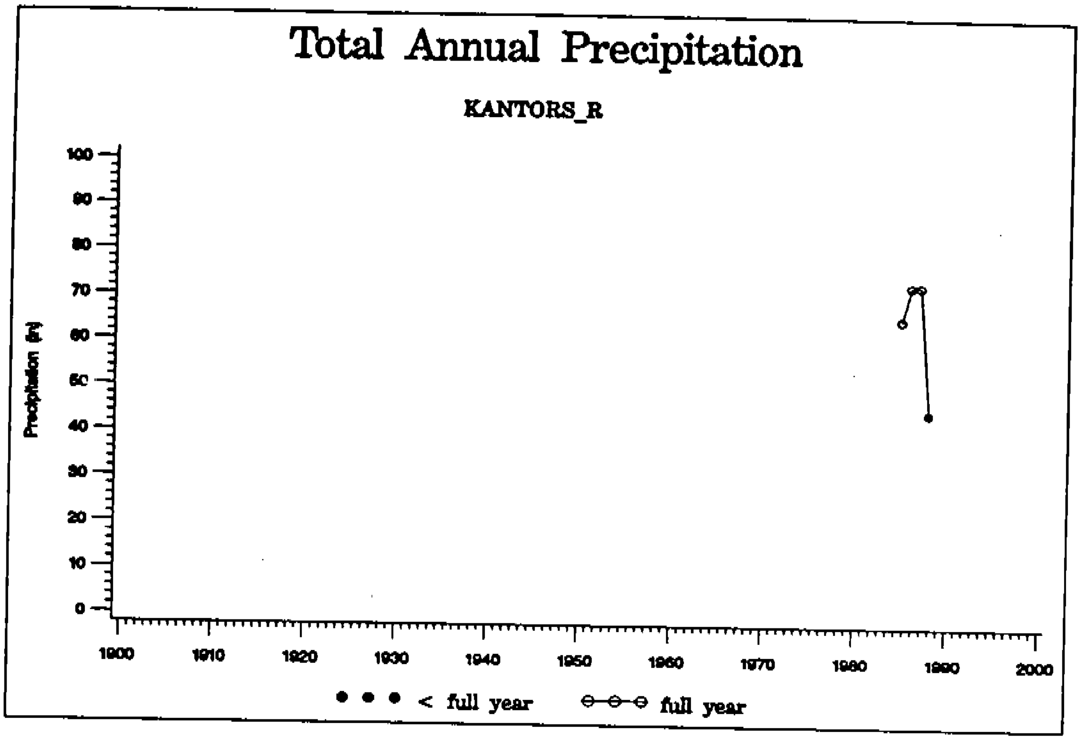
Total Annual Precipitation
KANTORS_R
Precipitation (in)
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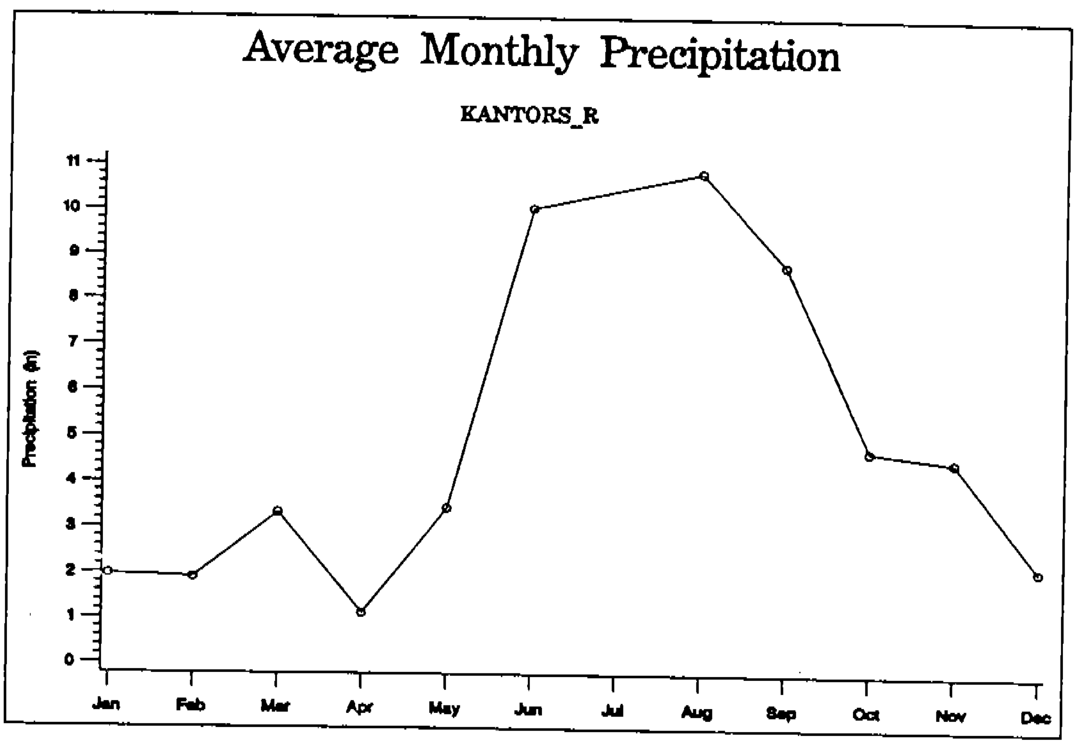
Average Monthly Precipitation
KANTORS_R
Precipitation (in)
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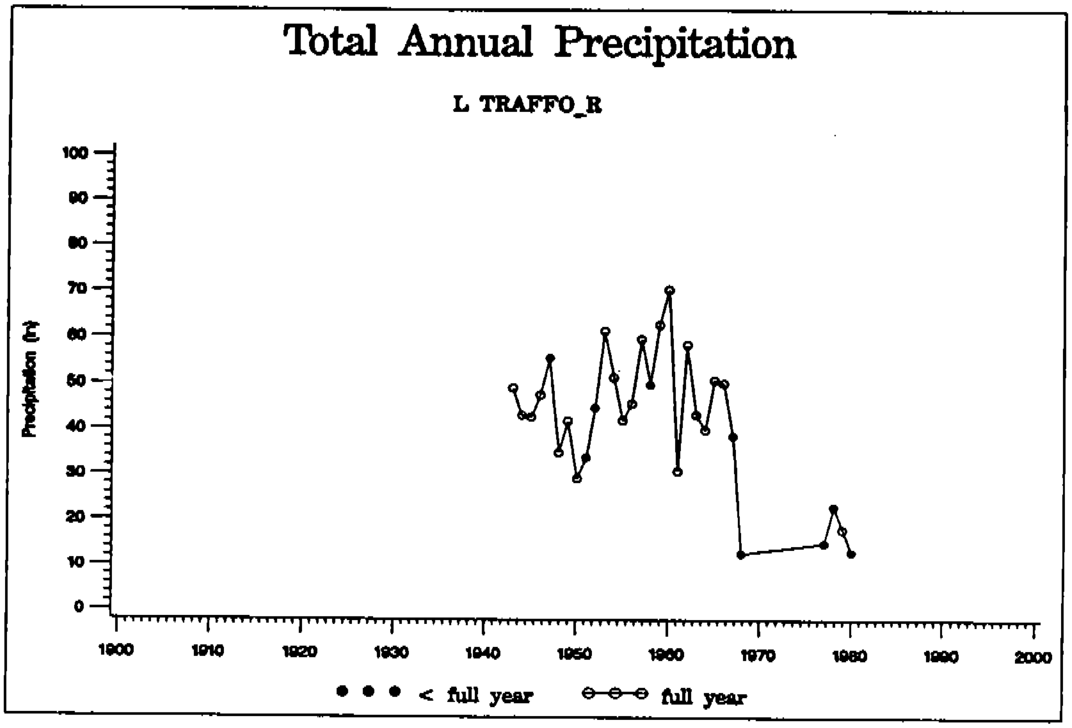
Total Annual Precipitation
L TRAFFO_R
Precipitation (in)
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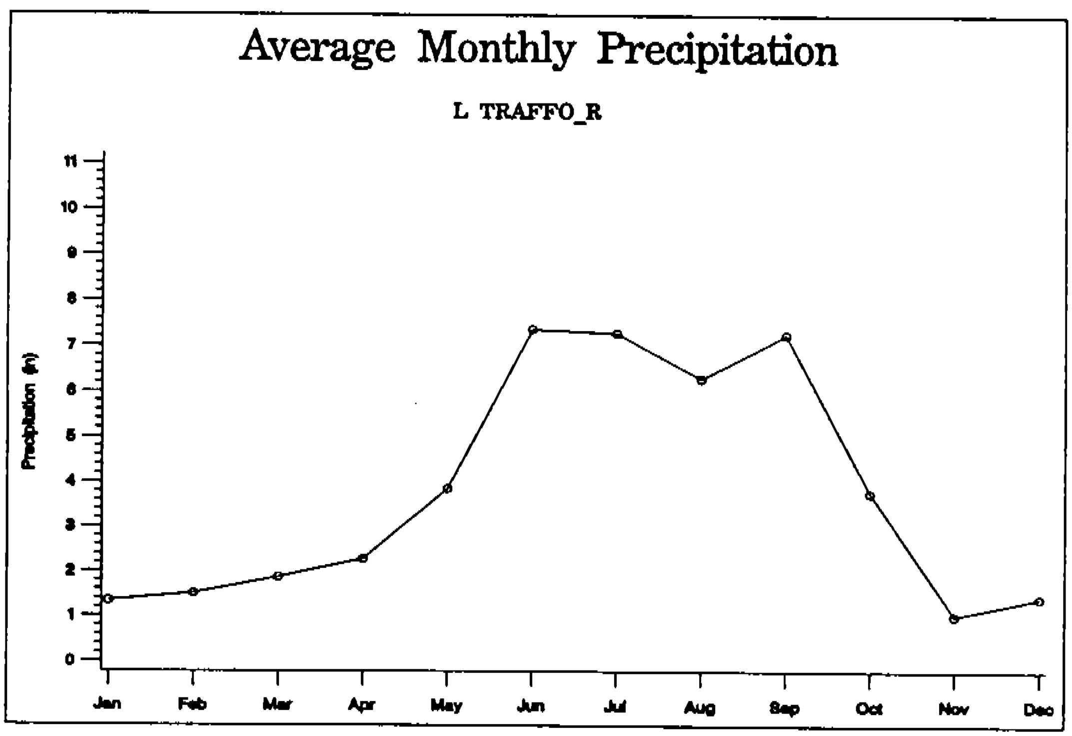
Average Monthly Precipitation
L TRAFFO_R
Precipitation (in)
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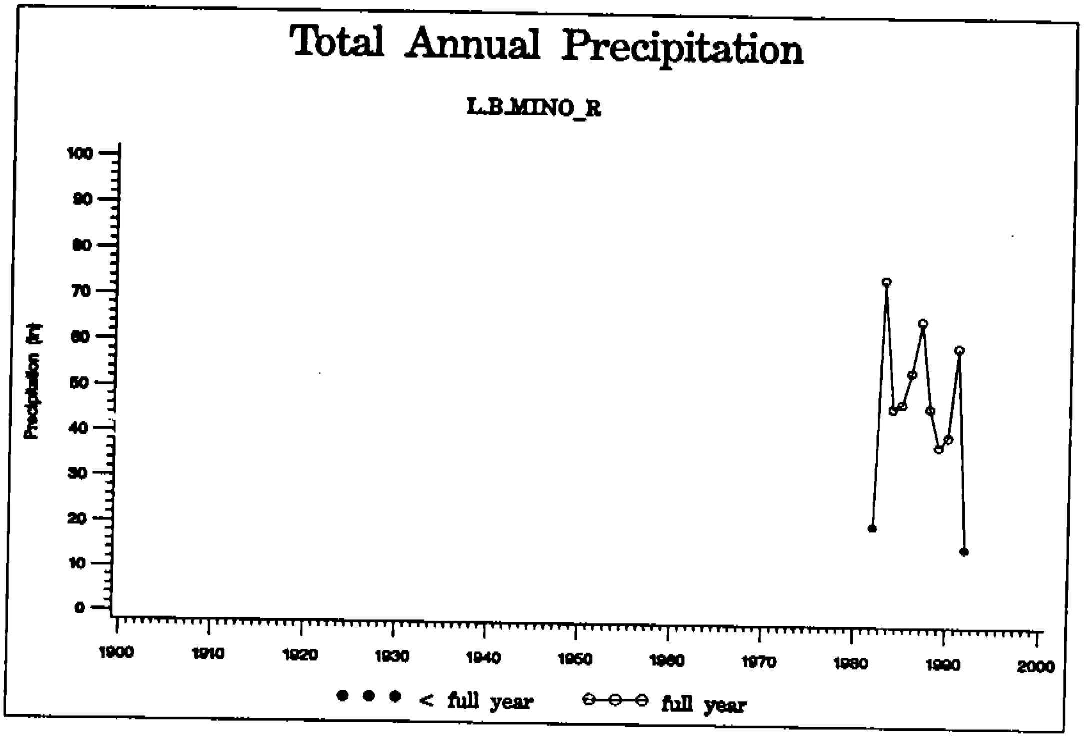
Total Annual Precipitation
L.B.MINO_R
Precipitation (in)
100
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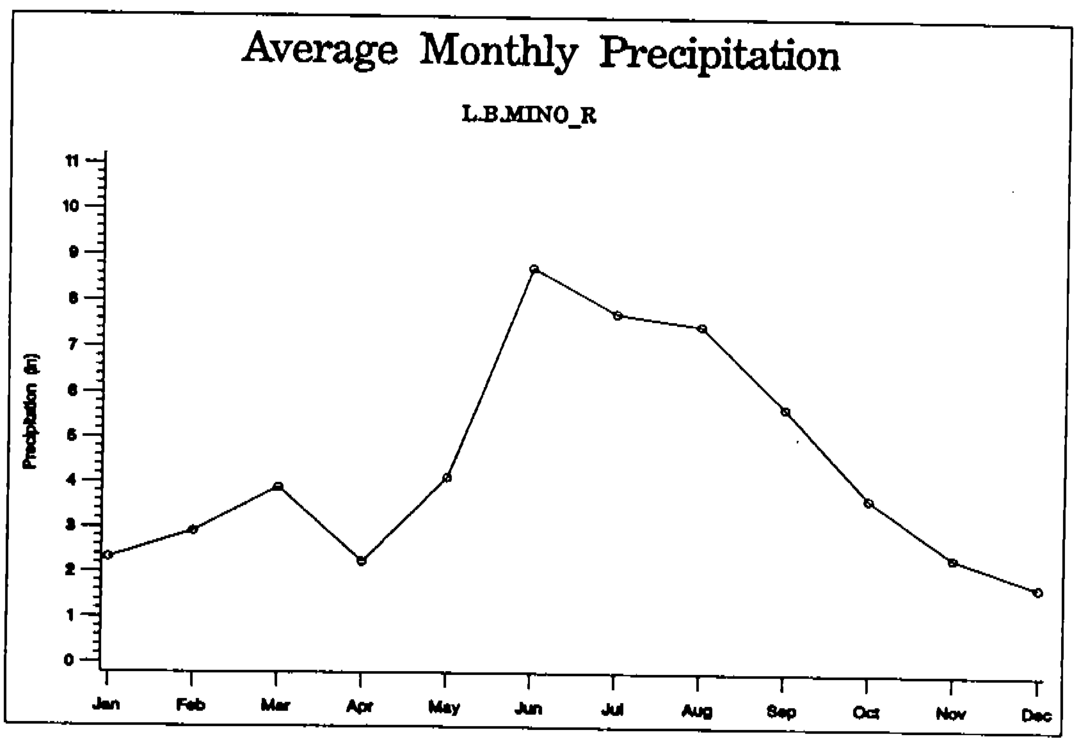
Average Monthly Precipitation
L.B.MINO_R
Precipitation (in)
11
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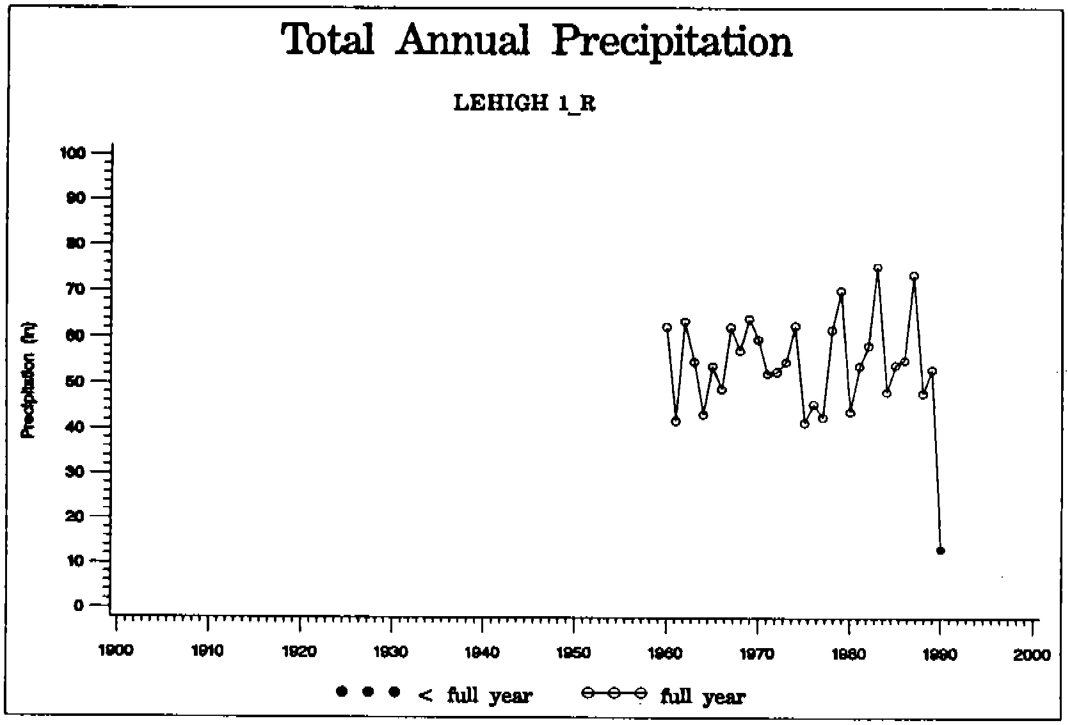
Total Annual Precipitation
LEHIGH 1_R
Precipitation (in)
0
10
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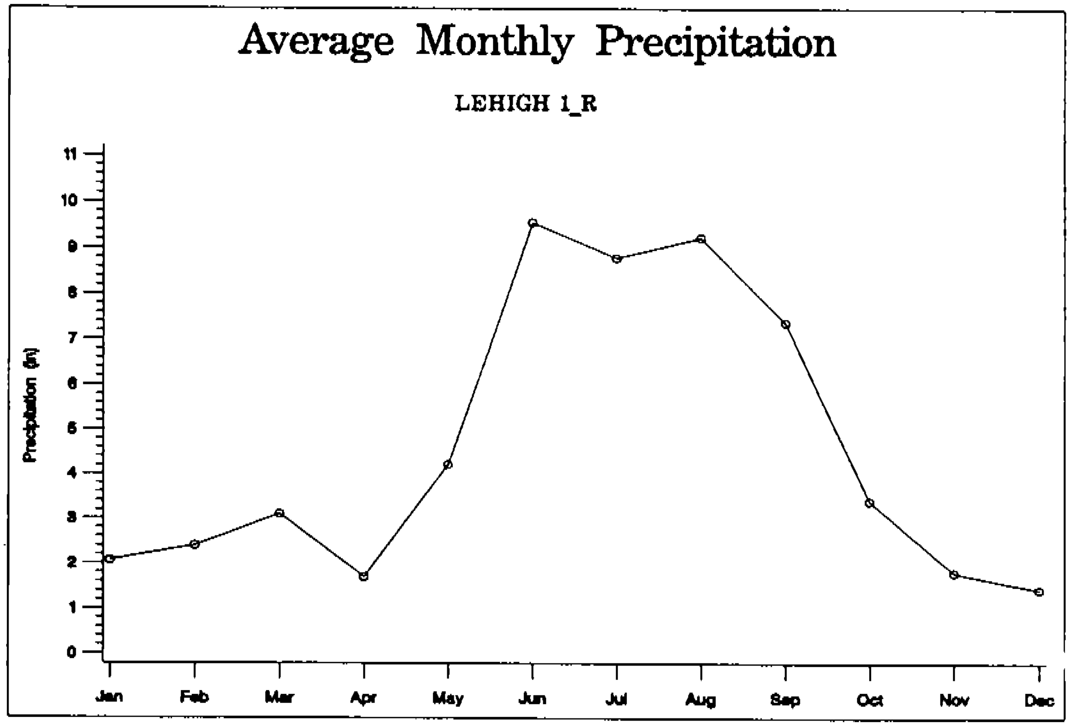
full year


Average Monthly Precipitation
LEHIGH 1_R
Precipitation (in)
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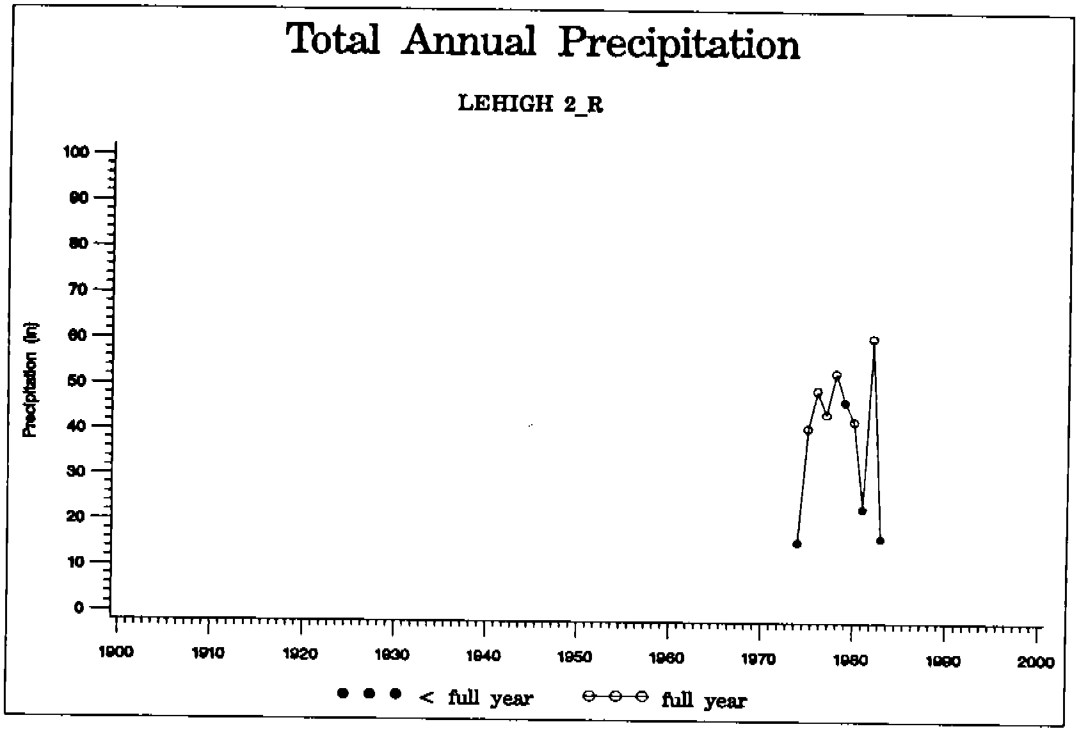

Total Annual Precipitation
LEHIGH 2_R
Precipitation (in)
0
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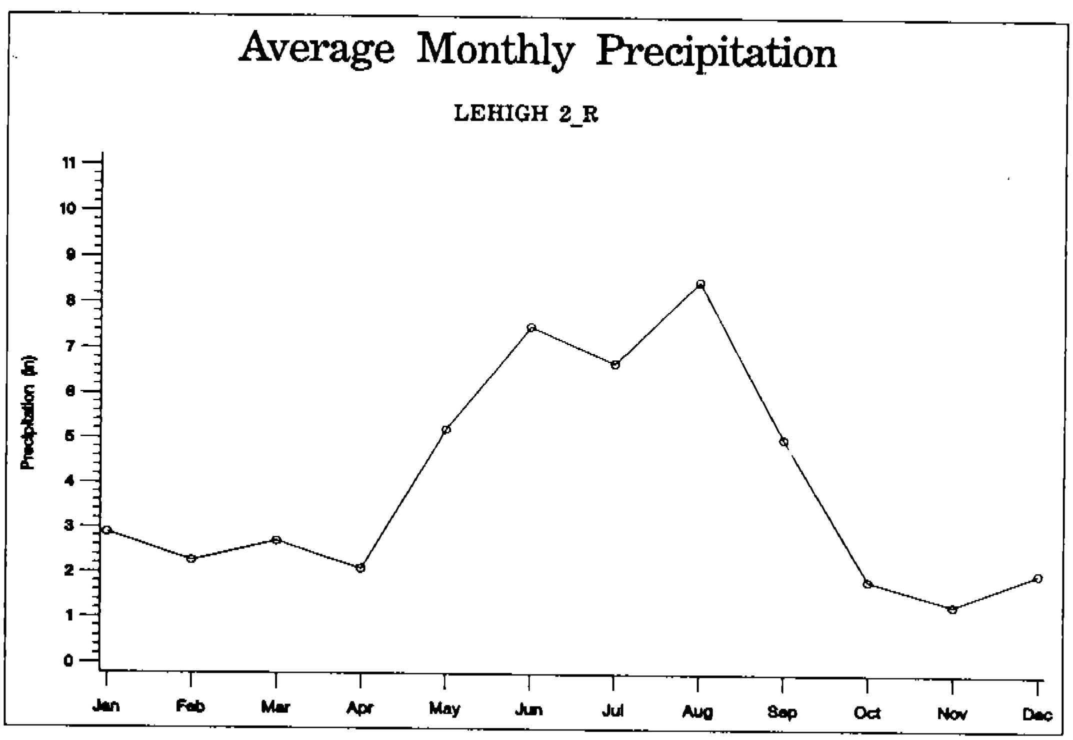

Average Monthly Precipitation
LEHIGH 2_R
Precipitation (in)
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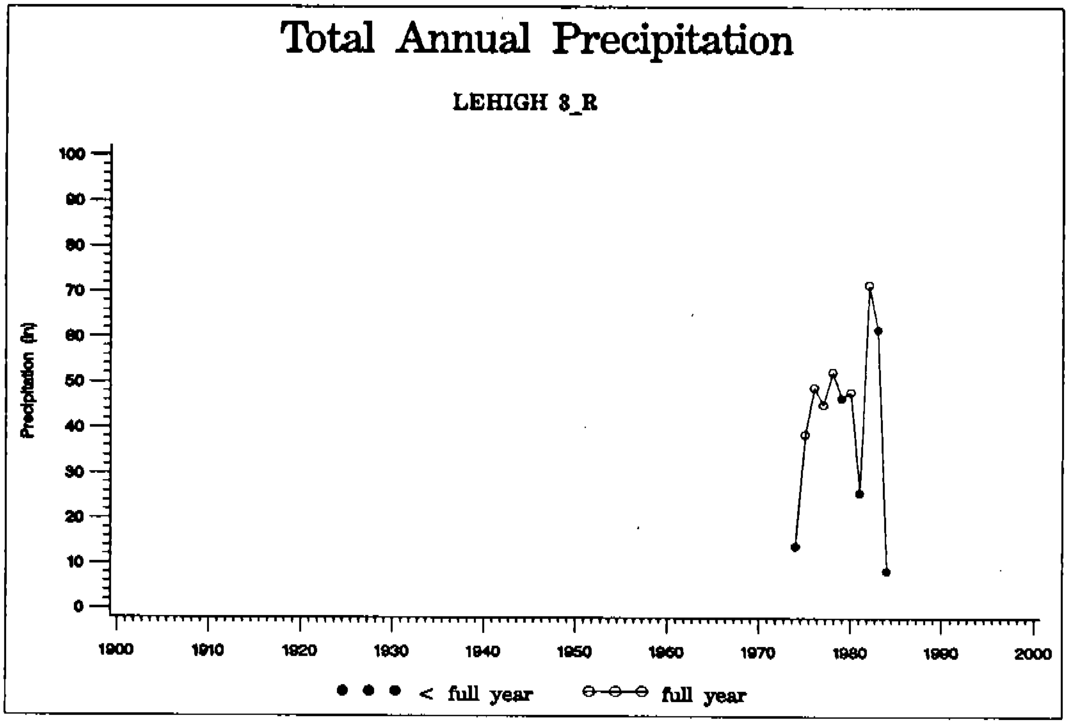

Total Annual Precipitation
LEHIGH 3_R
Precipitation (in)
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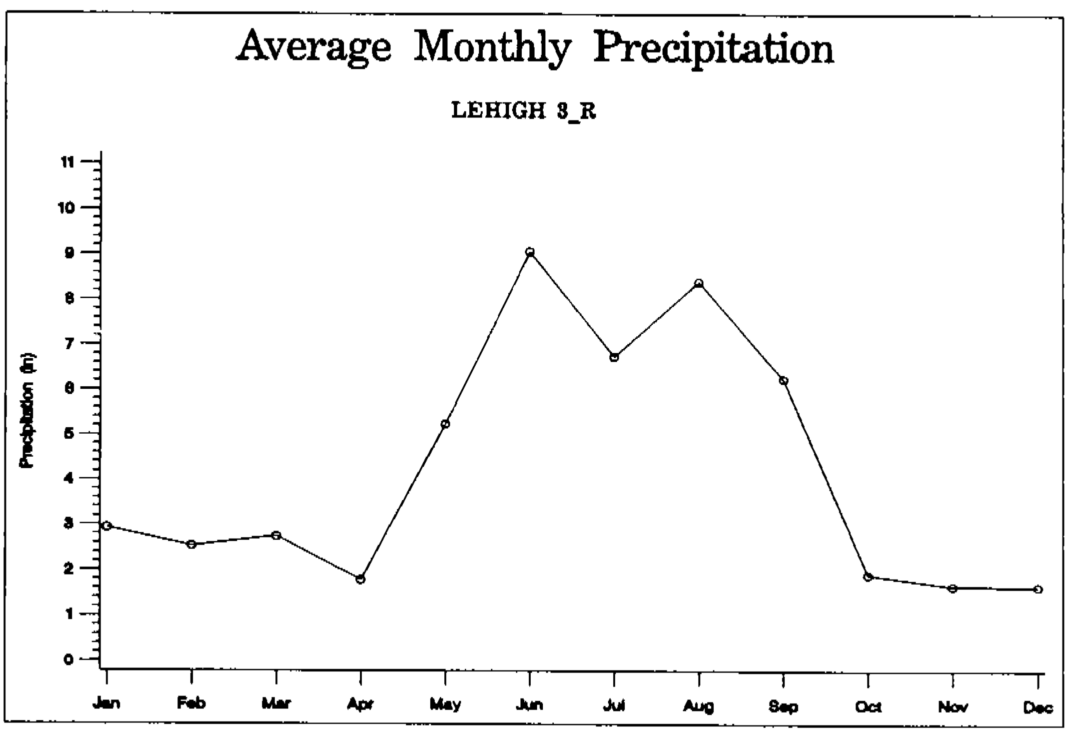

Average Monthly Precipitation
LEHIGH 3_R
Precipitation (in)
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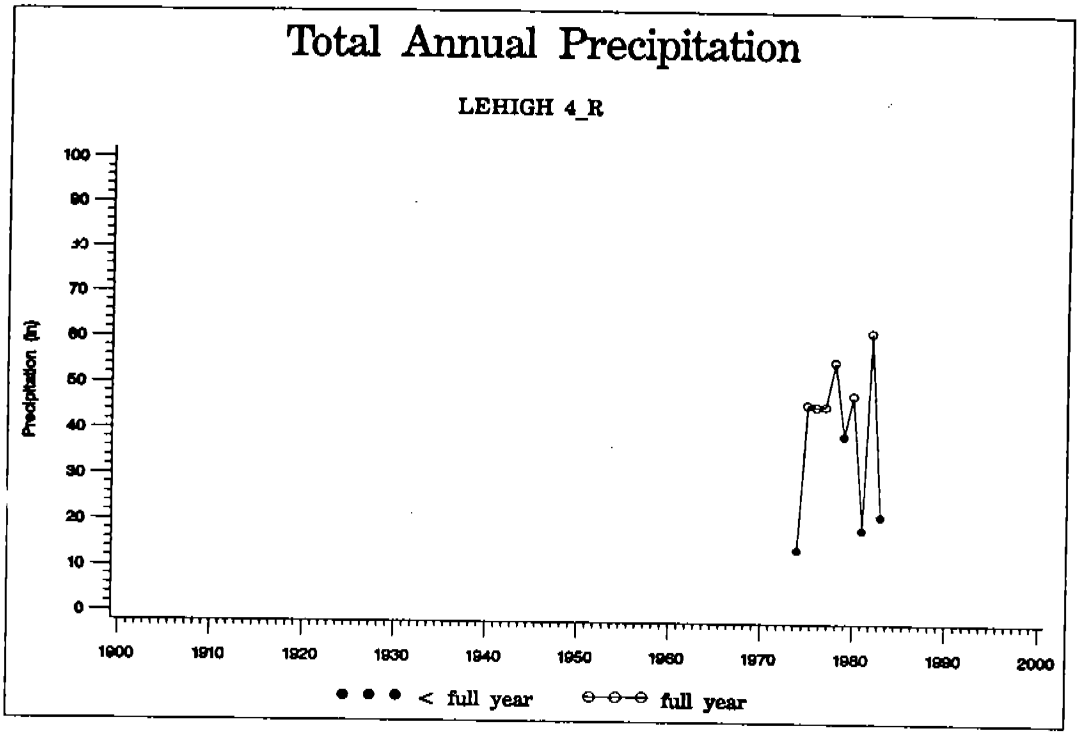
Total Annual Precipitation
LEHIGH 4_R
Precipitation (in)
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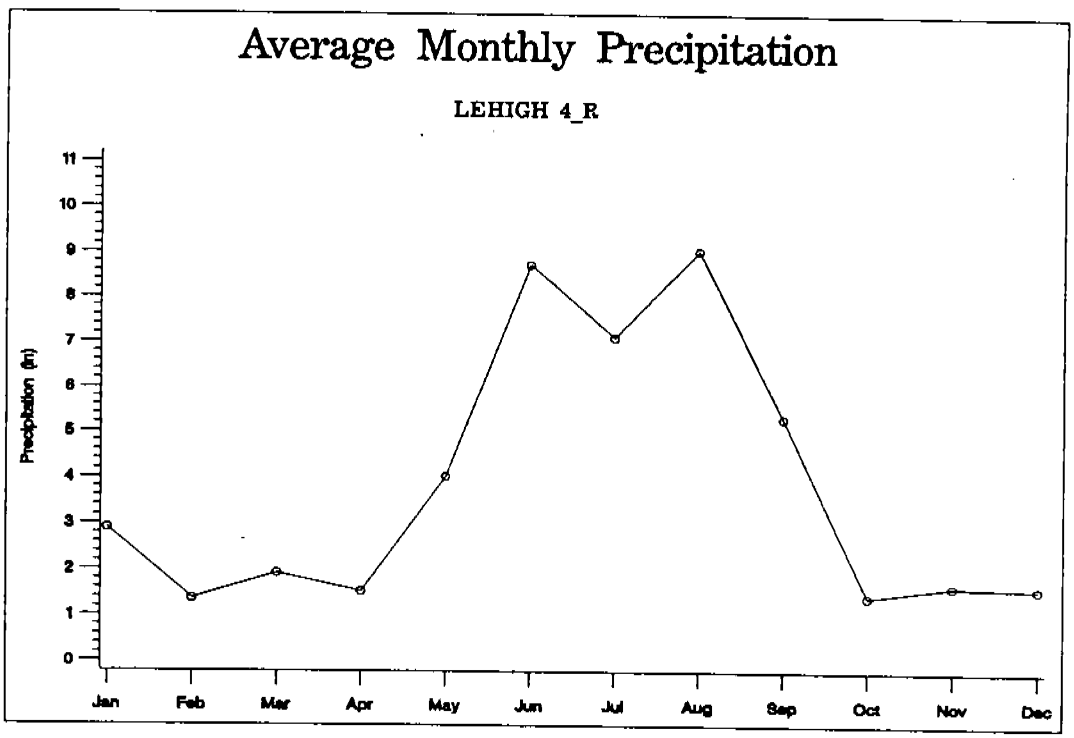
Average Monthly Precipitation
LEHIGH 4_R
Precipitation (in)
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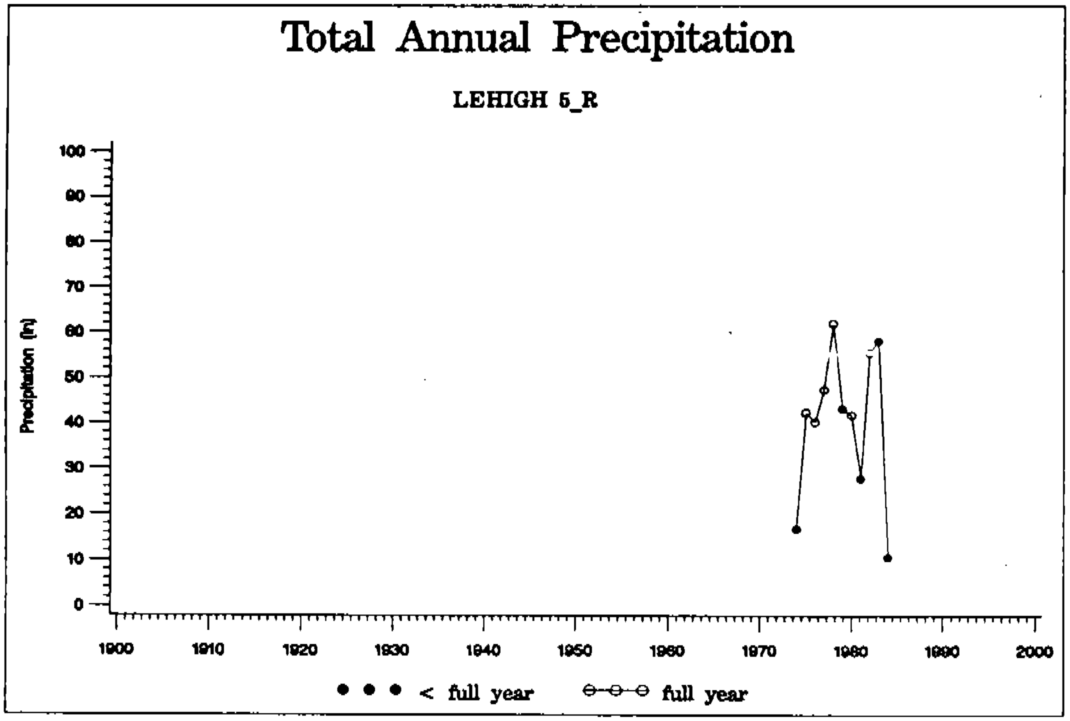
Total Annual Precipitation
LEHIGH 5_R
Precipitation (in)
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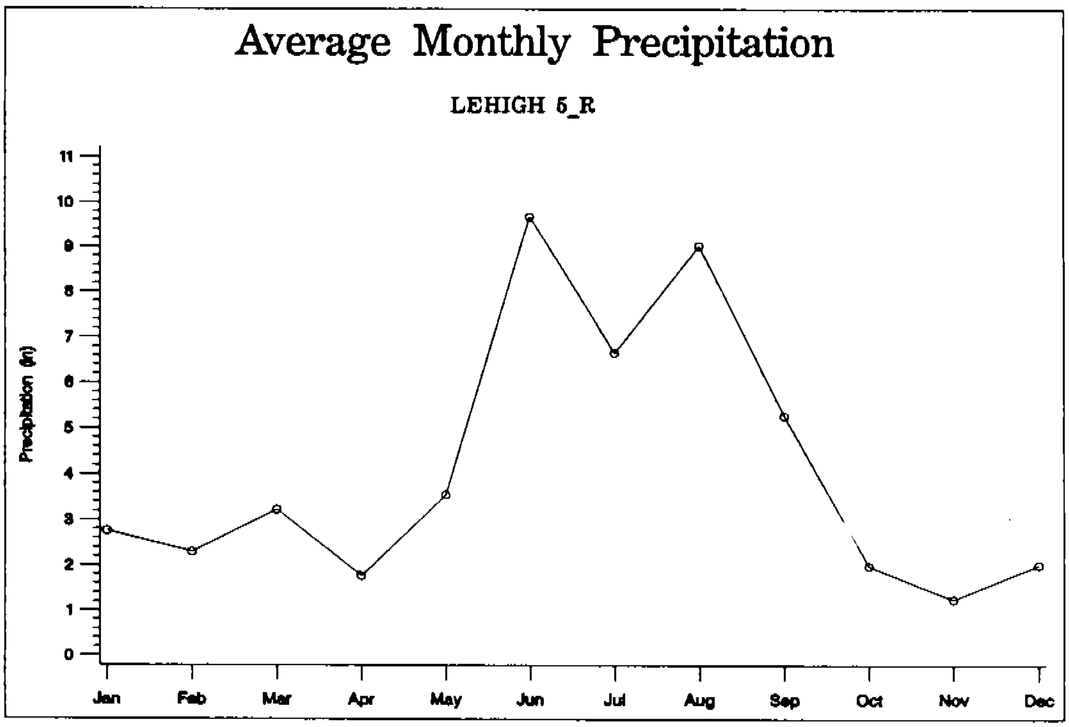
Average Monthly Precipitation
LEHIGH 5_R
Precipitation (in)
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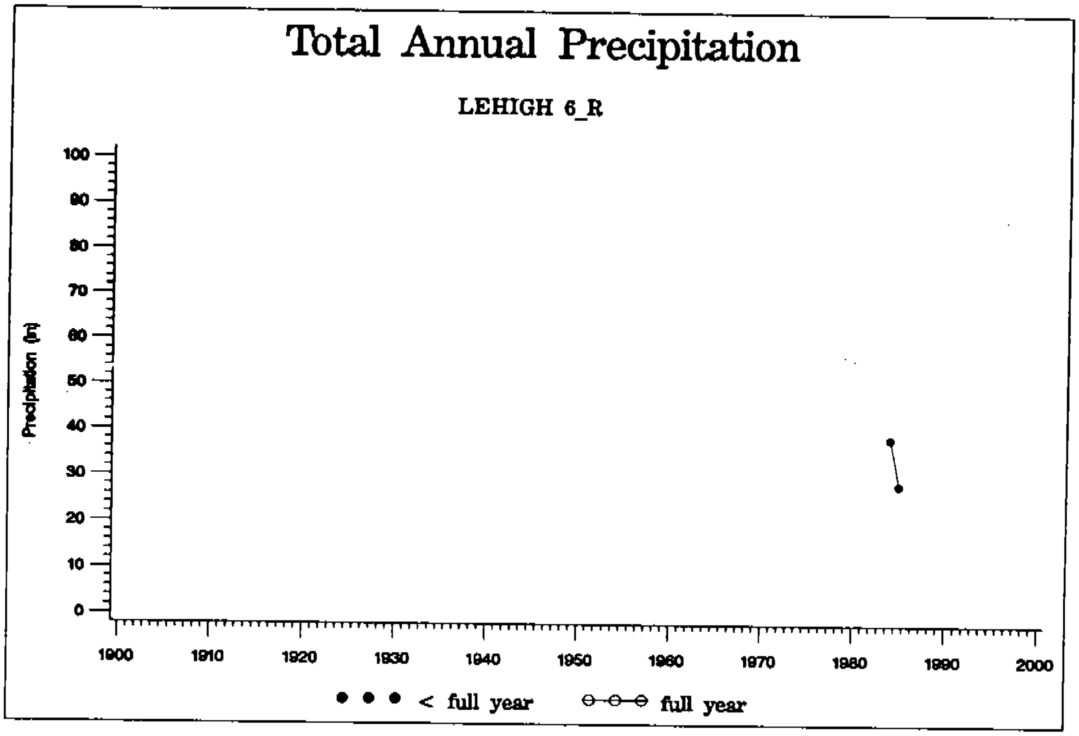
Total Annual Precipitation
LEHIGH 6_R
Precipitation (in)
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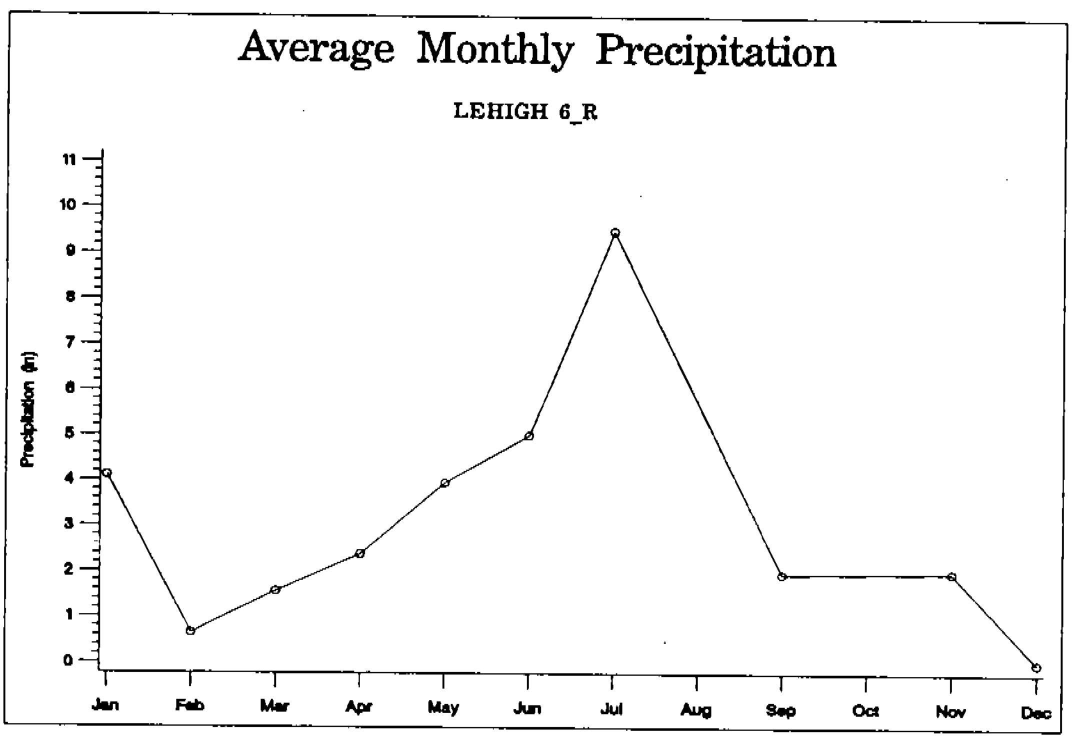
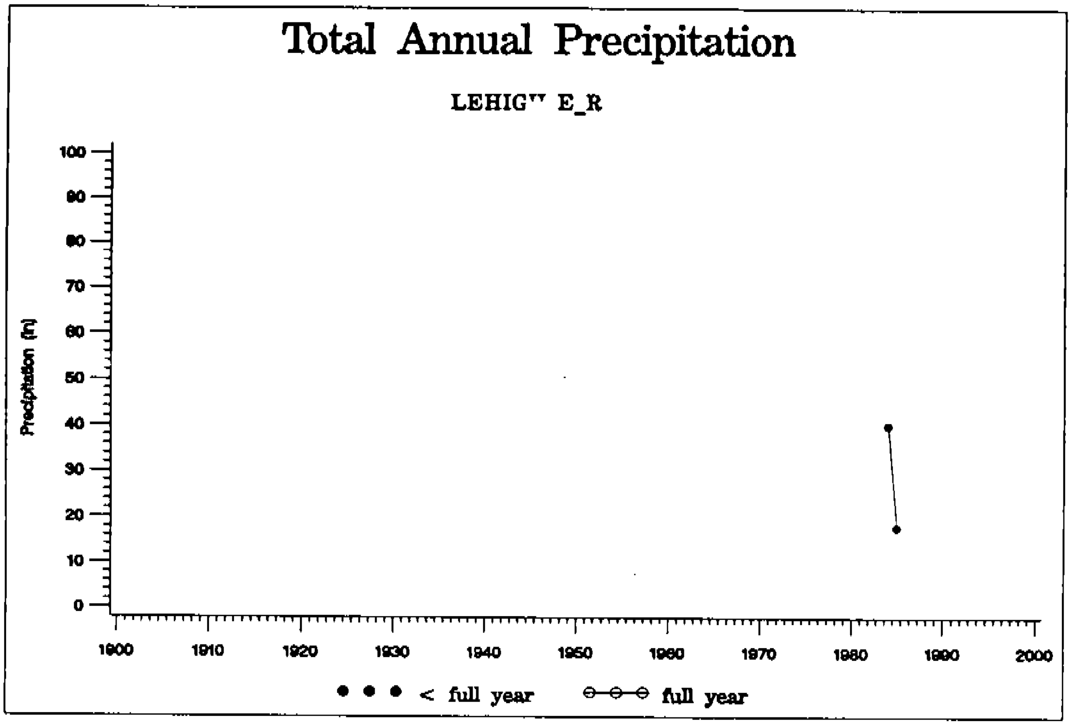
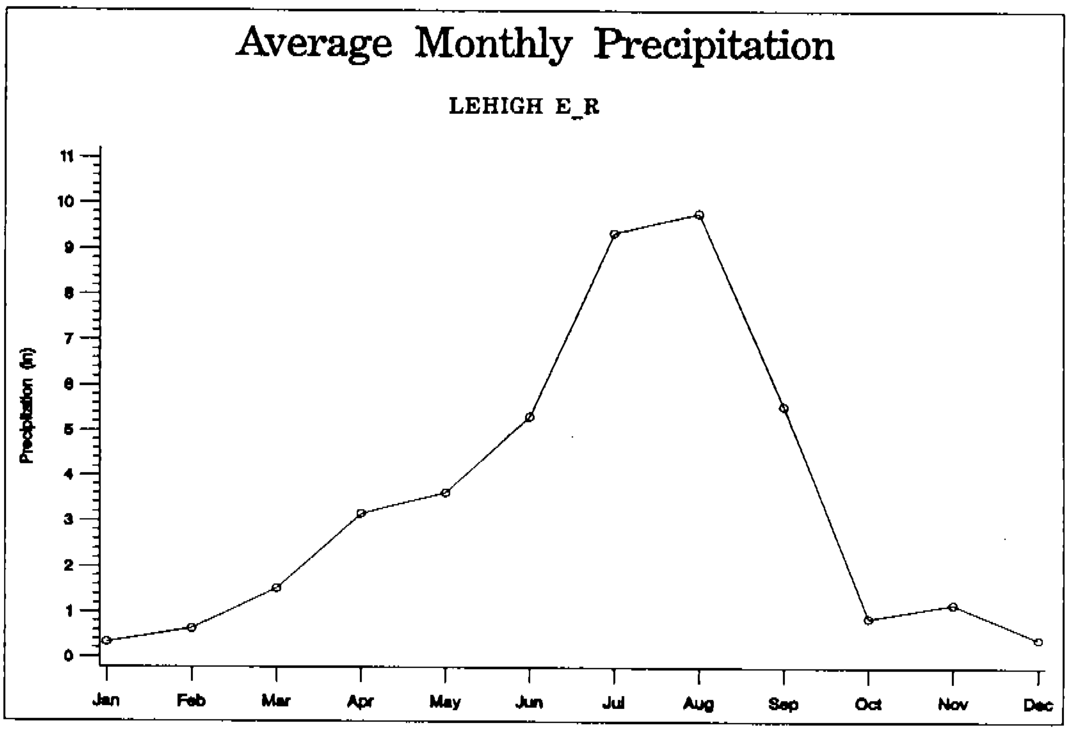
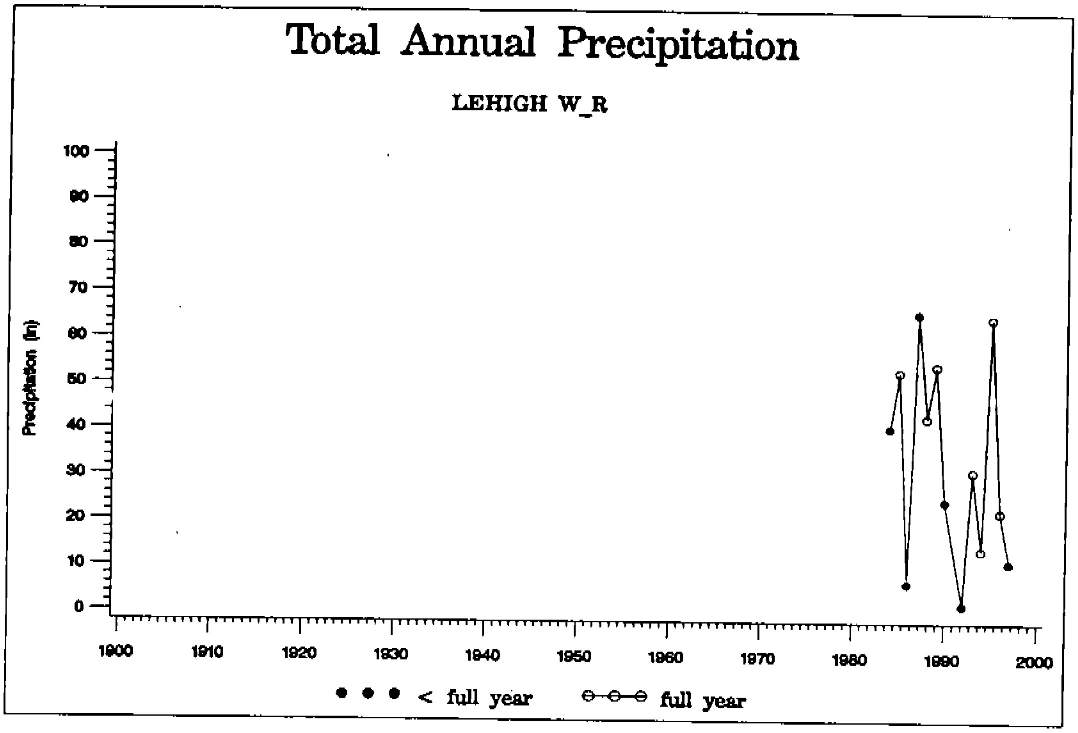
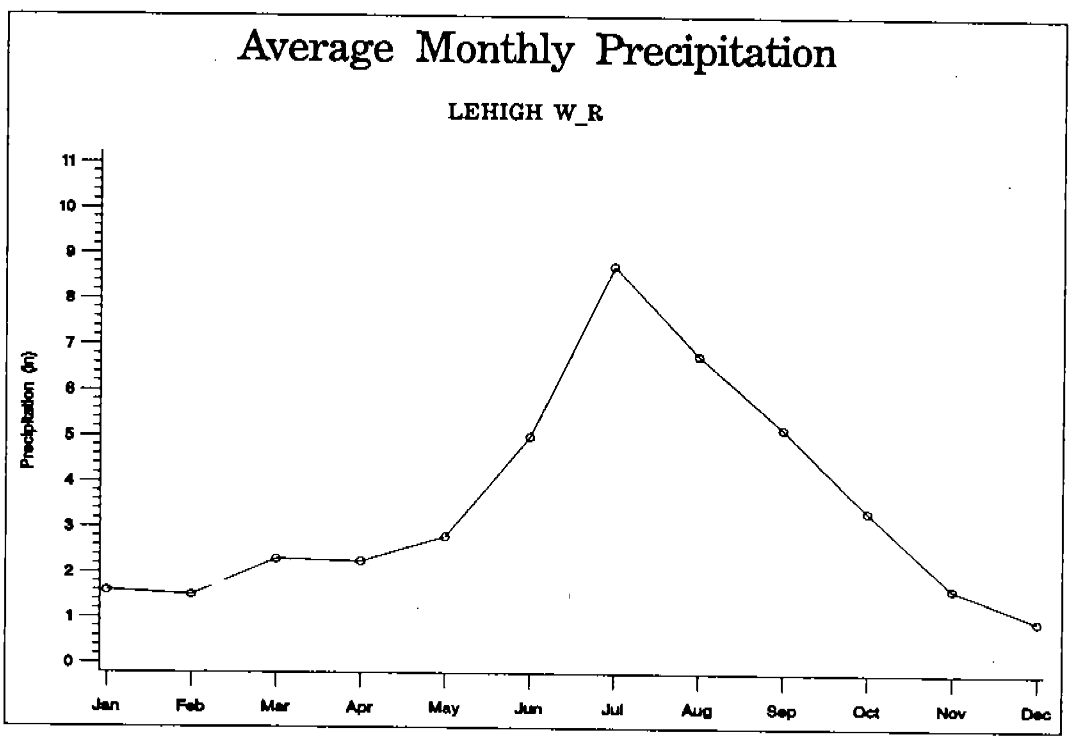
< full year
full year


Average Monthly Precipitation
LEHIGH 6_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
LEHIG" E_R
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
LEHIGH E_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
LEHIGH W_R
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
LEHIGH W_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
Jul
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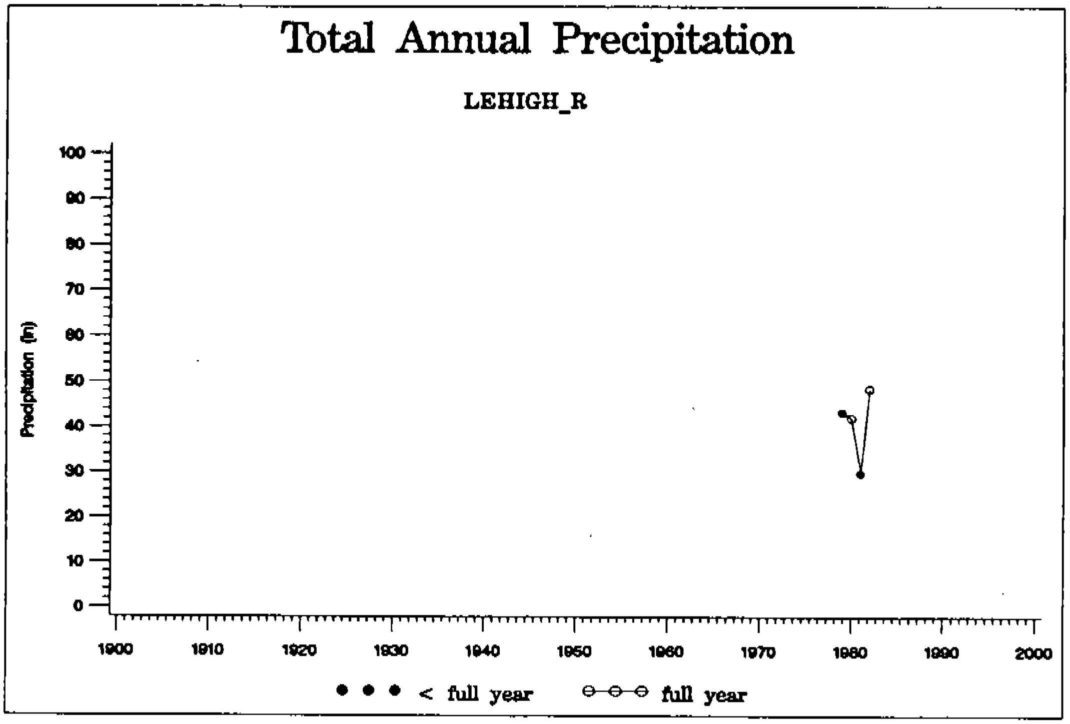
Sep
Oct
Nov
Dec


Total Annual Precipitation
LEHIGH_R
Precipitation (in)
0
10
20
30
40
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90
100
1900
1910
1920
1930
1940
1950
1960
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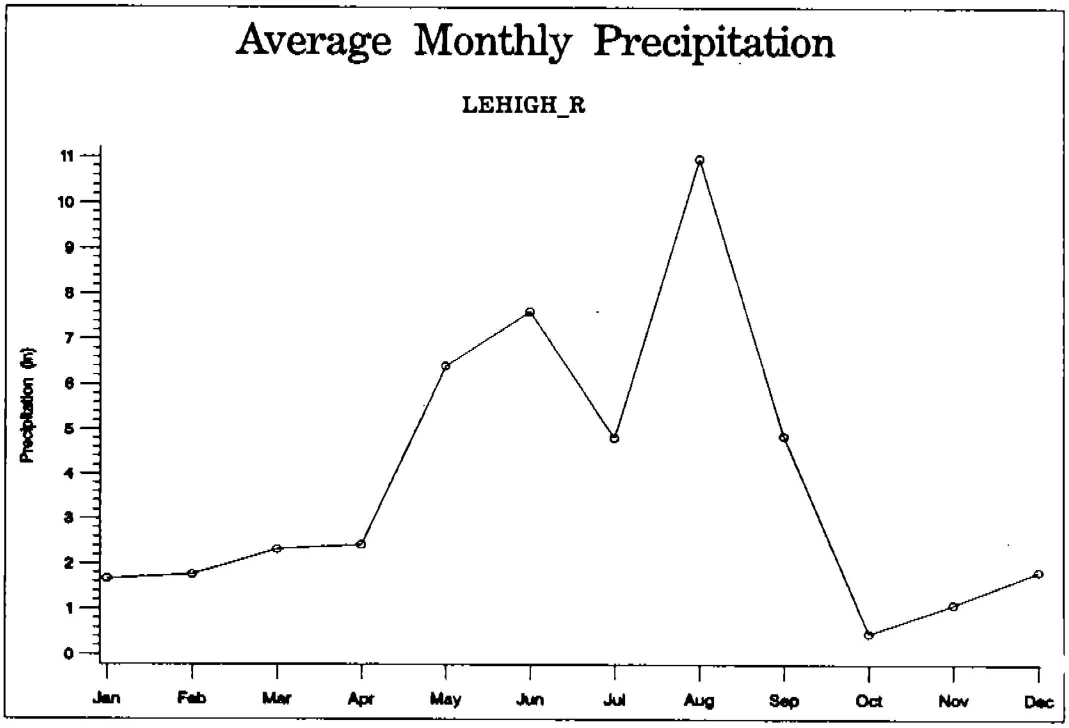
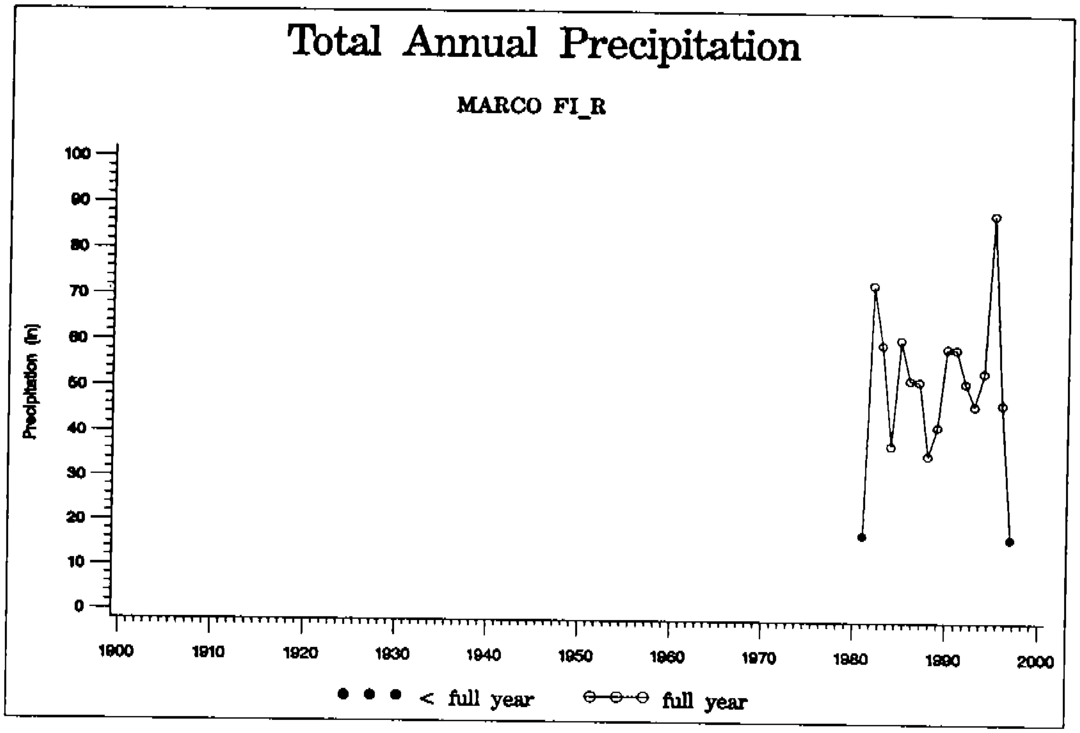
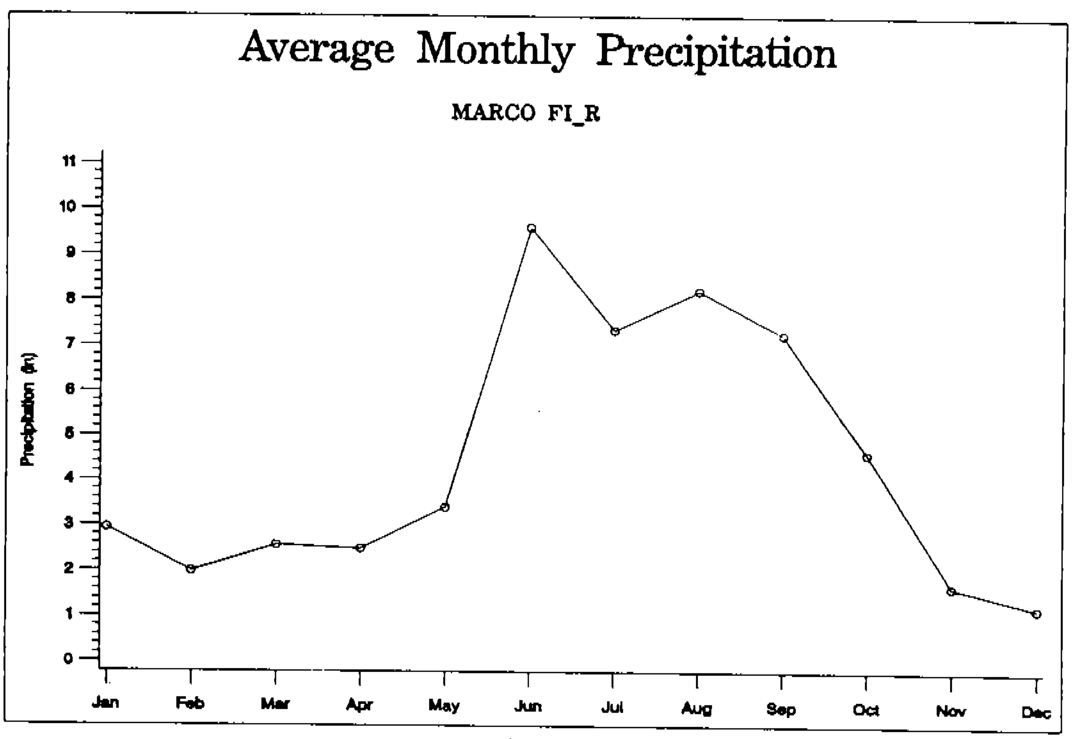
2000
< full year
full year


Average Monthly Precipitation
LEHIGH_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
MARCO FI_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
MARCO FI_R
Precipitation (in)
11
10
9
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7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
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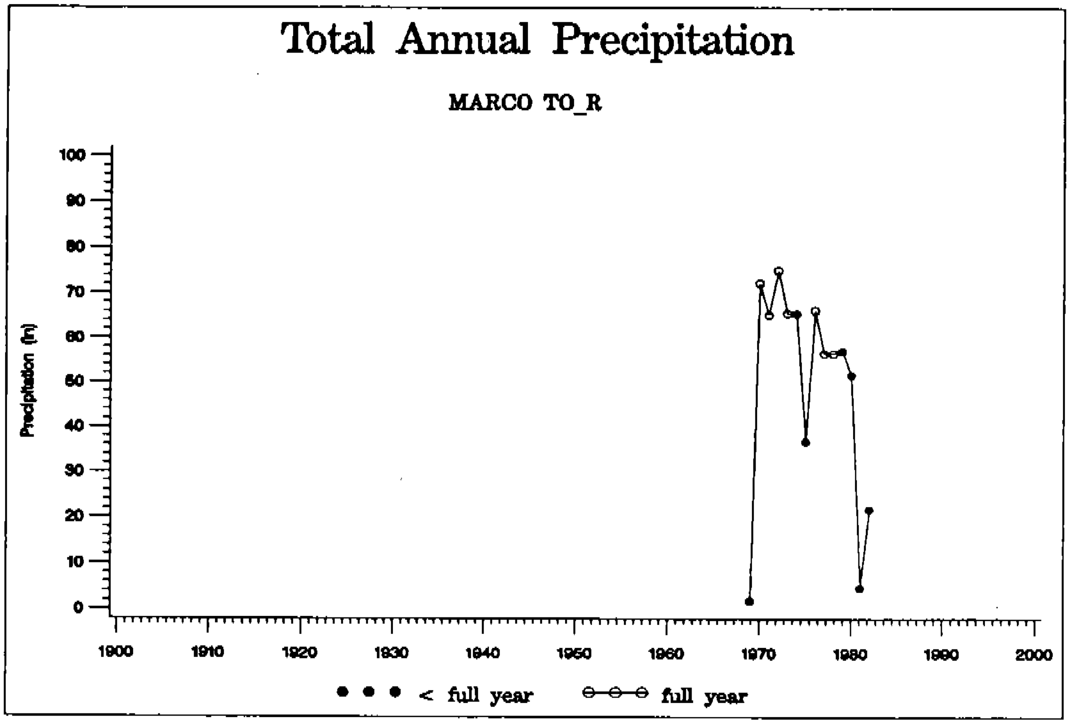
Sep
Oct
Nov
Dec


Total Annual Precipitation
MARCO TO_R
Precipitation (in)
100
90
80
70
60
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0
1900
1910
1920
1930
1940
1950
1960
1970
1980
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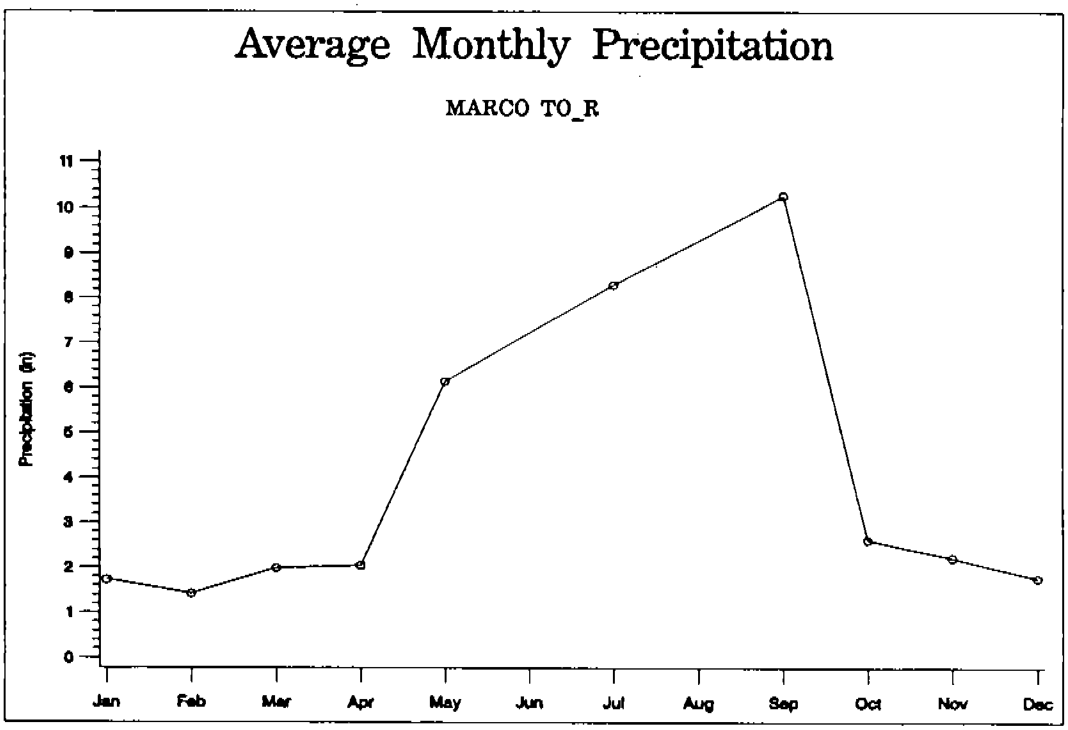
2000
< full year
full year


Average Monthly Precipitation
MARCO TO_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
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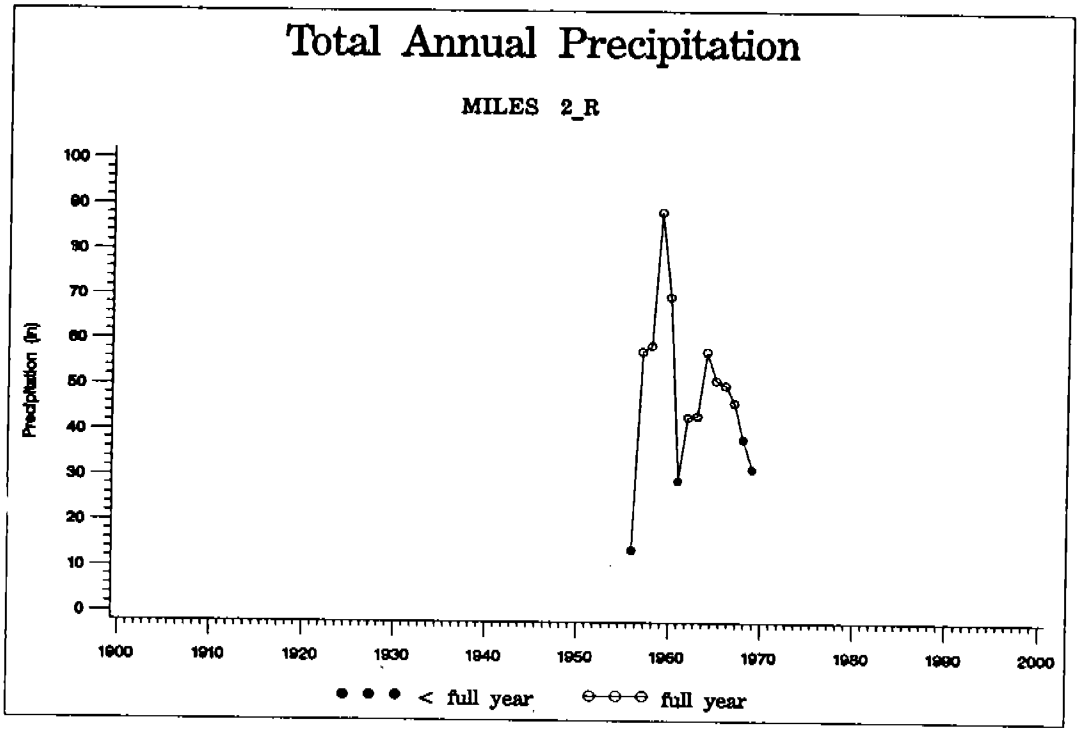
Sep
Oct
Nov
Dec



Total Annual Precipitation
MILES 2_R
Precipitation (in)
100
90
80
70
60
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30
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0
1900
1910
1920
1930
1940
1950
1960
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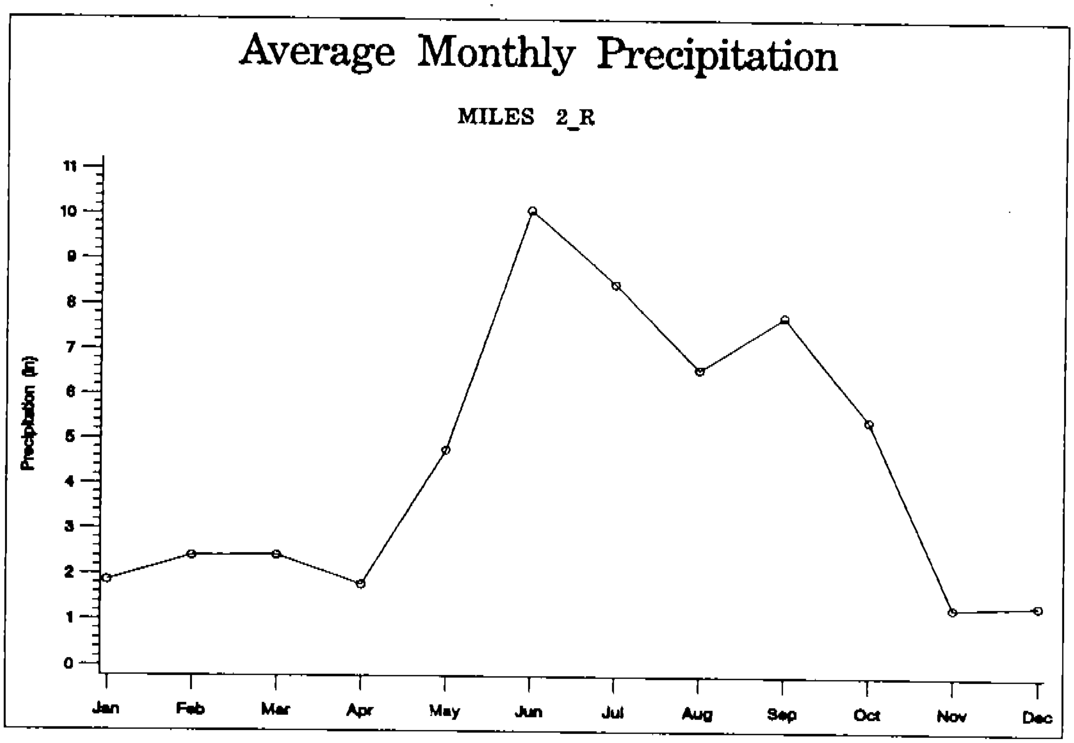
1990
2000
< full year
full year



Average Monthly Precipitation
MILES 2_R
Precipitation (in)
11
10
9
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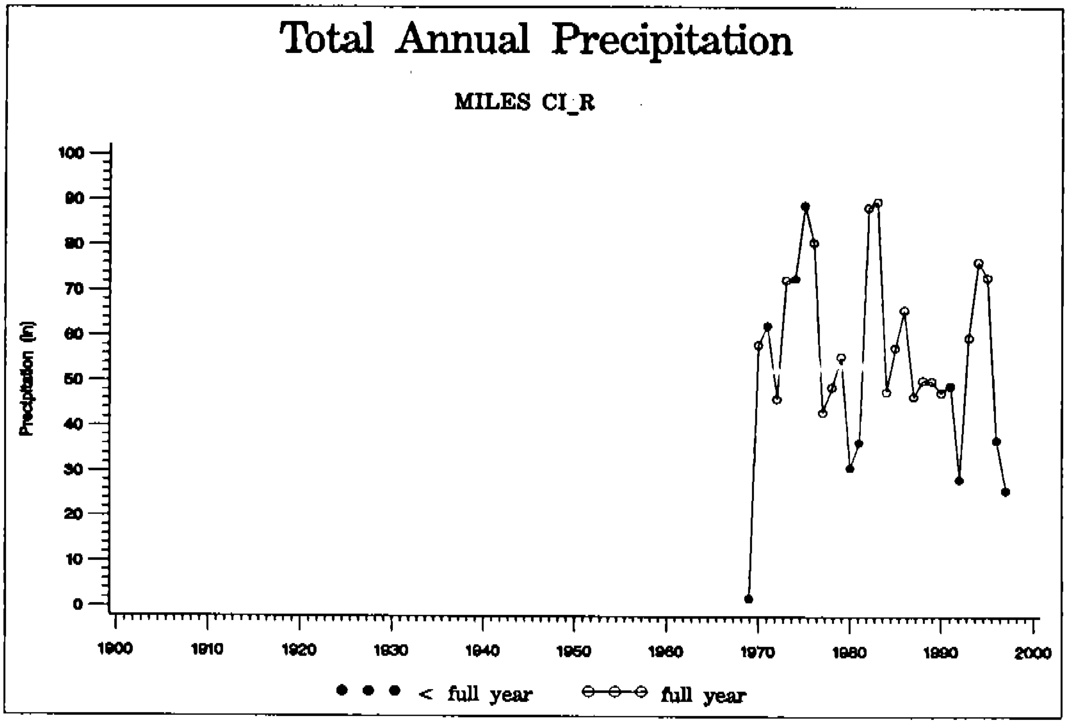
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
MILES CI_R
Precipitation (in)
100
90
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60
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1960
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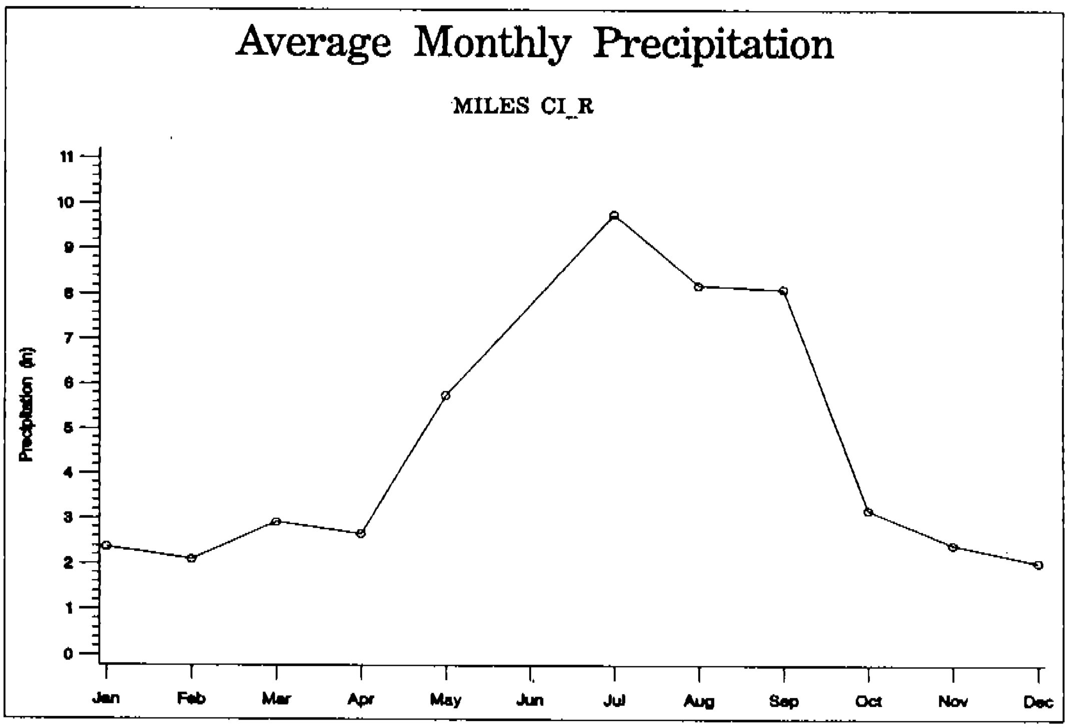
2000
< full year
full year



Average Monthly Precipitation
MILES CI_R
Precipitation (in)
11
10
9
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4
3
2
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Jan
Feb
Mar
Apr
May
Jun
Jul
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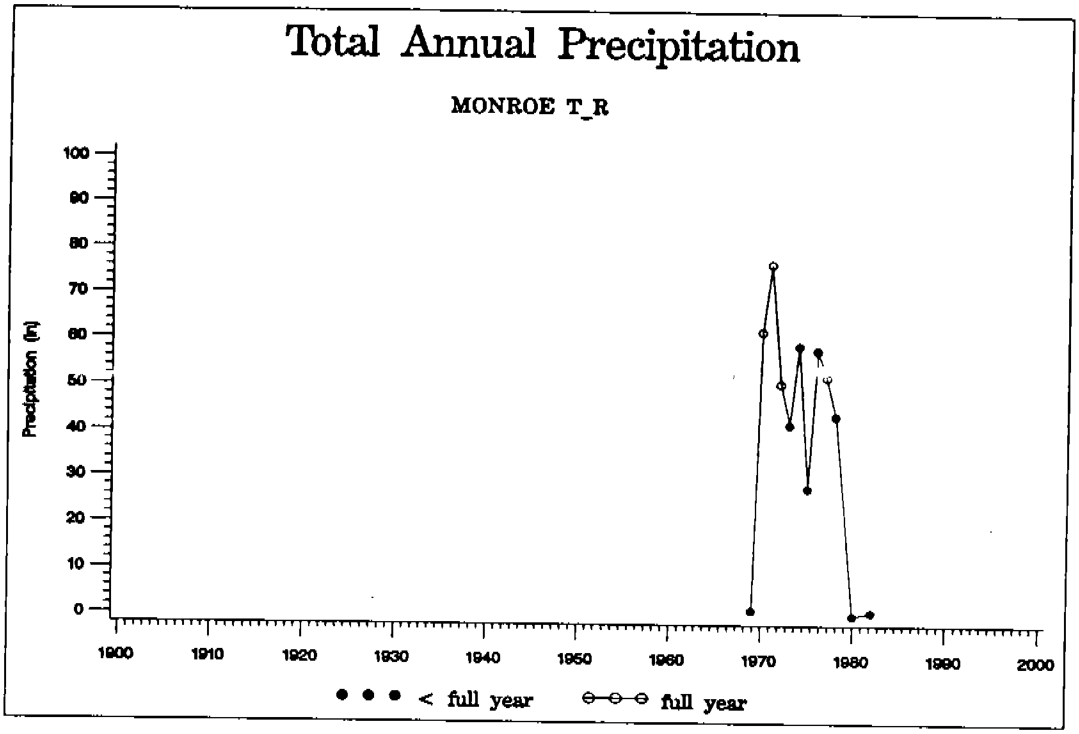
Sep
Oct
Nov
Dec



Total Annual Precipitation
MONROE T_R
Precipitation (in)
100
90
80
70
60
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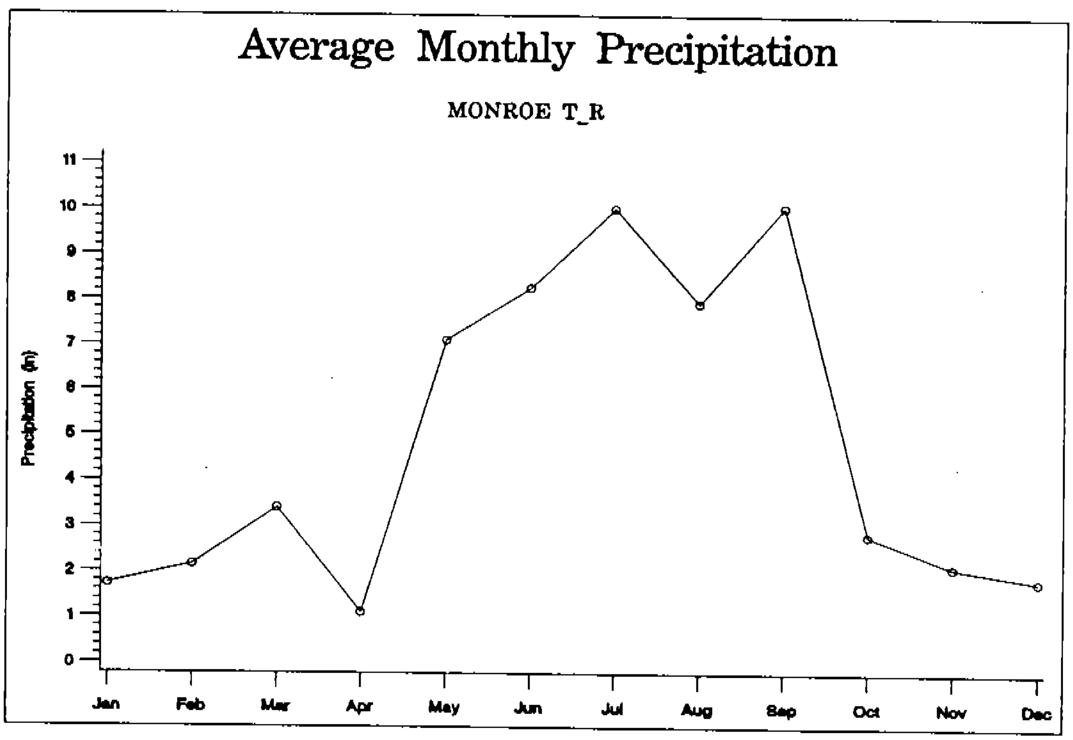
full year



Average Monthly Precipitation
MONROE T_R
Precipitation (in)
11
10
9
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6
5
4
3
2
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0
Jan
Feb
Mar
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May
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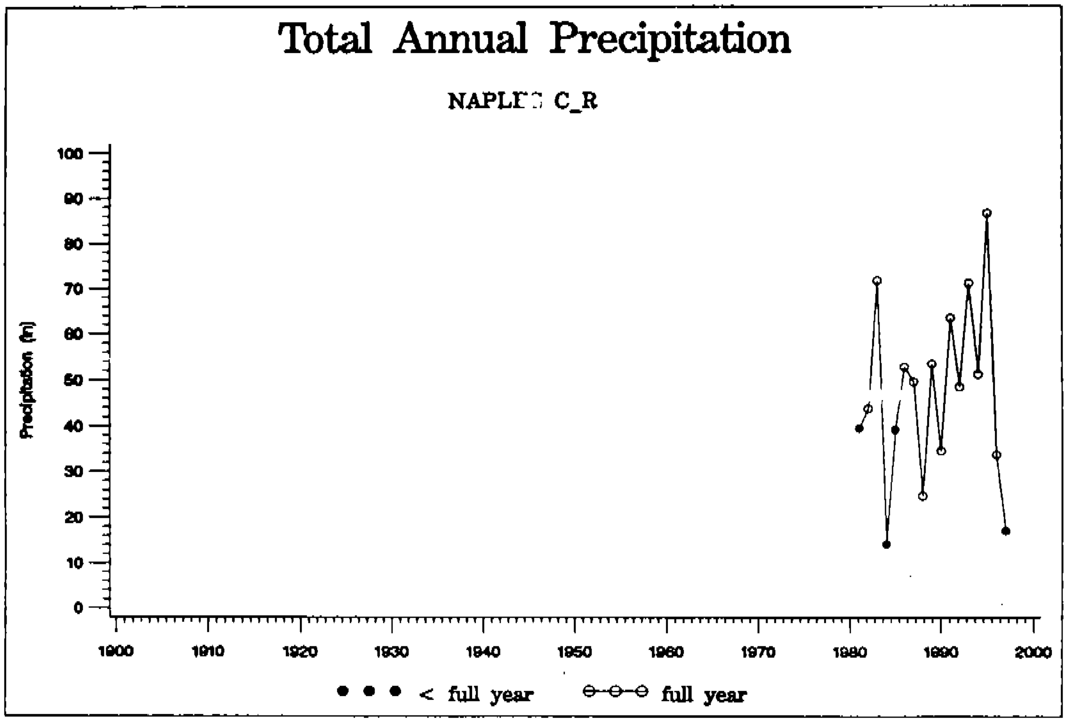
Nov
Dec



Total Annual Precipitation
NAPLES C_R
Precipitation (in)
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90
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70
60
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1900
1910
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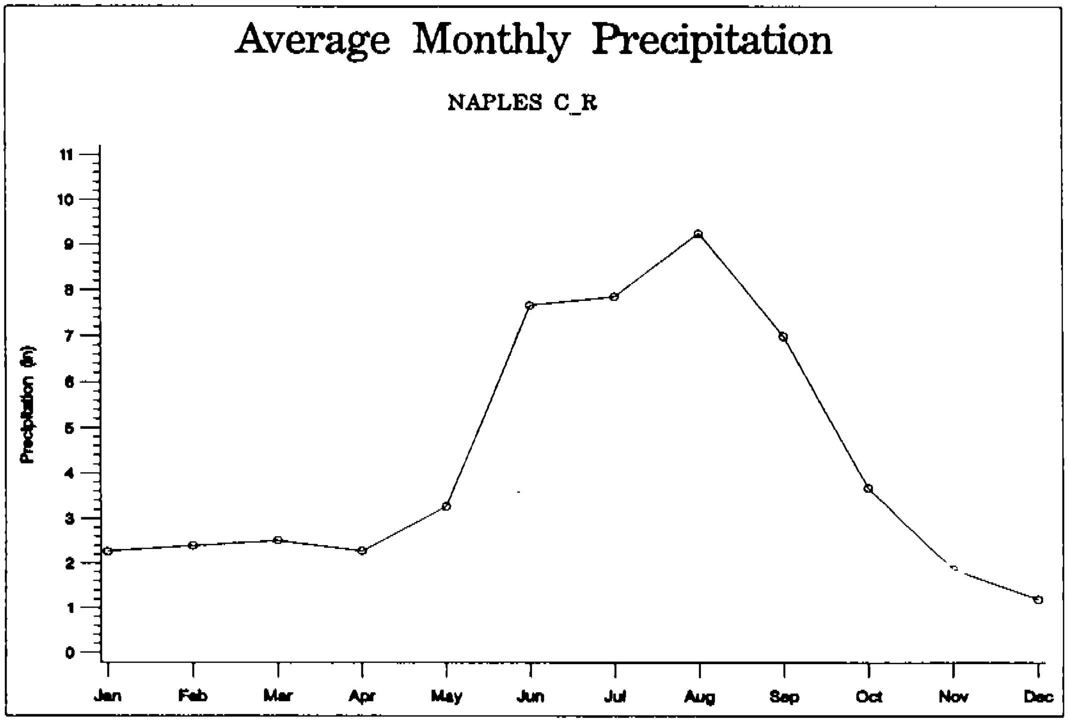
full year



Average Monthly Precipitation
NAPLES C_R
Precipitation (in)
11
10
9
8
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6
5
4
3
2
1
0
Jan
Feb
Mar
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May
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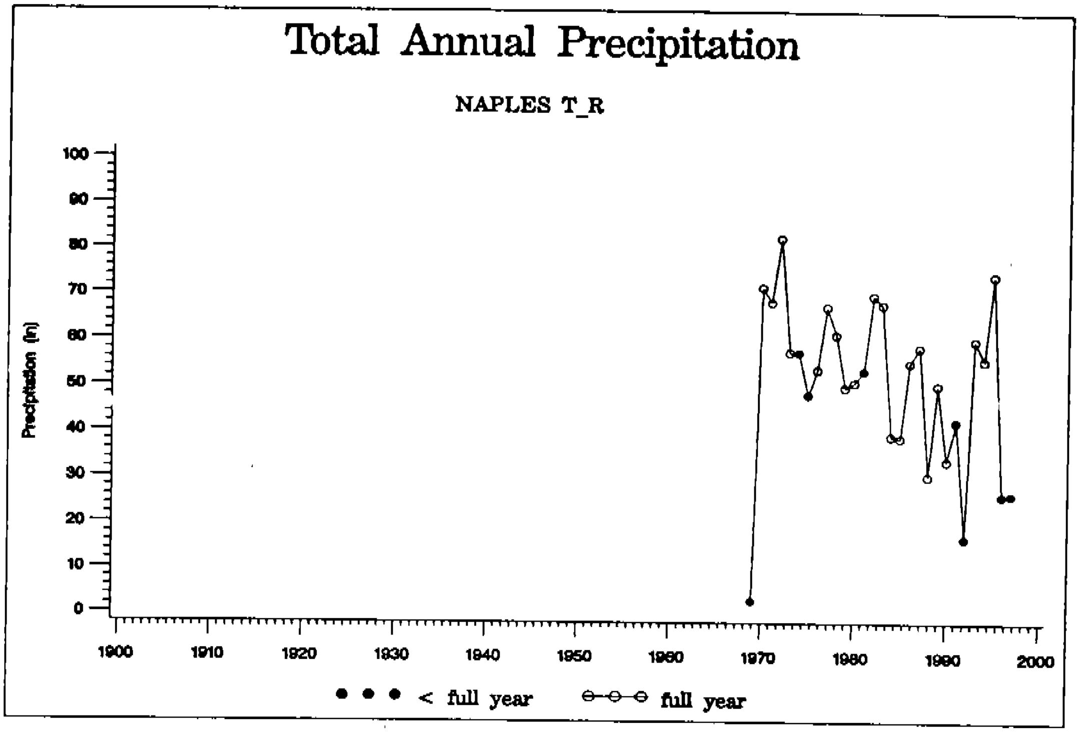
Total Annual Precipitation
NAPLES T_R
Precipitation (in)
100
90
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70
60
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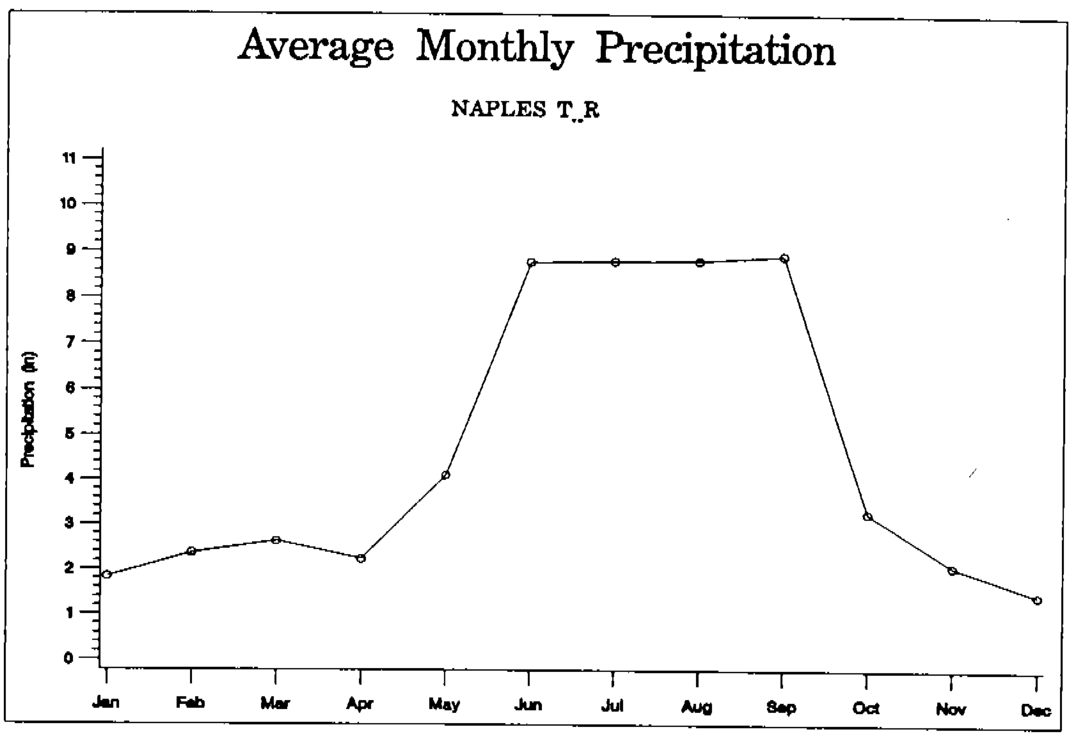
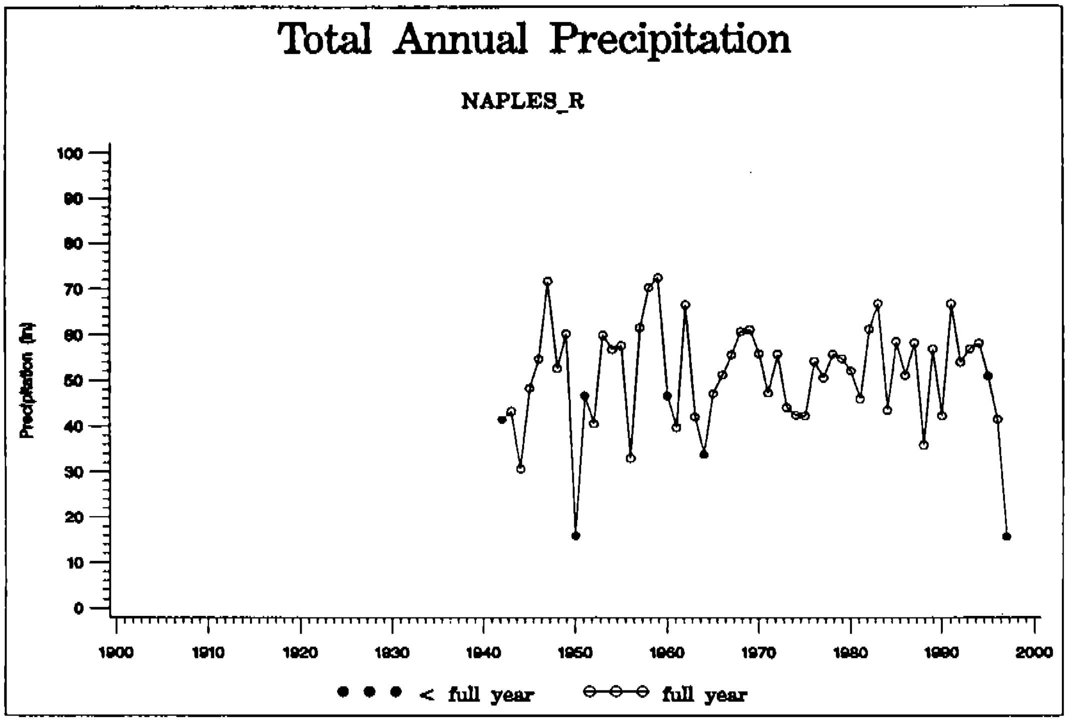
full year


Average Monthly Precipitation
NAPLES T_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
NAPLES_R
Precipitation (in)
0
10
20
30
40
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60
70
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90
100
1900
1910
1920
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1940
1950
1960
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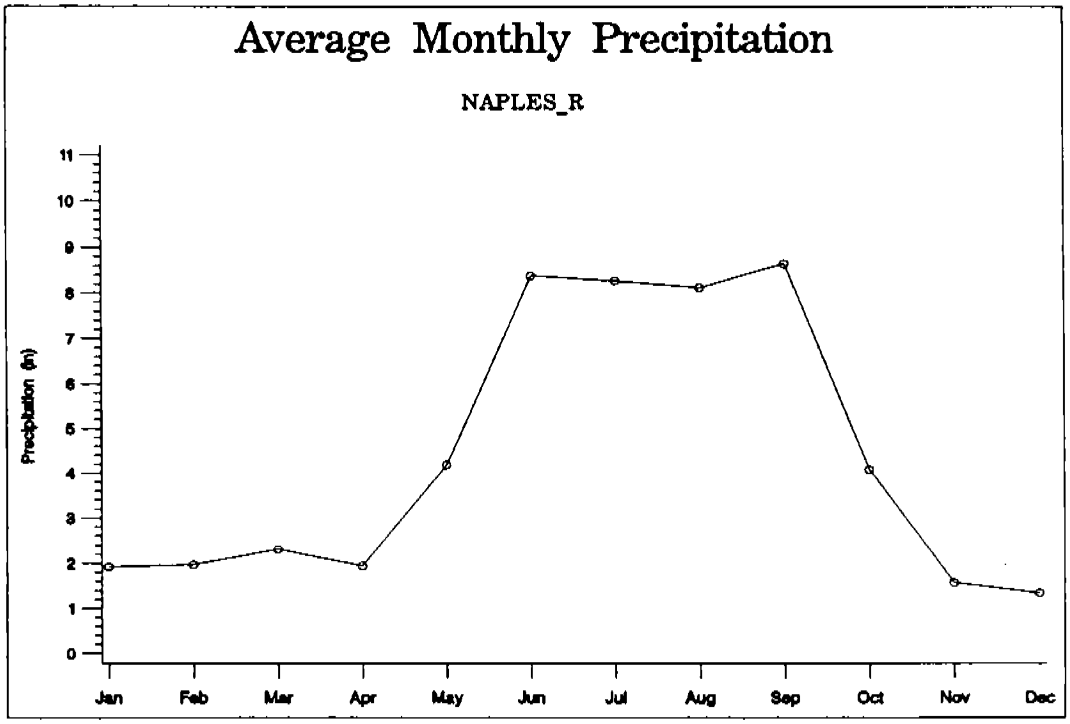
1980
1990
2000
< full year
full year



Average Monthly Precipitation
NAPLES_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
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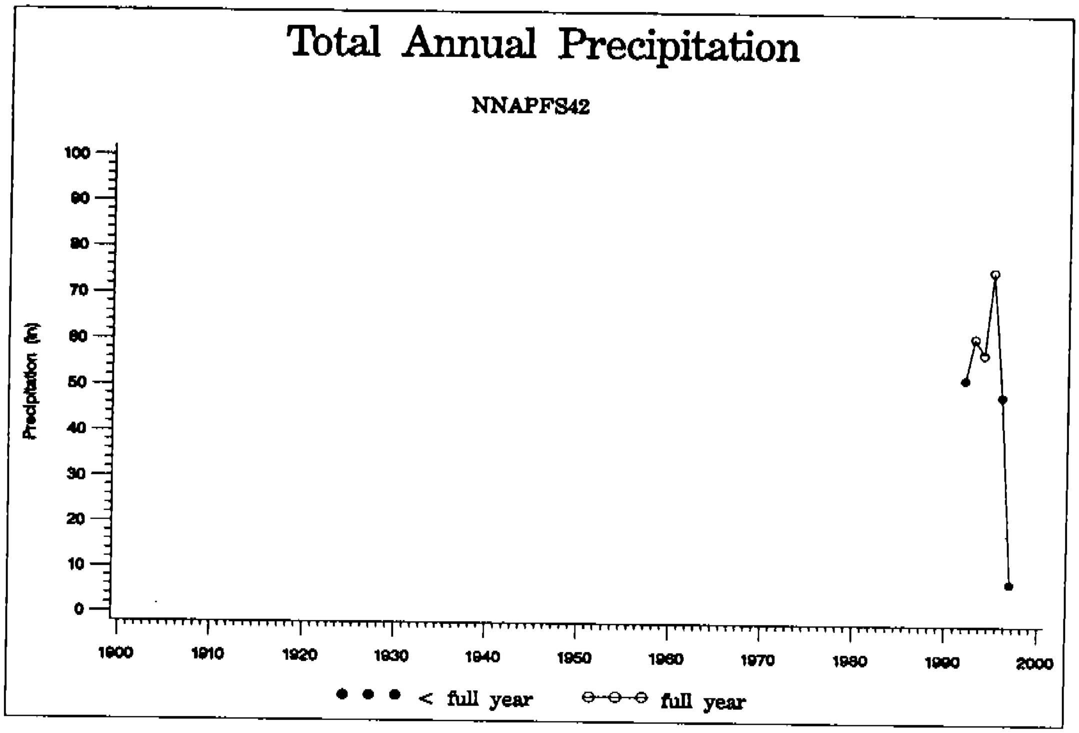
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
NNAPFS42
Precipitation (in)
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2000
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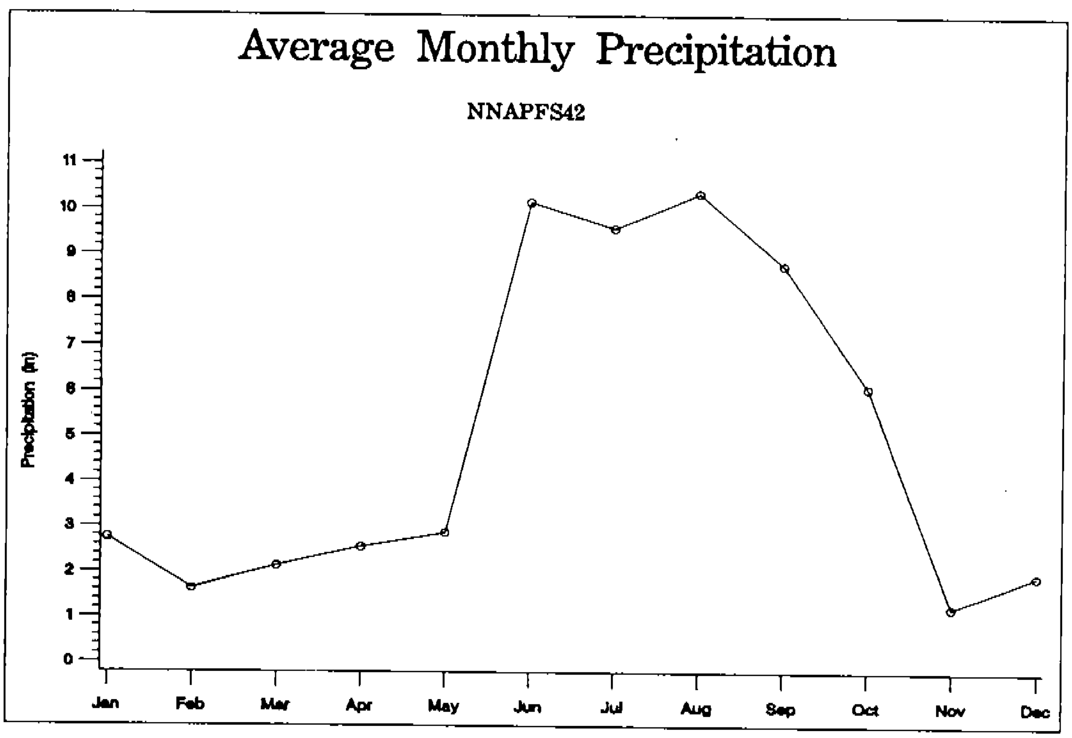
full year


Average Monthly Precipitation
NNAPFS42
Precipitation (in)
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2
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Jan
Feb
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Apr
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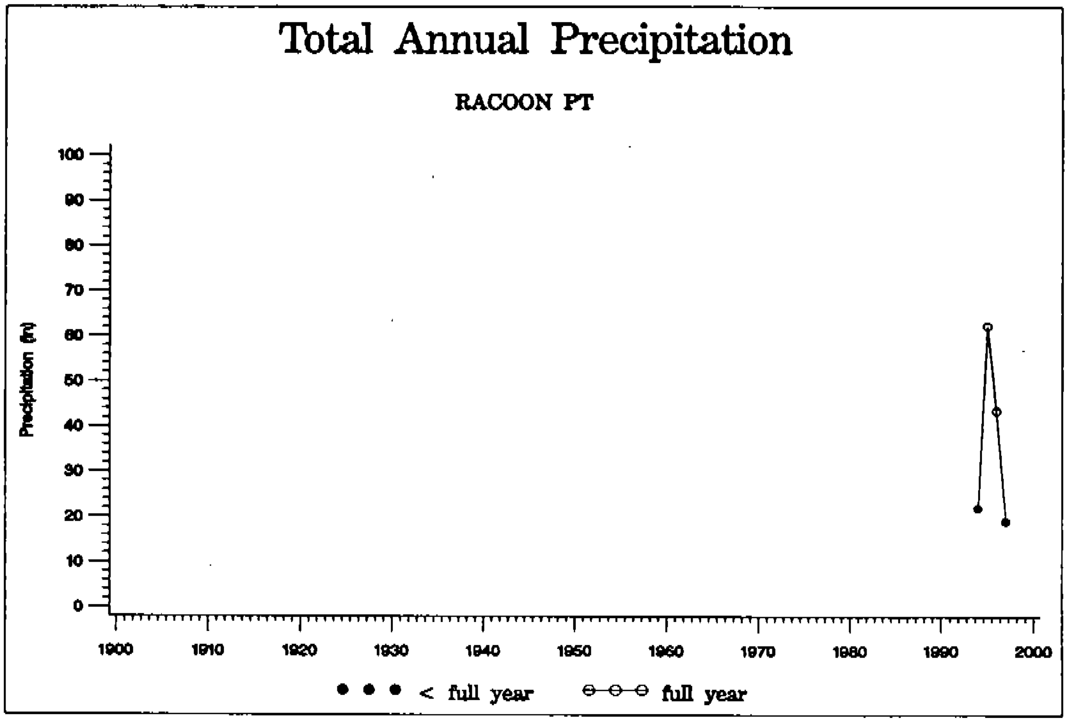
Oct
Nov
Dec


Total Annual Precipitation
RACOON PT
Precipitation (in)
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60
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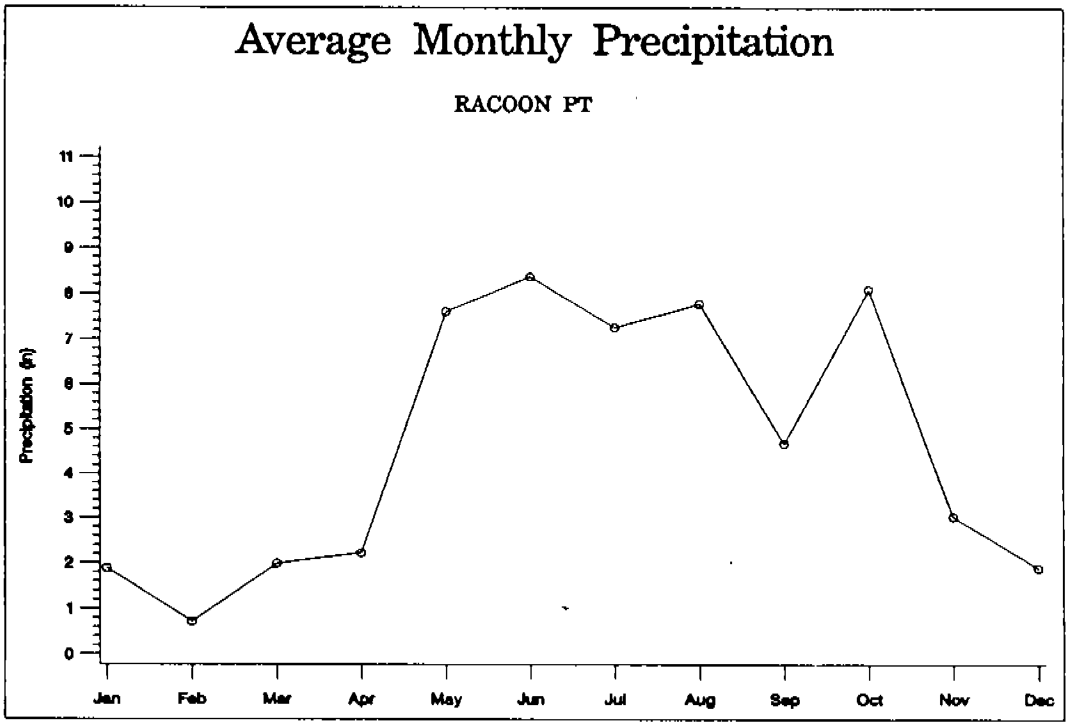
full year


Average Monthly Precipitation
RACOON PT
Precipitation (in)
11
10
9
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6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
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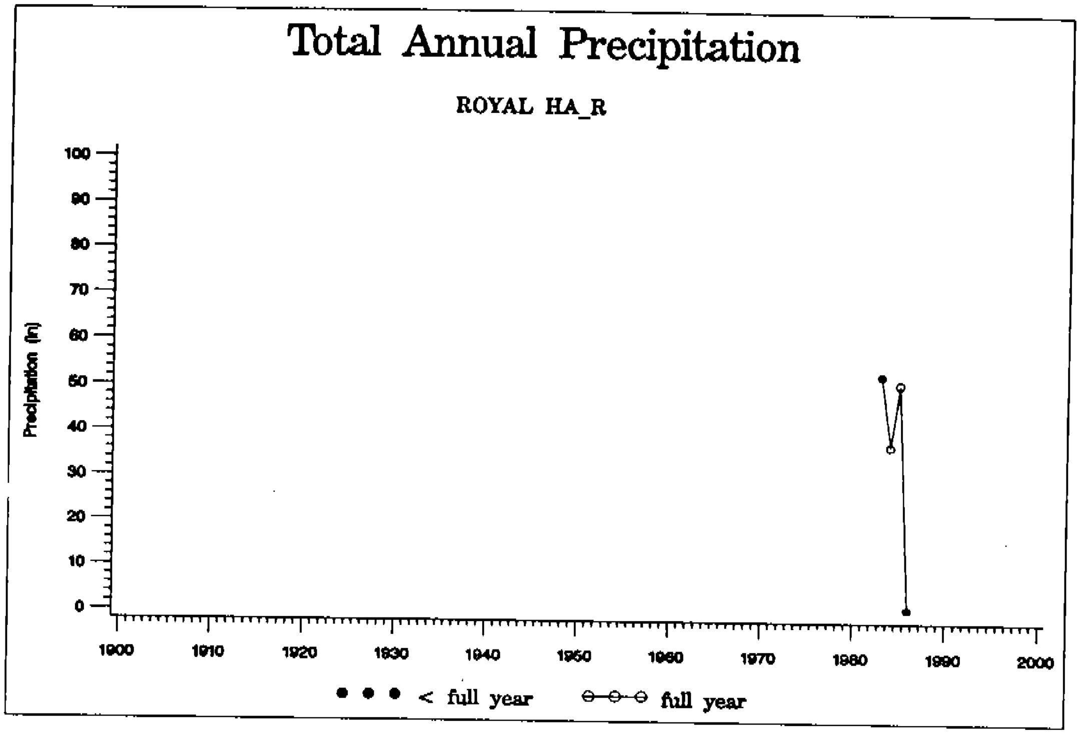
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
ROYAL HA_R
Precipitation (in)
100
90
80
70
60
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0
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1910
1920
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1960
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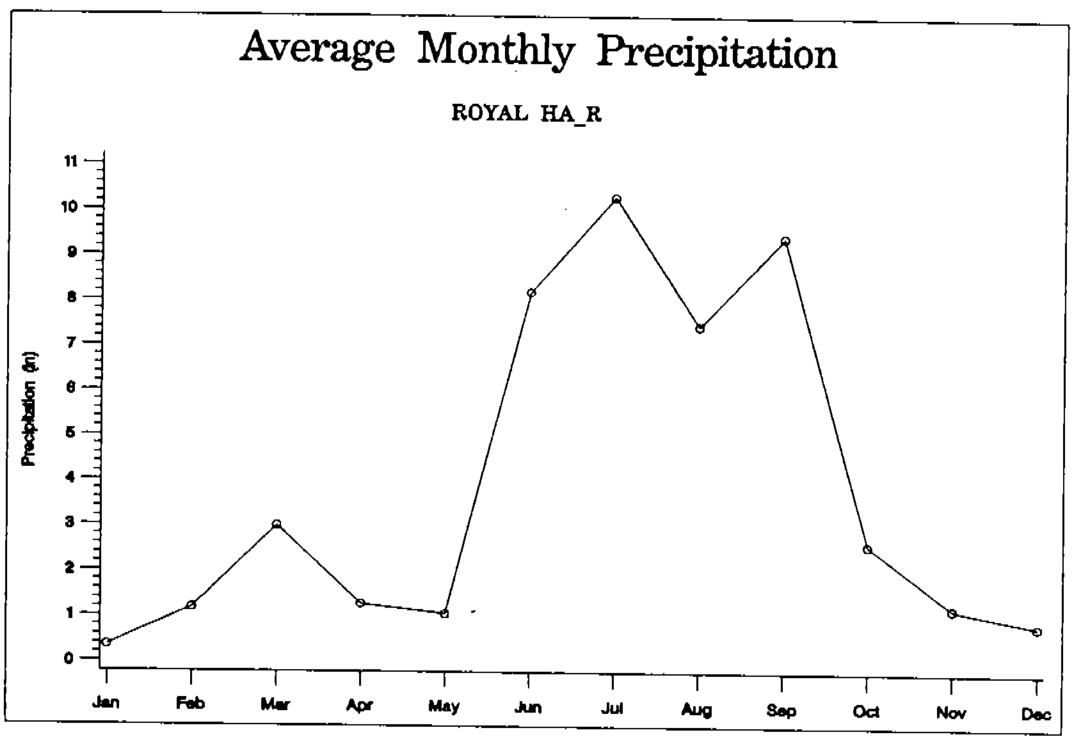
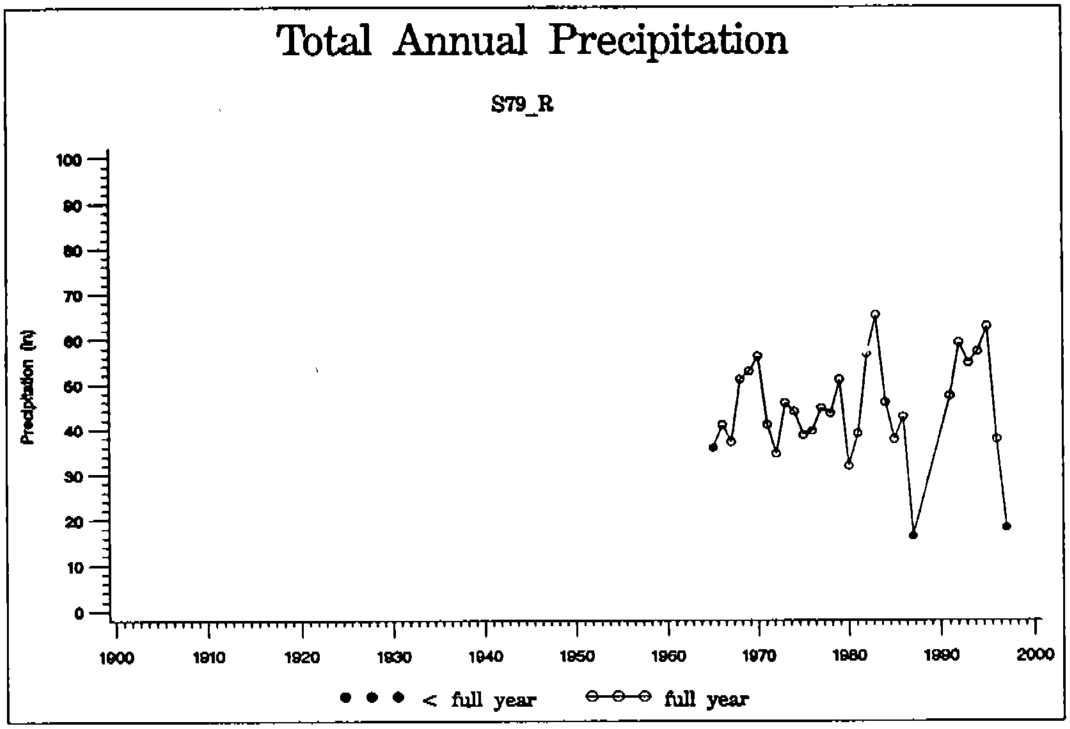
1990
2000
< full year
full year



Average Monthly Precipitation
ROYAL HA_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
S79_R
Precipitation (in)
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2000
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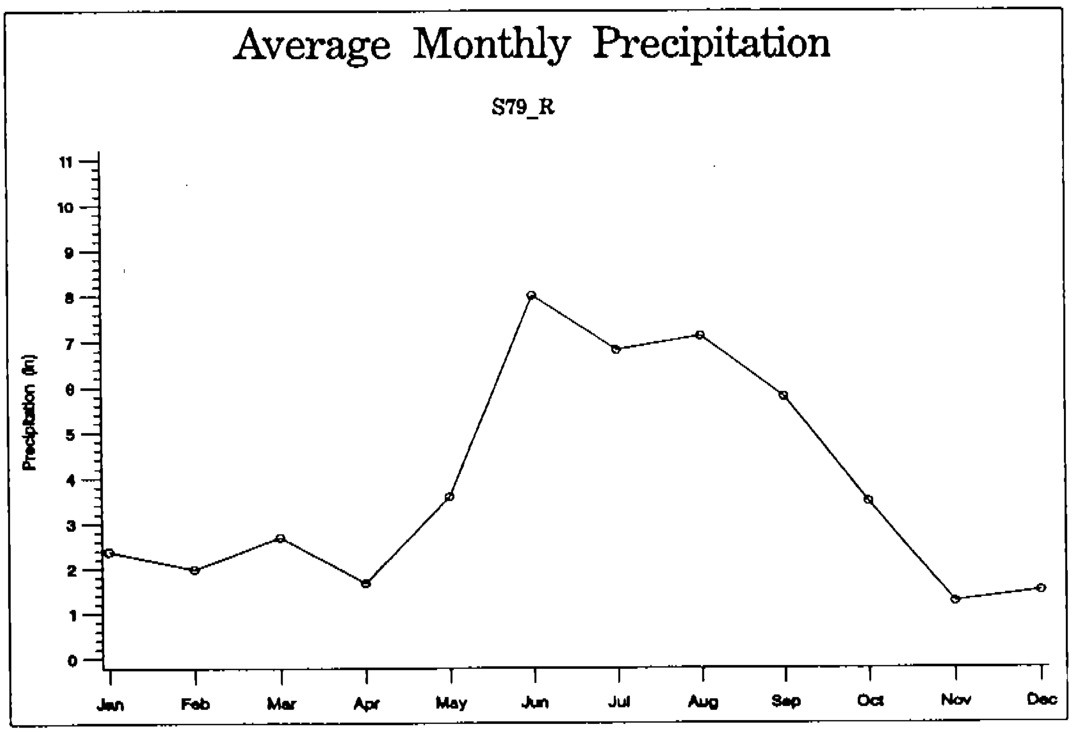
full year


Average Monthly Precipitation
S79_R
Precipitation (in)
0
1
2
3
4
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6
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8
9
10
11
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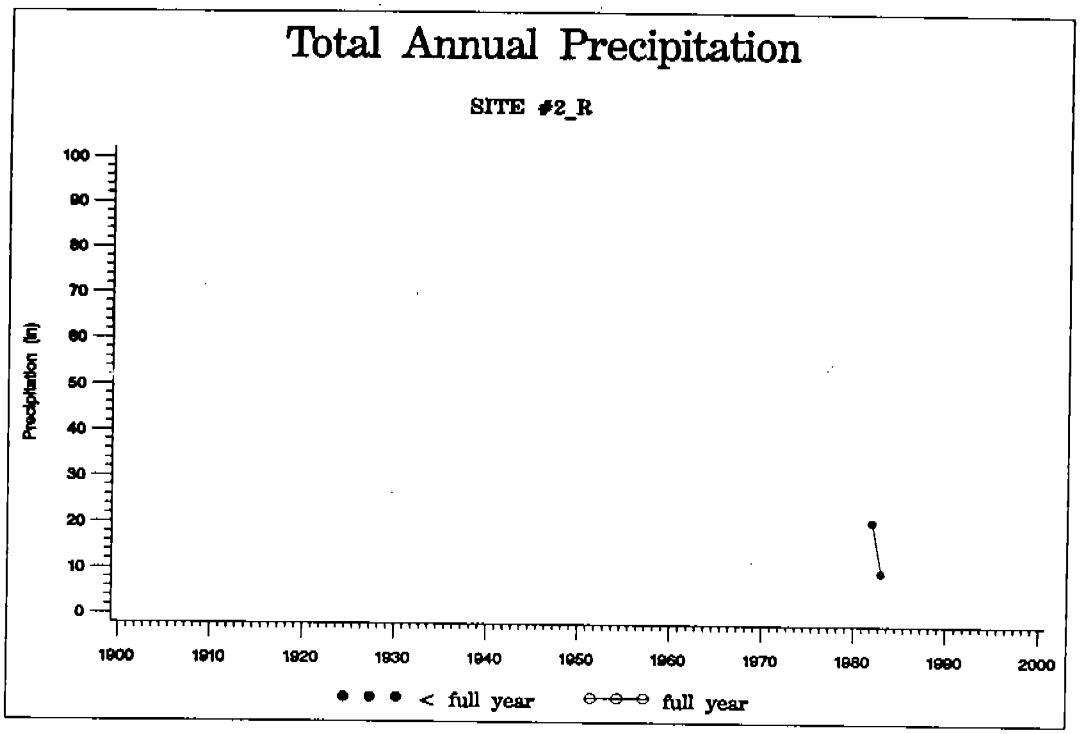
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
SITE #2_R
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
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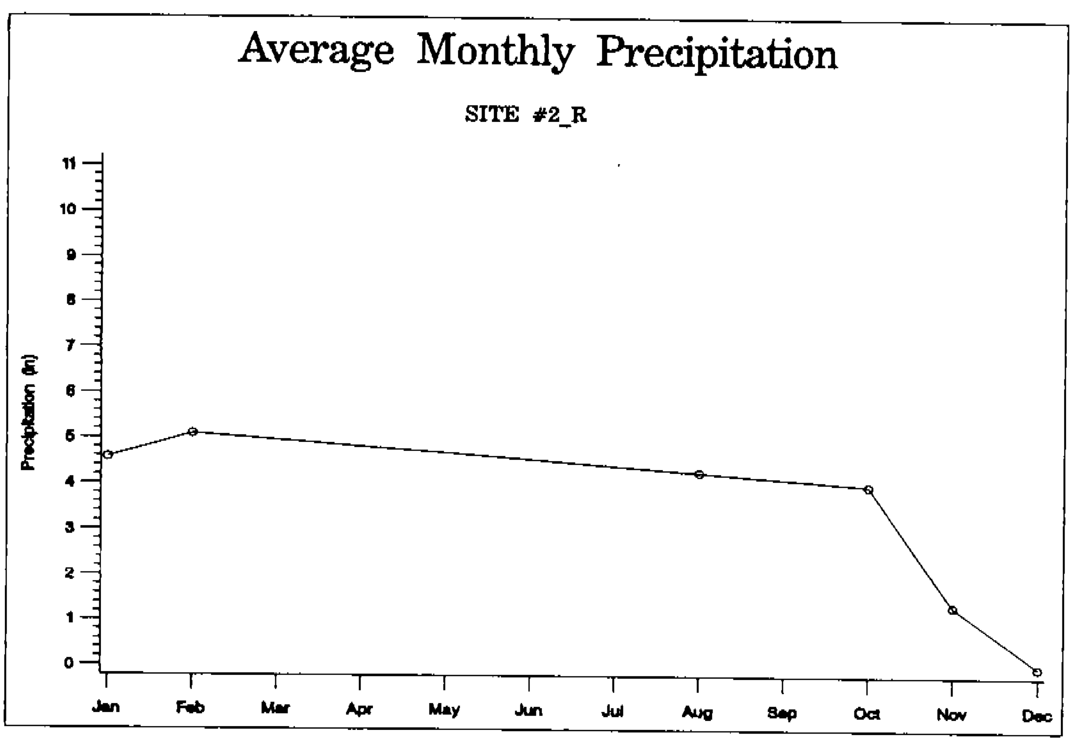
1940
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Precipitation
SITE #2_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
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Jan
Feb
Mar
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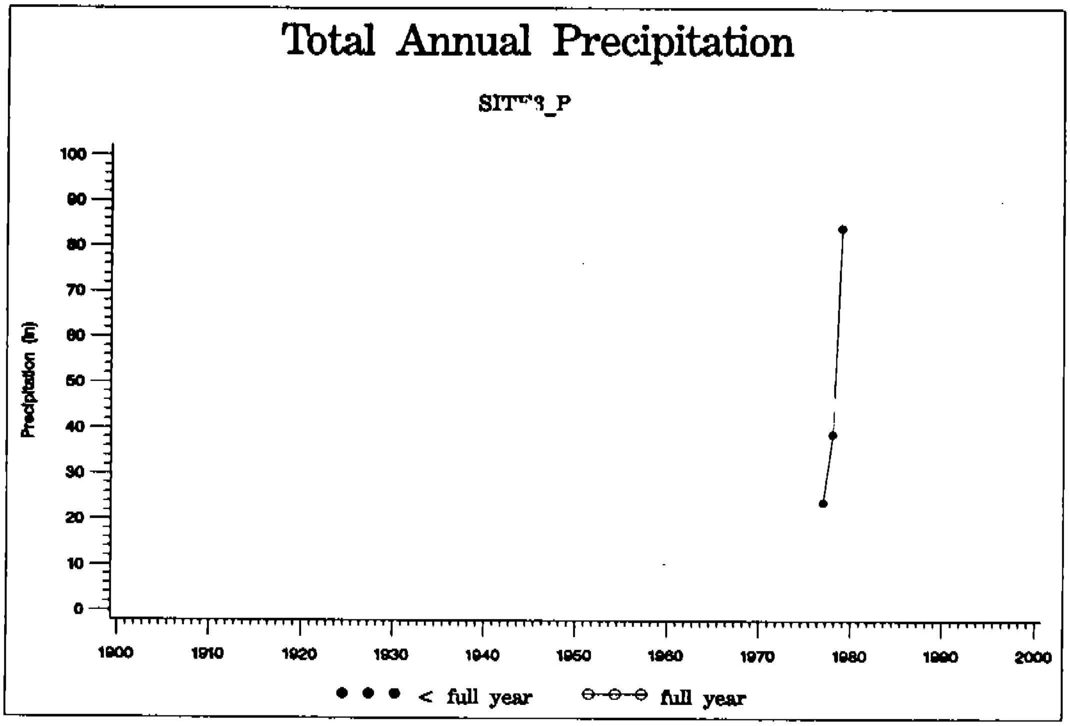
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
SIT"3_P
Precipitation (in)
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60
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2000
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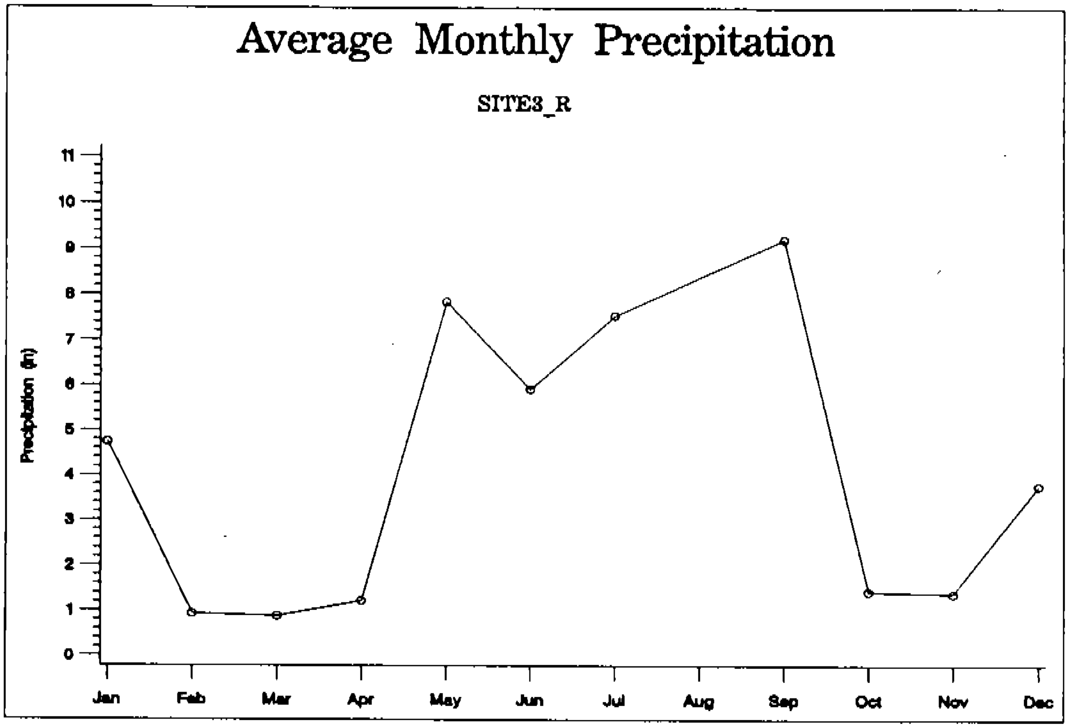
full year


Average Monthly Precipitation
SITE3_R
Precipitation (in)
11
10
9
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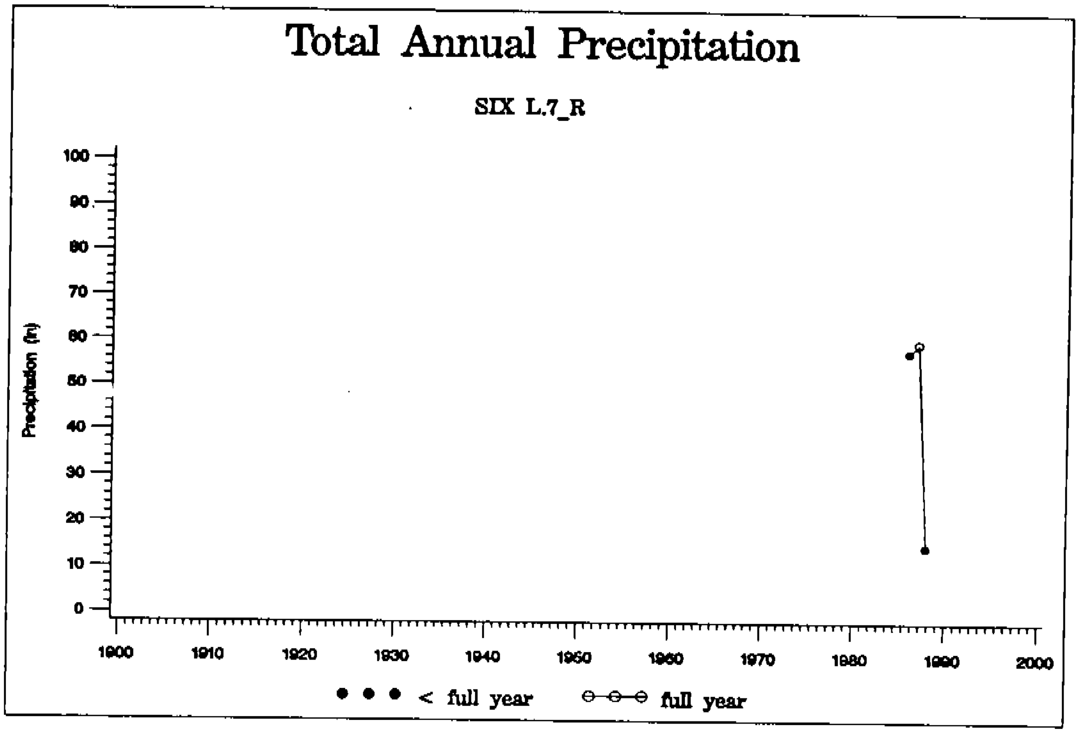
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
SIX L.7_R
Precipitation (in)
100
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60
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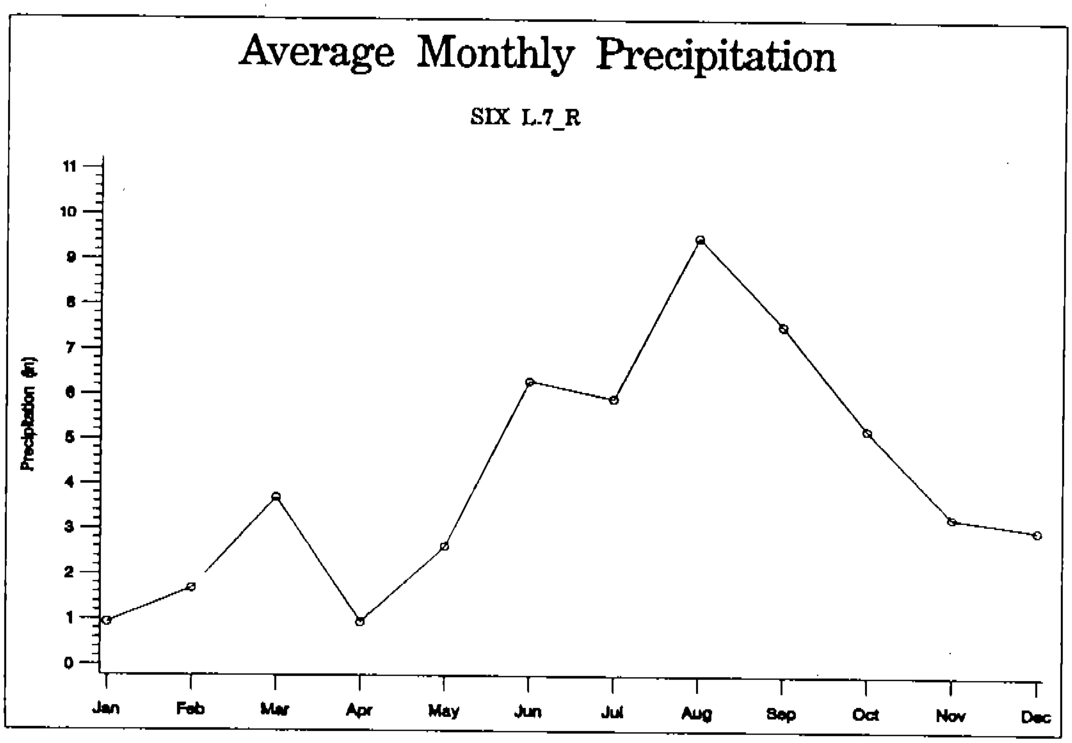
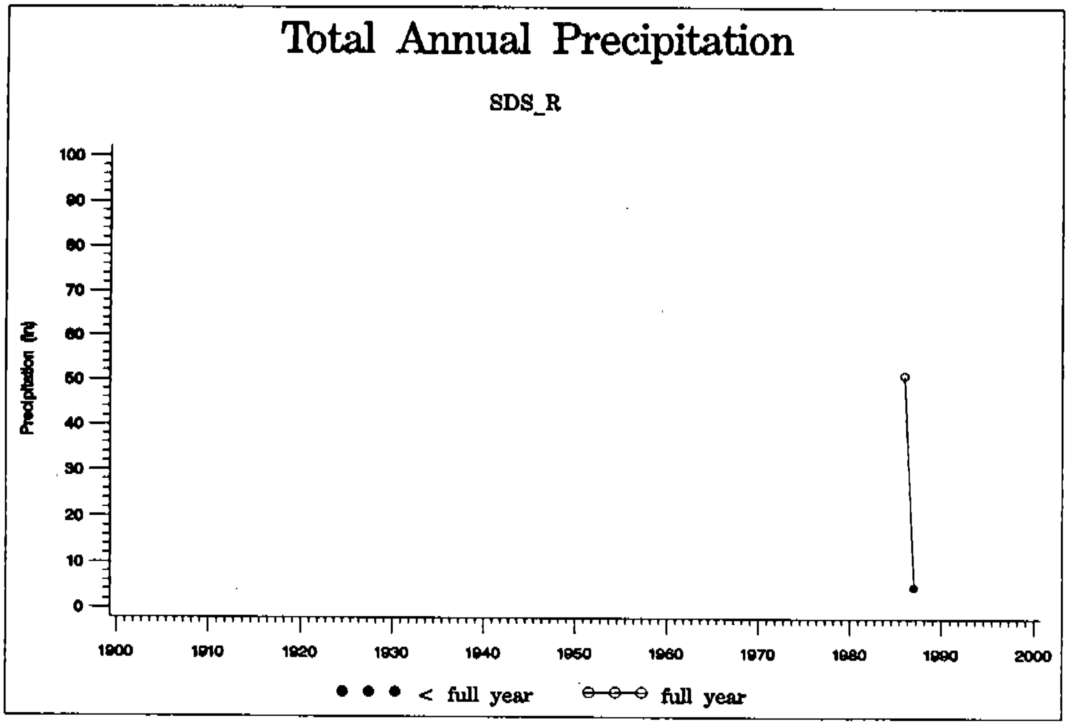
2000
< full year
full year


Average Monthly Precipitation
SIX L.7_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
SDS_R
Precipitation (in)
100
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80
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60
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1920
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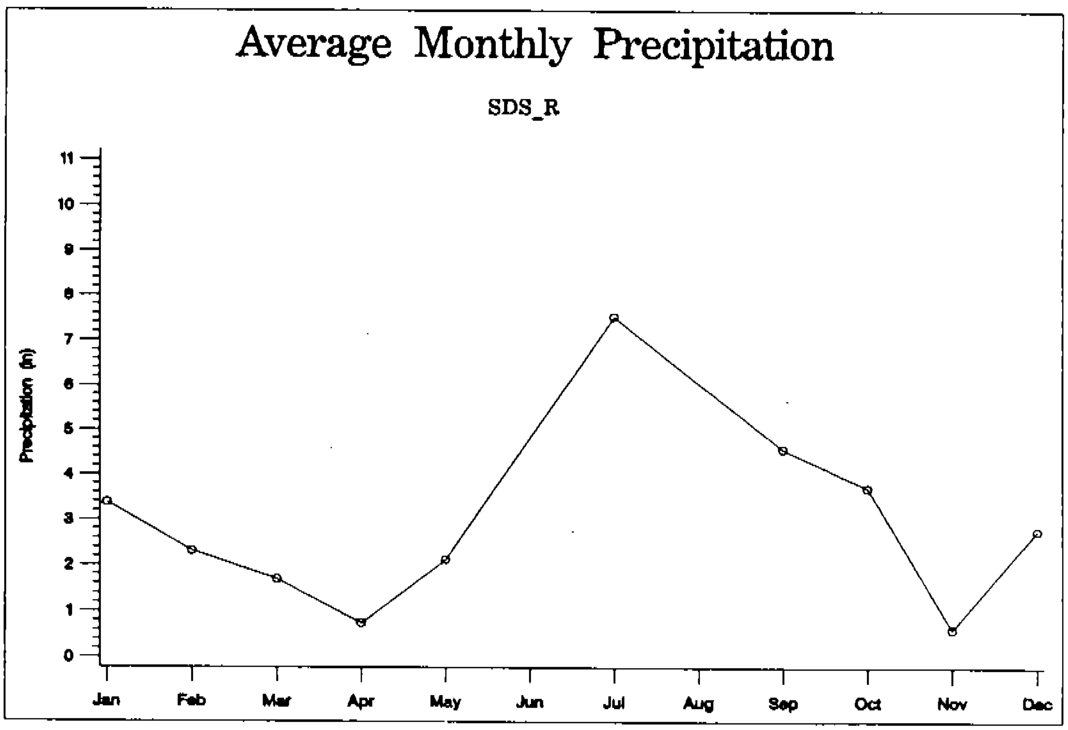
1990
2000
< full year
full year


Average Monthly Precipitation
SDS_R
Precipitation (in)
11
10
9
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Jan
Feb
Mar
Apr
May
Jun
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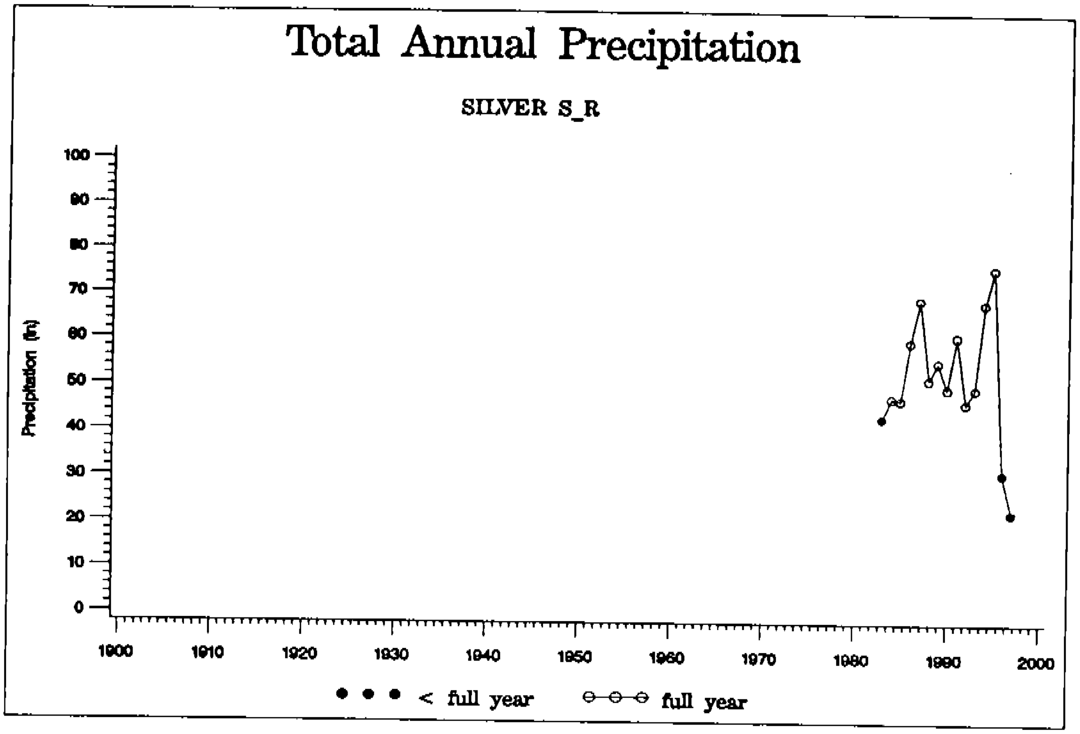
Nov
Dec



Total Annual Precipitation
SILVER S_R
Precipitation (in)
100
90
80
70
60
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1960
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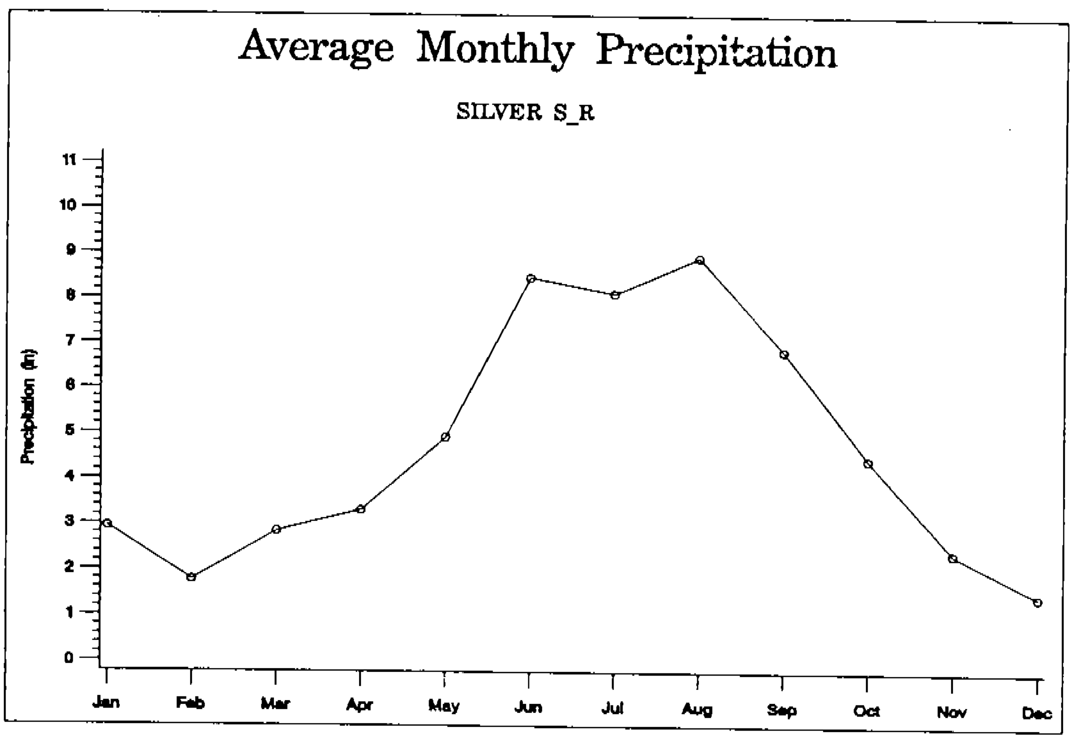
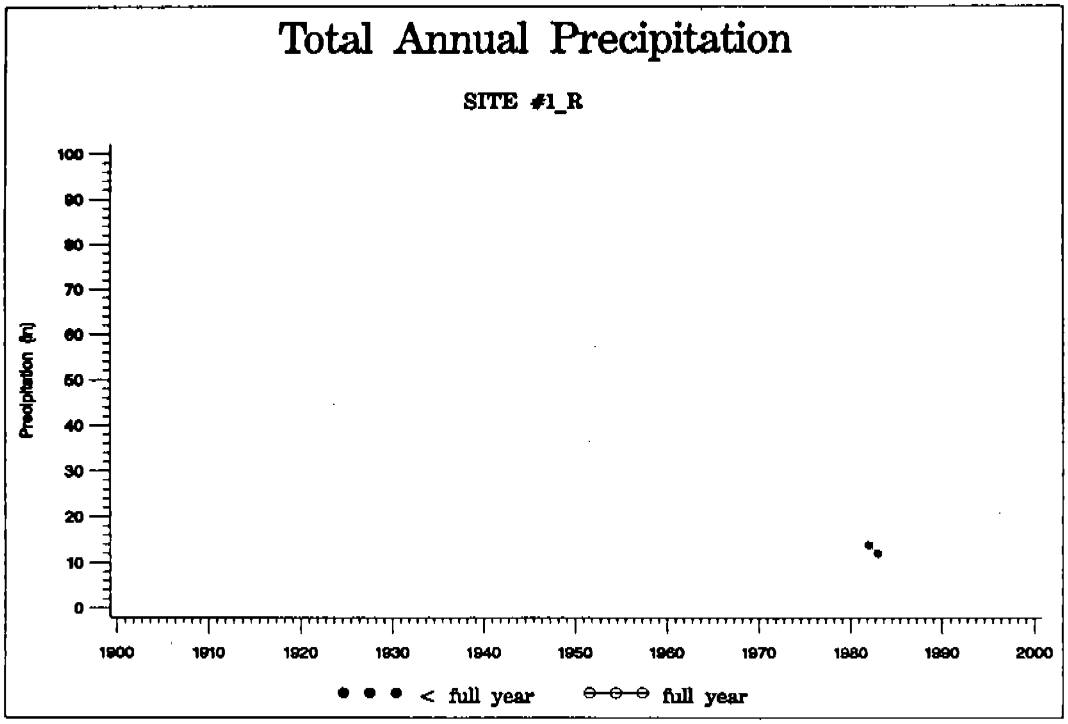
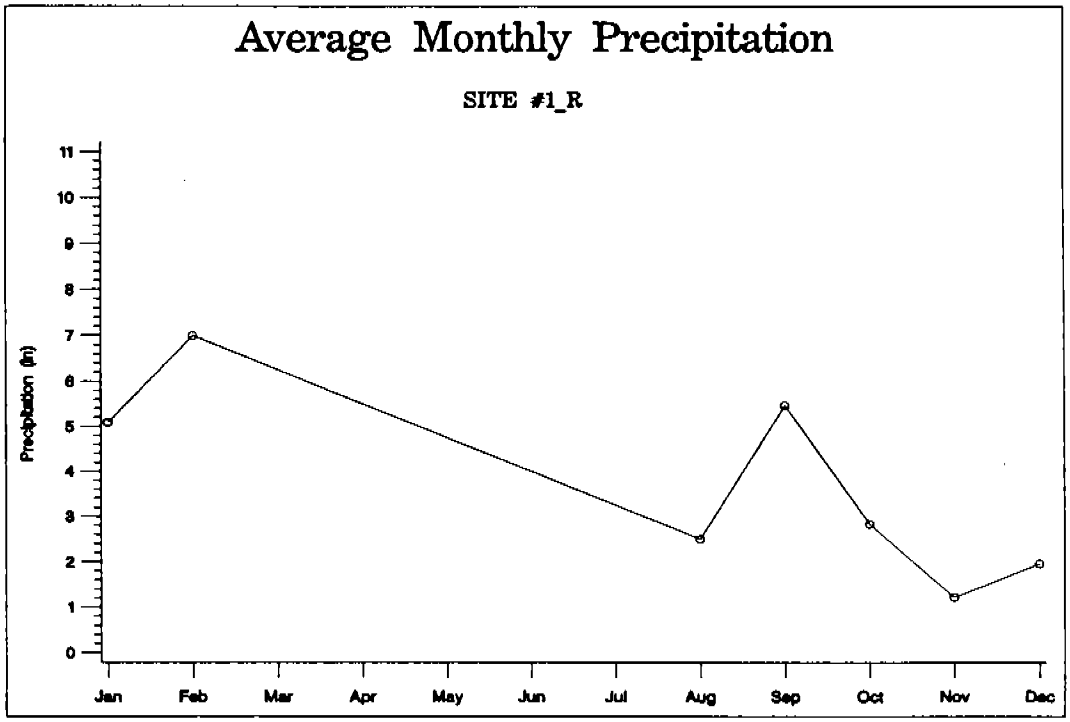
2000
< full year
full year



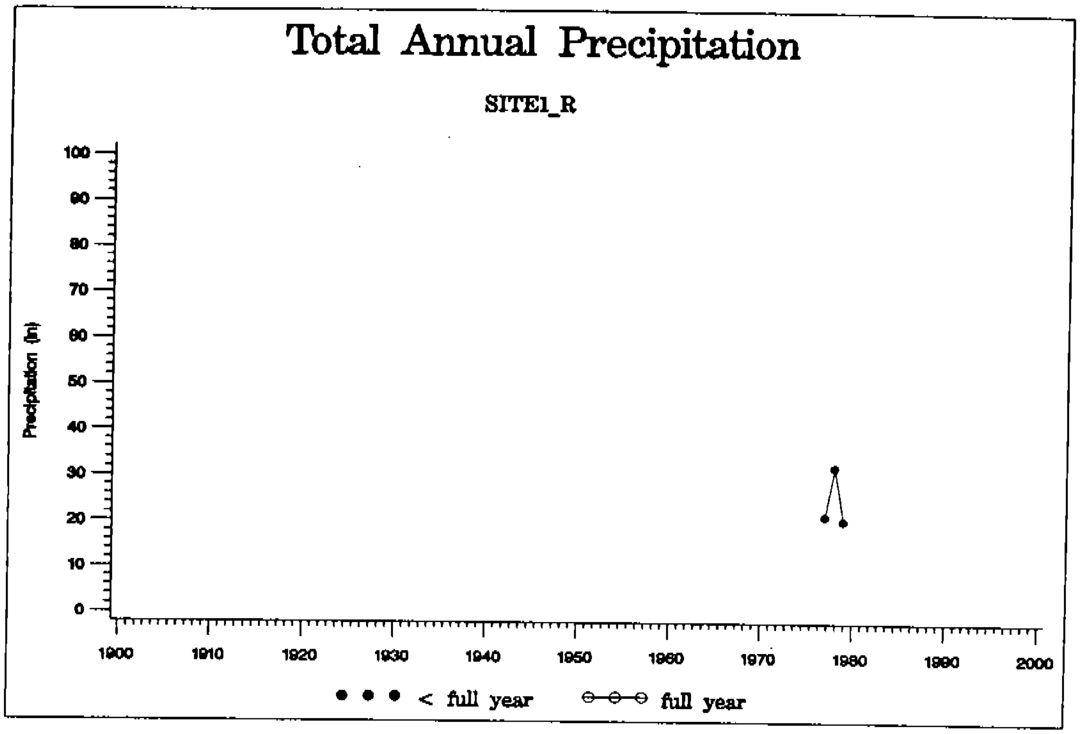
Average Monthly Precipitation
SILVER S_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

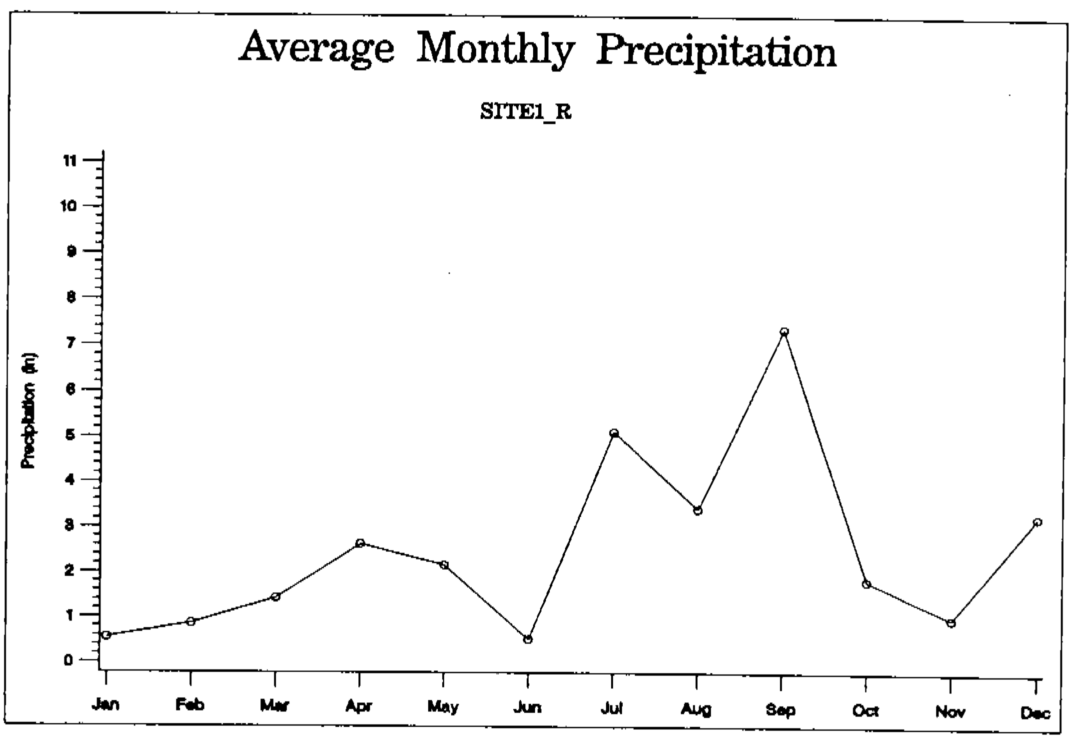


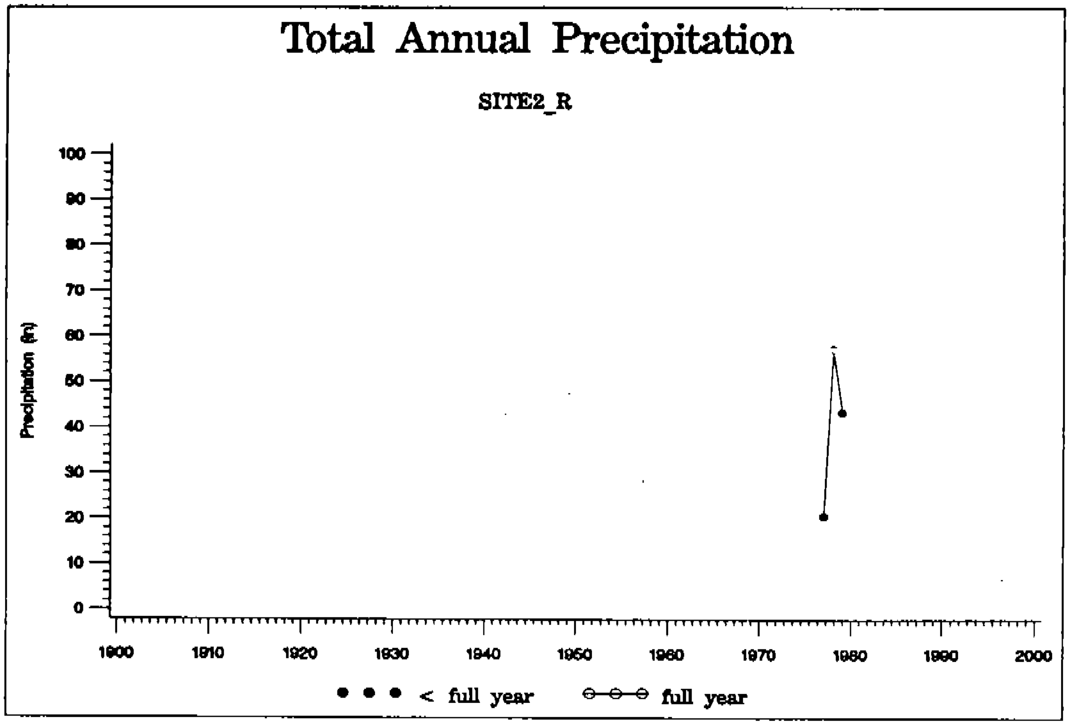
Total Annual Precipitation
SITE #1_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

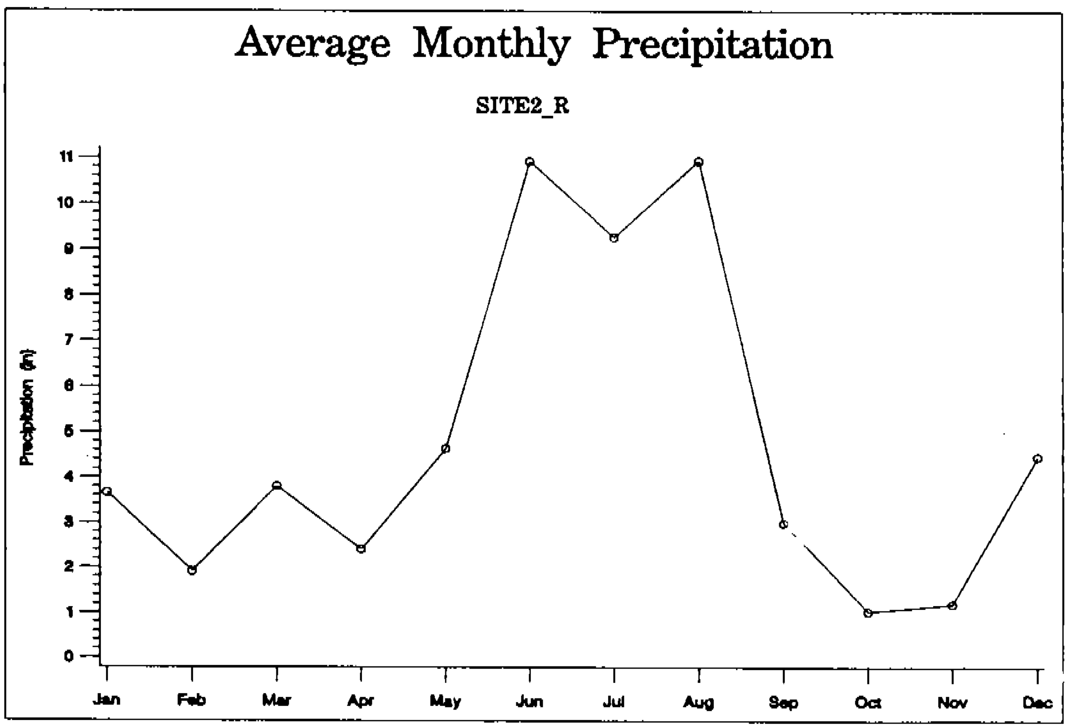


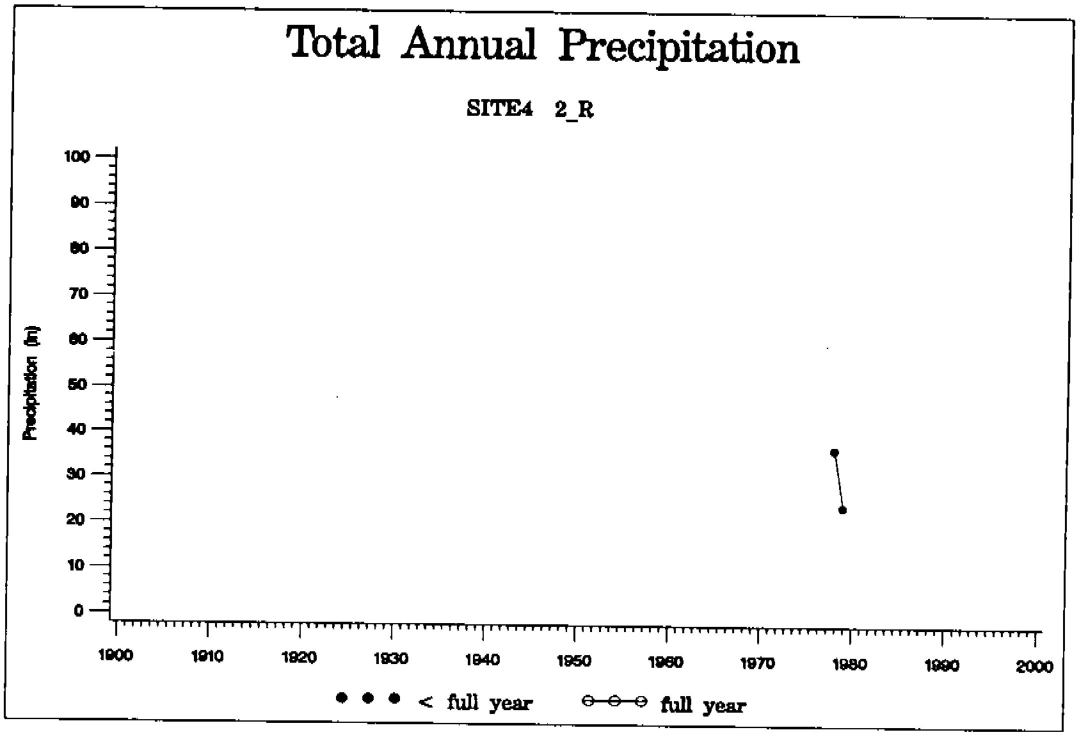
Average Monthly Precipitation
SITE #1_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

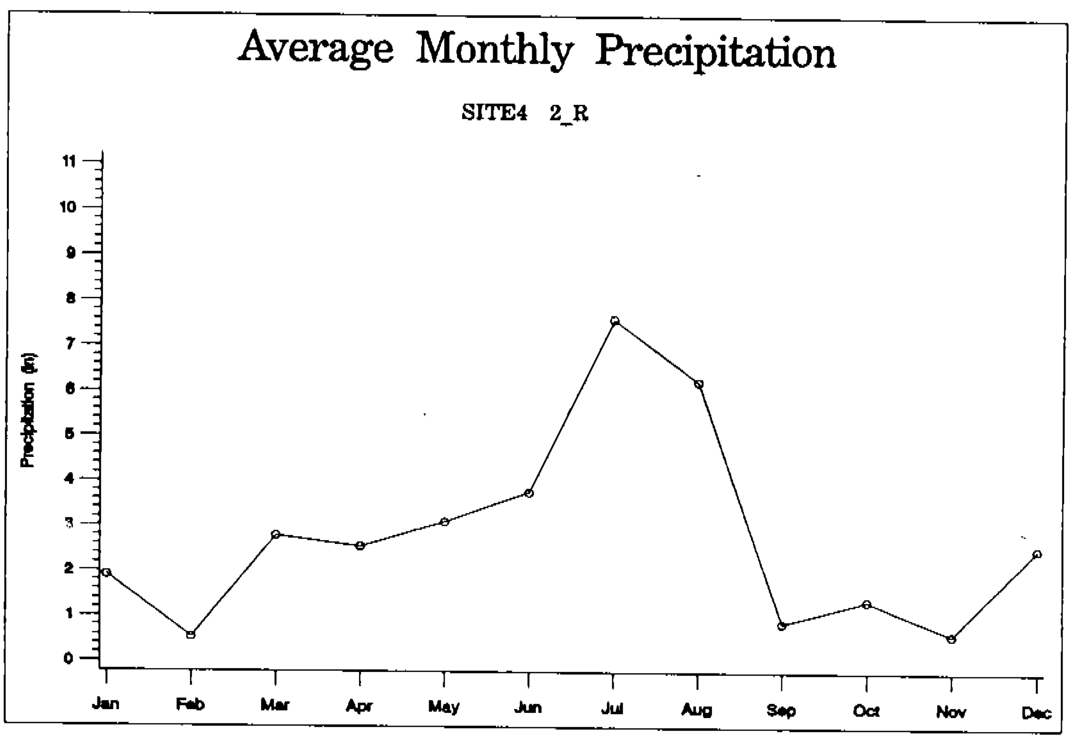

Total Annual Precipitation
SITE1_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
SITE1_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

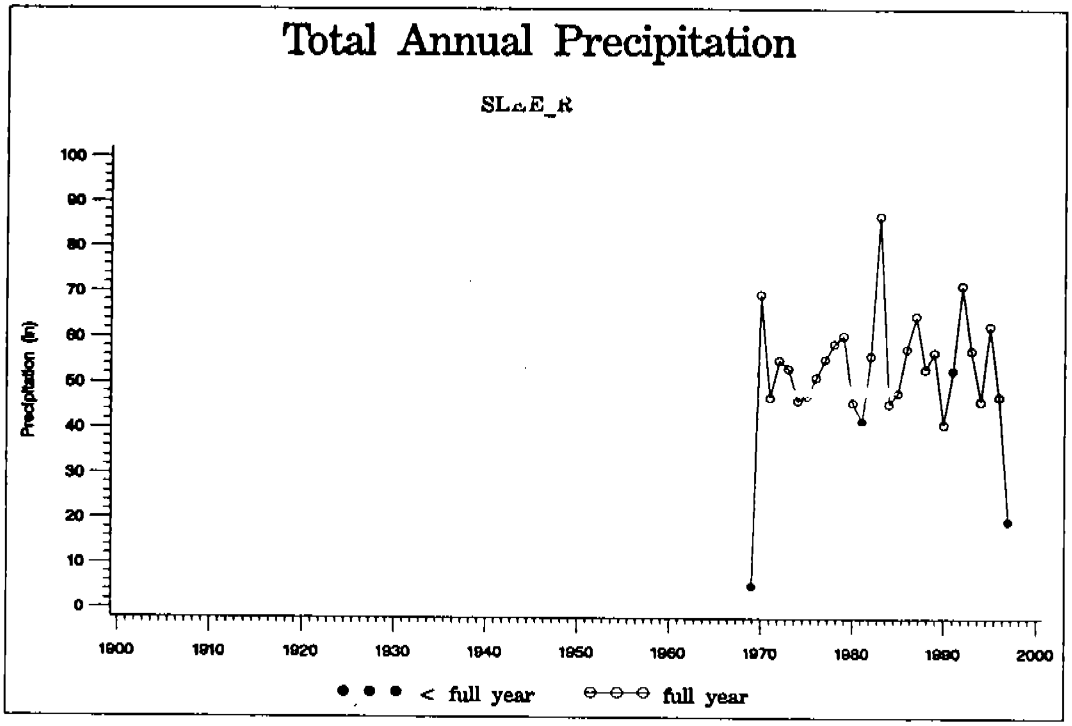

Total Annual Precipitation
SITE2_R
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

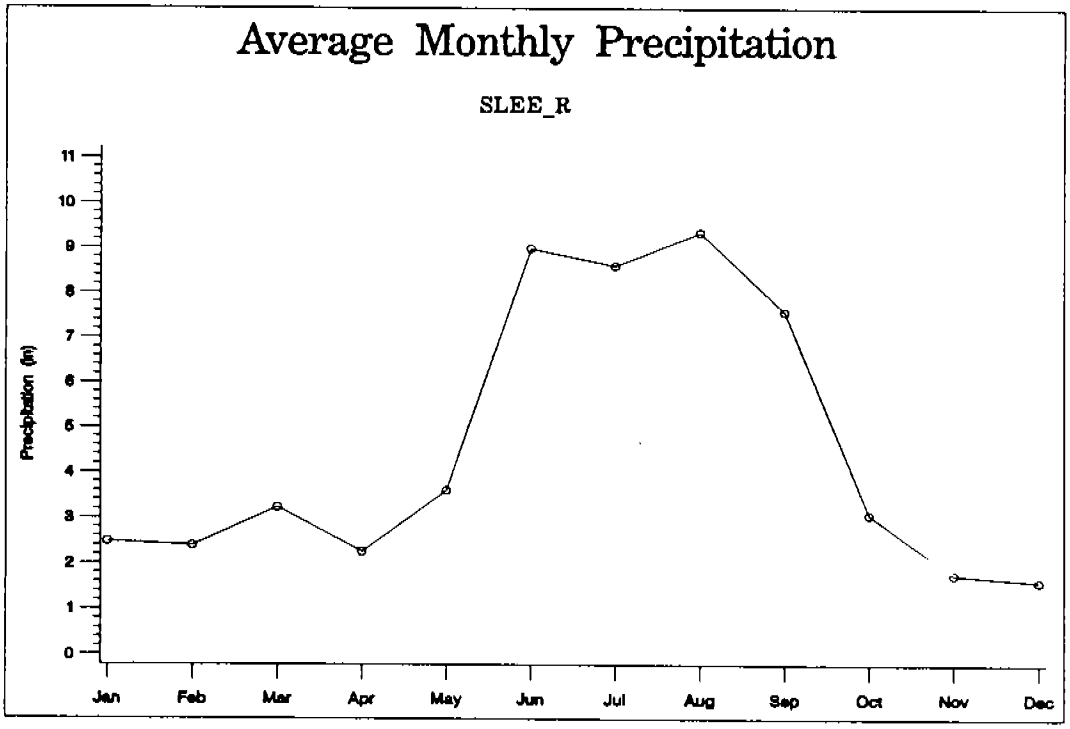

Average Monthly Precipitation
SITE2_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

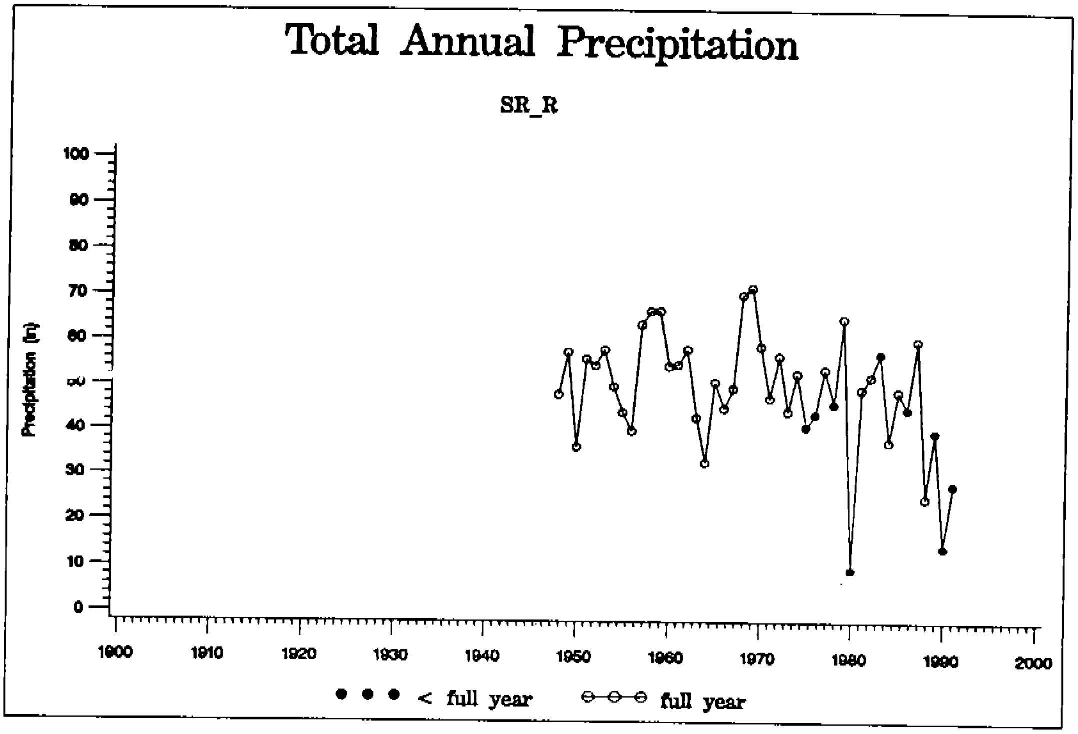

Total Annual Precipitation
SITE4 2_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

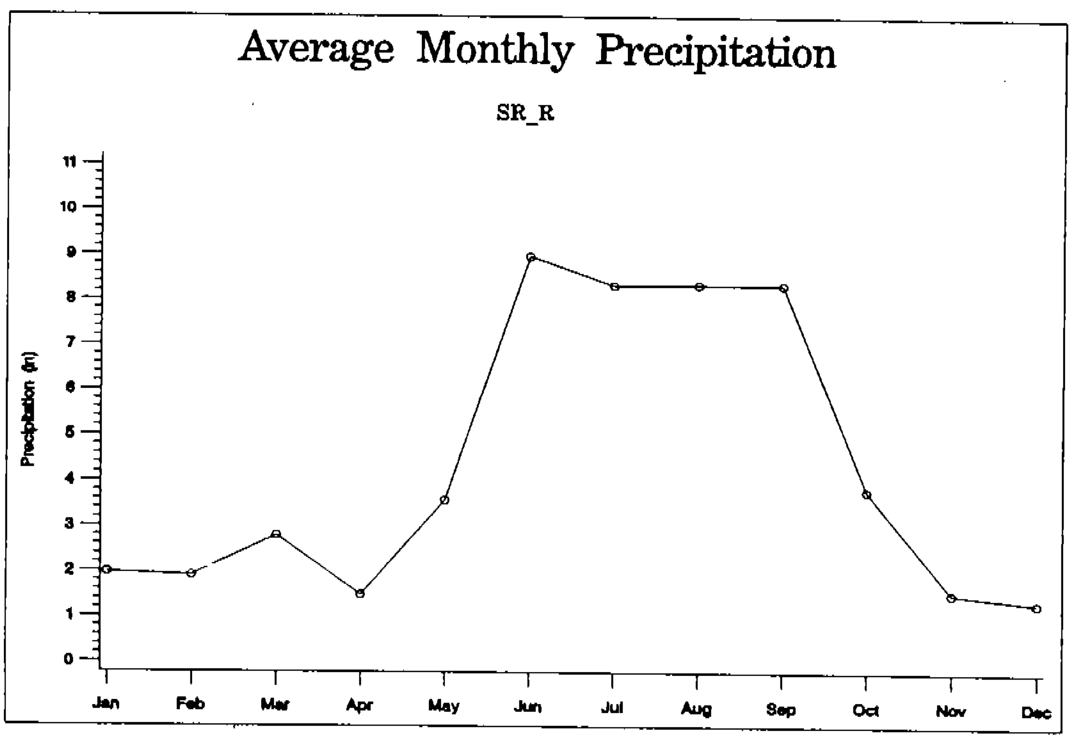

Average Monthly Precipitation
SITE4 2_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Tidal Calbco






Total Annual Precipitation
SR_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖⊖⊖ full year


Average Monthly Precipitation
SR_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
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May
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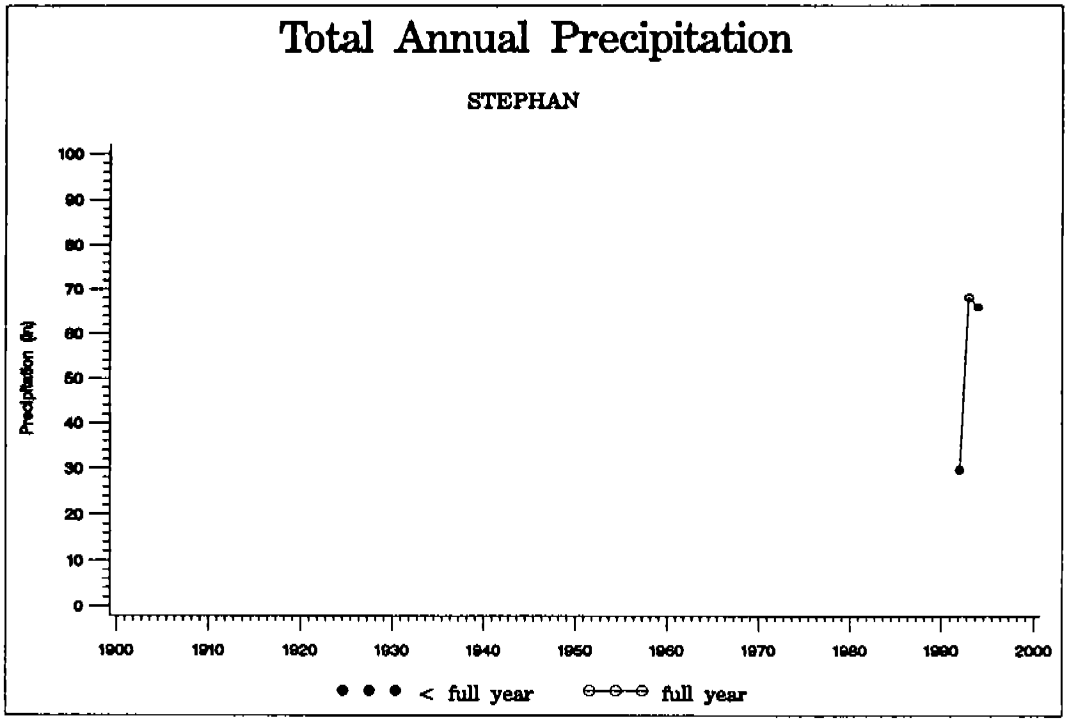
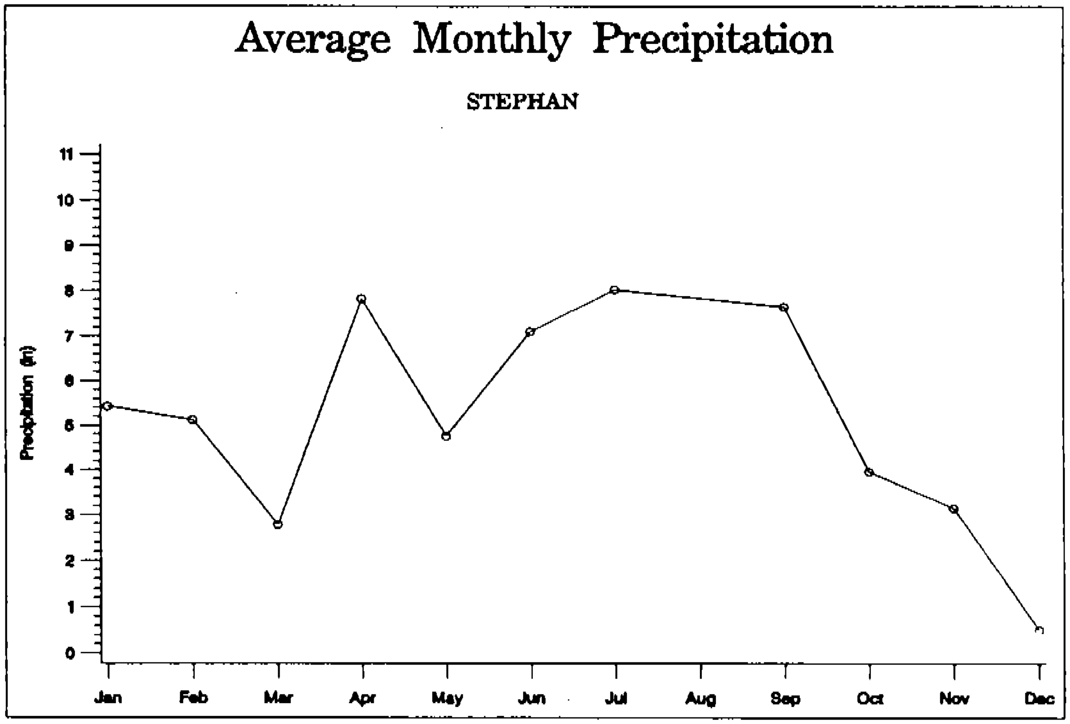
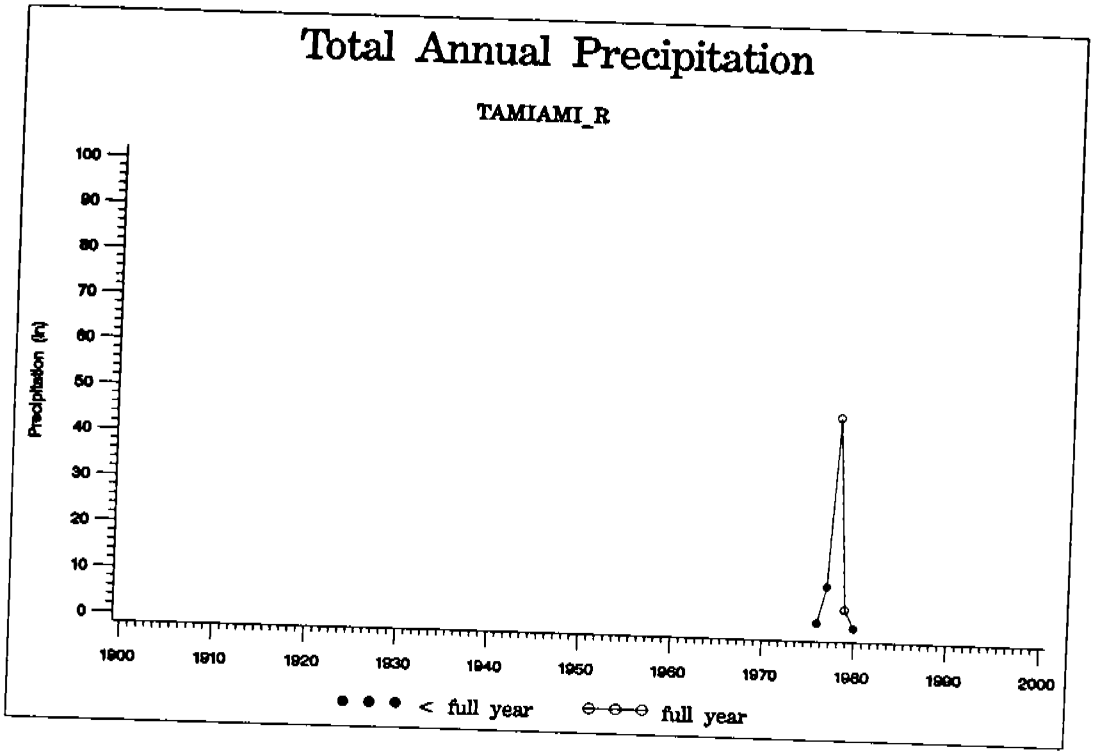
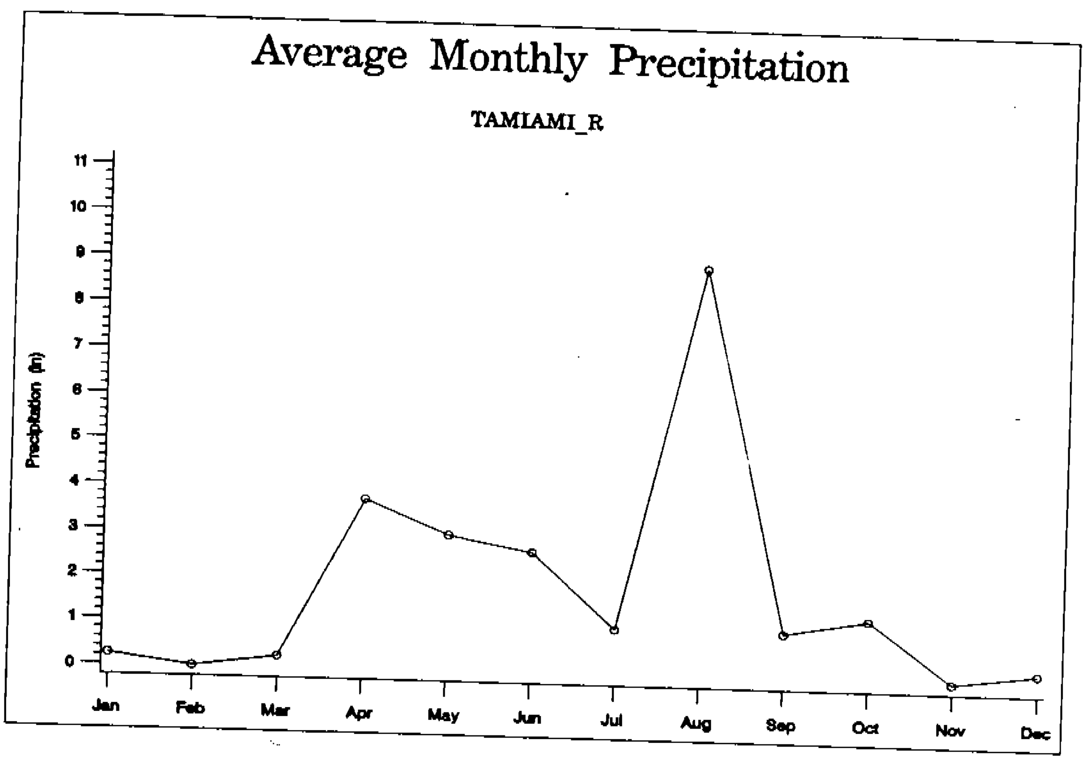
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
STEPHAN
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

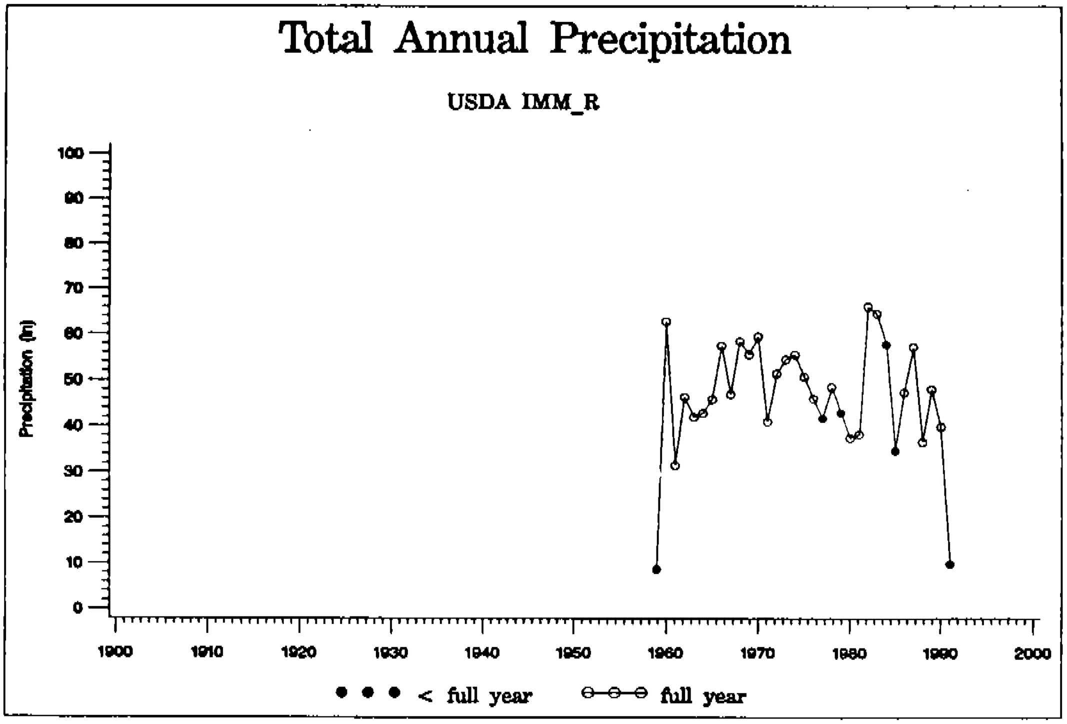

Average Monthly Precipitation
STEPHAN
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

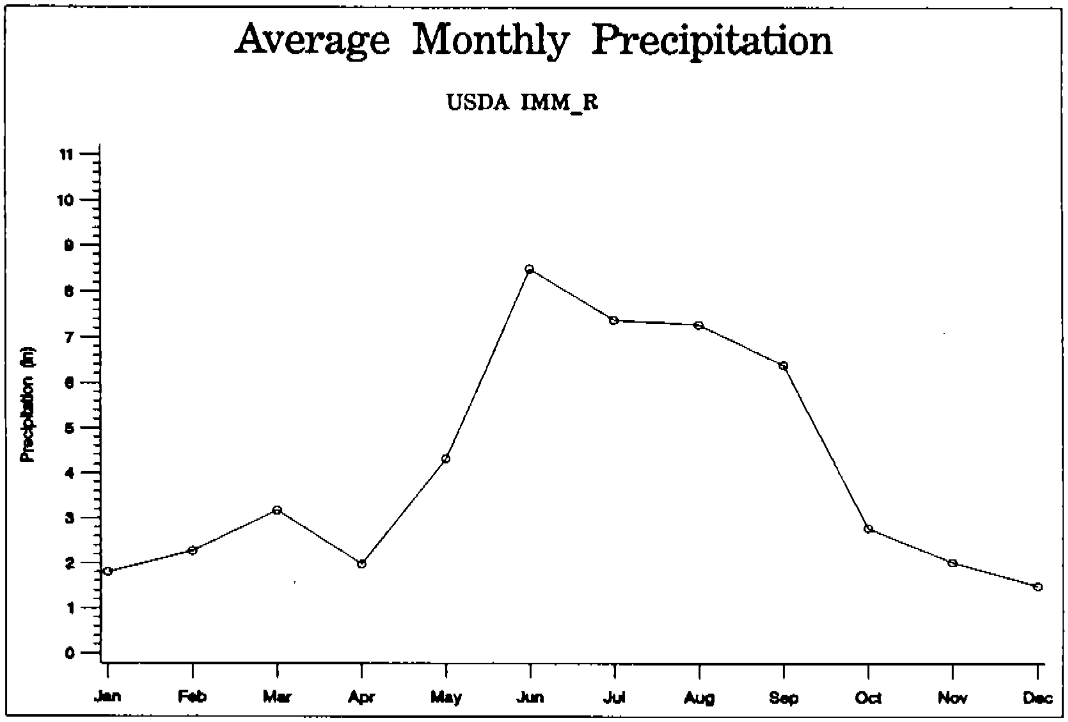


Total Annual Precipitation
TAMIAMI_R
Precipitation (in)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Precipitation
TAMIAMI_R
Precipitation (in)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
USDA IMM_R
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
USDA IMM_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
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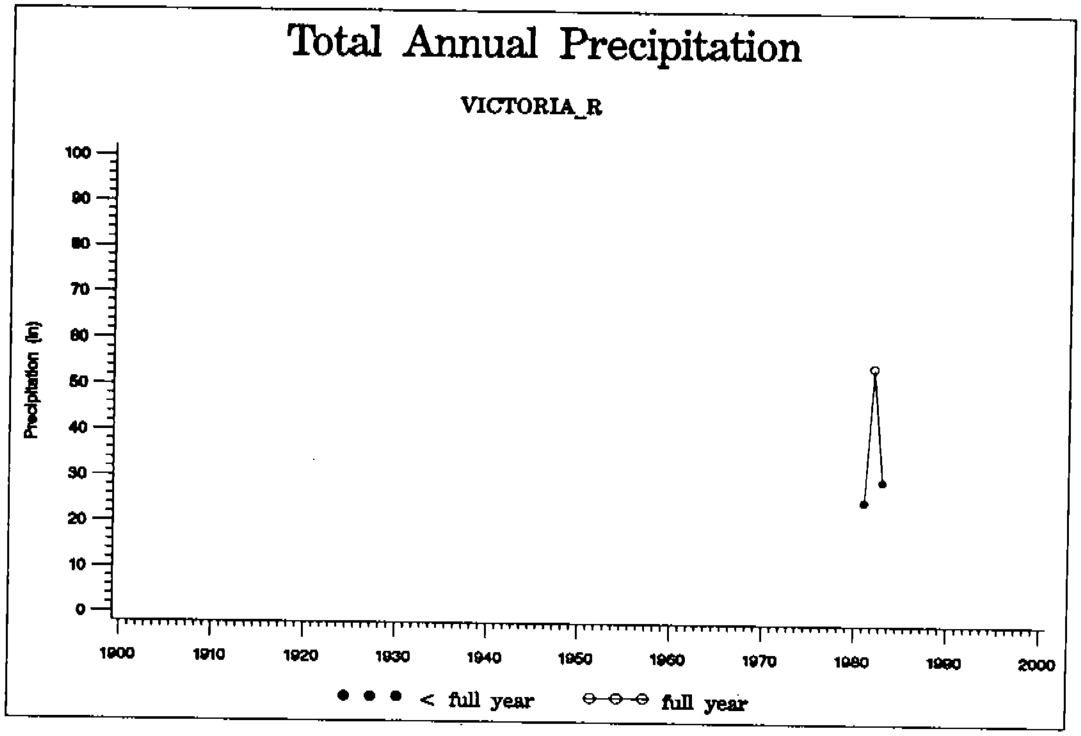
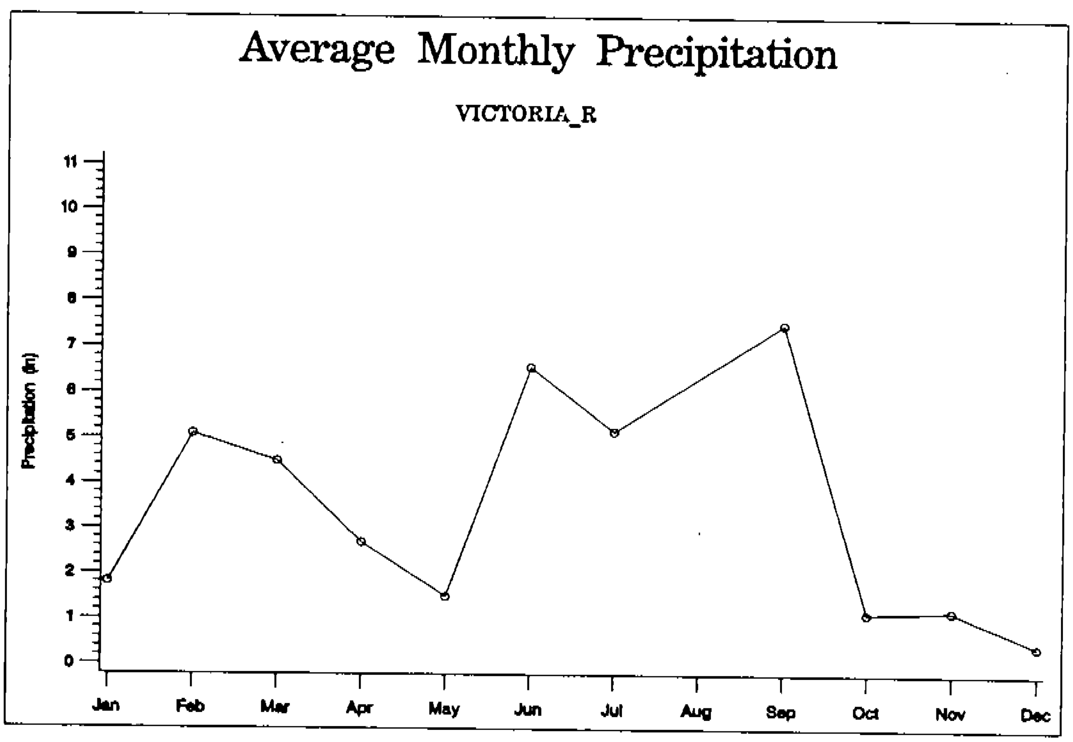
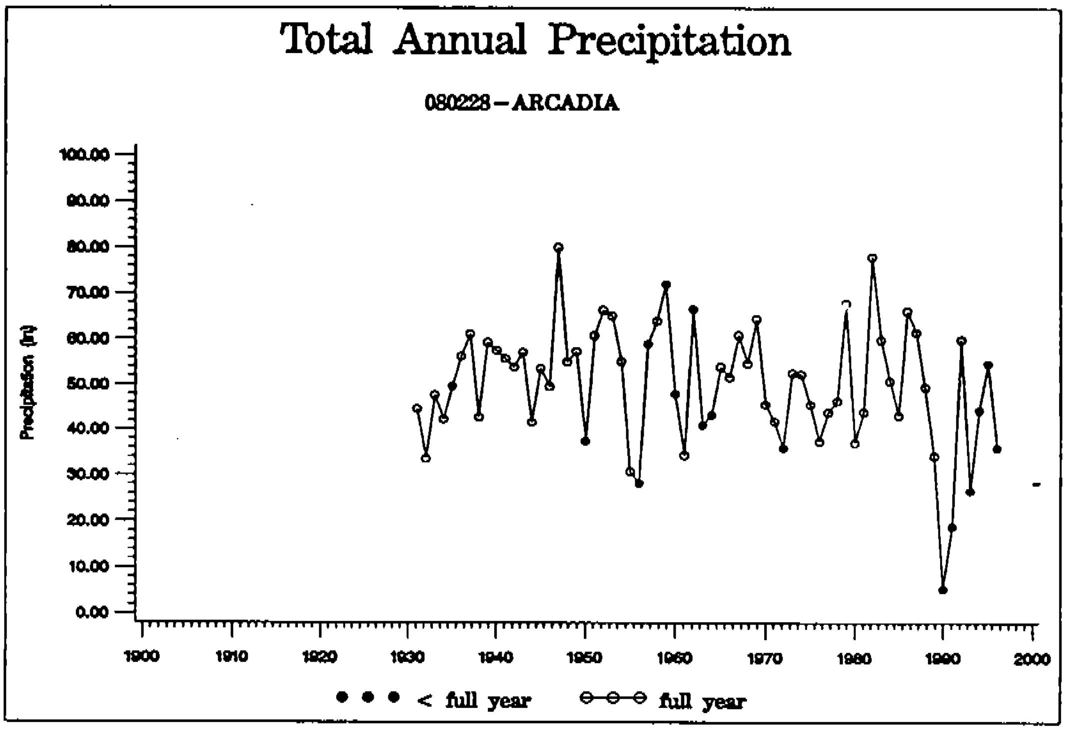
Aug
Sep
Oct
Nov
Dec

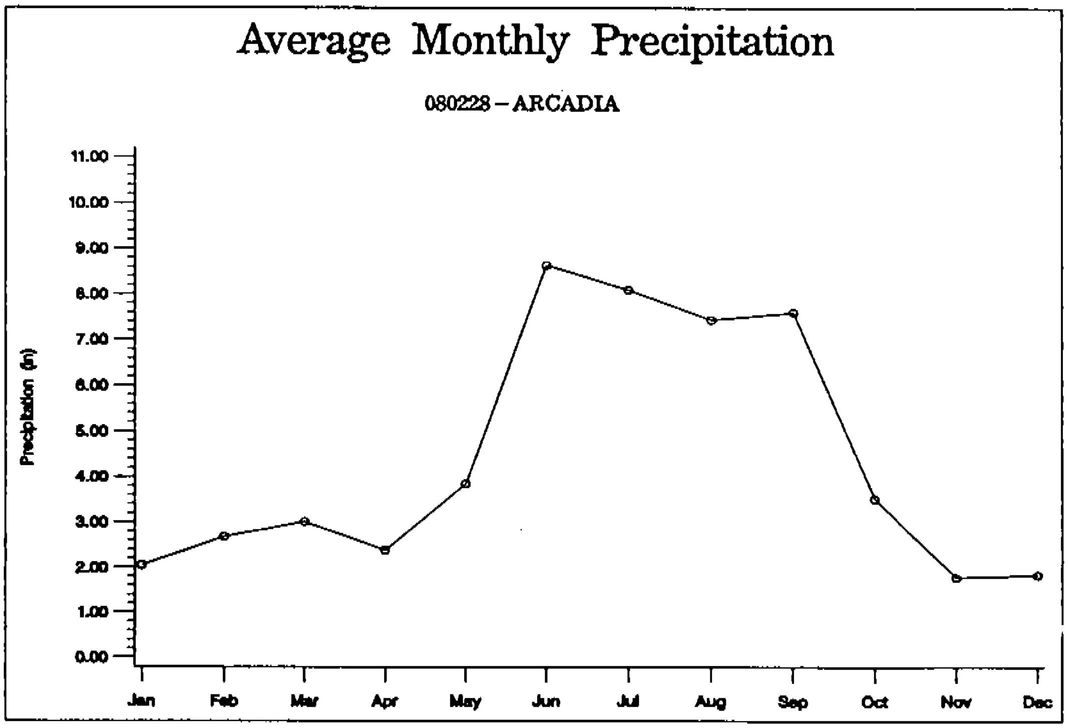


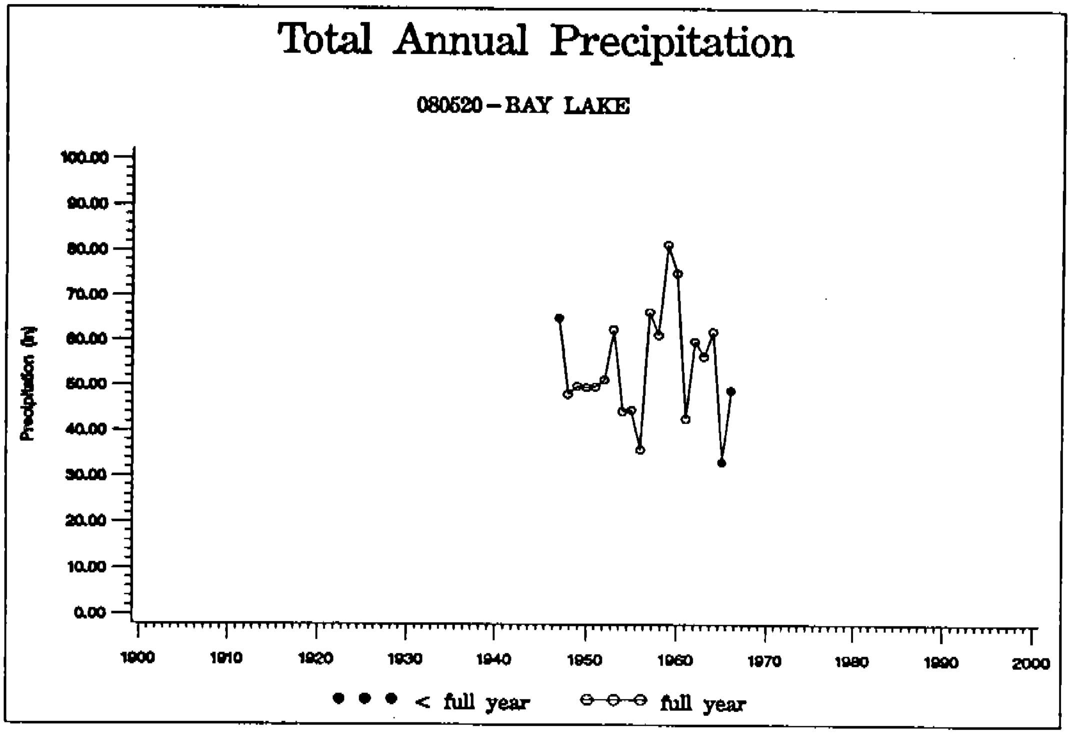
Total Annual Precipitation
VICTORIA_R
Precipitation (in)
0
10
20
30
40
50
60
70
80
90
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

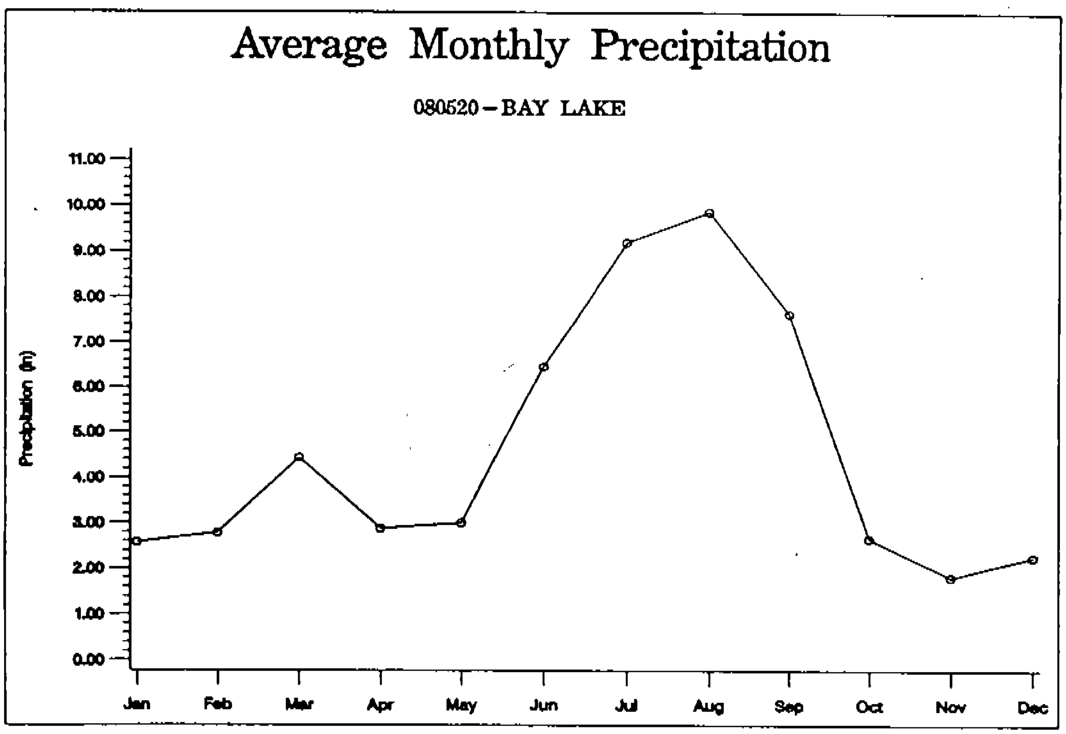


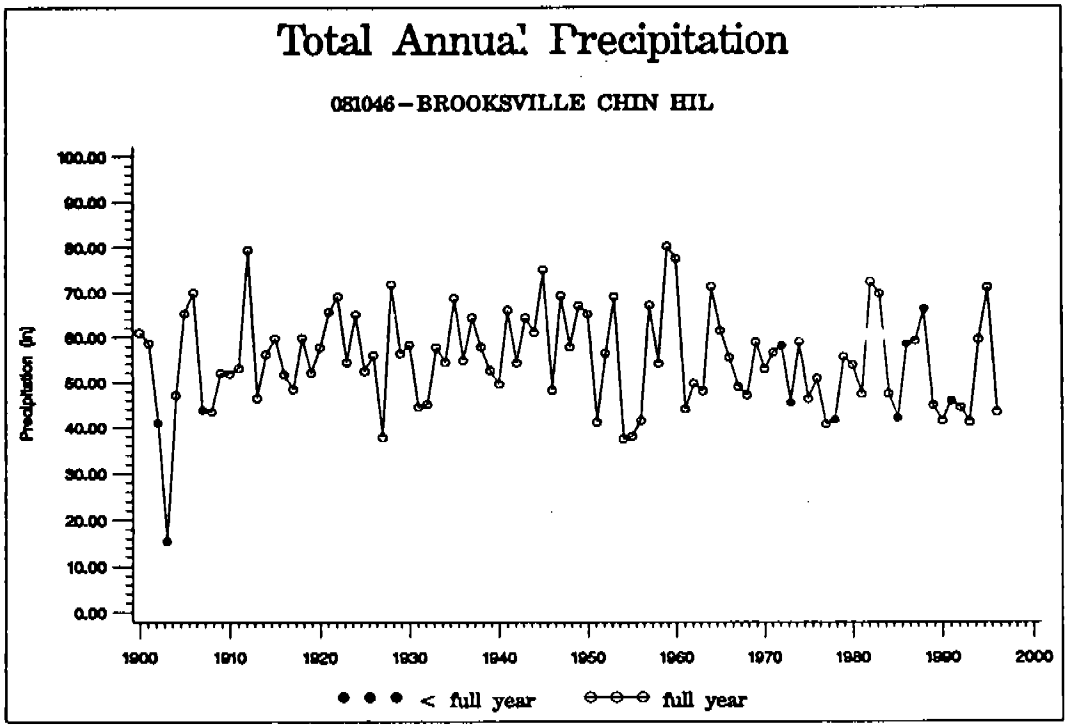
Average Monthly Precipitation
VICTORIA_R
Precipitation (in)
0
1
2
3
4
5
6
7
8
9
10
11
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

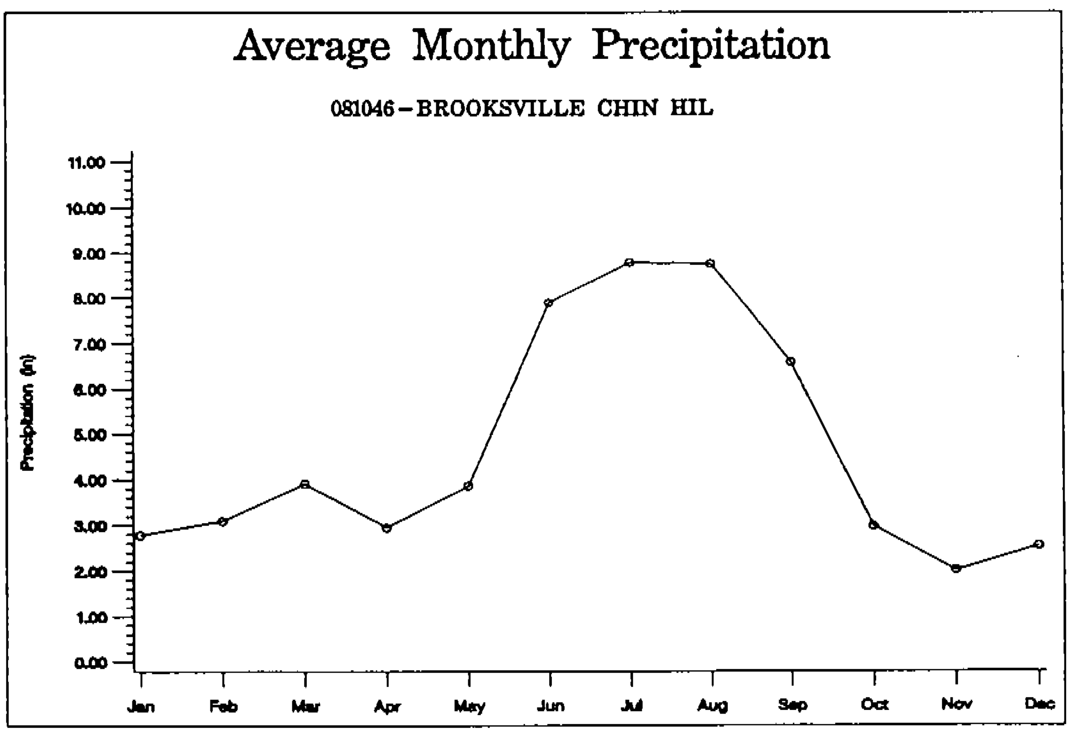

Total Annual Precipitation
080228 – ARCADIA
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

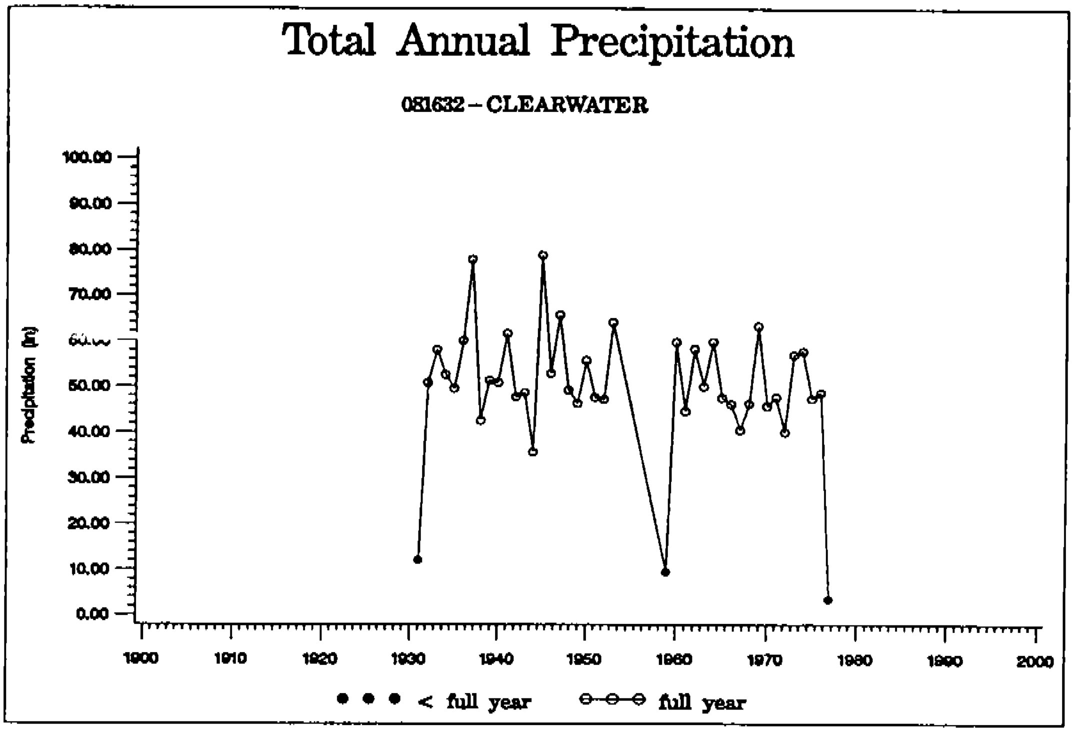

Average Monthly Precipitation
080228 – ARCADIA
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

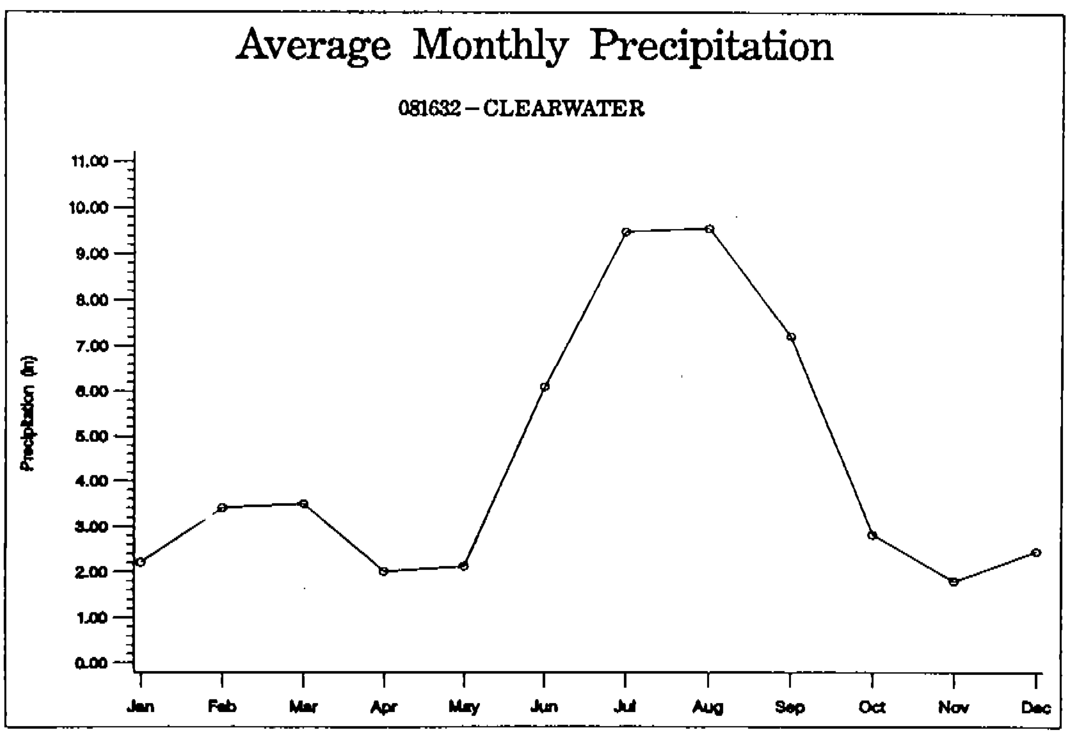

Total Annual Precipitation
080520 – BAY LAKE
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

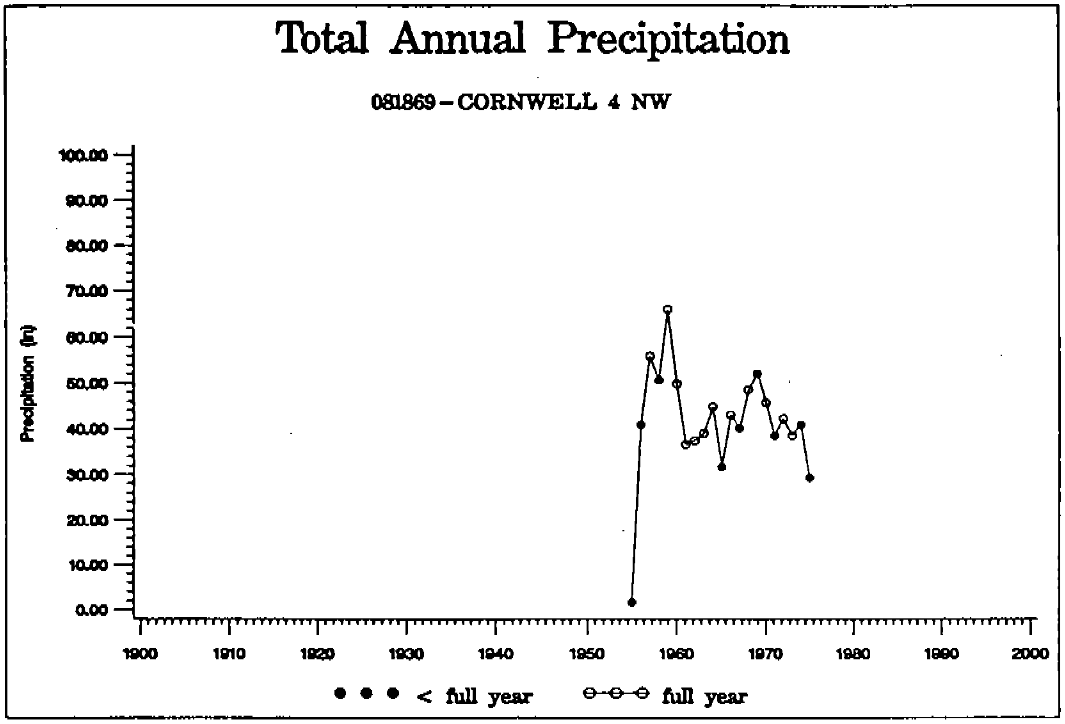

Average Monthly Precipitation
080520 – BAY LAKE
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

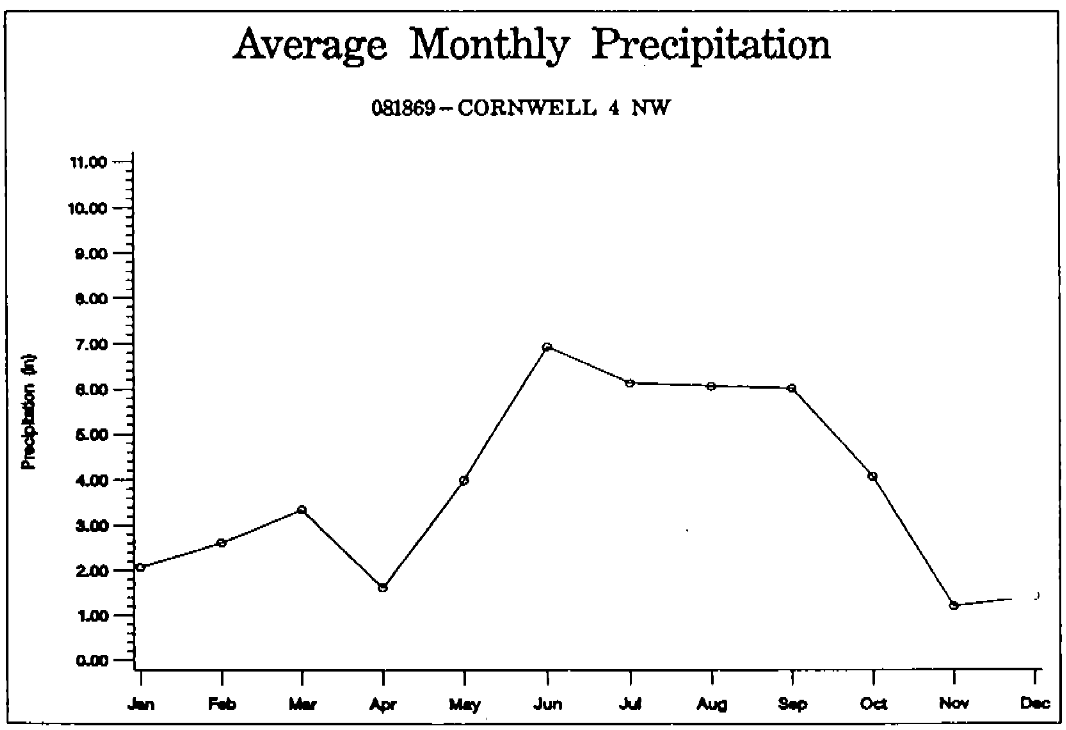

Total Annual Precipitation
081046-BROOKSVILLE CHIN HIL
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

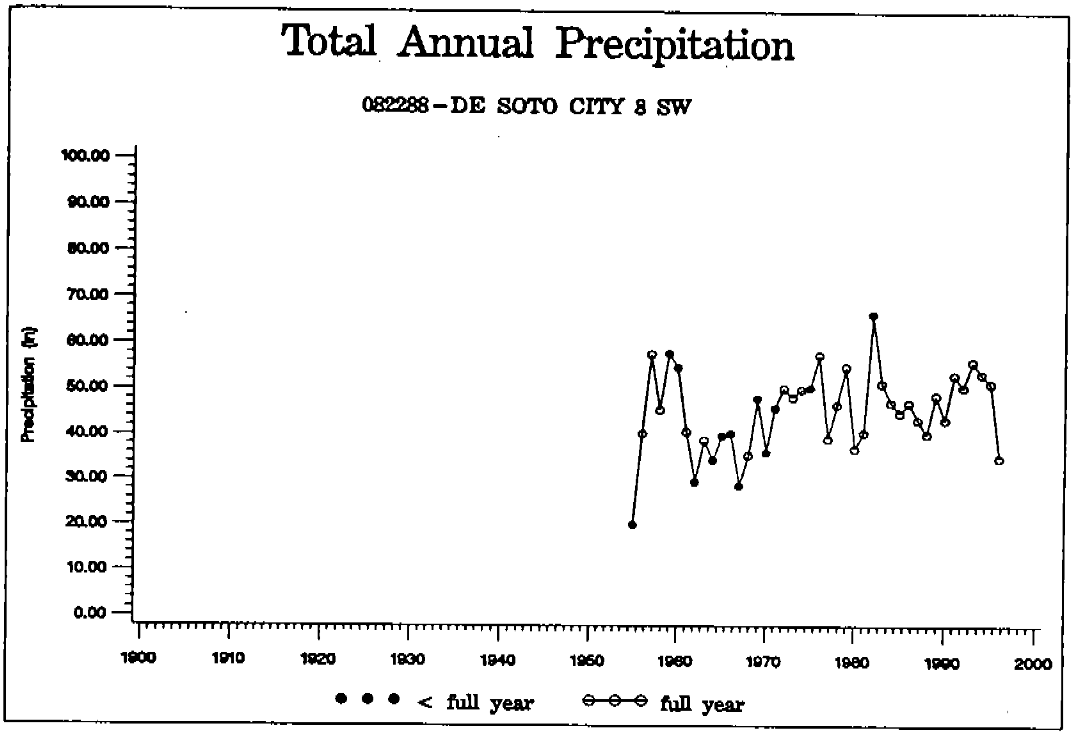

Average Monthly Precipitation
081046-BROOKSVILLE CHIN HIL
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

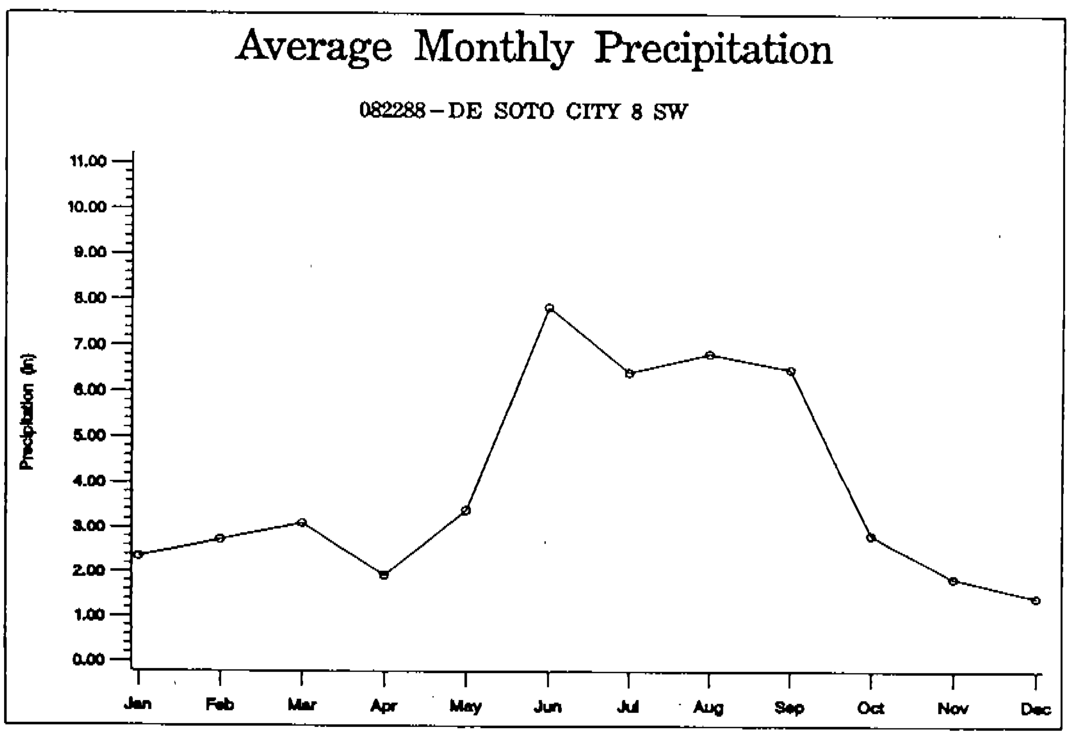

Total Annual Precipitation
081632 – CLEARWATER
Precipitation (in)
100.00
90.00
80.00
70.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

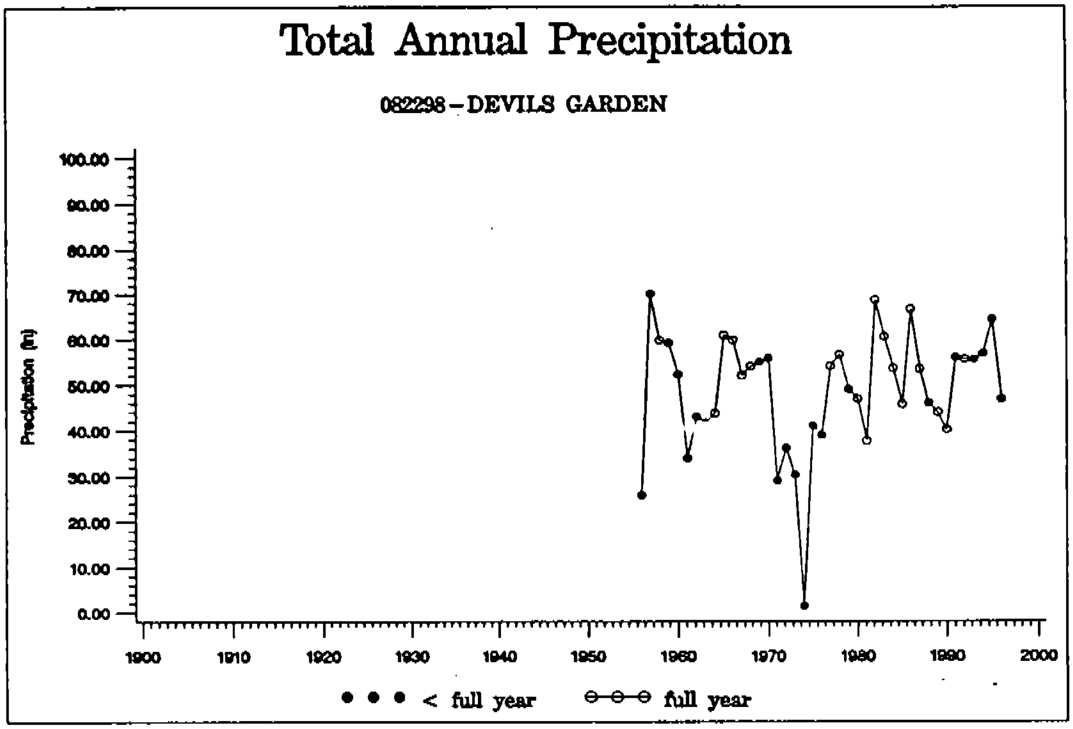

Average Monthly Precipitation
081632 – CLEARWATER
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

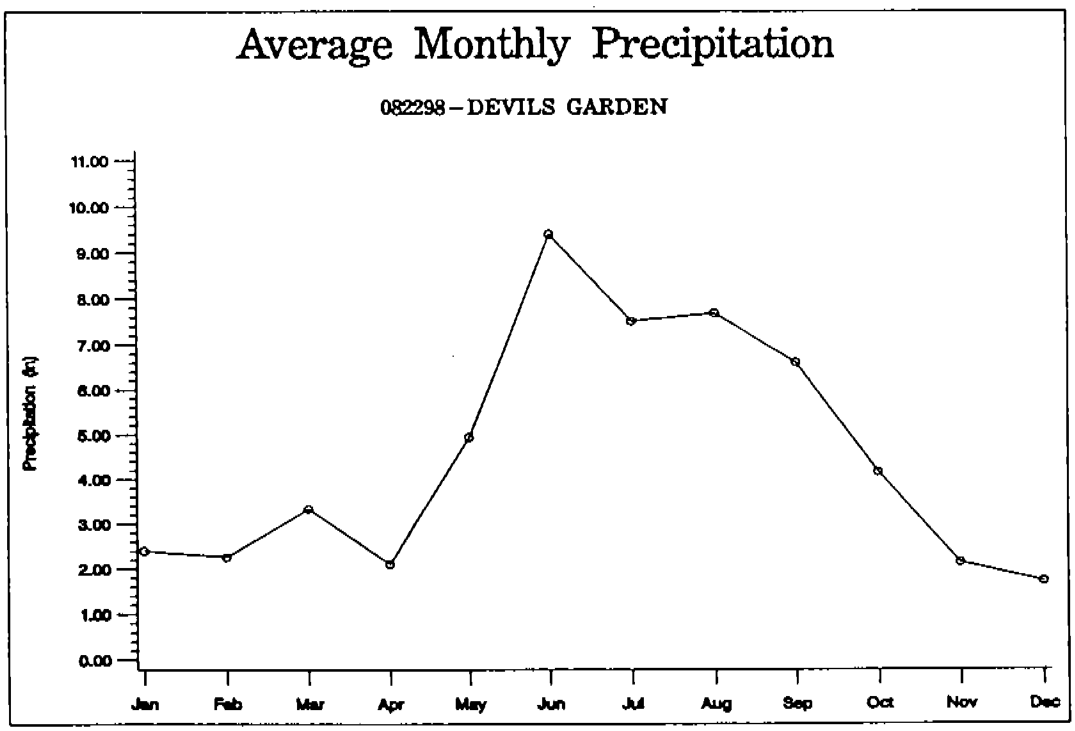

Total Annual Precipitation
081869 – CORNWELL 4 NW
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Precipitation (in)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

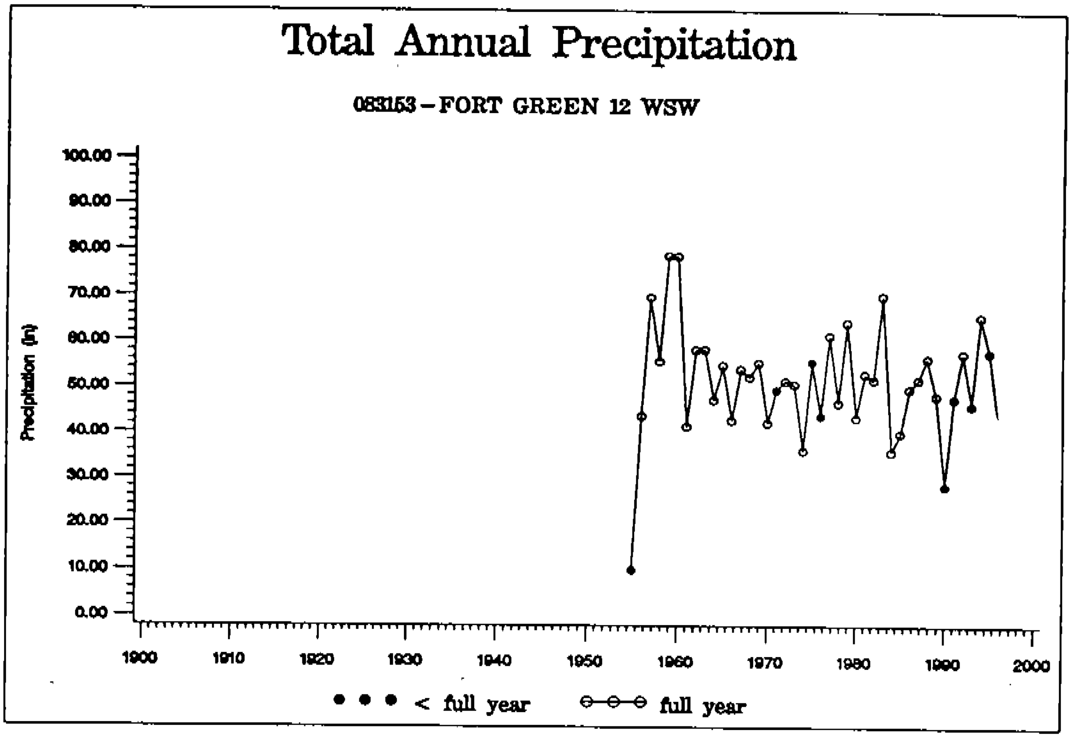

Average Monthly Precipitation
081869 – CORNWELL 4 NW
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Precipitation (in)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

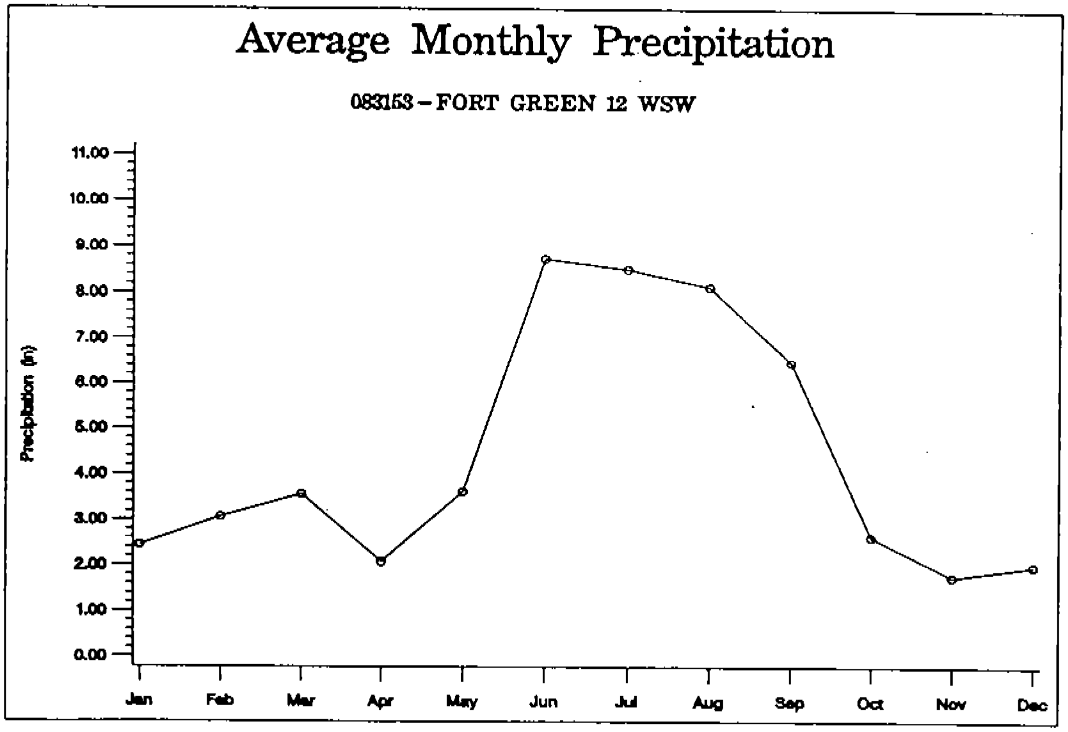

Total Annual Precipitation
082288-DE SOTO CITY 8 SW
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

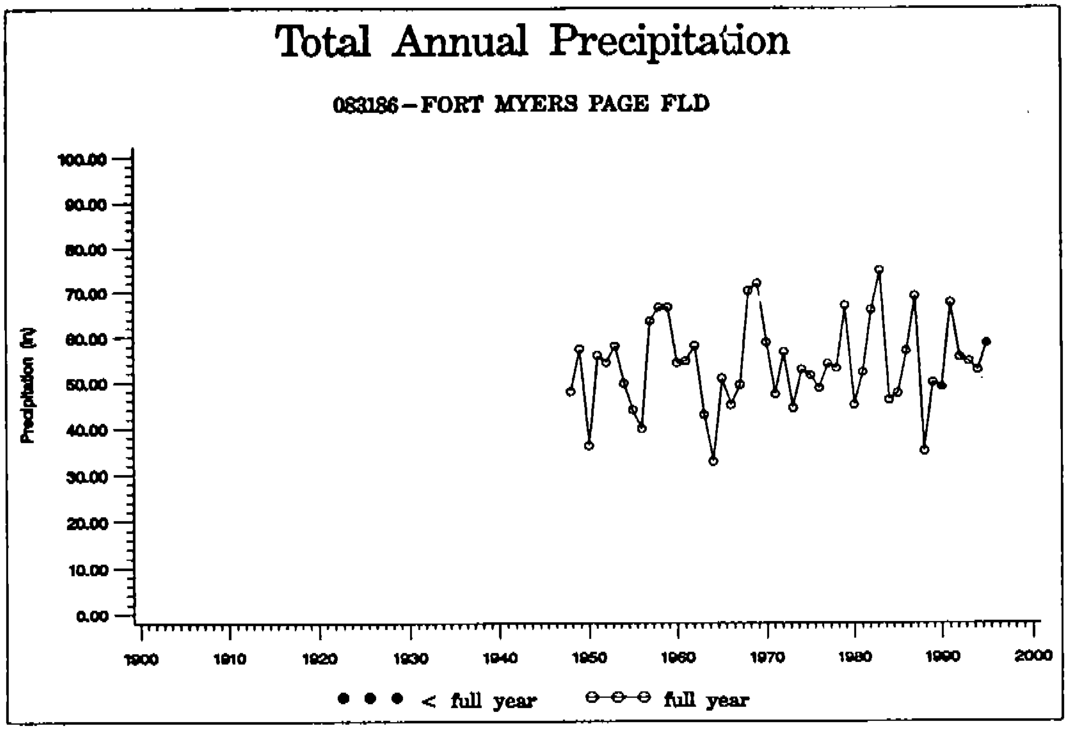

Average Monthly Precipitation
082288-DE SOTO CITY 8 SW
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

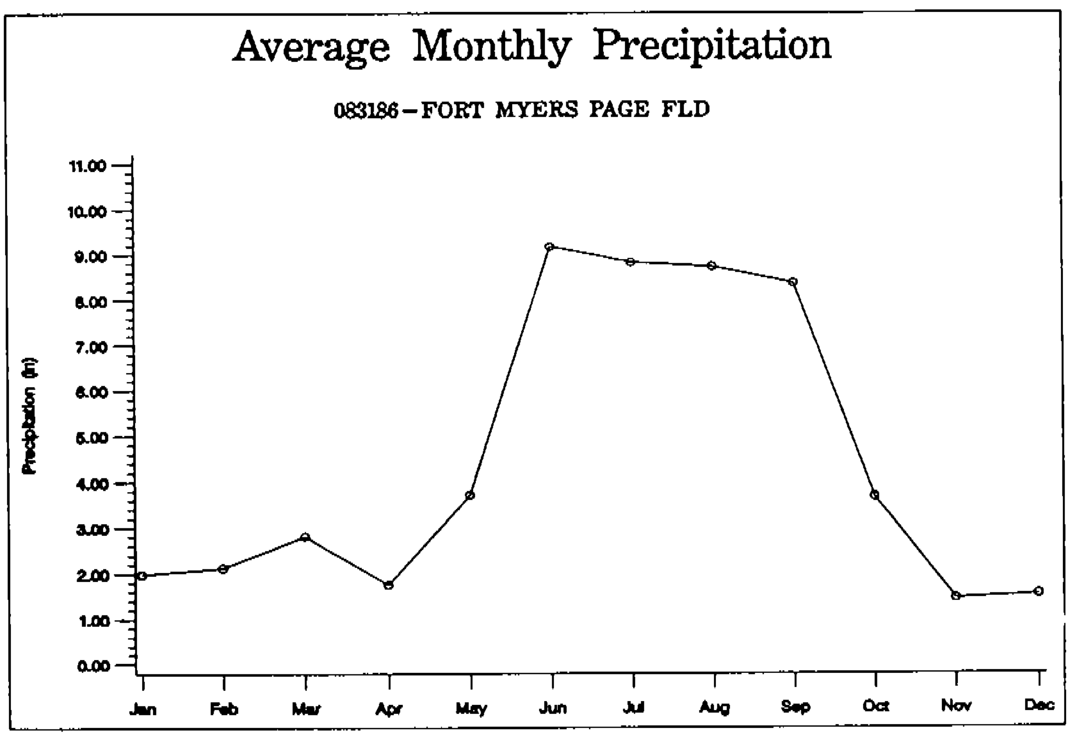

Total Annual Precipitation
082298 - DEVILS GARDEN
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
• • • < full year
full year

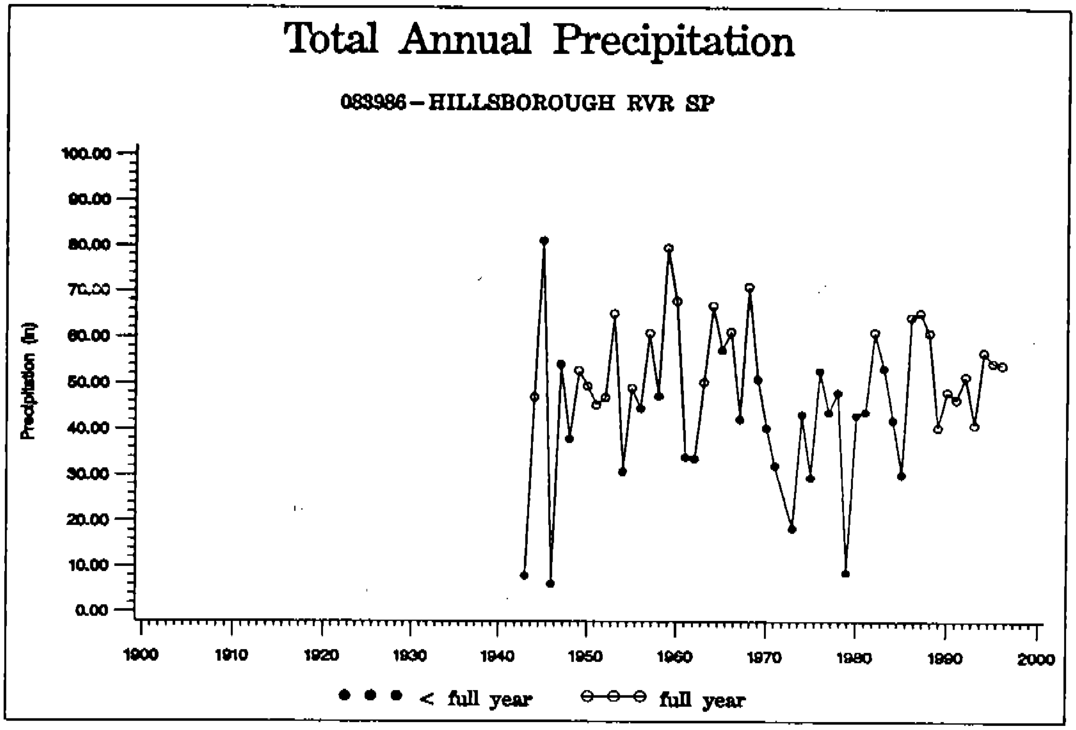

Average Monthly Precipitation
082298 - DEVILS GARDEN
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
083153 - FORT GREEN 12 WSW
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Precipitation (in)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖⊖⊖ full year


Average Monthly Precipitation
083153 - FORT GREEN 12 WSW
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Precipitation (in)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
083186 - FORT MYERS PAGE FLD
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
• • • < full year
o-o-o full year


Average Monthly Precipitation
083186 - FORT MYERS PAGE FLD
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
083986–HILLSBOROUGH RVR SP
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
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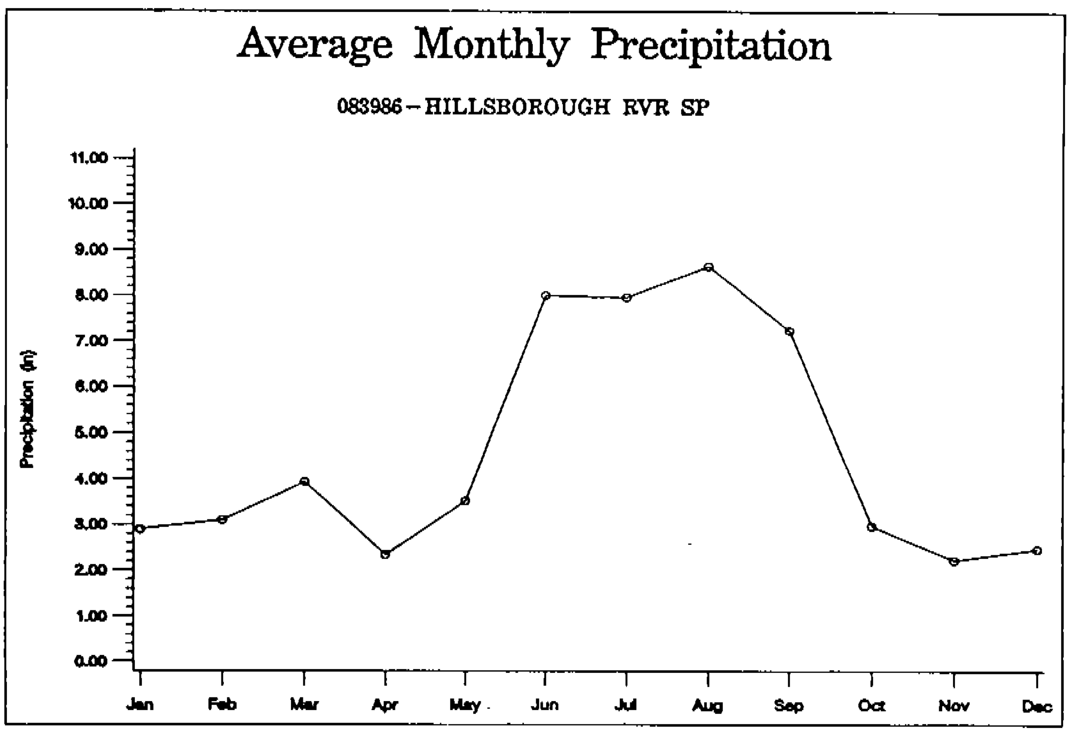
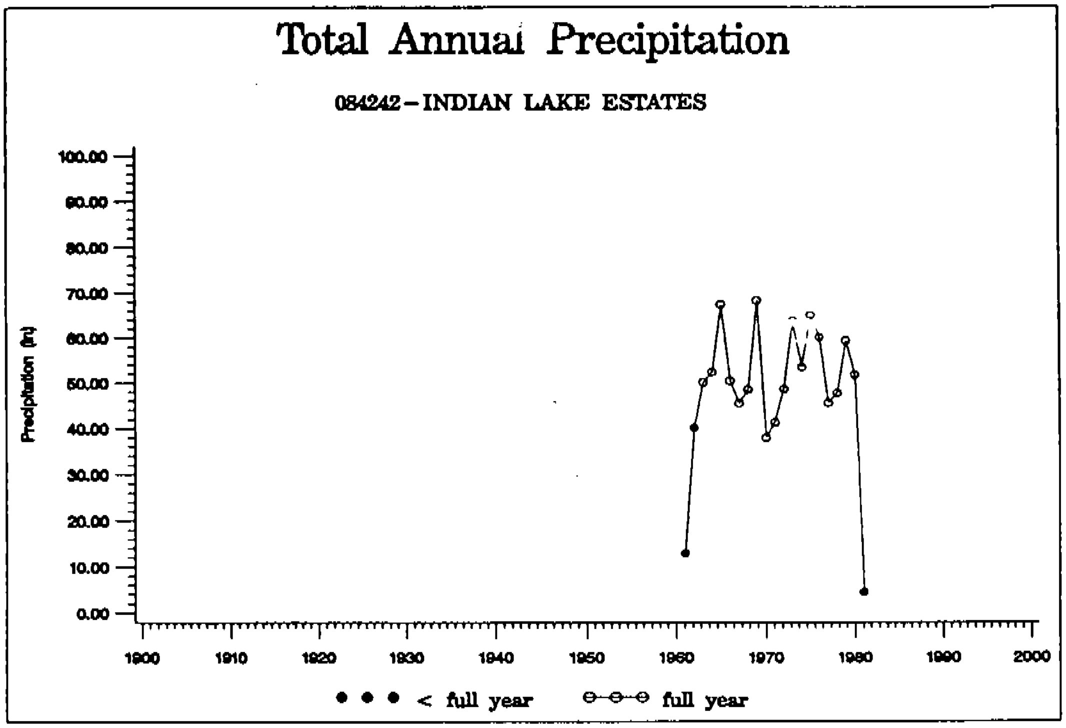
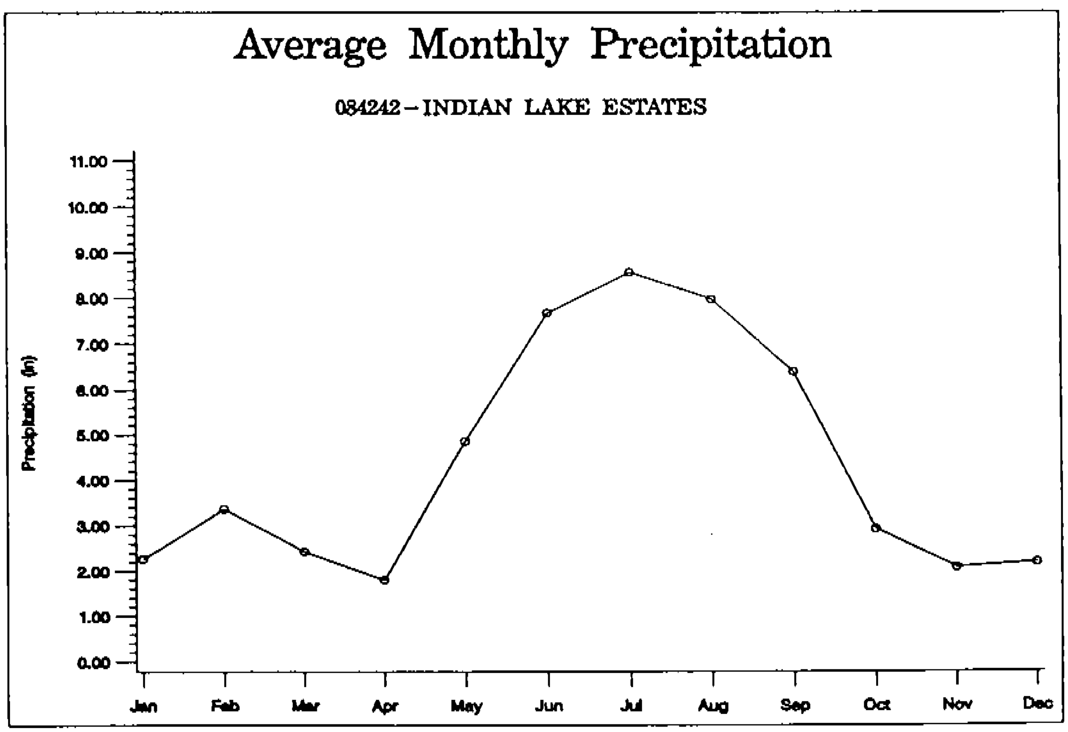
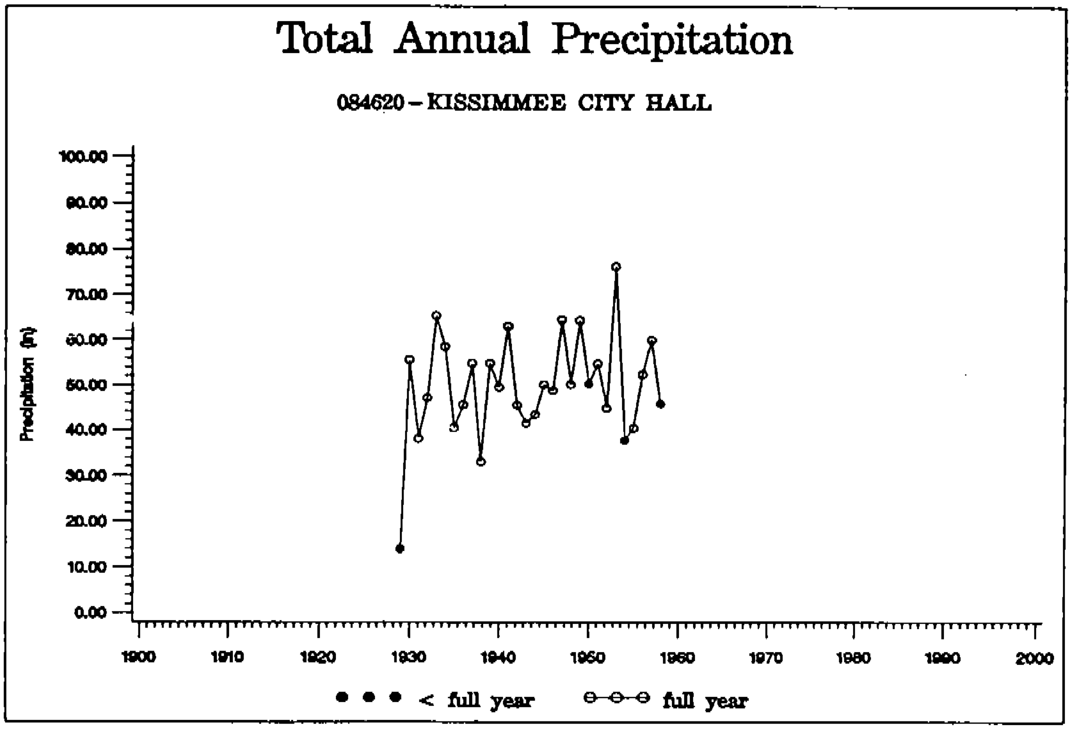
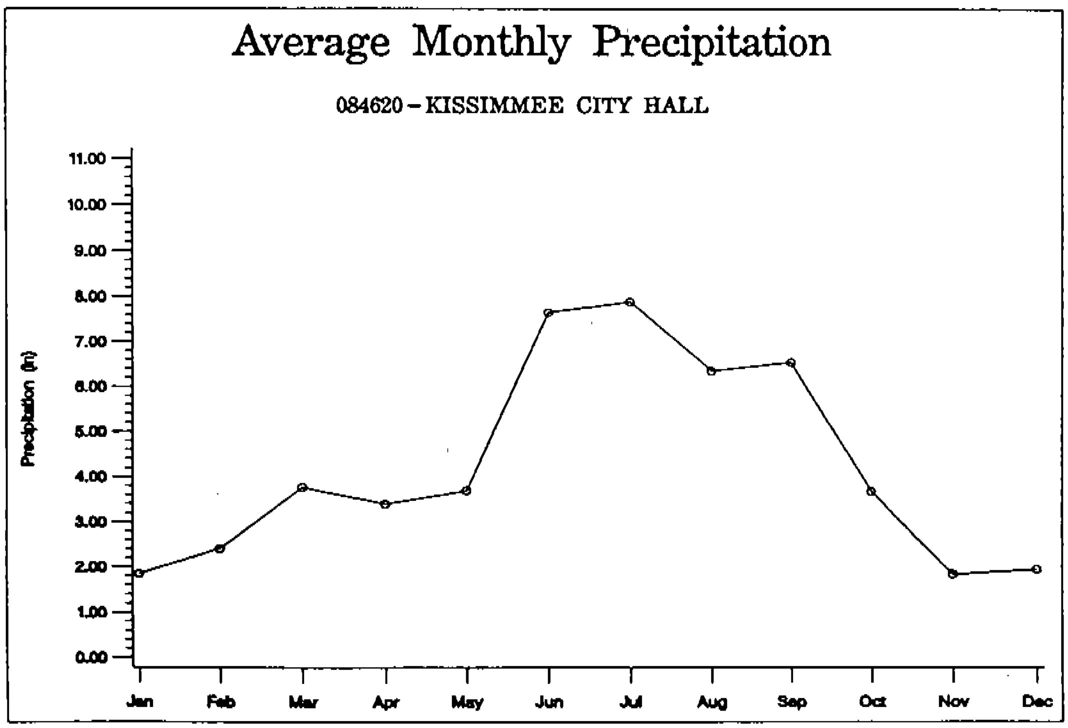
full year

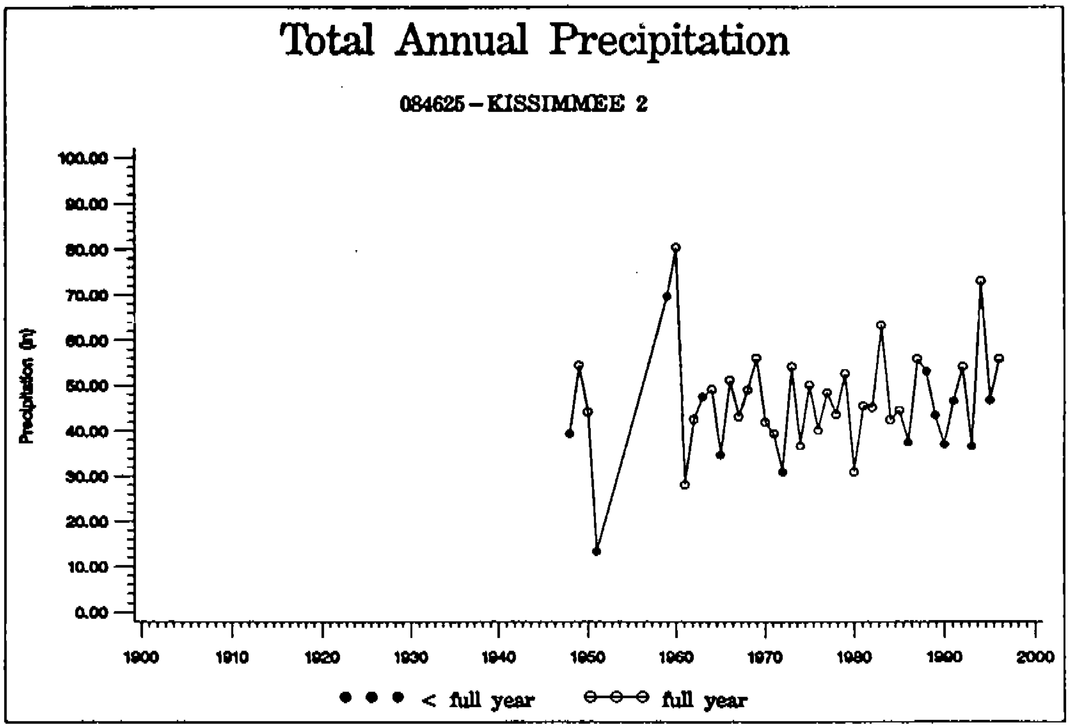

Average Monthly Precipitation
083986–HILLSBOROUGH RVR SP
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

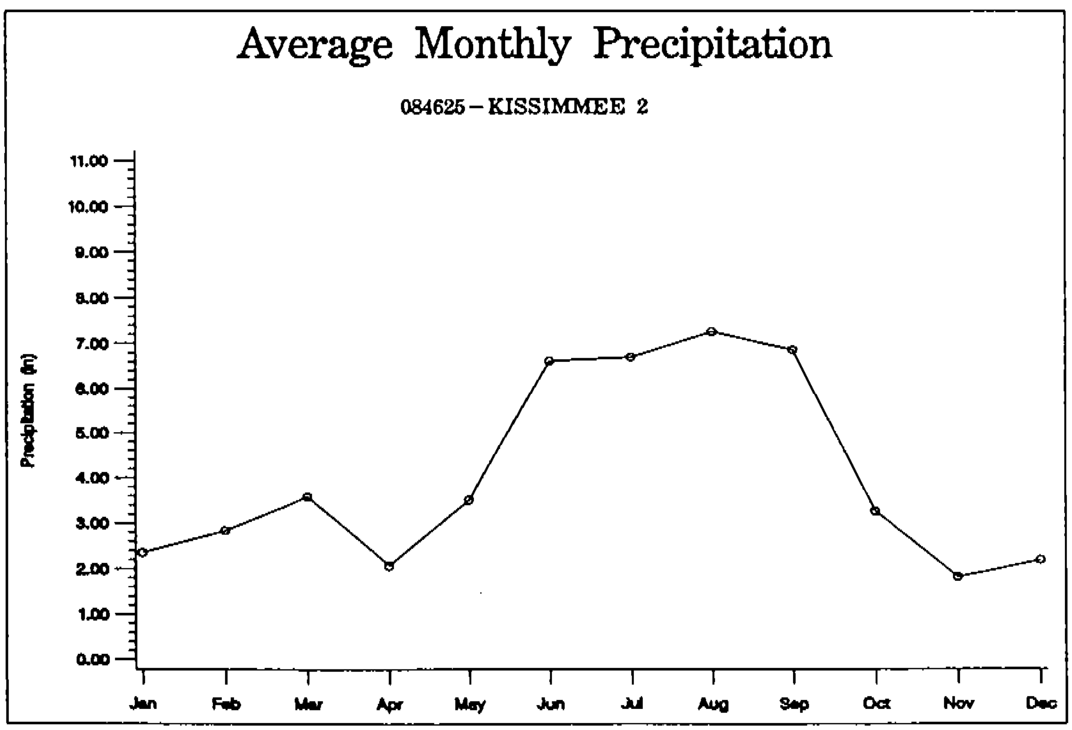

Total Annual Precipitation
084242 - INDIAN LAKE ESTATES
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
084242 - INDIAN LAKE ESTATES
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
084620 - KISSIMMEE CITY HALL
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
084620 - KISSIMMEE CITY HALL
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
084625 – KISSIMMEE 2
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
084625 – KISSIMMEE 2
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
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May
Jun
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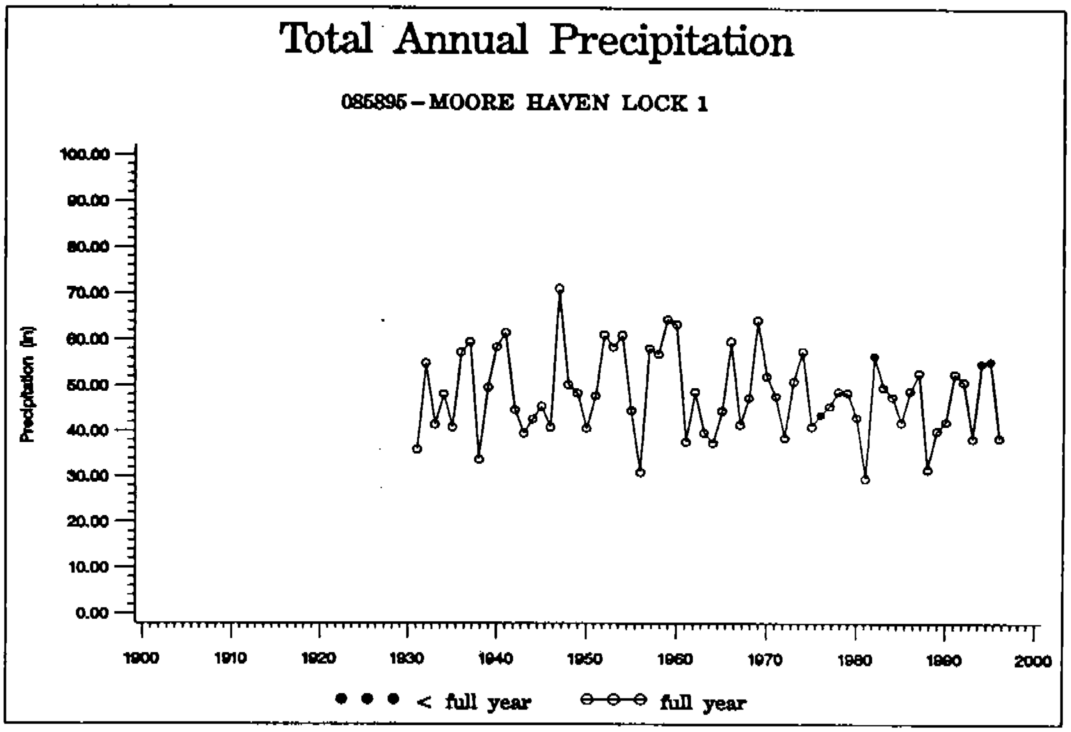
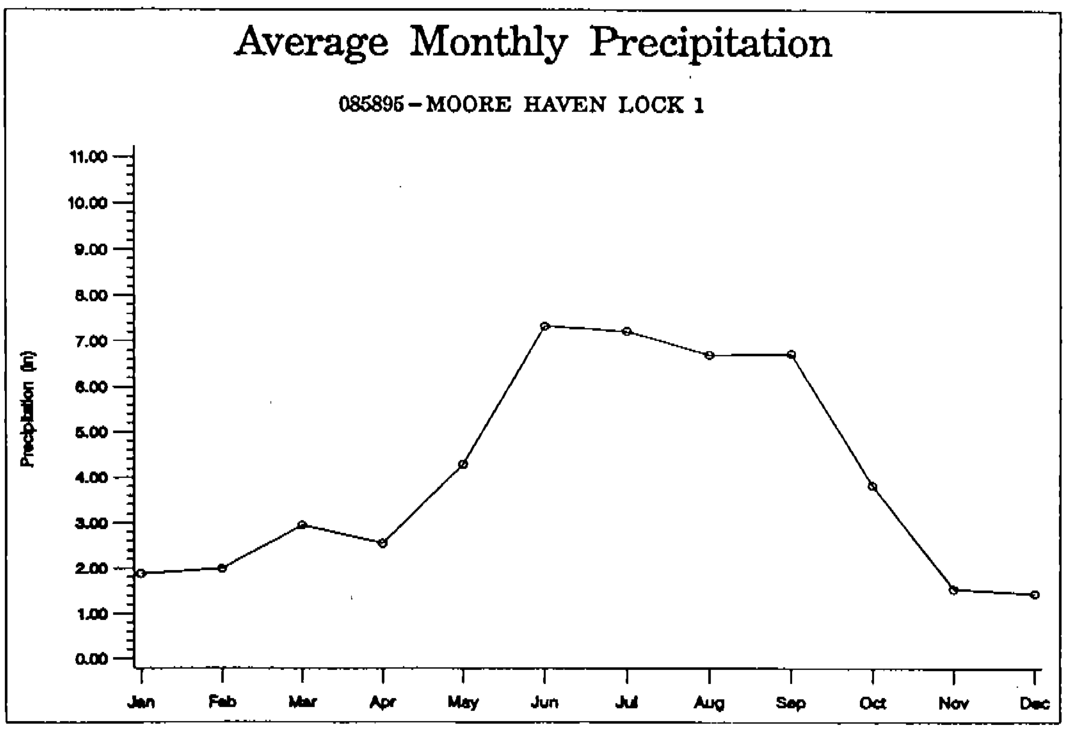
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
085895 - MOORE HAVEN LOCK 1
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
085895 - MOORE HAVEN LOCK 1
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
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May
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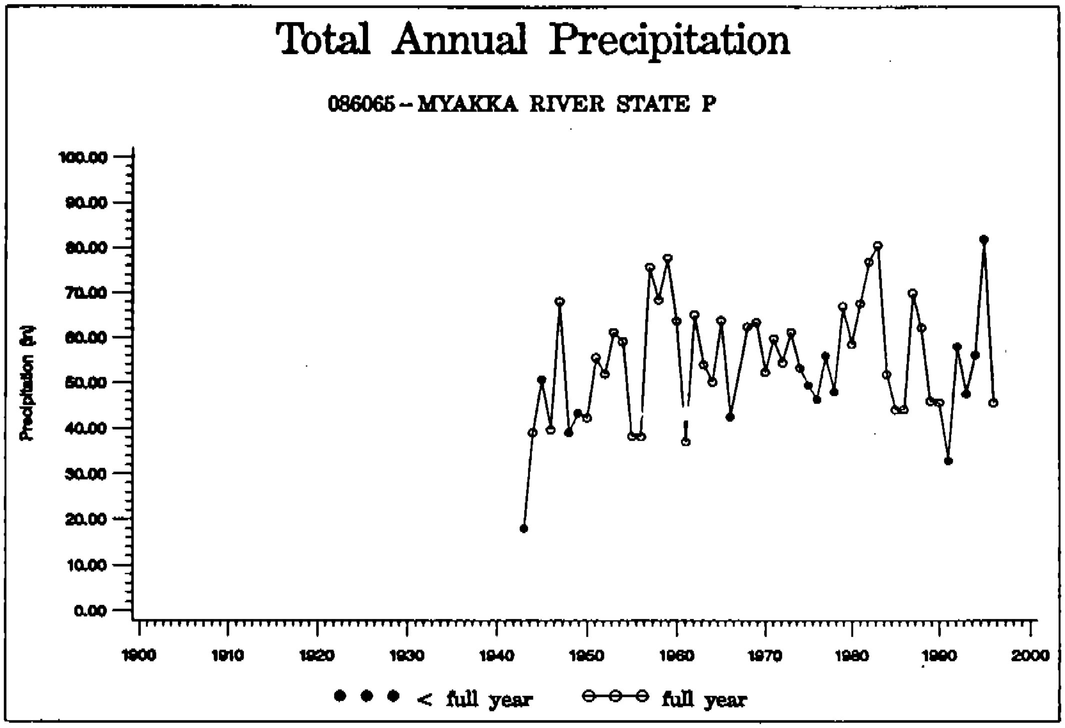
Sep
Oct
Nov
Dec


Total Annual Precipitation
086065 - MYAKKA RIVER STATE P
Precipitation (in)
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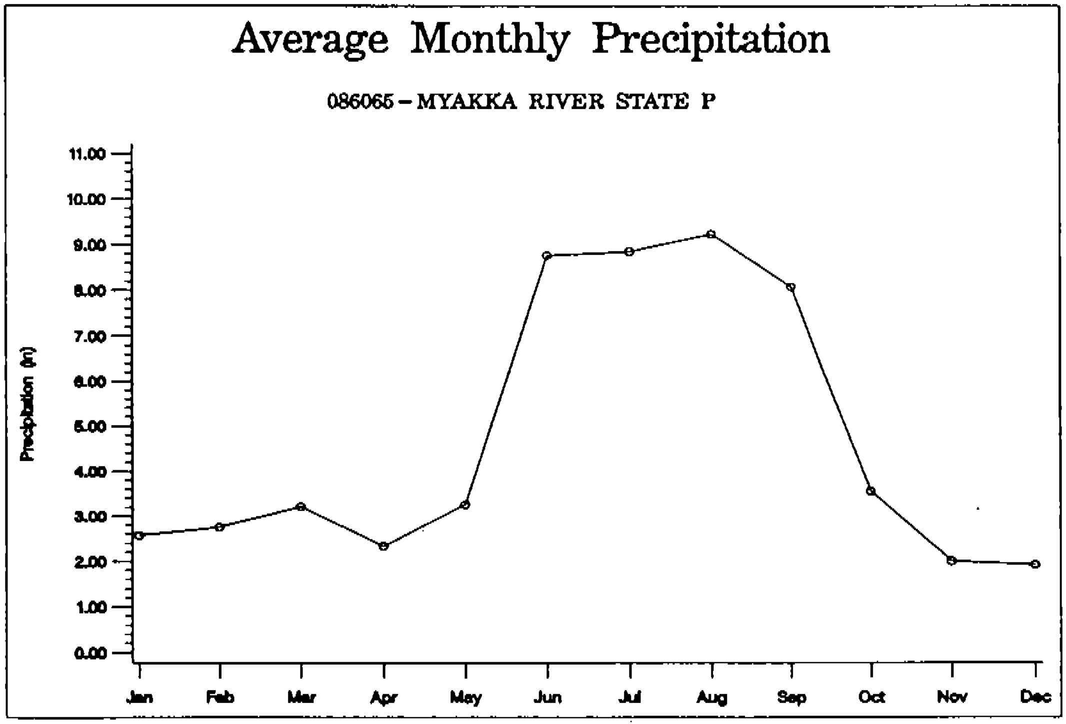
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
086065 - MYAKKA RIVER STATE P
Precipitation (in)
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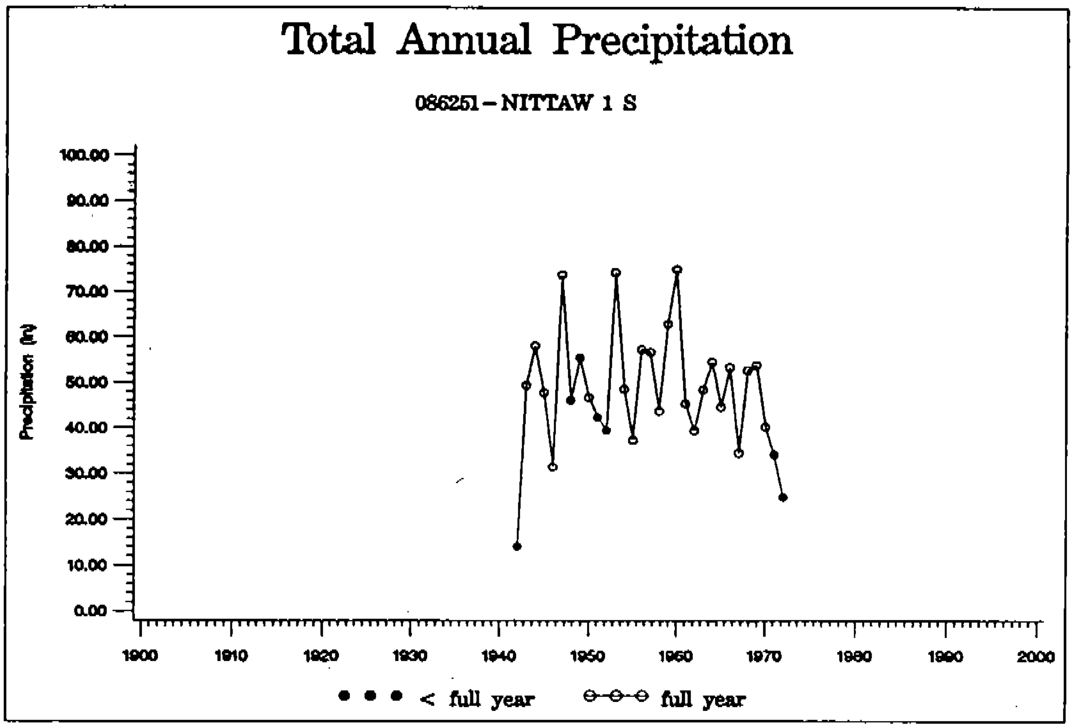
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
086251 – NITTAW 1 S
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
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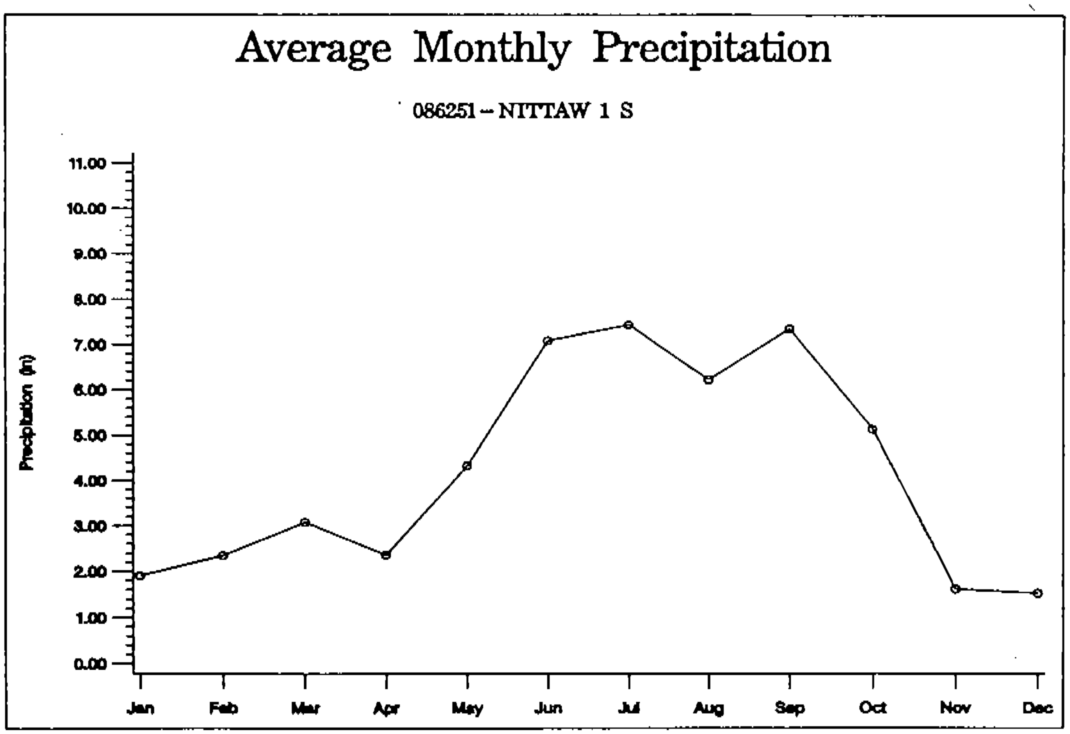
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
086251 – NITTAW 1 S
Precipitation (in)
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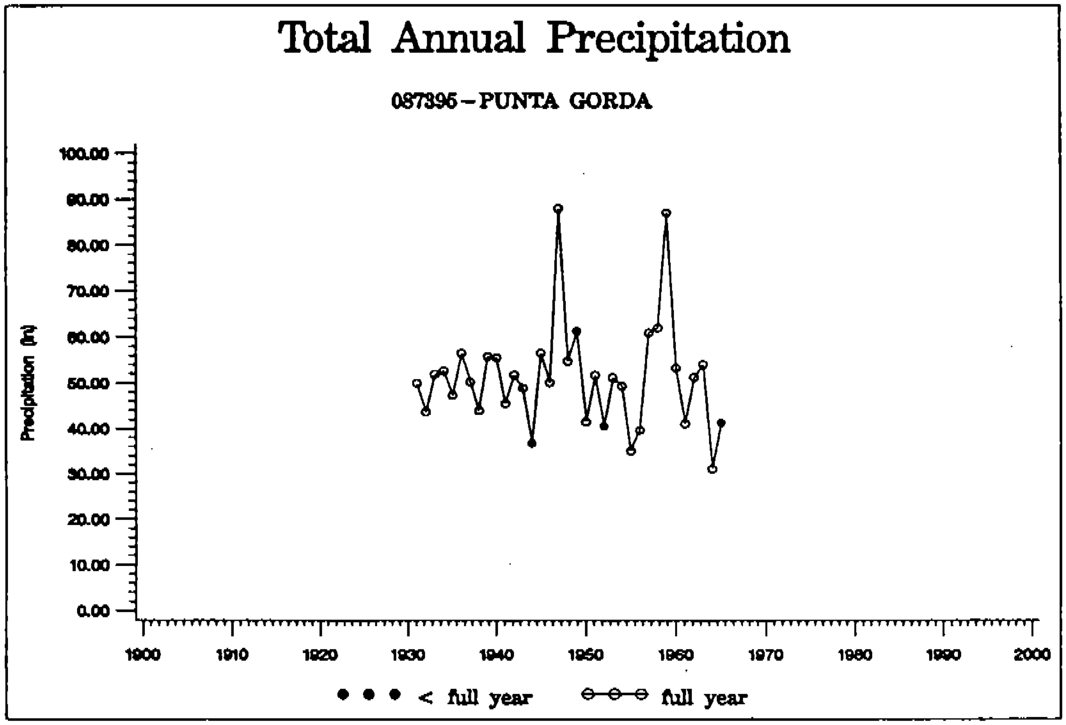
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
087395-PUNTA GORDA
Precipitation (in)
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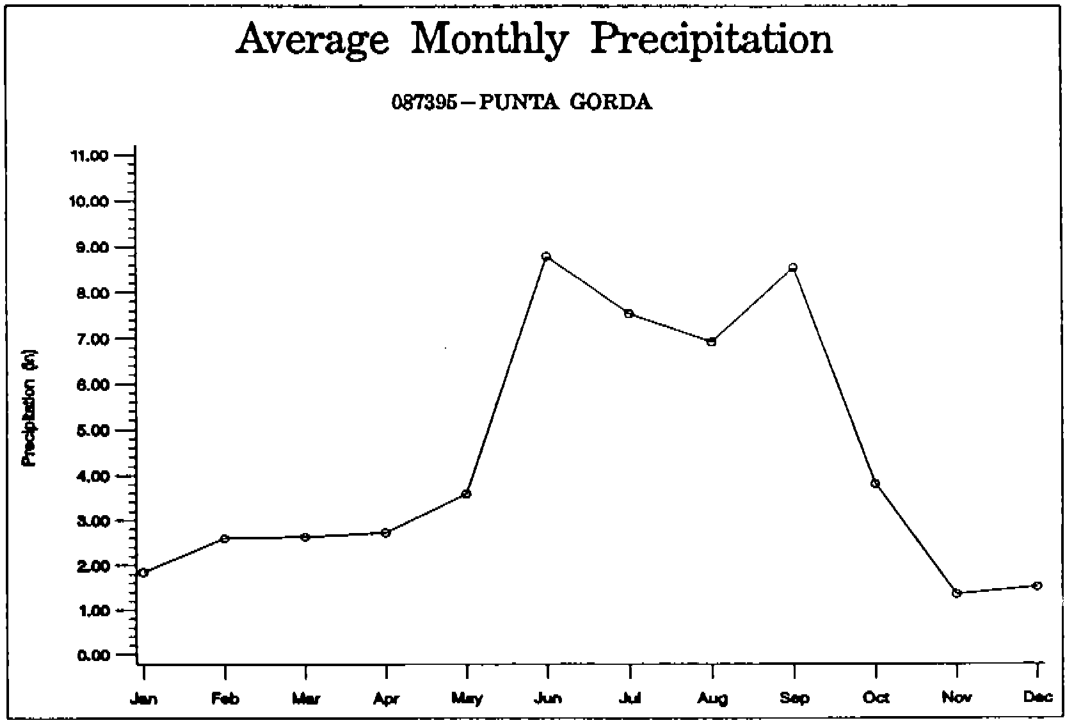
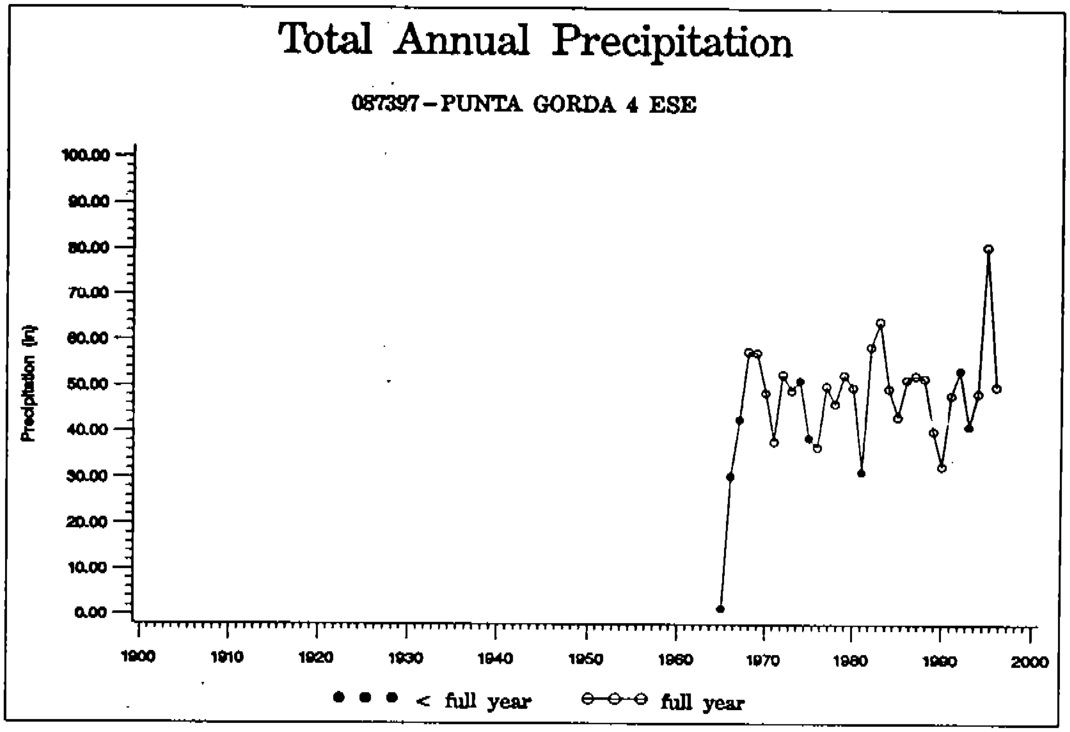
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
087395-PUNTA GORDA
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
087397-PUNTA GORDA 4 ESE
Precipitation (in)
100.00
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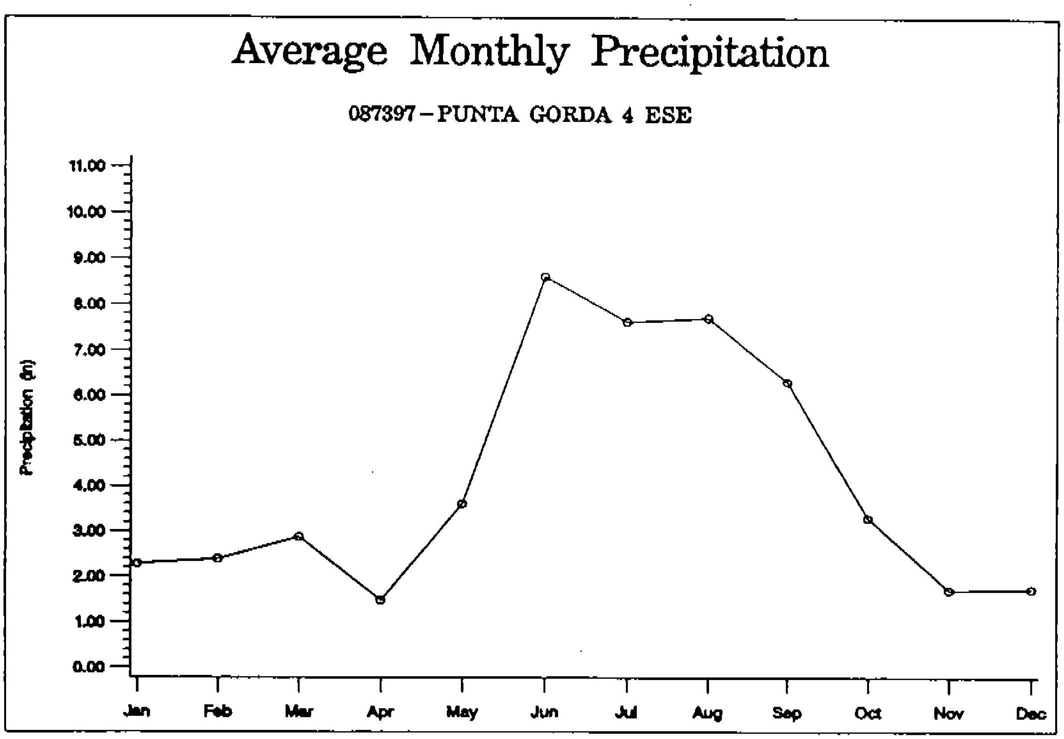
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
087397-PUNTA GORDA 4 ESE
Precipitation (in)
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10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
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1.00
0.00
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Feb
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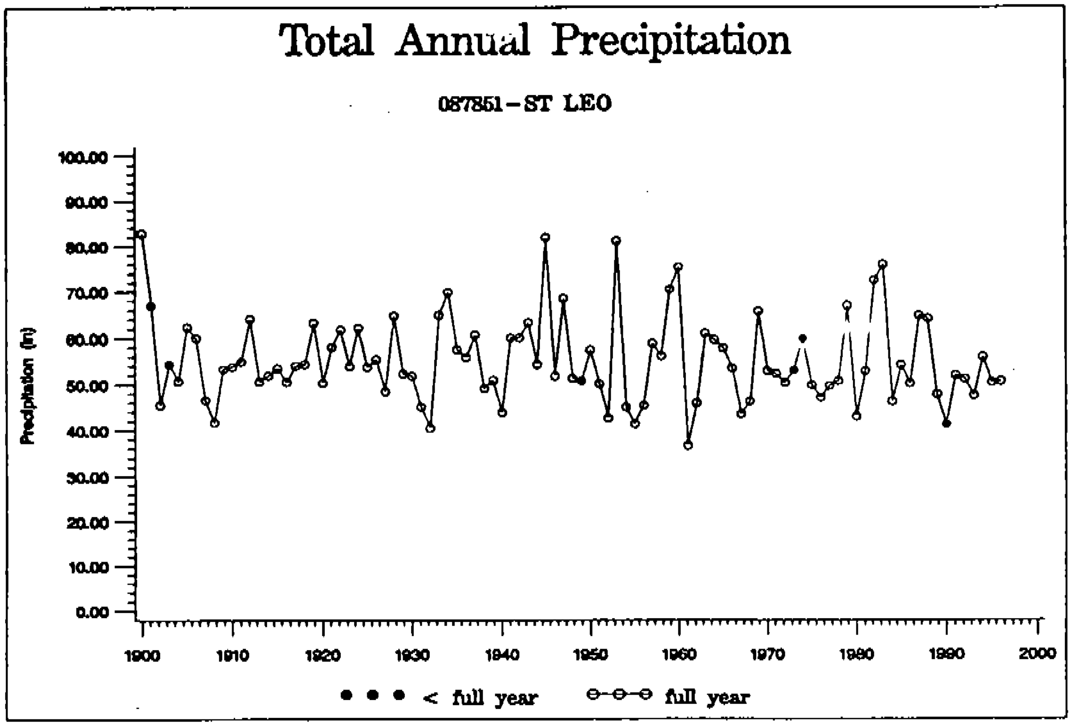
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
087851-ST LEO
Precipitation (in)
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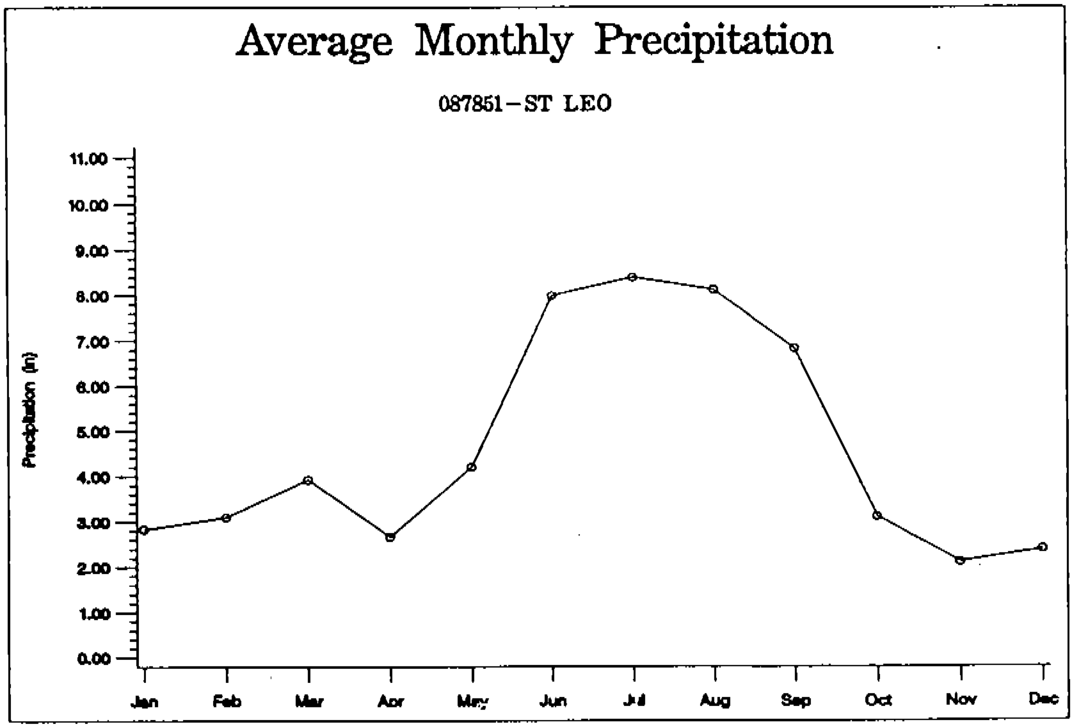
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
ɵ-ɵ-ɵ full year


Average Monthly Precipitation
087851-ST LEO
Precipitation (in)
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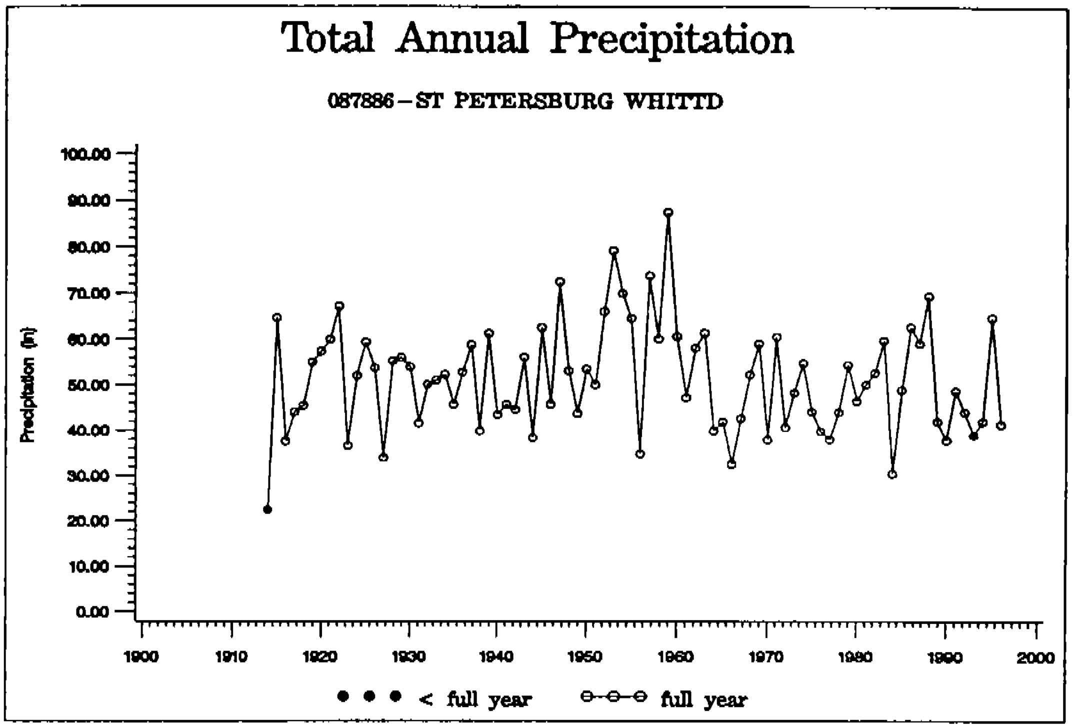
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
087886 - ST PETERSBURG WHITTD
Precipitation (in)
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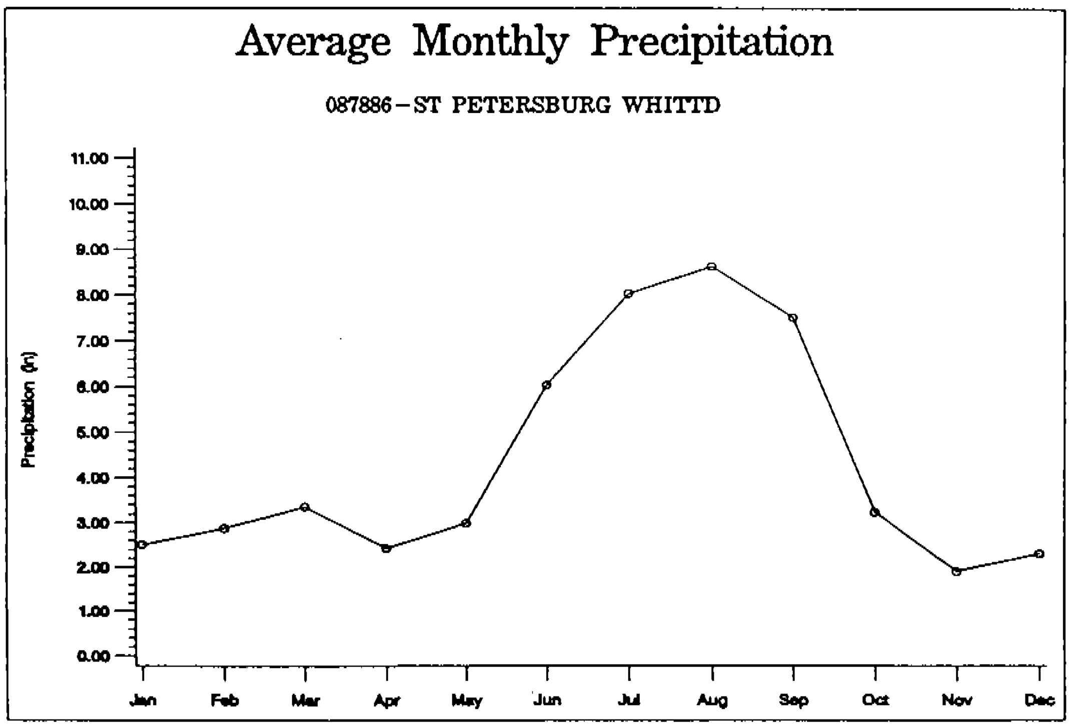
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
087886 - ST PETERSBURG WHITTD
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
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May
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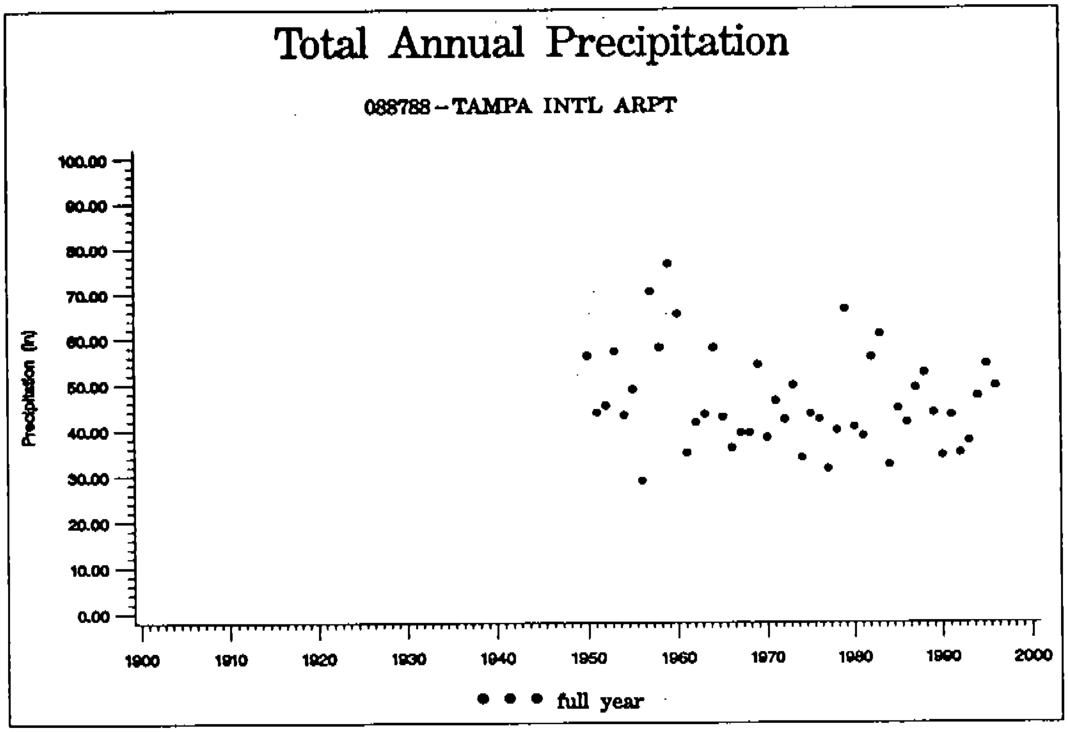
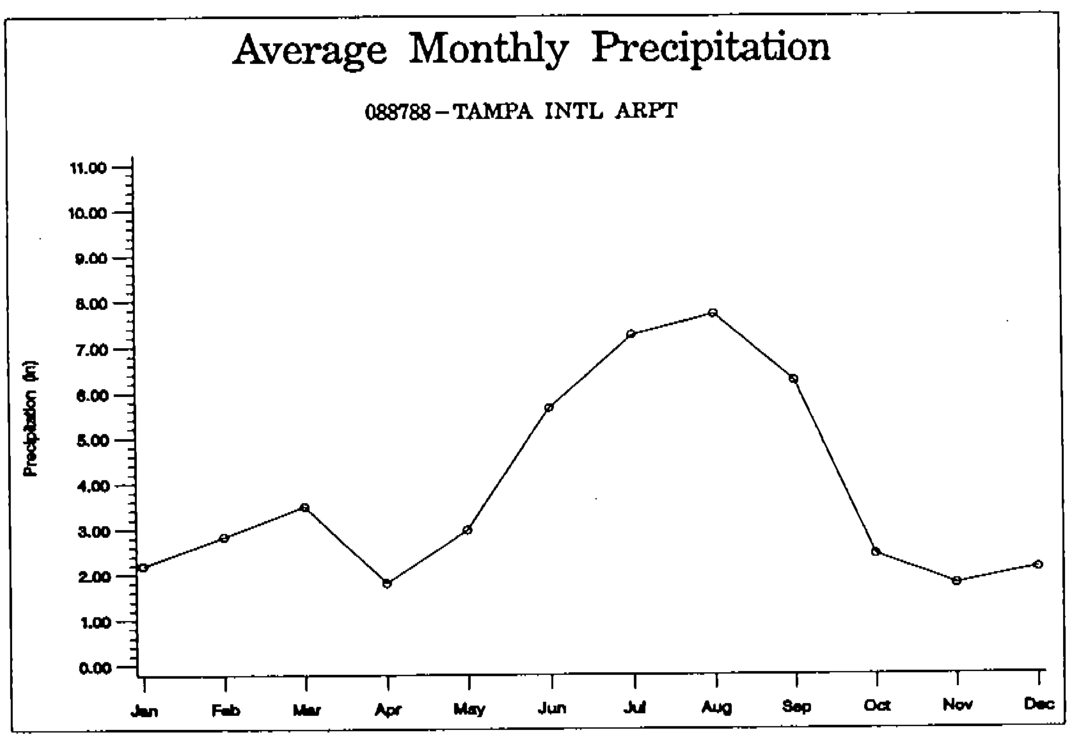
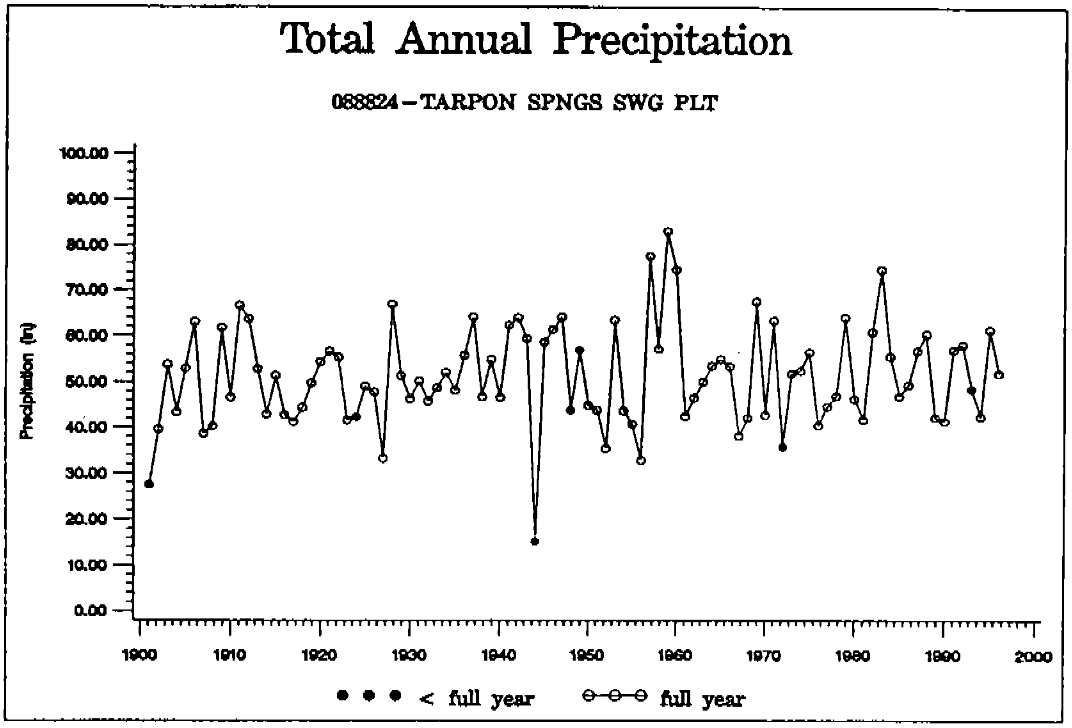
Aug
Sep
Oct
Nov
Dec



Total Annual Precipitation
088788 - TAMPA INTL ARPT
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
full year



Average Monthly Precipitation
088788 - TAMPA INTL ARPT
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
088824 – TARPON SPNGS SWG PLT
Precipitation (in)
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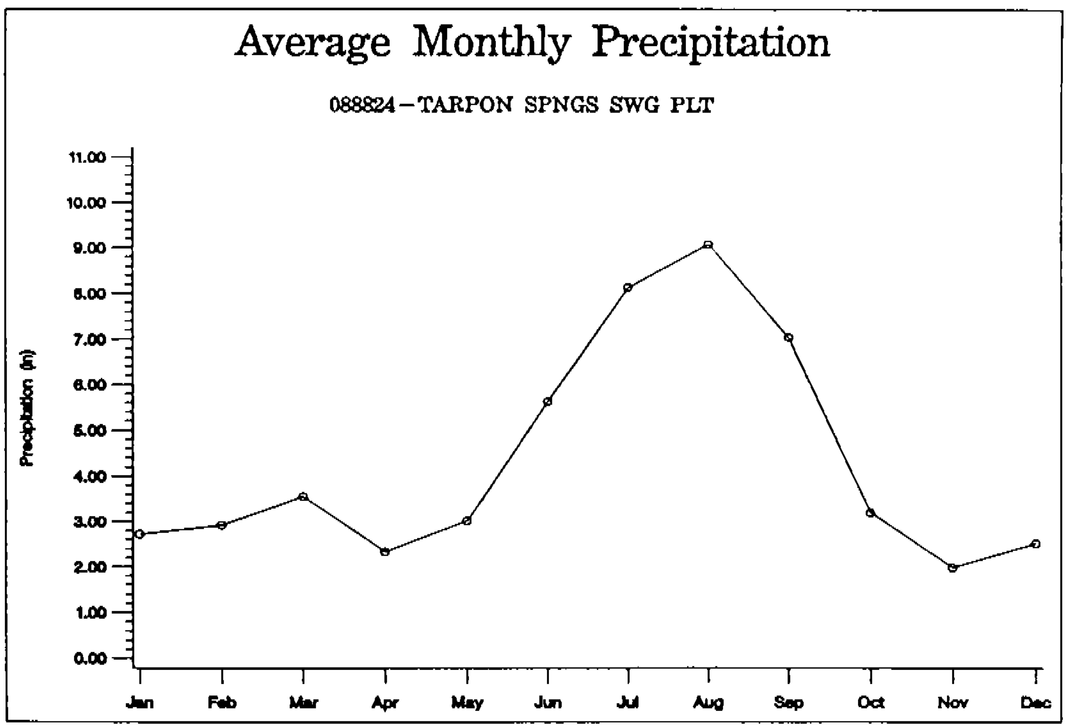
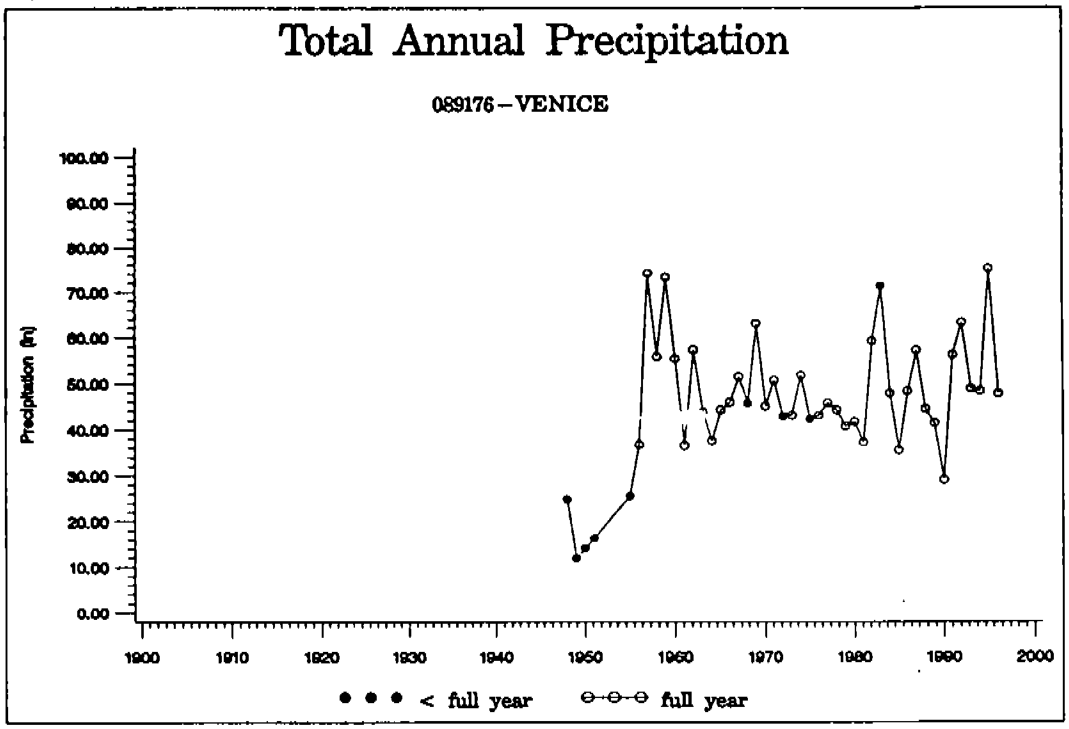
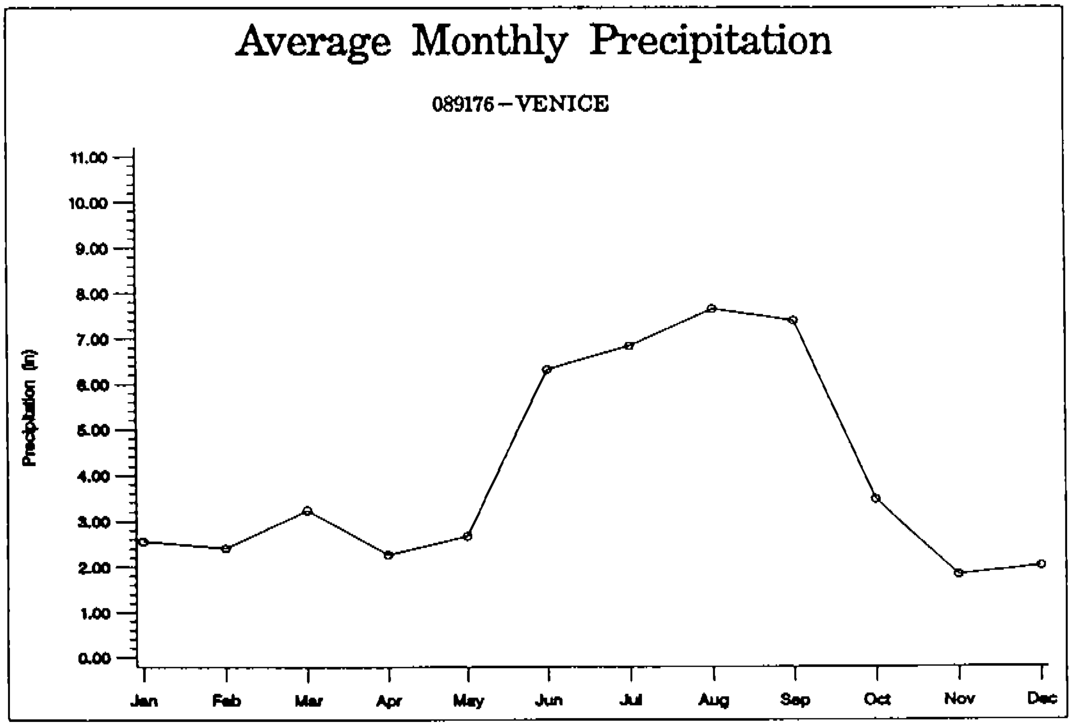
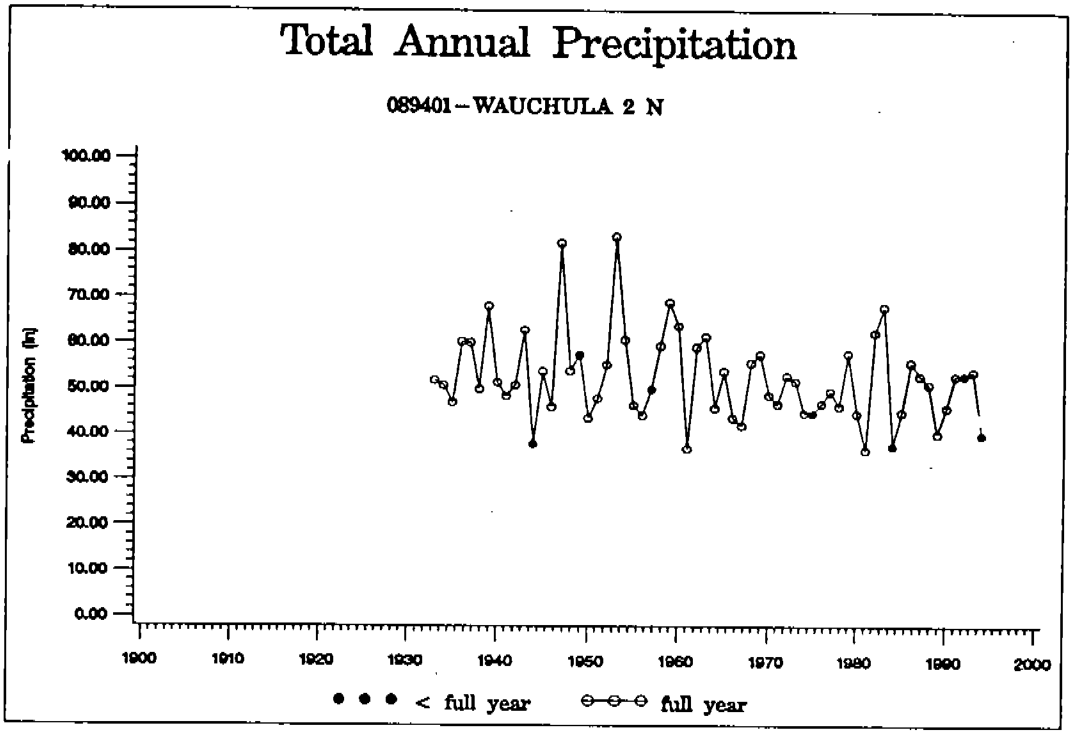
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

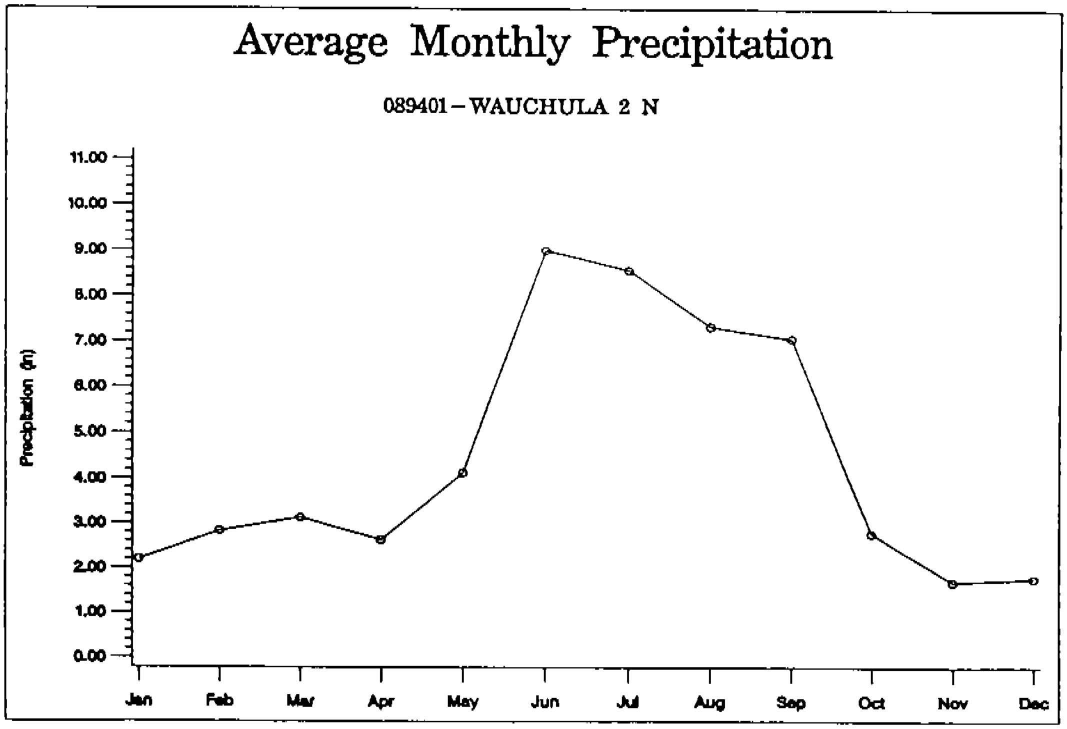

Average Monthly Precipitation
088824 – TARPON SPNGS SWG PLT
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
089176 – VENICE
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Precipitation (in)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖-⊖-⊖ full year

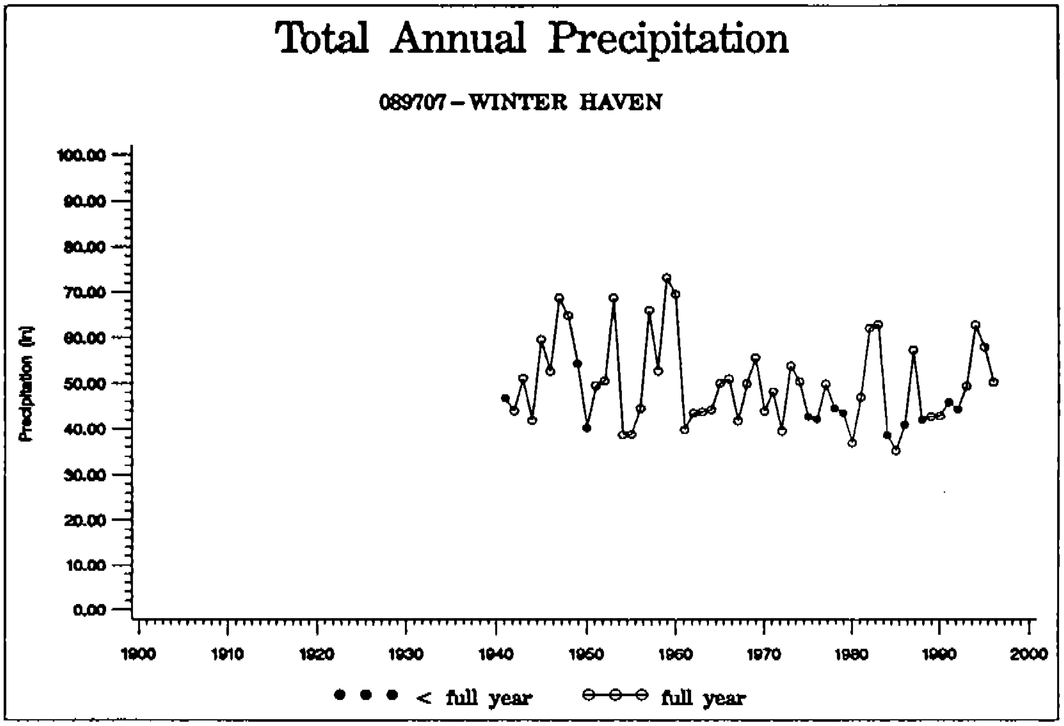

Average Monthly Precipitation
089176 – VENICE
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Precipitation (in)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

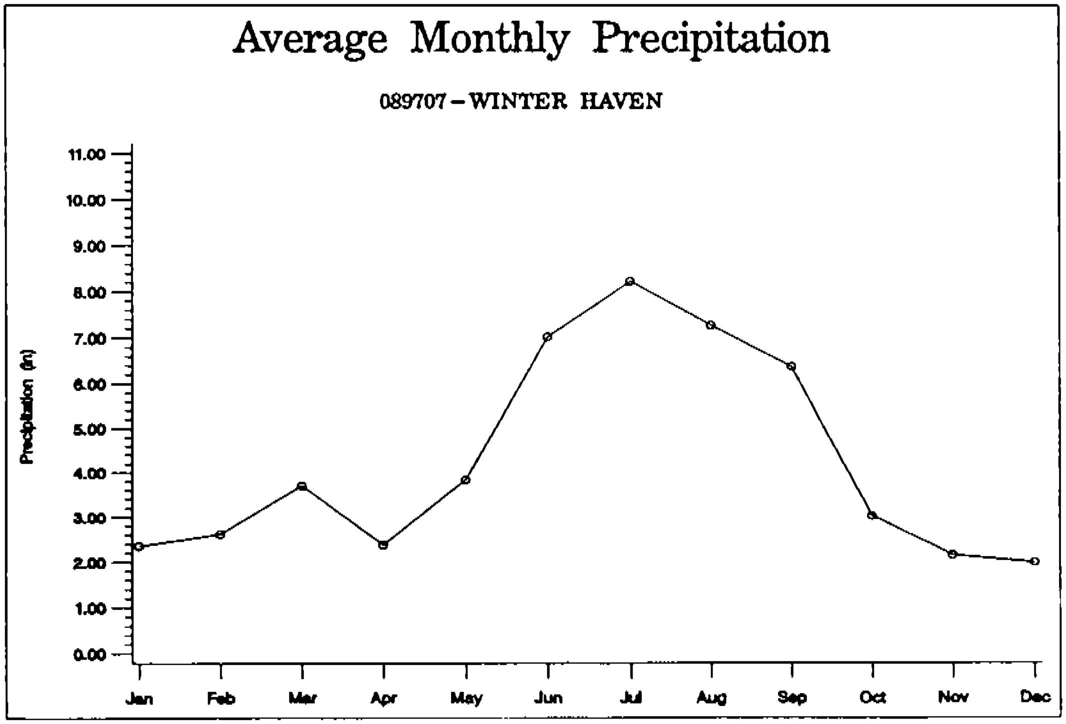


Total Annual Precipitation
089401 – WAUCHULA 2 N
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Precipitation
089401 – WAUCHULA 2 N
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Precipitation
089707 - WINTER HAVEN
Precipitation (in)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Precipitation
089707 - WINTER HAVEN
Precipitation (in)
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan
Feb
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May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Appendix B

Total annual and mean monthly streamflow plots for basins within the Charlotte Harbor Study Area

Myakka River Basin
Peace River Basin
Charlotte Harbor Basin
Pine Island/ Matlacha Pass Basin
Caloosahatchee River Basin
Estero Bay Basin
Coastal Venice Basin

WATER RESOURCES DATA FOR FLORIDA, 1995
Volume 3A: Southwest Florida Surface Water

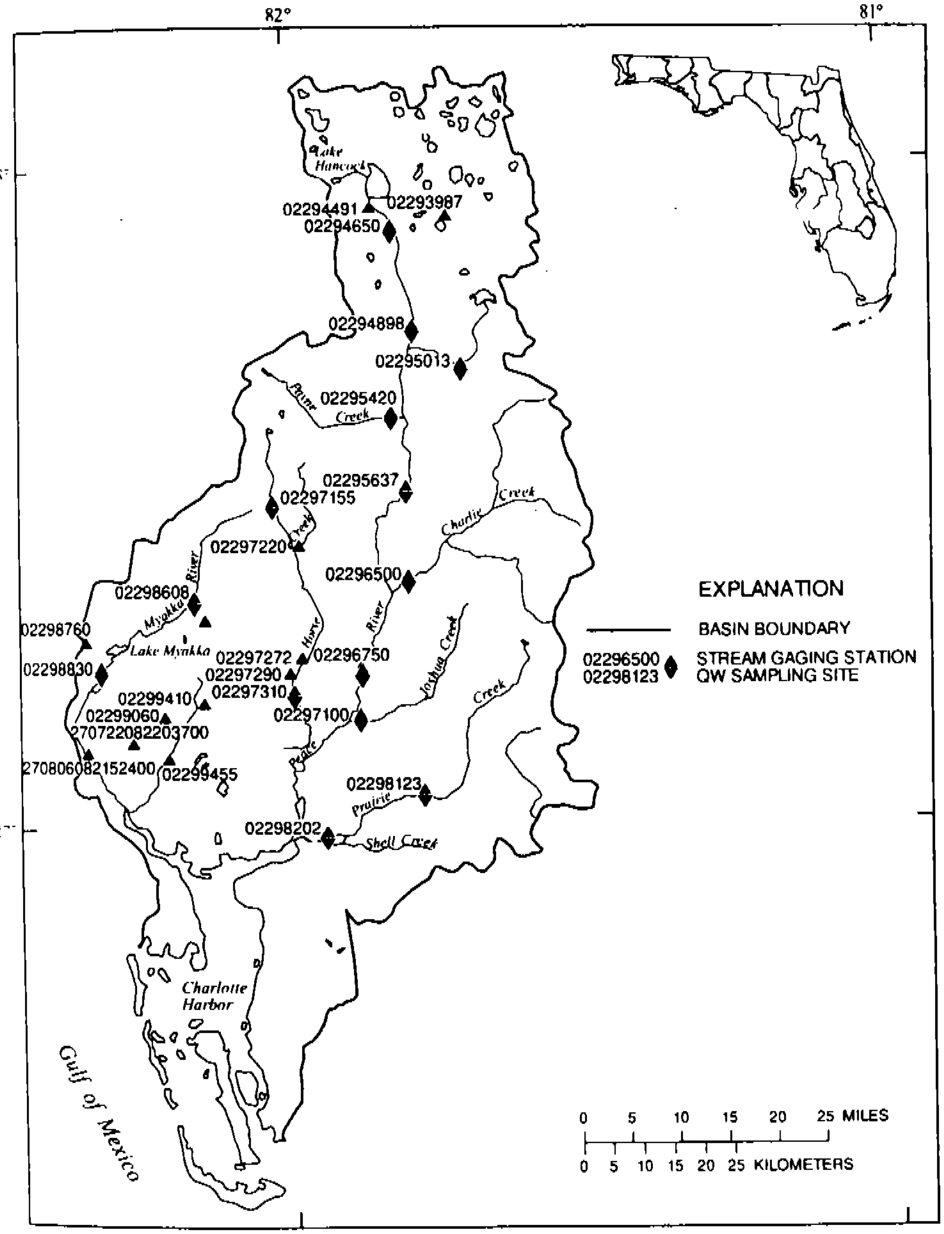


Figure 14.--Location of stream gaging stations in the Peace and Myakka River basins, Charlotte Harbor and Coastal area.

WATER RESOURCES DATA FOR FLORIDA, 1995
Volume 3A: Southwest Florida Surface Water

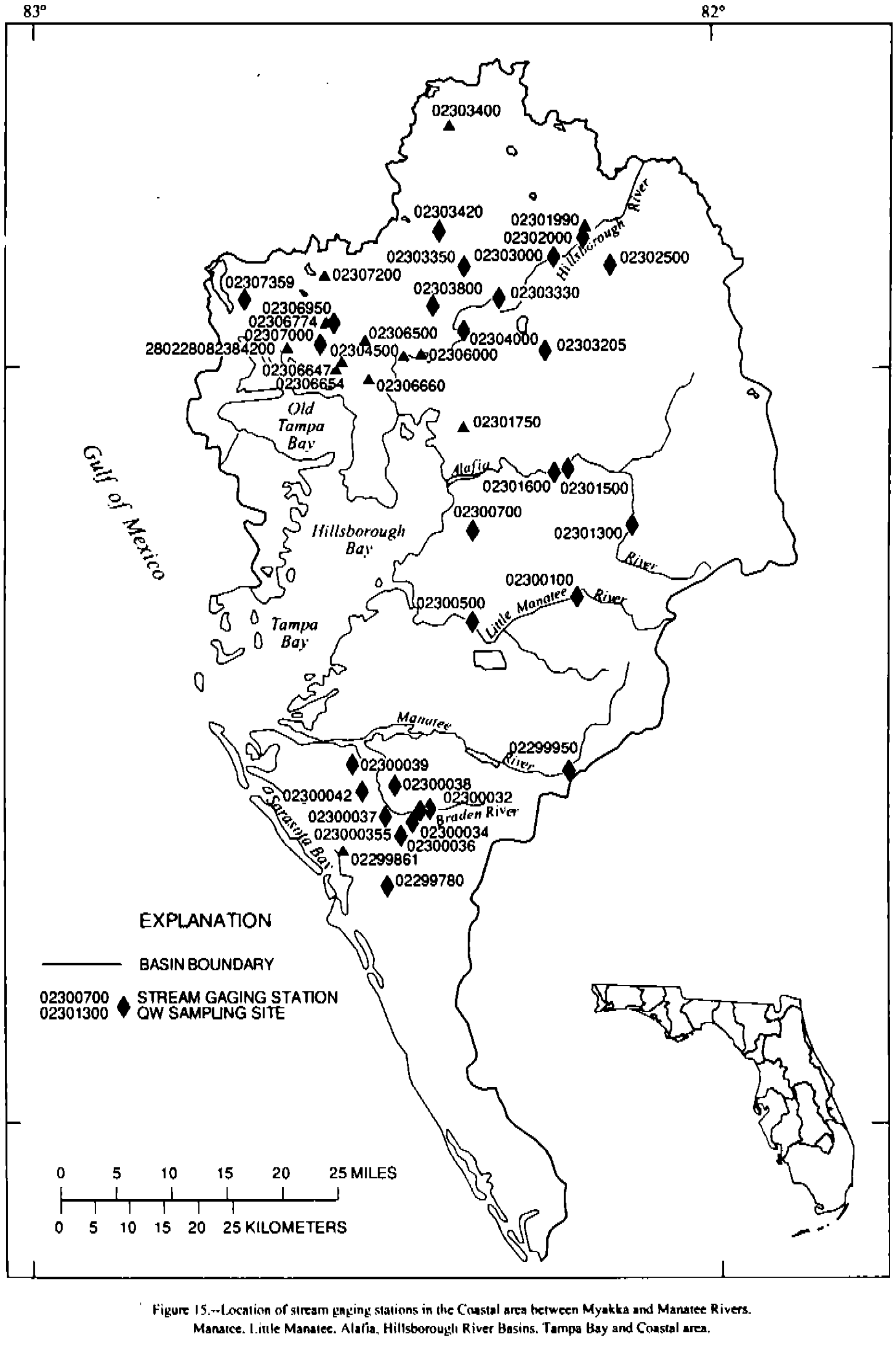


Figure 15.--Location of stream gaging stations in the Coastal area between Myakka and Manatee Rivers. Manatee. Little Manatee. Alafia, Hillsborough River Basins. Tampa Bay and Coastal area.

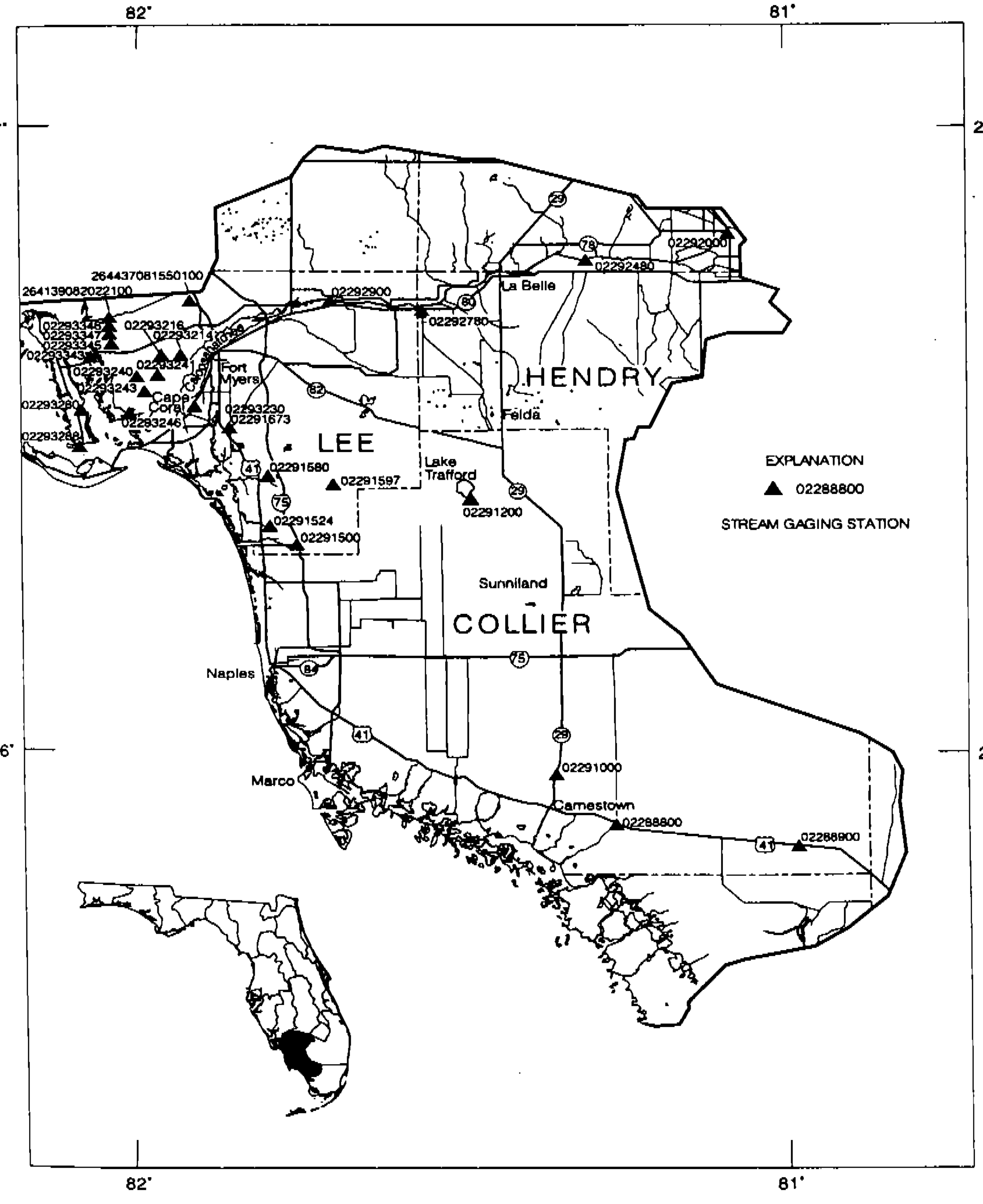
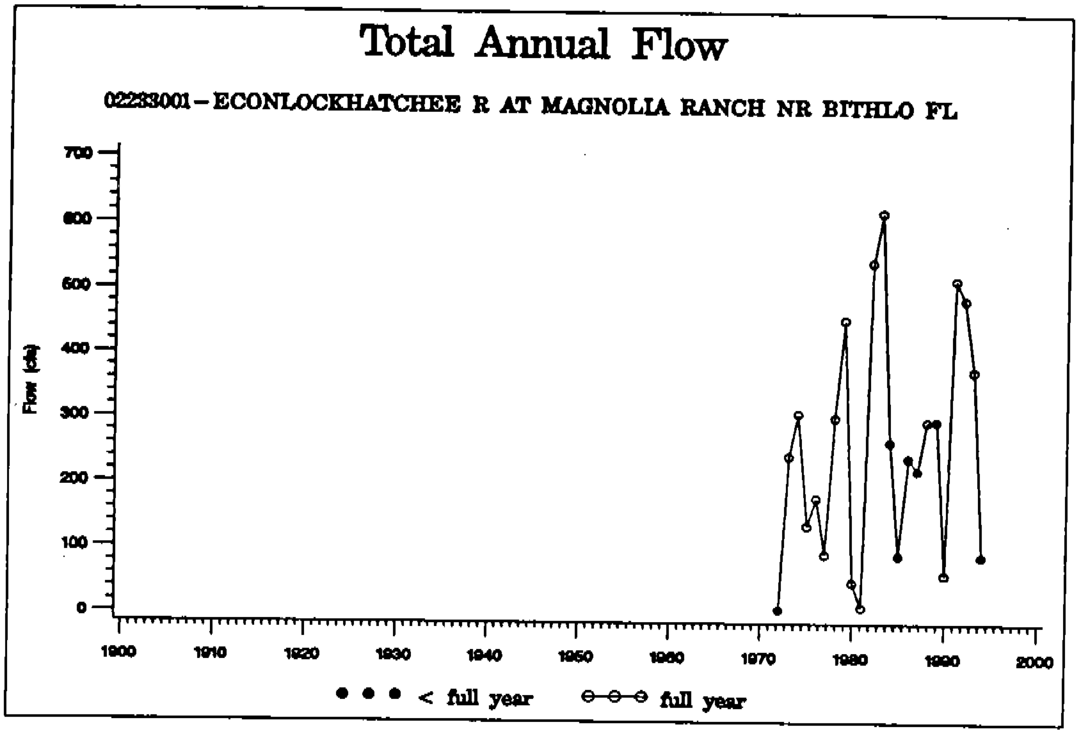
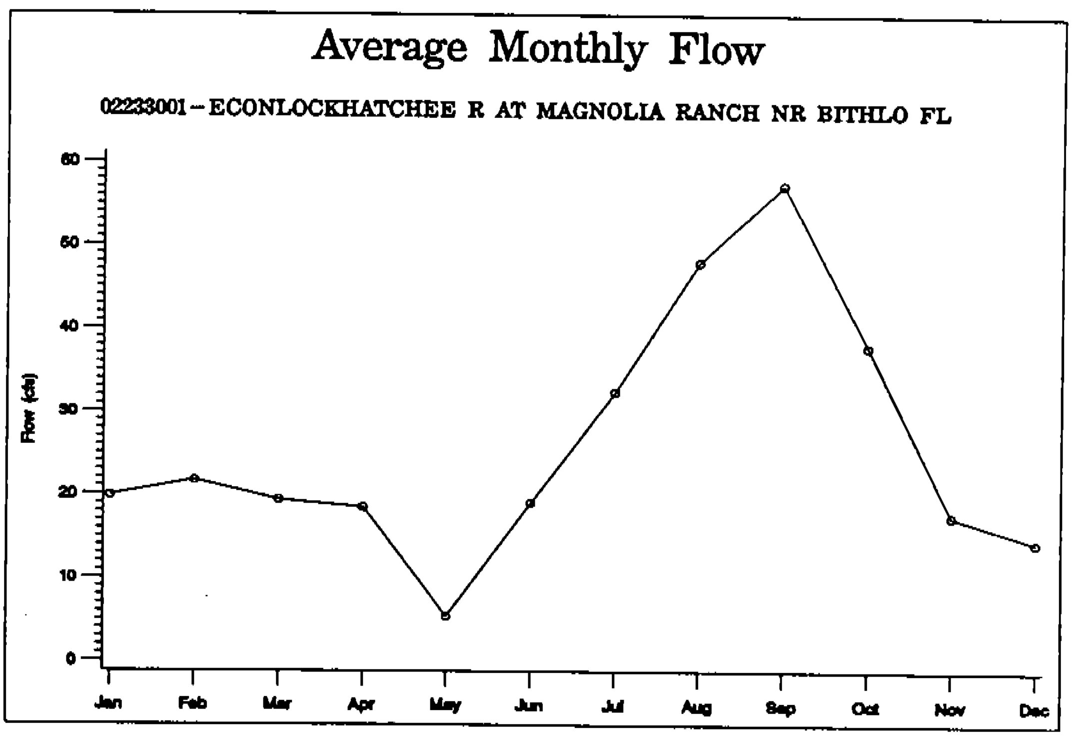
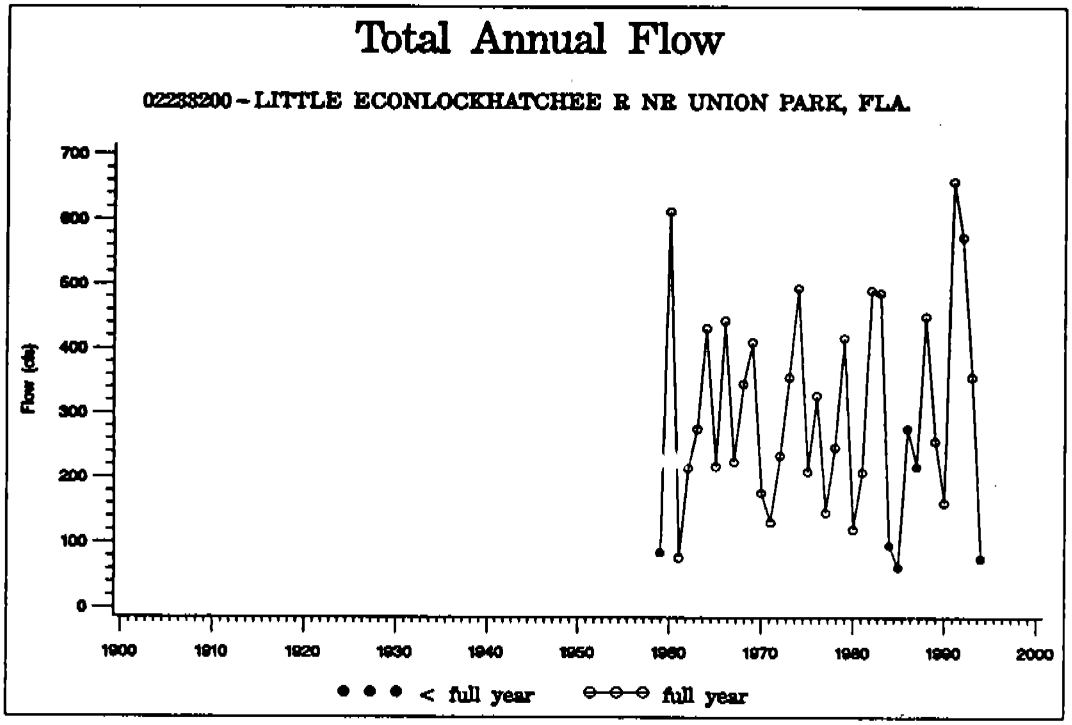
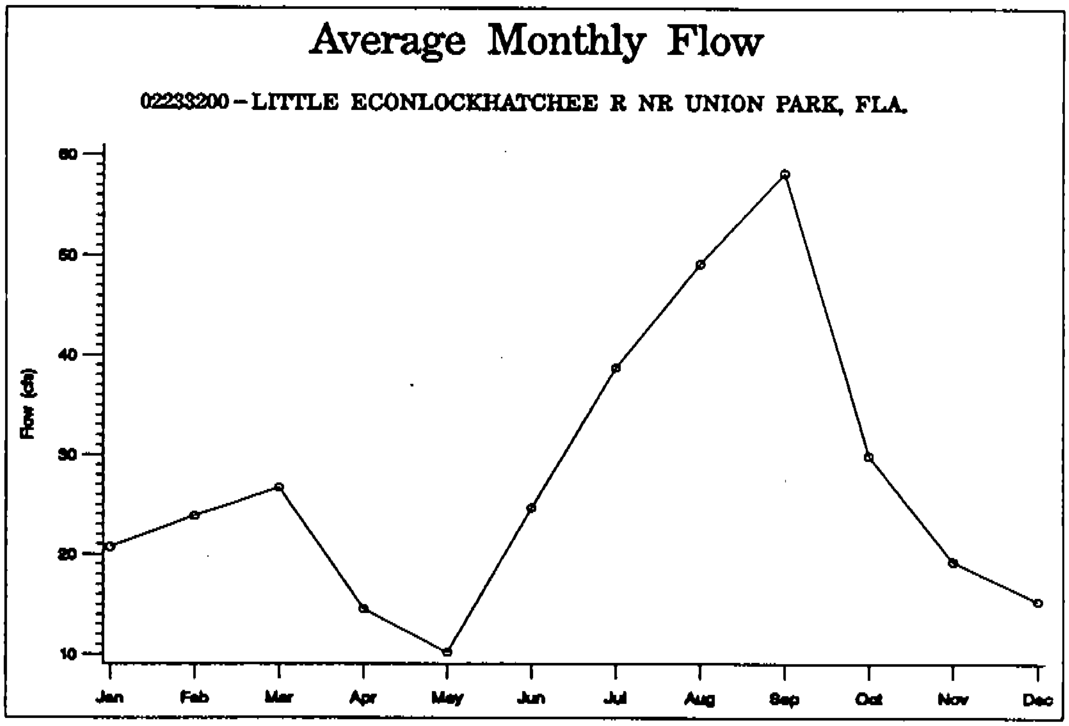


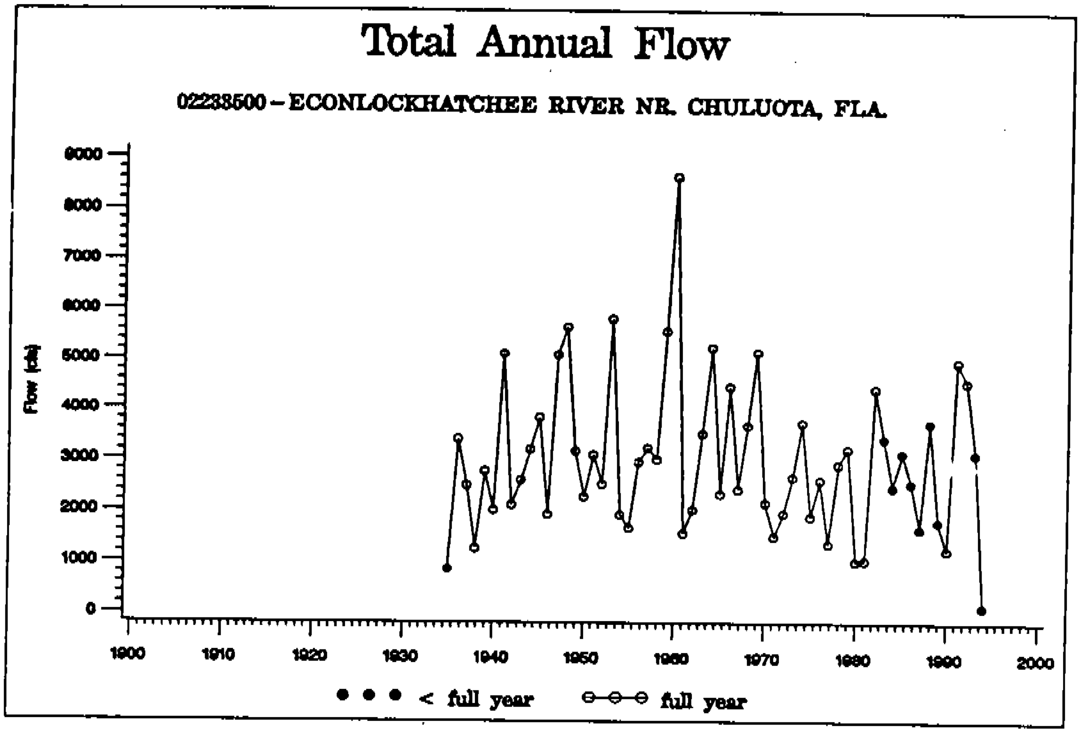
Figure 10. Location of gaging stations in the Big Cypress Swamp and southwestern coastal area; the Caloosahatchee River; Lake Trafford; Charlotte Harbor and the coastal area.


Total Annual Flow
02233001 – ECONLOCKHATCHEE R AT MAGNOLIA RANCH NR BITHLO FL
Flow (cfs)
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

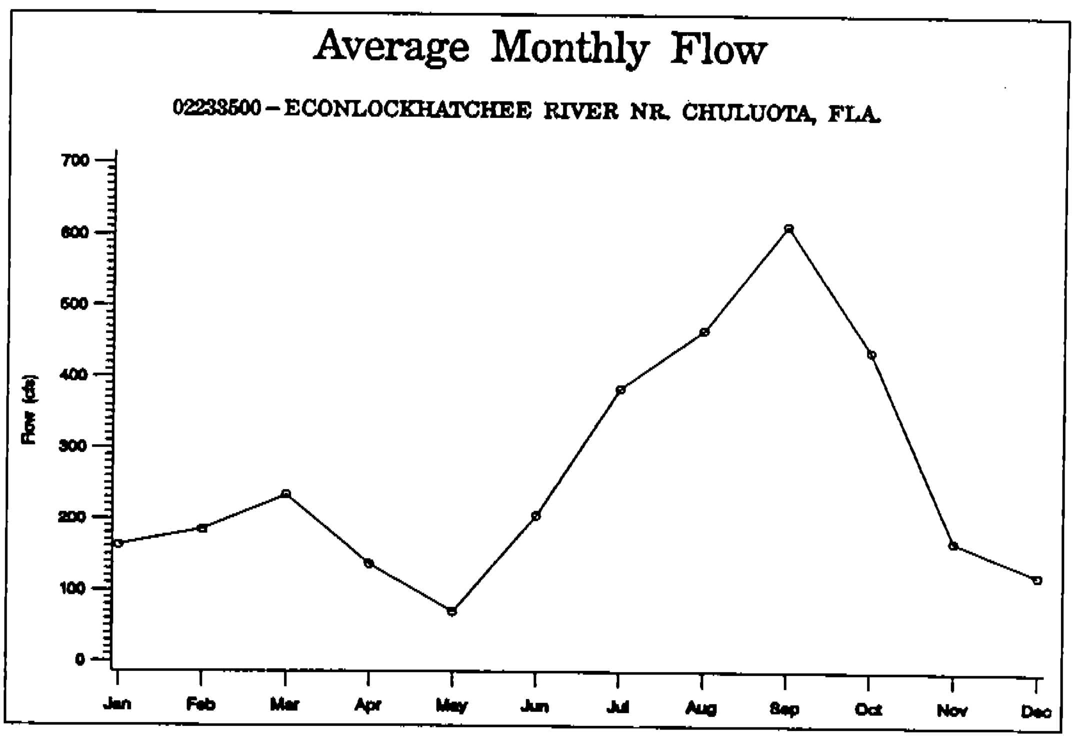

Average Monthly Flow
02233001 – ECONLOCKHATCHEE R AT MAGNOLIA RANCH NR BITHLO FL
Flow (cfs)
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02233200 - LITTLE ECONLOCKHATCHEE R NR UNION PARK, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

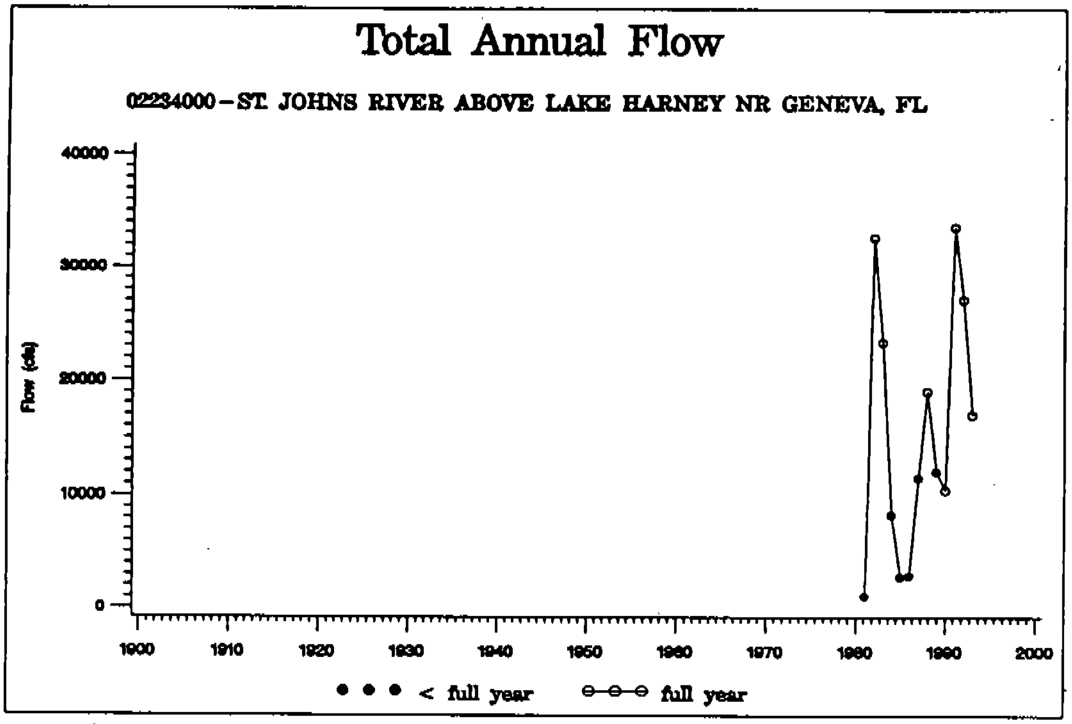

Average Monthly Flow
02233200 - LITTLE ECONLOCKHATCHEE R NR UNION PARK, FLA.
Flow (cfs)
10
20
30
40
50
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

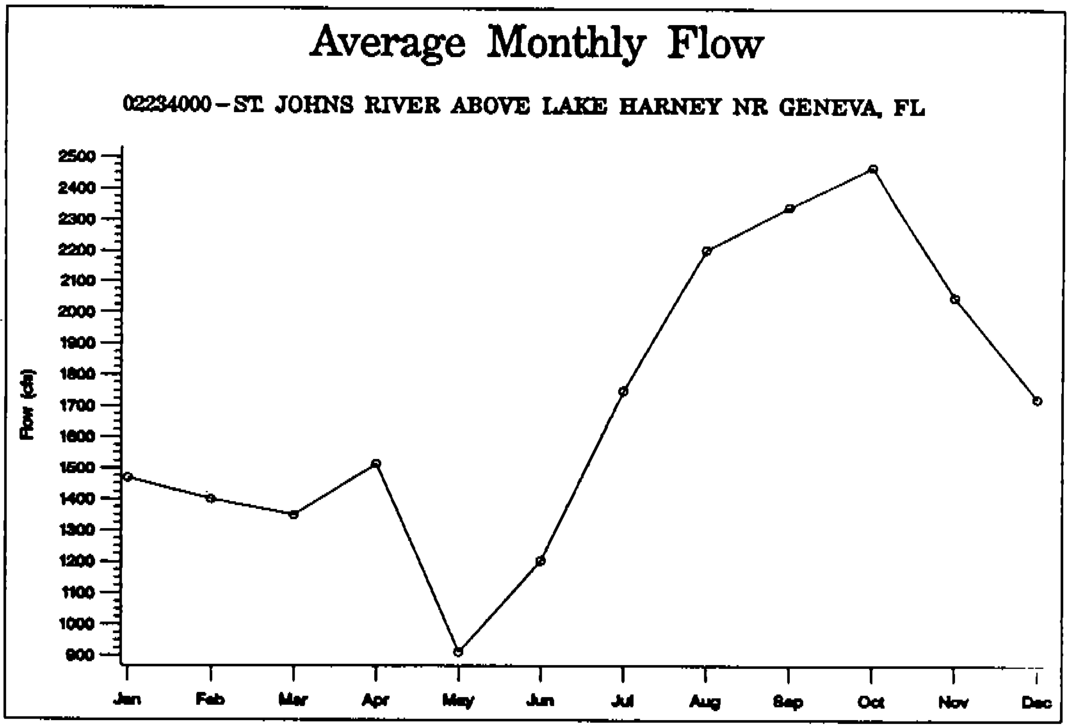


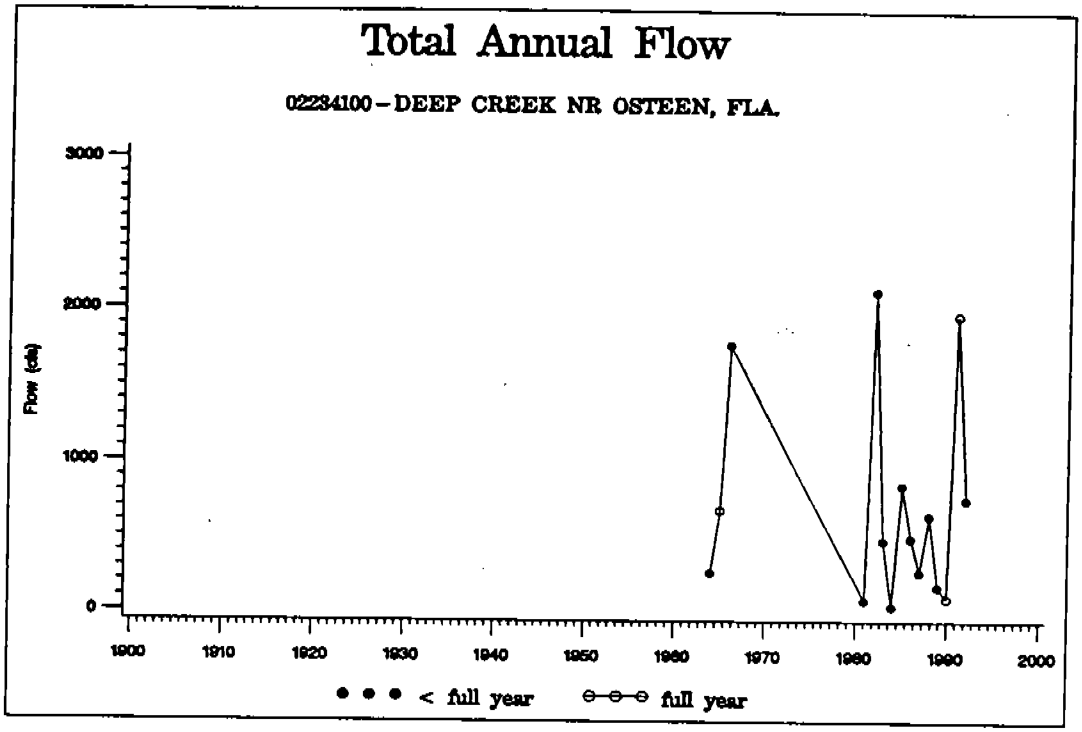
Total Annual Flow
02233500 – ECONLOCKHATCHEE RIVER NR. CHULUOTA, FLA.
Flow (cfs)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
o–o–o full year



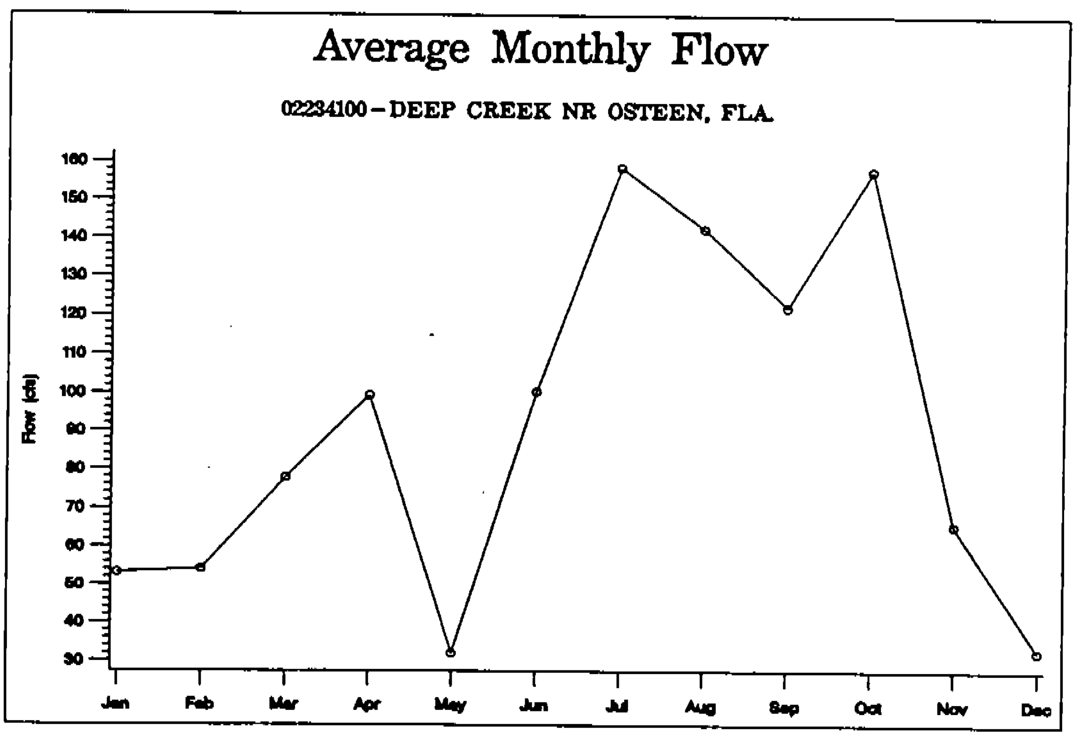
Average Monthly Flow
02233500 – ECONLOCKHATCHEE RIVER NR. CHULUOTA, FLA.
Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02234000 – ST. JOHNS RIVER ABOVE LAKE HARNEY NR GENEVA, FL
Flow (cfs)
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

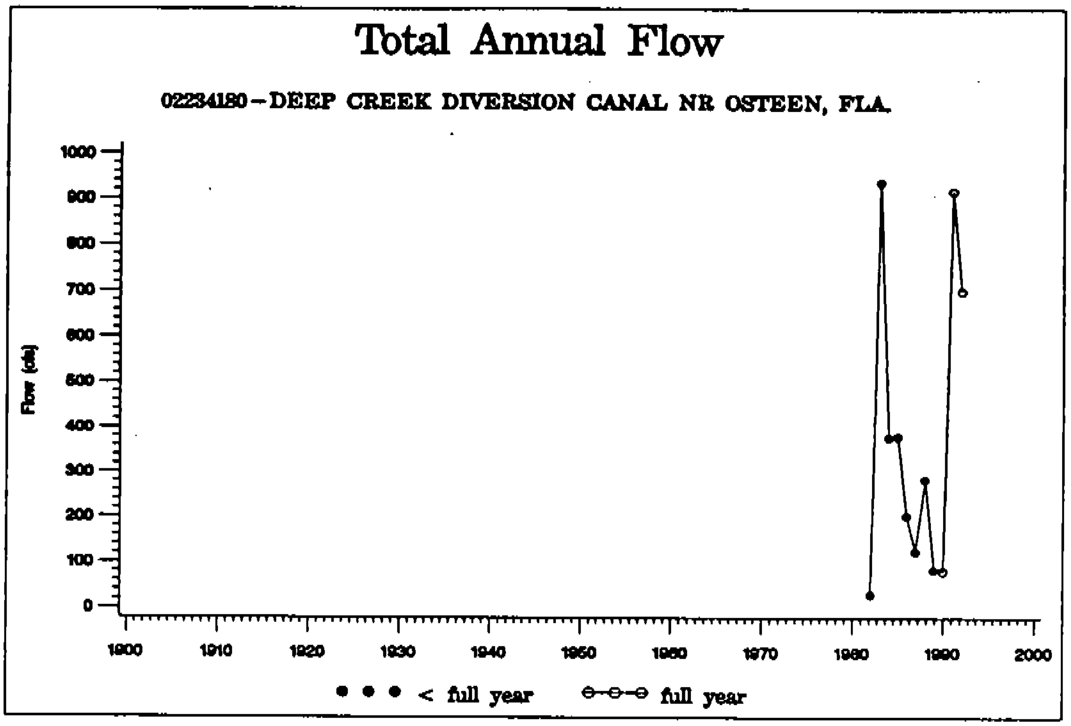

Average Monthly Flow
02234000 – ST. JOHNS RIVER ABOVE LAKE HARNEY NR GENEVA, FL
Flow (cfs)
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



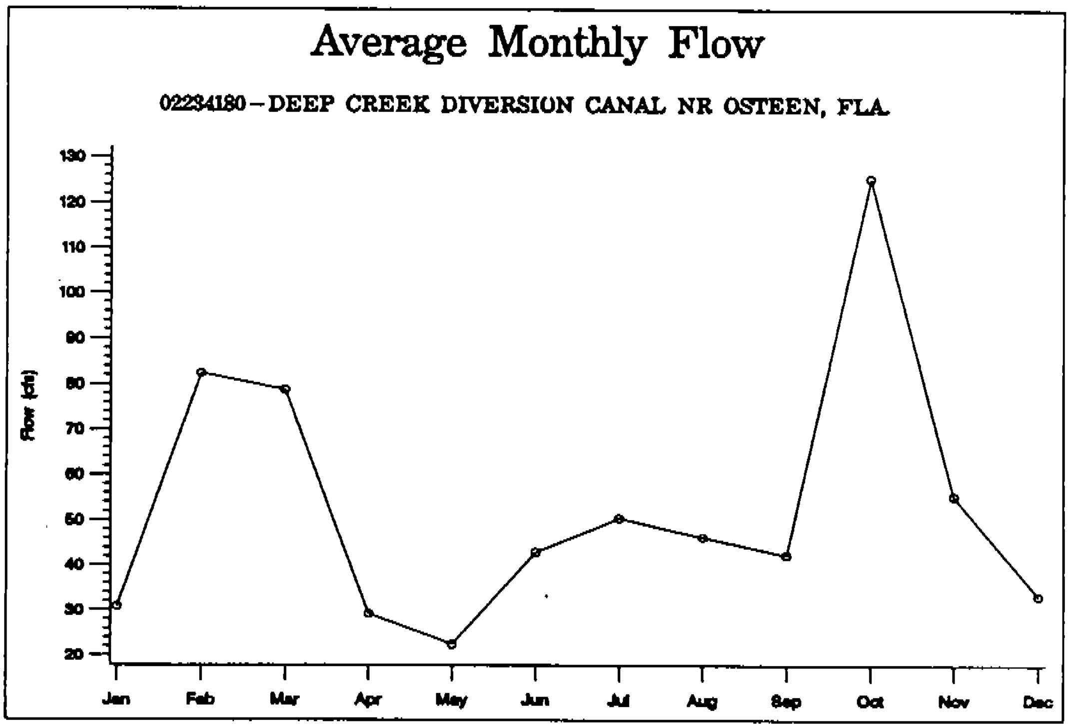
Total Annual Flow
02234100 – DEEP CREEK NR OSTEEN, FLA.
Flow (cfs)
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



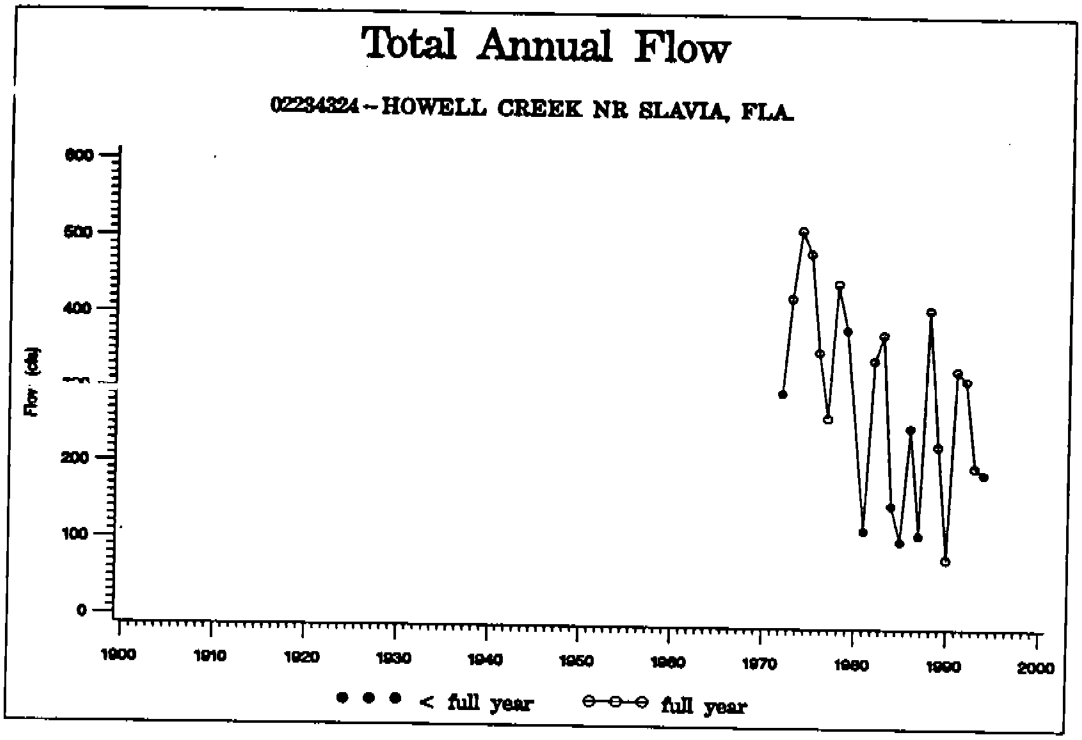
Average Monthly Flow
02234100 – DEEP CREEK NR OSTEEN, FLA.
Flow (cfs)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

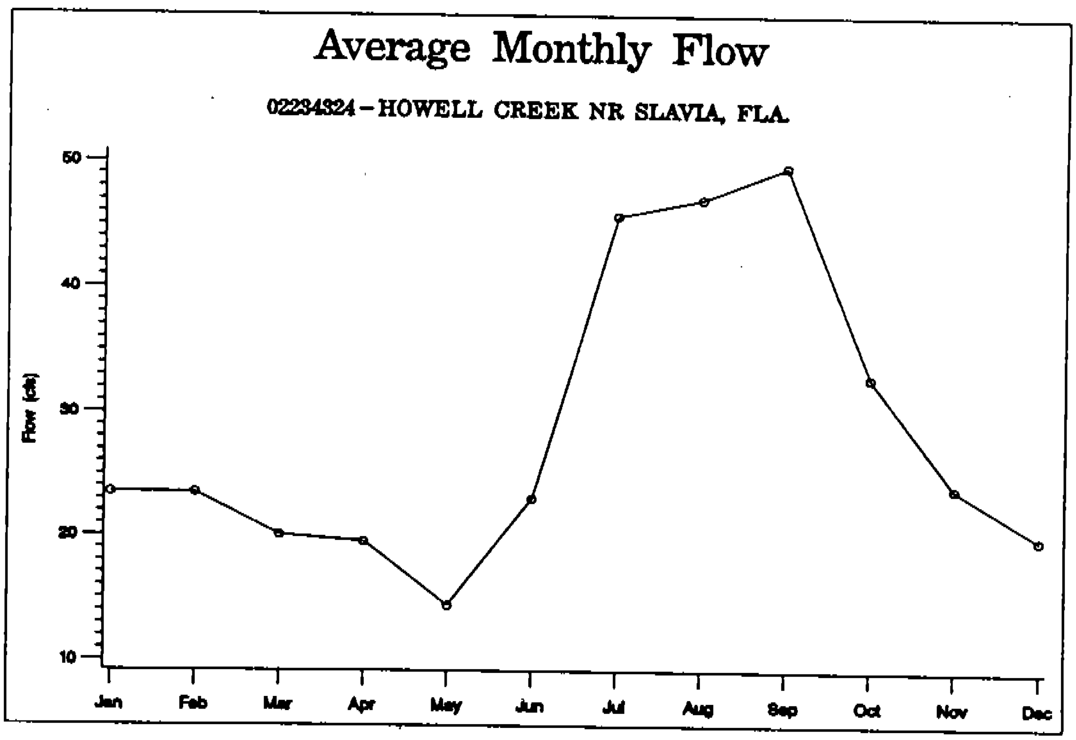


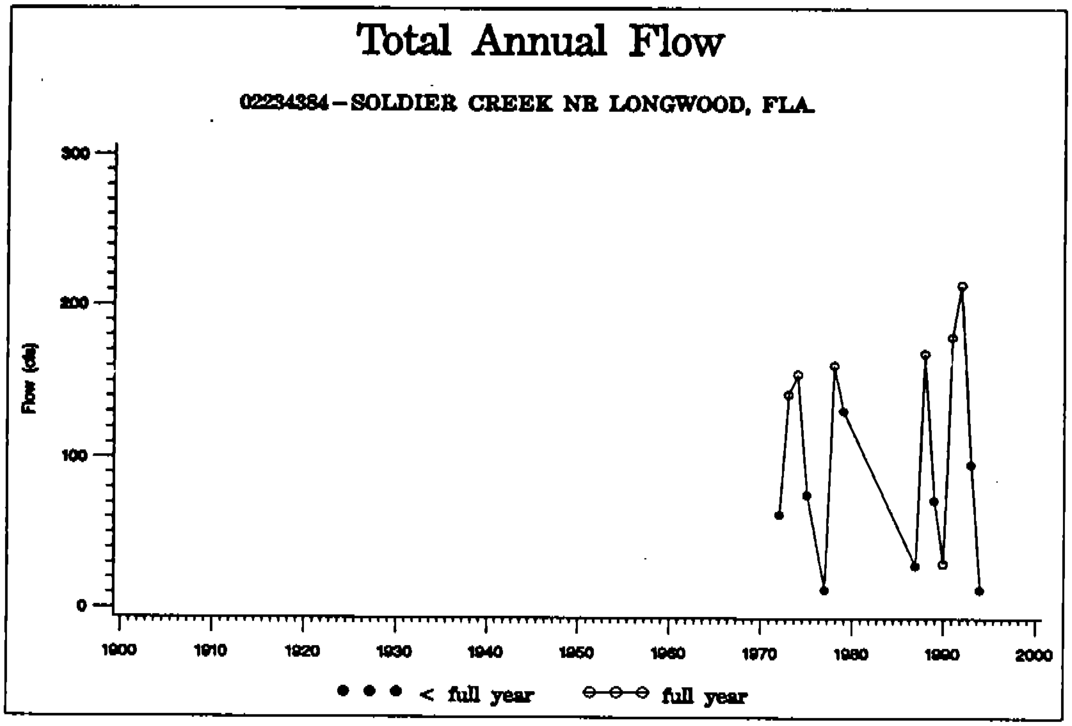
Total Annual Flow
02234180 – DEEP CREEK DIVERSION CANAL NR OSTEEN, FLA.
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
o-o-o full year

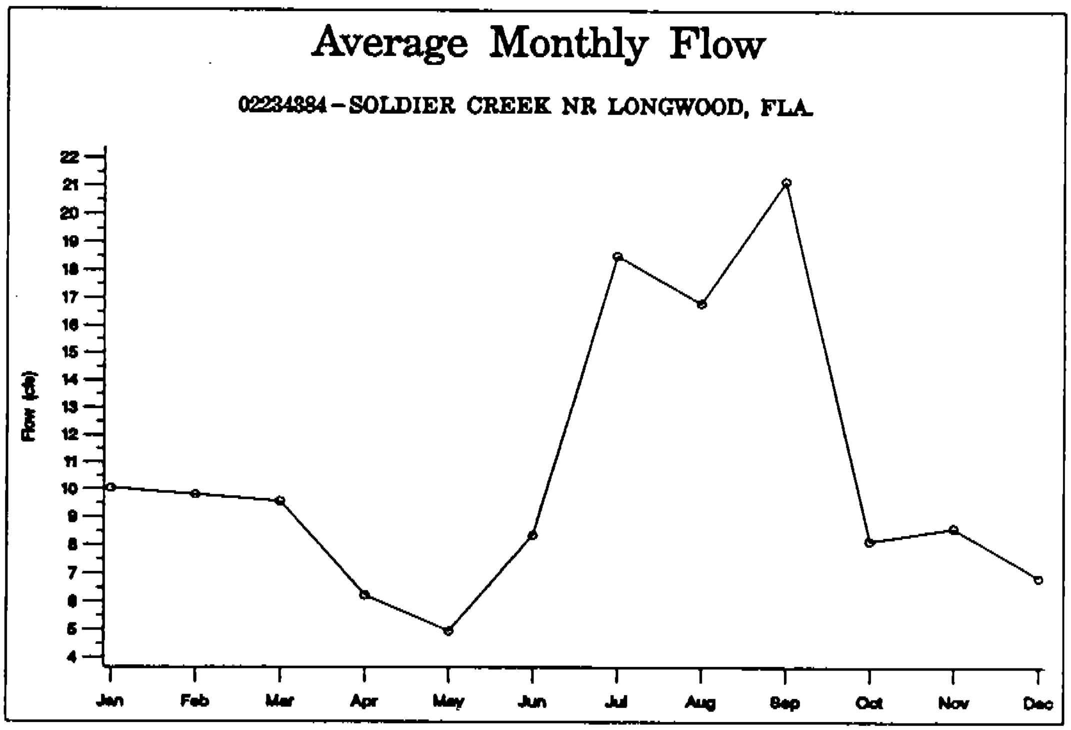


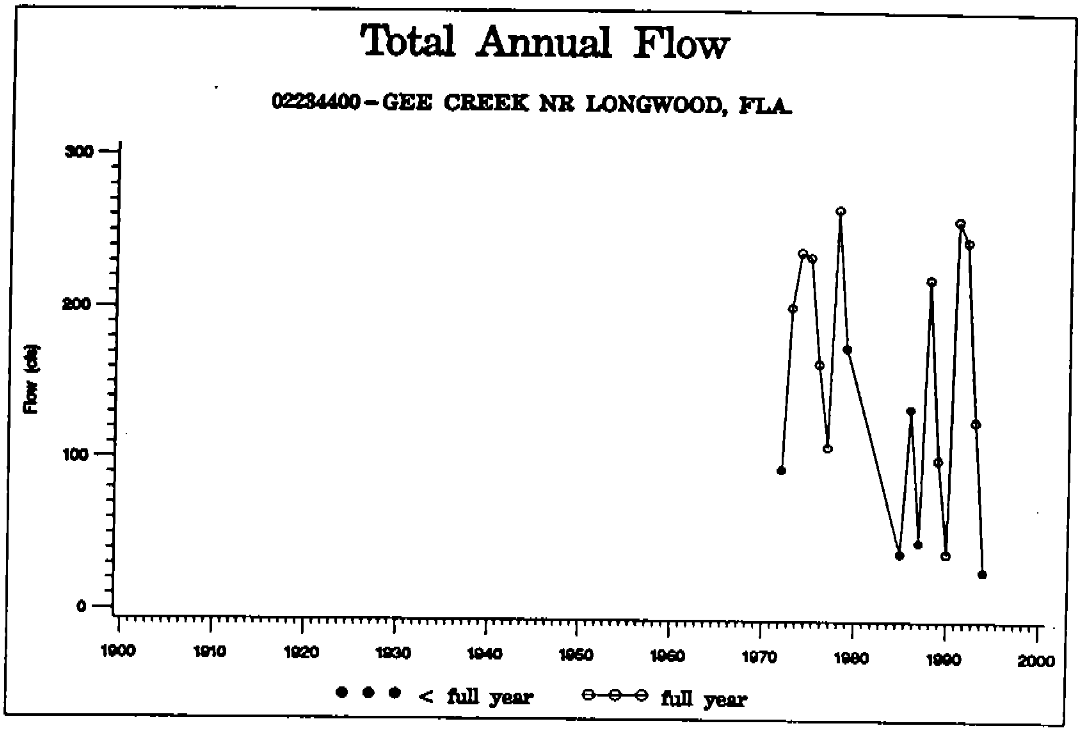
Average Monthly Flow
02234180 – DEEP CREEK DIVERSION CANAL NR OSTEEN, FLA.
Flow (cfs)
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

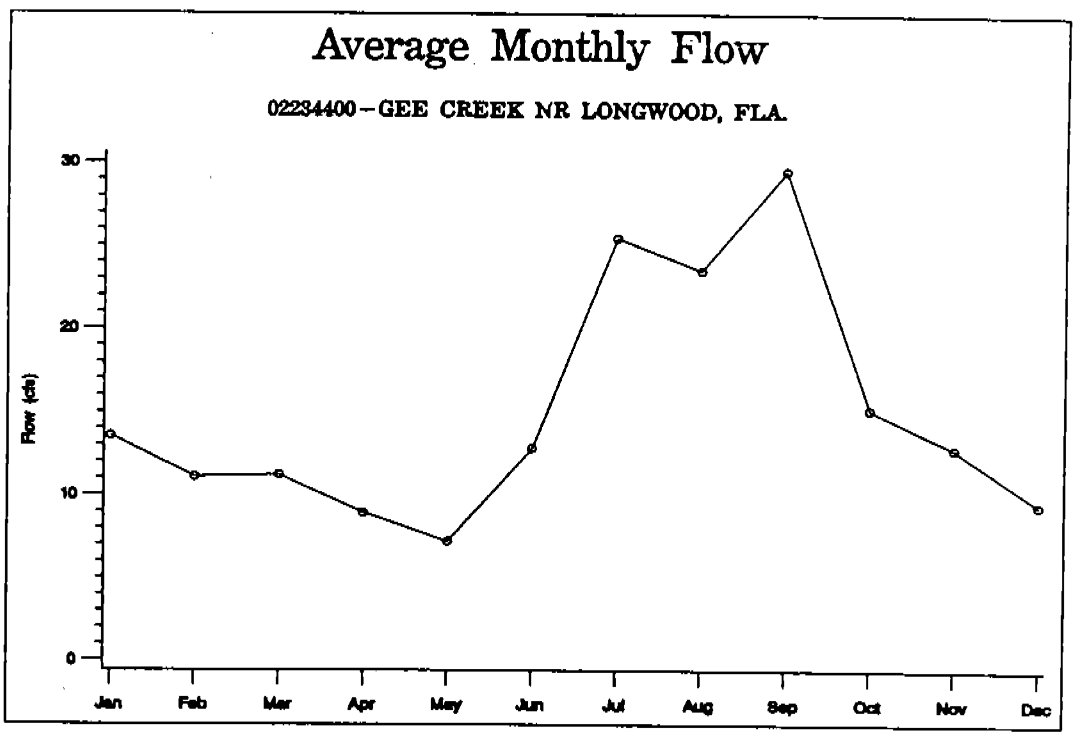

Total Annual Flow
02234324 – HOWELL CREEK NR SLAVIA, FLA.
Flow (cfs)
600
500
400
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

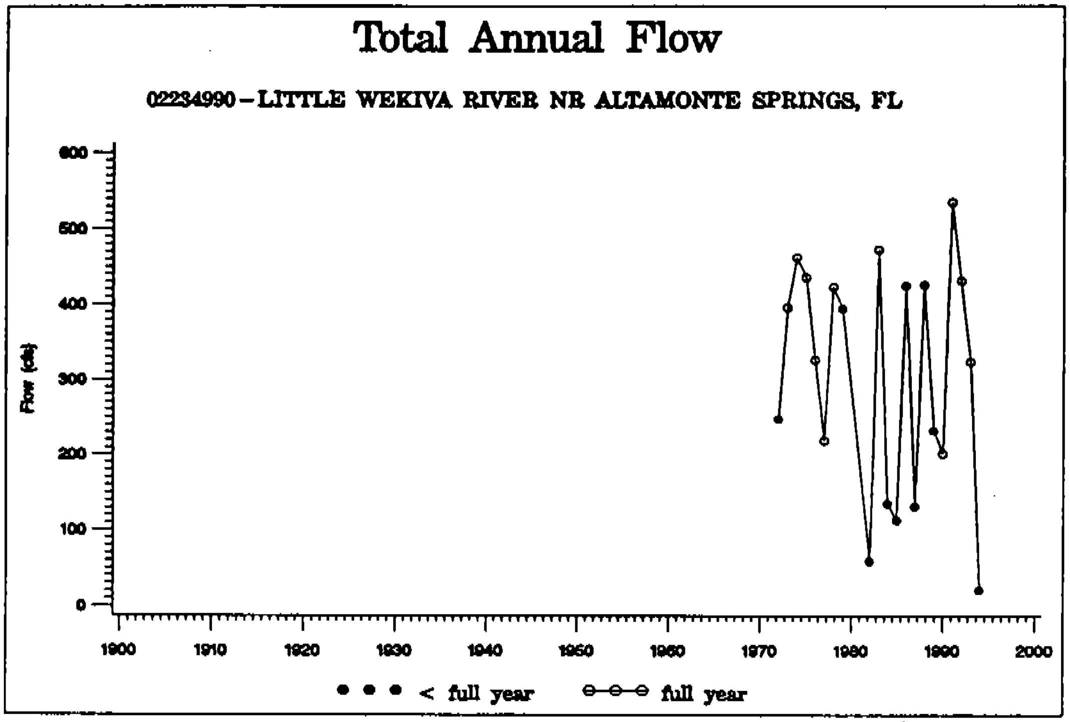

Average Monthly Flow
02234324 – HOWELL CREEK NR SLAVIA, FLA.
Flow (cfs)
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

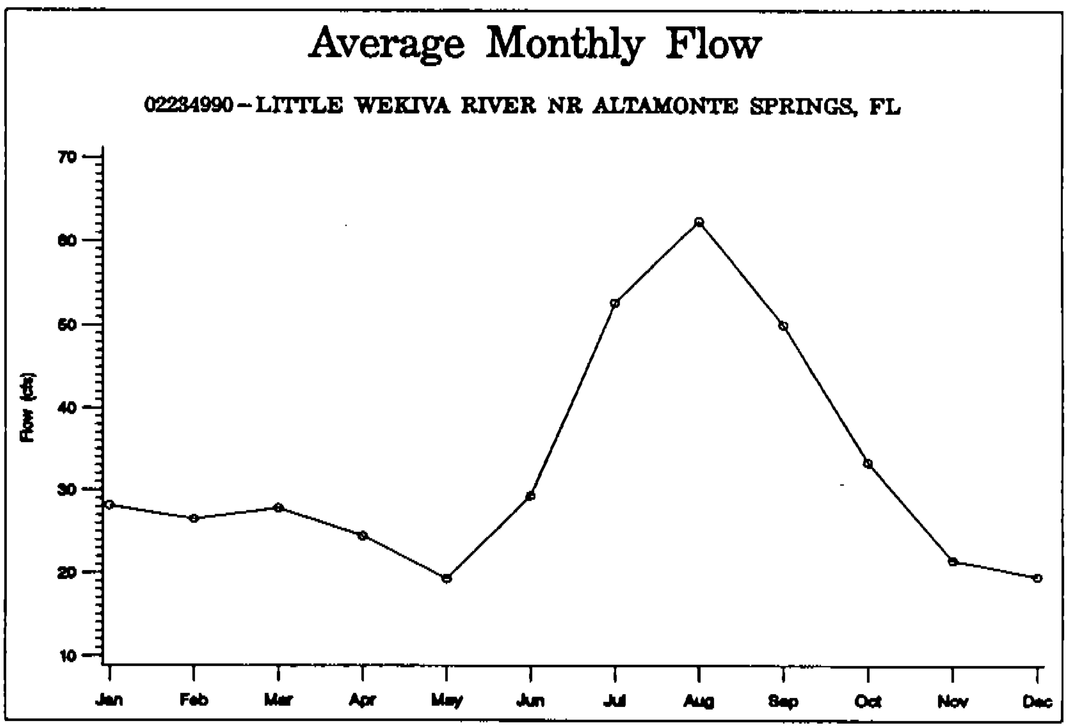

Total Annual Flow
02234384 - SOLDIER CREEK NR LONGWOOD, FLA.
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

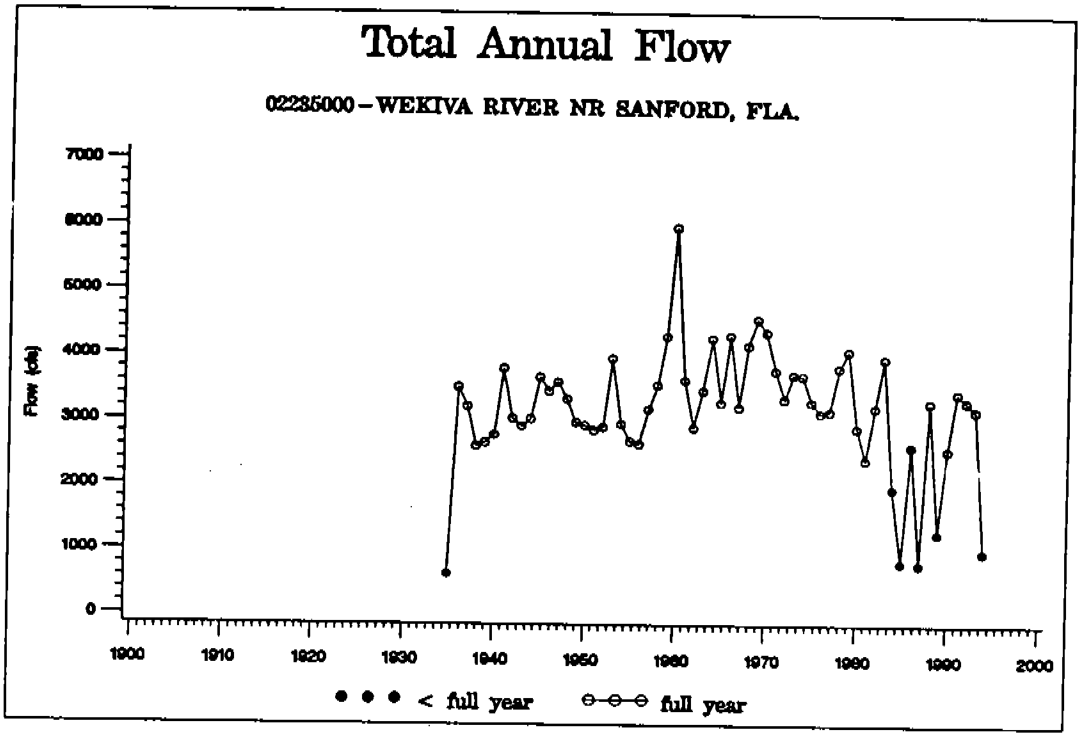

Average Monthly Flow
02234384 - SOLDIER CREEK NR LONGWOOD, FLA.
Flow (cfs)
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

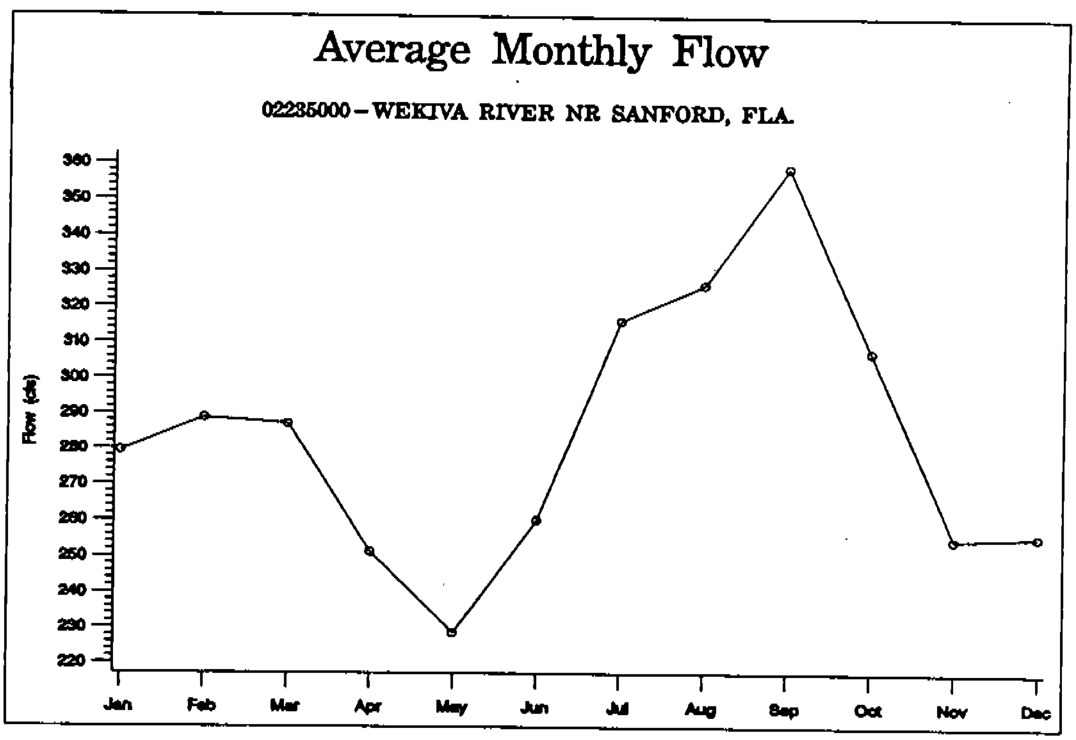

Total Annual Flow
02234400-GEE CREEK NR LONGWOOD, FLA.
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

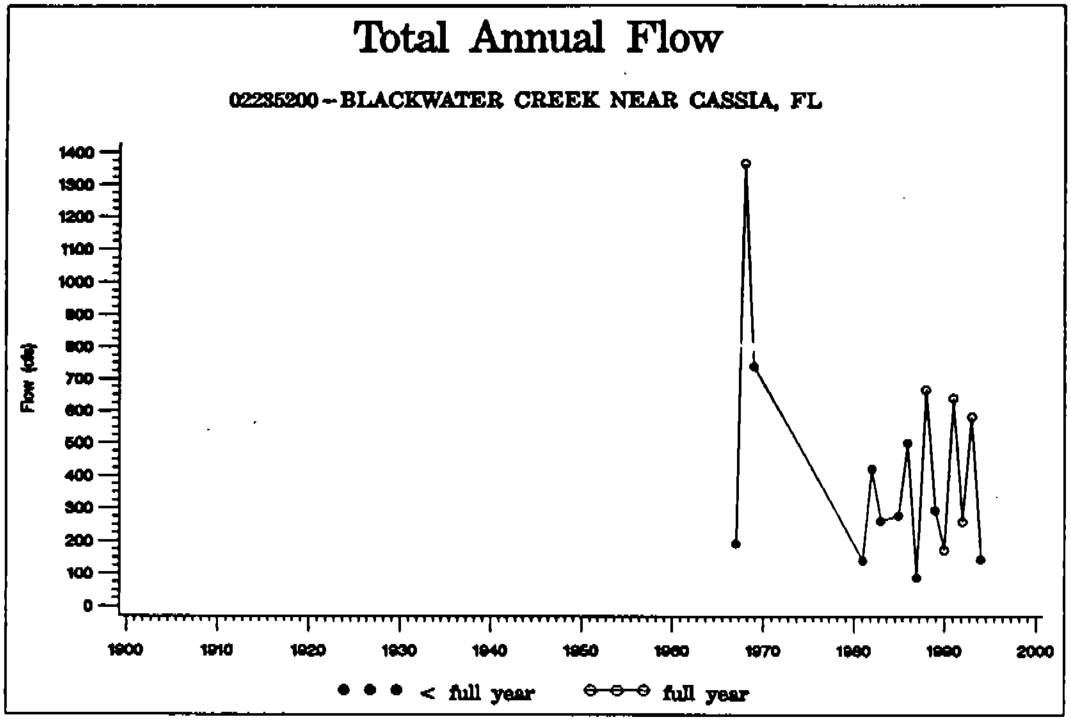

Average Monthly Flow
02234400-GEE CREEK NR LONGWOOD, FLA.
Flow (cfs)
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

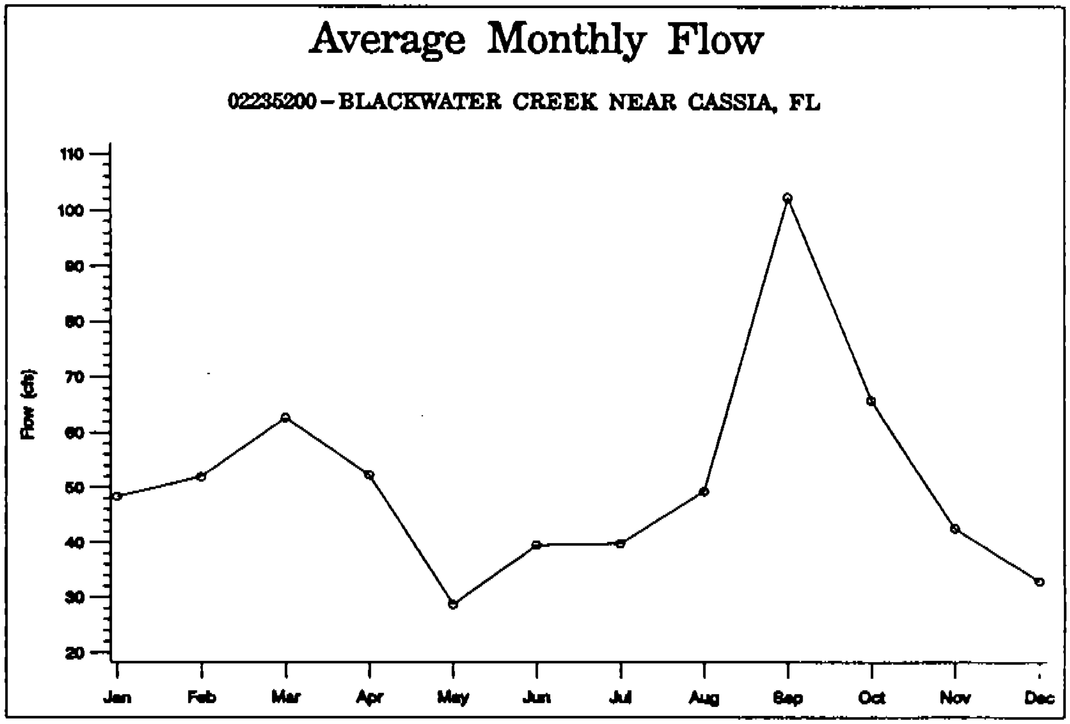

Total Annual Flow
02234990 - LITTLE WEKIVA RIVER NR ALTAMONTE SPRINGS, FL
Flow (cfs)
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

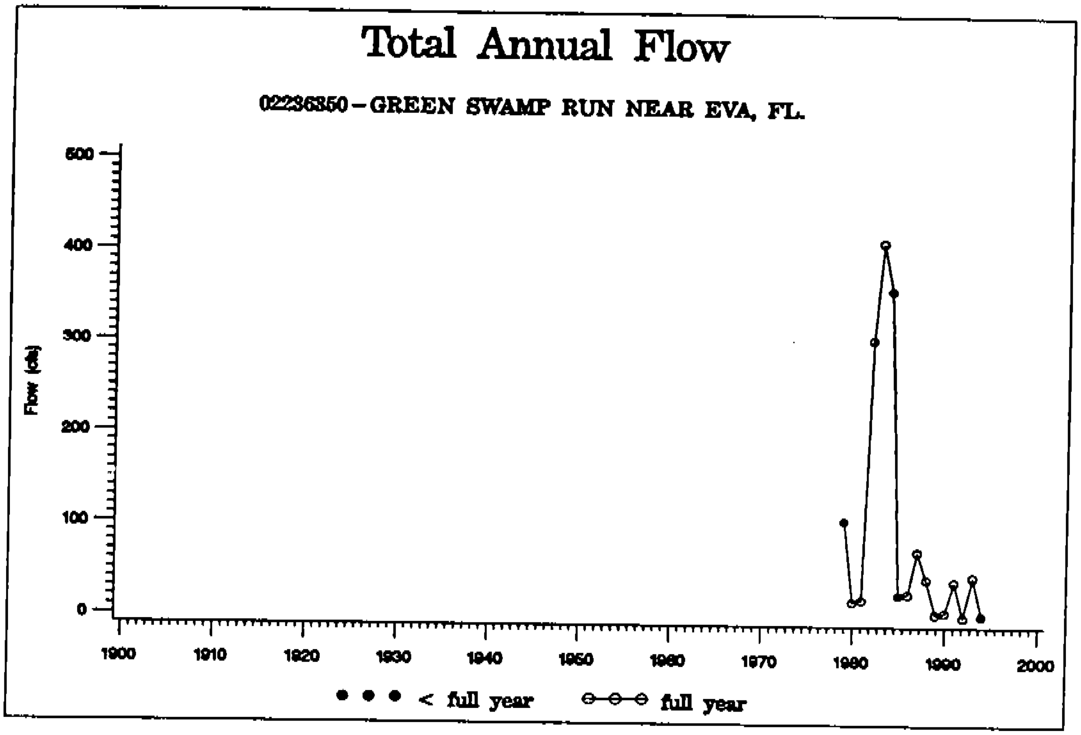

Average Monthly Flow
02234990 - LITTLE WEKIVA RIVER NR ALTAMONTE SPRINGS, FL
Flow (cfs)
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02235000 - WEKIVA RIVER NR SANFORD, FLA.
Flow (cfs)
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖-⊖-⊖ full year

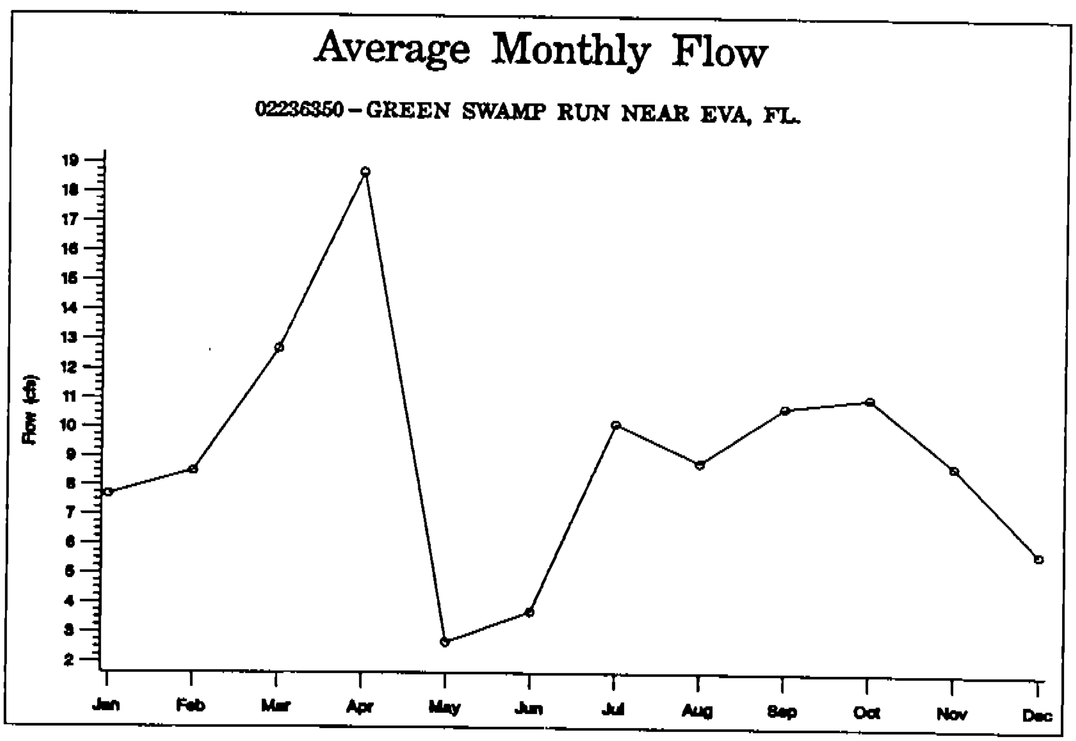

Average Monthly Flow
02235000 - WEKIVA RIVER NR SANFORD, FLA.
Flow (cfs)
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02235200 - BLACKWATER CREEK NEAR CASSIA, FL
Flow (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

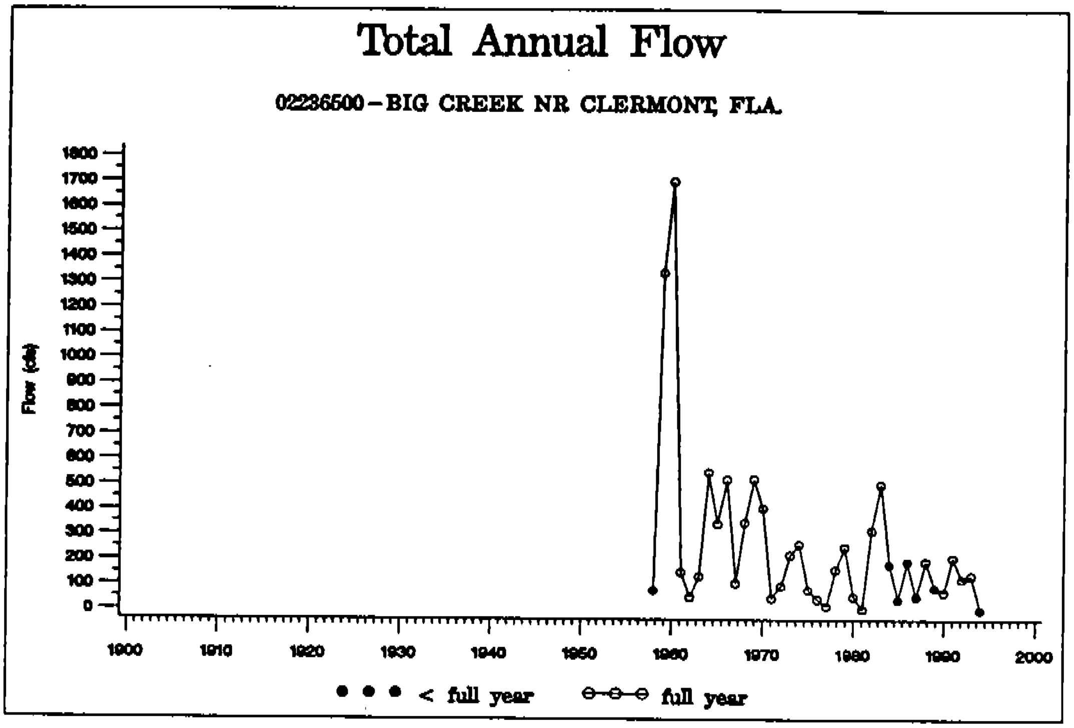

Average Monthly Flow
02235200 - BLACKWATER CREEK NEAR CASSIA, FL
Flow (cfs)
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

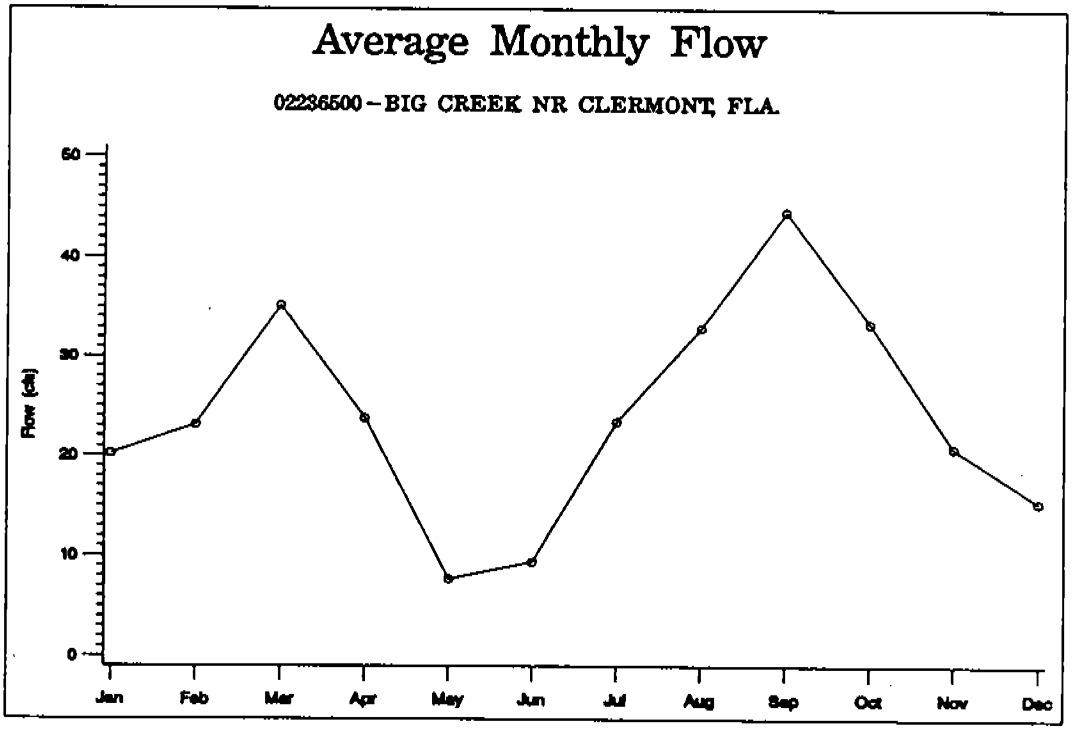


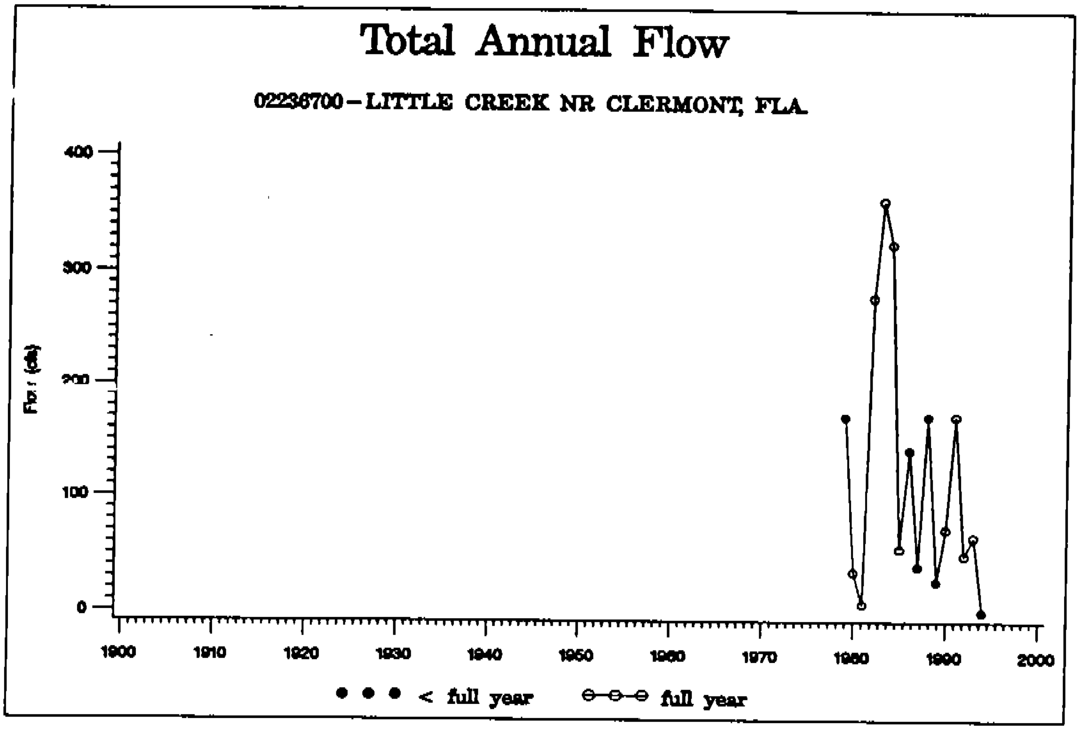
Total Annual Flow
02236350 - GREEN SWAMP RUN NEAR EVA, FL.
Flow (cfs)
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖⊖⊖ full year

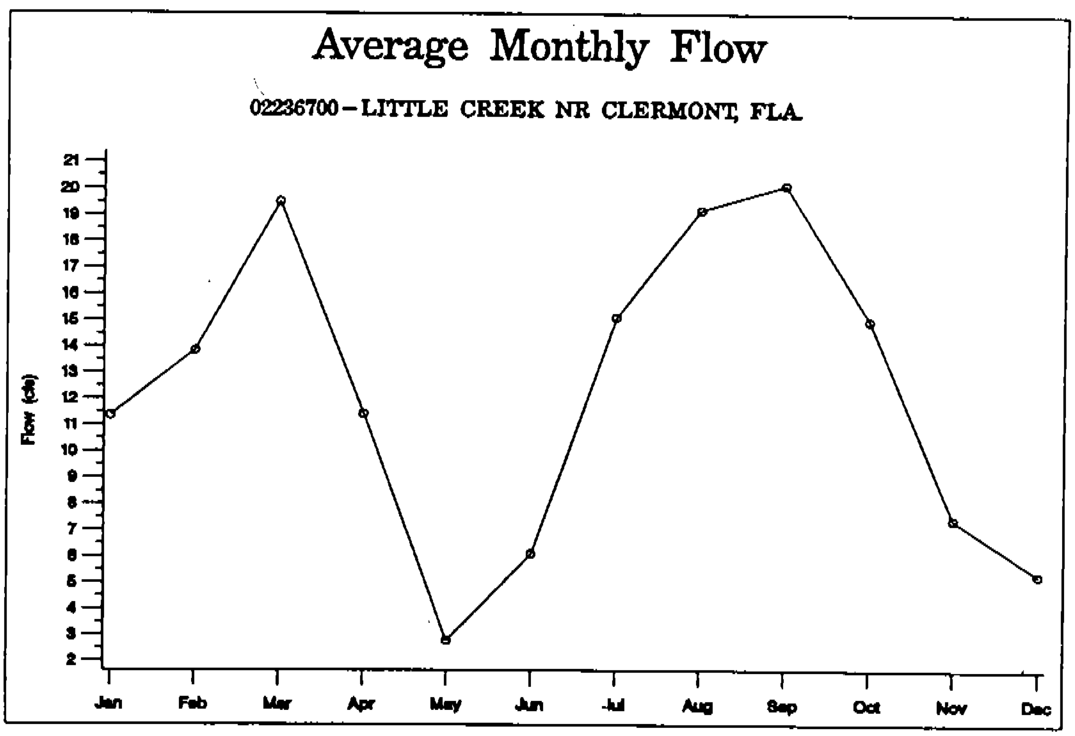


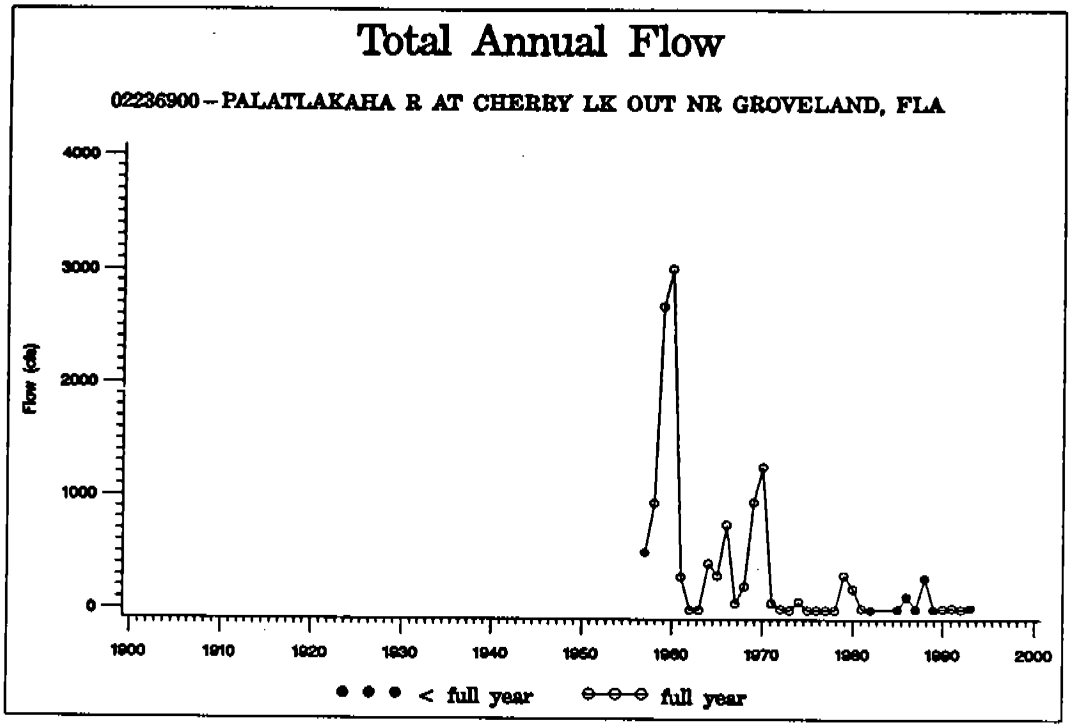
Average Monthly Flow
02236350 - GREEN SWAMP RUN NEAR EVA, FL.
Flow (cfs)
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

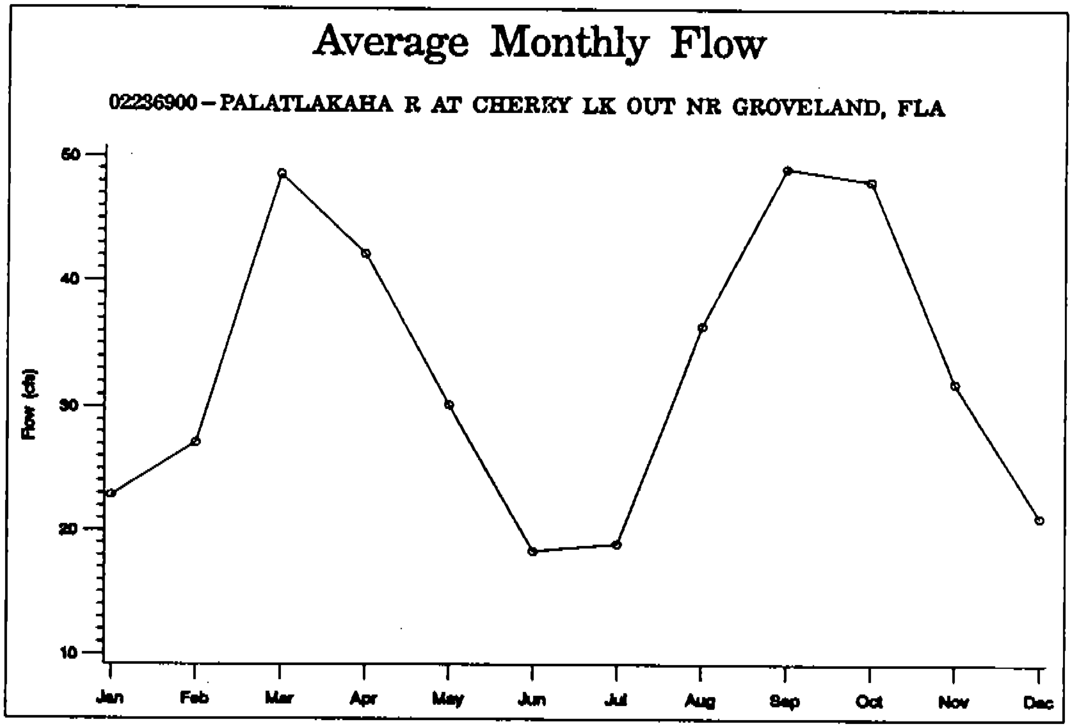

Total Annual Flow
02236500 - BIG CREEK NR CLERMONT, FLA.
Flow (cfs)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Flow
02236500 - BIG CREEK NR CLERMONT, FLA.
Flow (cfs)
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

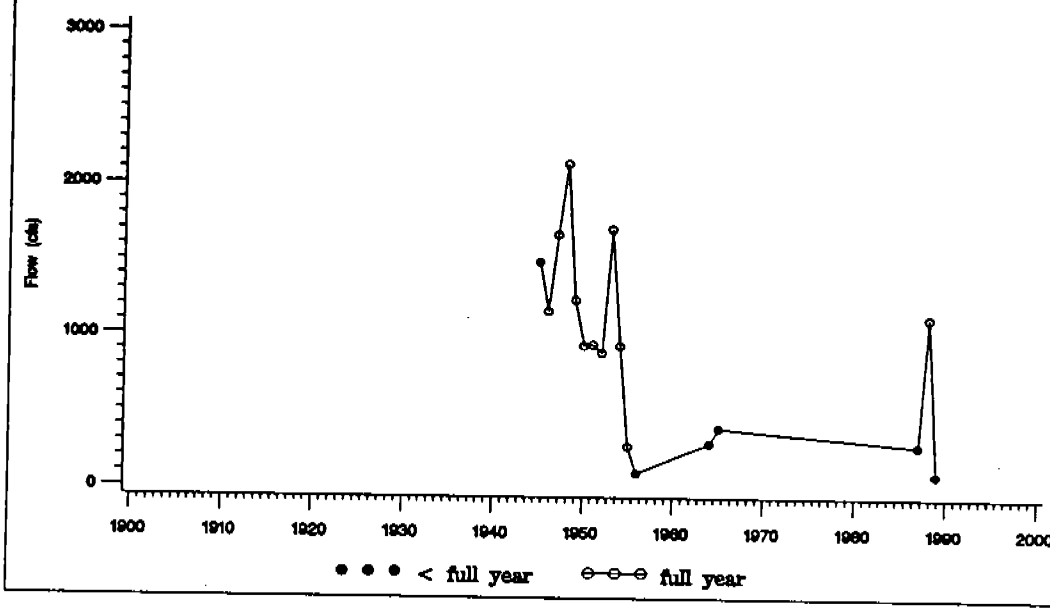

Total Annual Flow
02236700 – LITTLE CREEK NR CLERMONT, FLA.
Flow (cfs)
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Flow
02236700 – LITTLE CREEK NR CLERMONT, FLA.
Flow (cfs)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

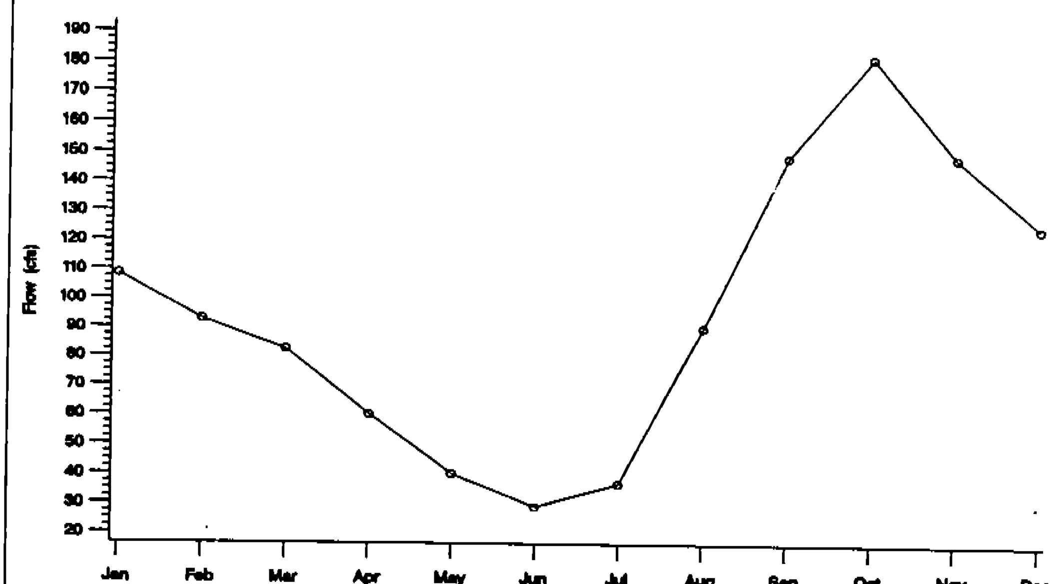

Total Annual Flow
02236900 – PALATLAKAHA R AT CHERRY LK OUT NR GROVELAND, FLA
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

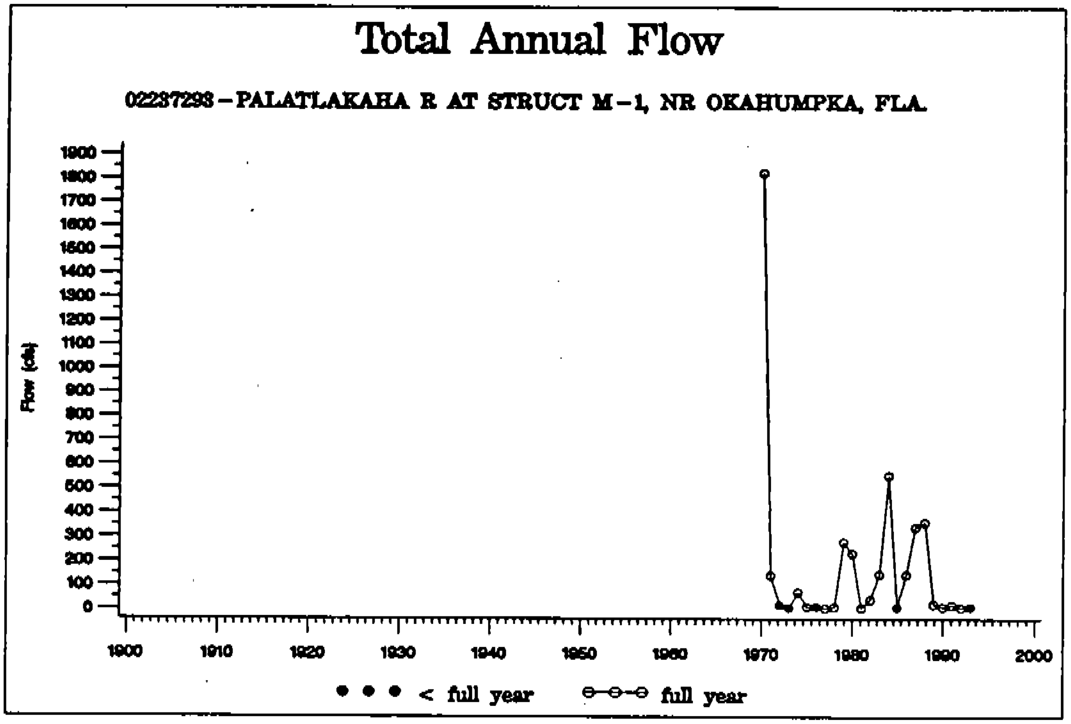

Average Monthly Flow
02236900 – PALATLAKAHA R AT CHERRY LK OUT NR GROVELAND, FLA
Flow (cfs)
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

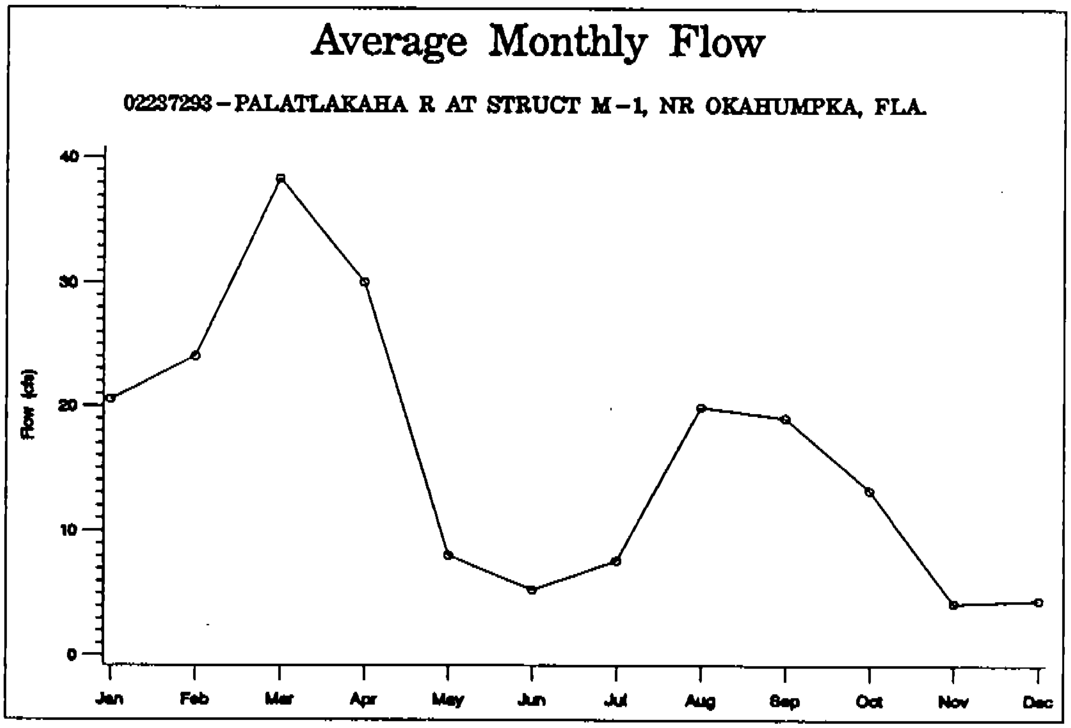
Total Annual Flow

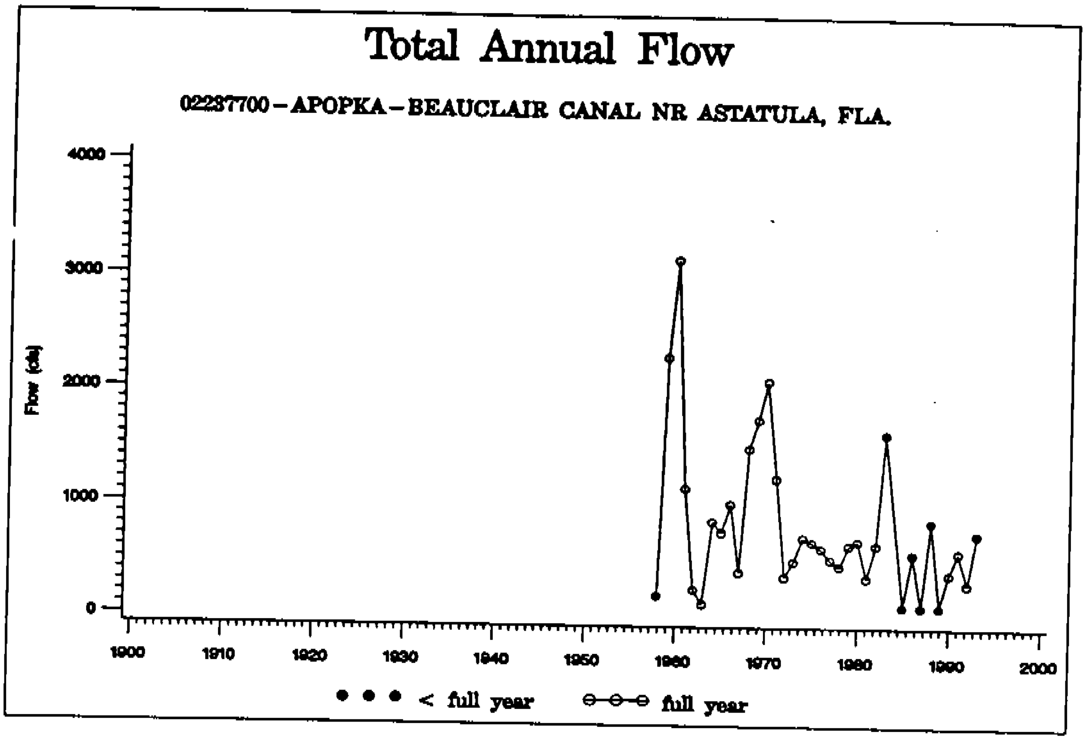


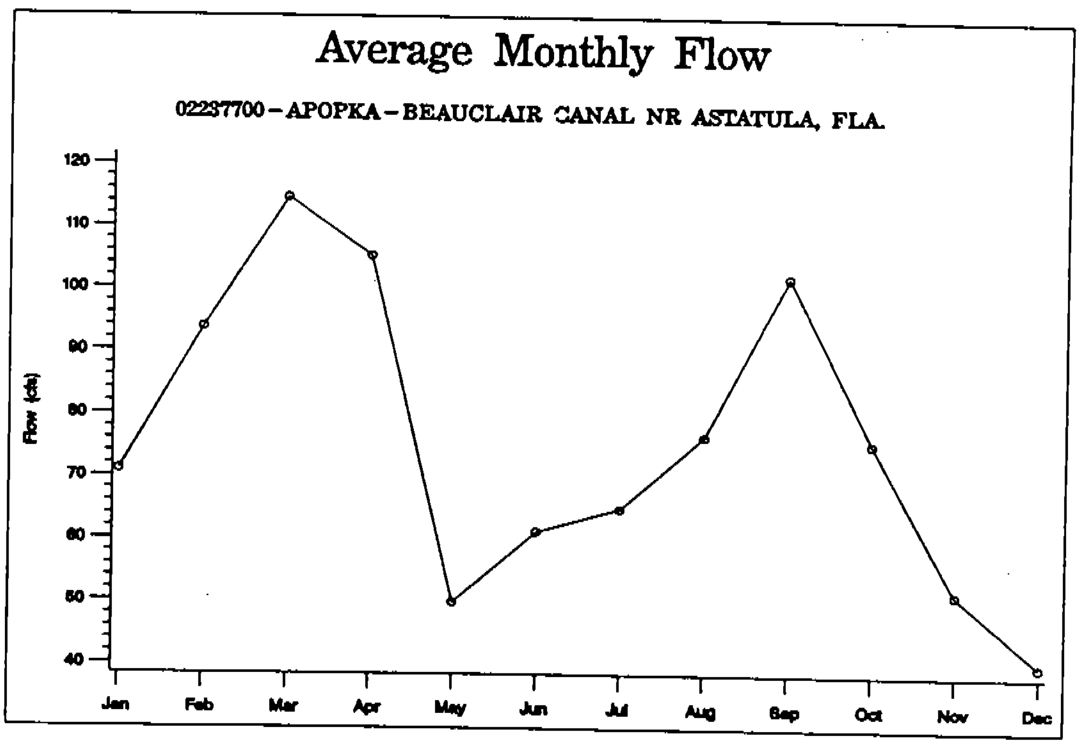
Average Monthly Flow

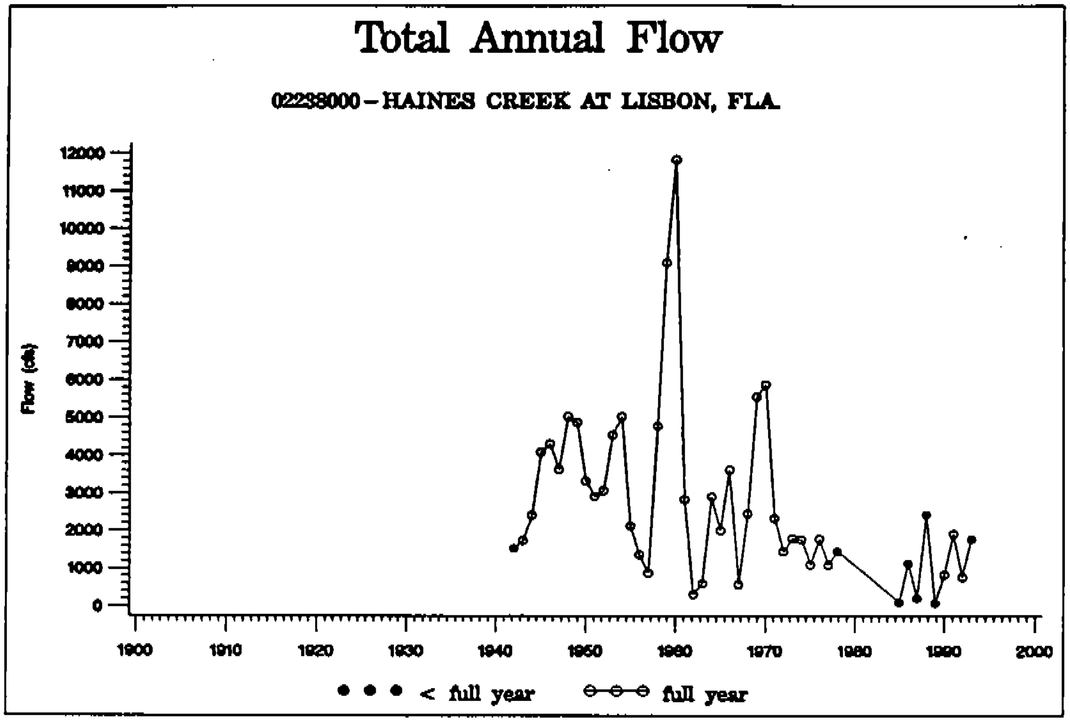


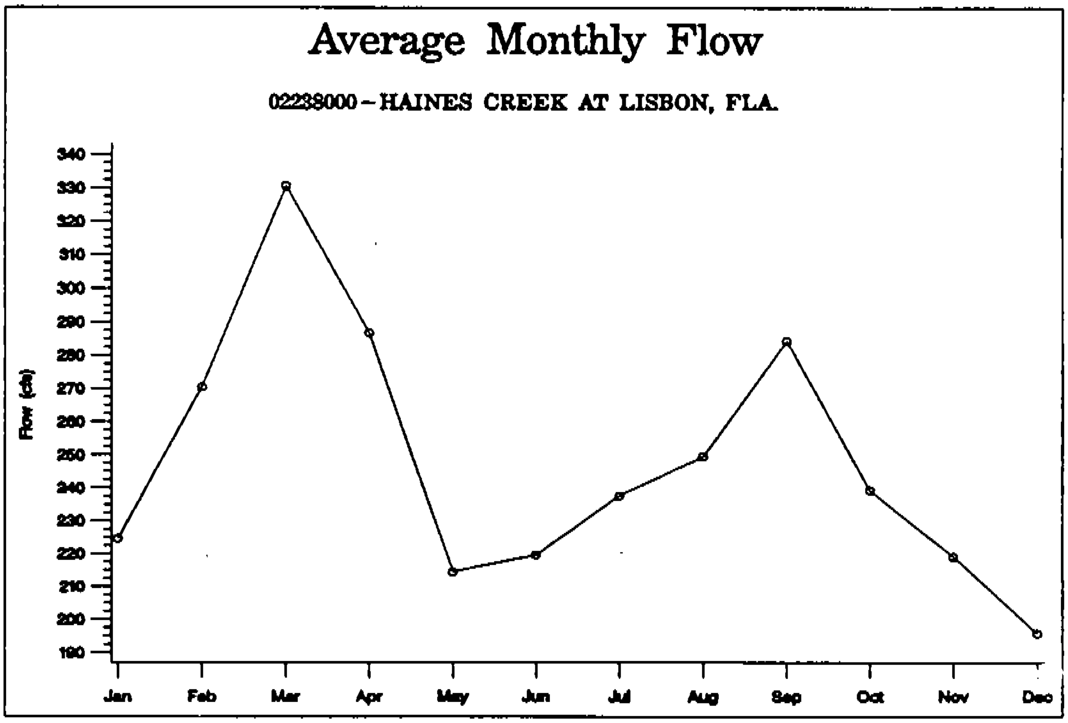

Total Annual Flow
02237293 - PALATLAKAHA R AT STRUCT M-1, NR OKAHUMPKA, FLA.
Flow (cfs)
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

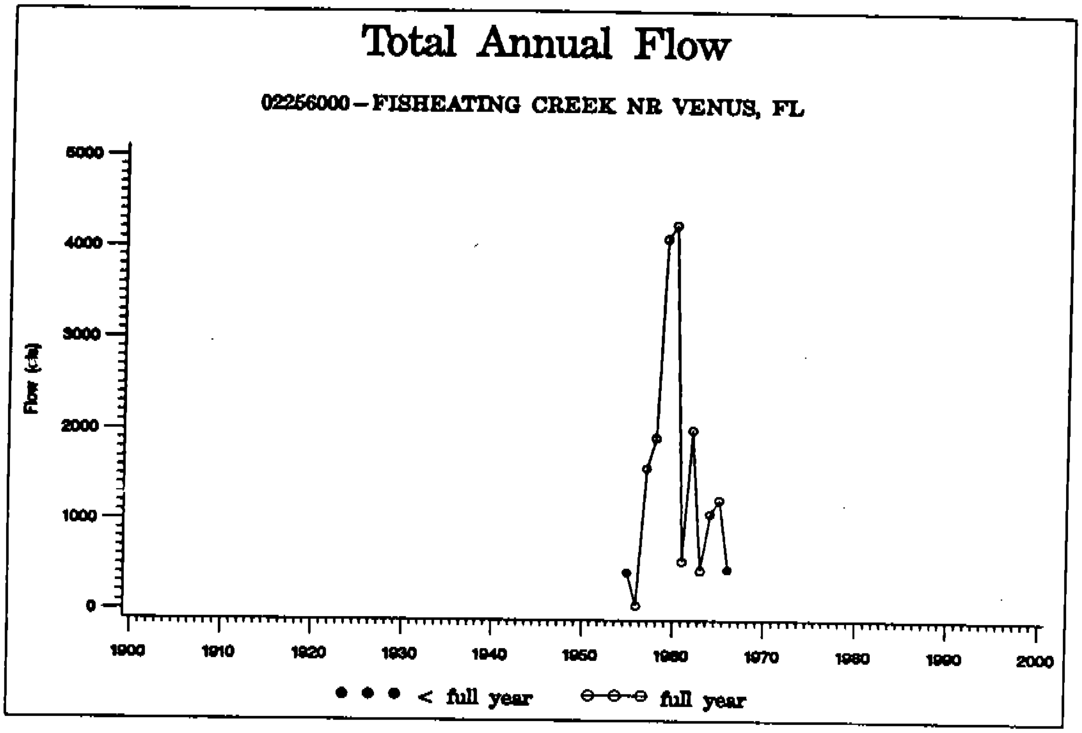

Average Monthly Flow
02237293 - PALATLAKAHA R AT STRUCT M-1, NR OKAHUMPKA, FLA.
Flow (cfs)
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

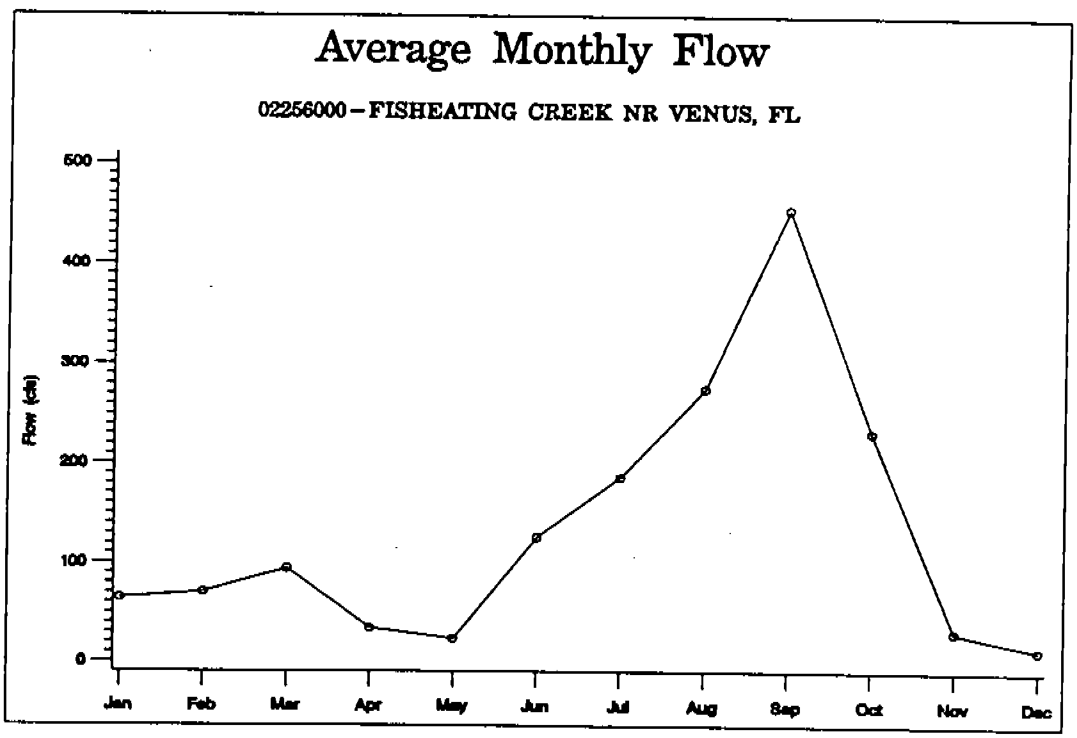

Total Annual Flow
02237700 – APOPKA – BEAUCLAIR CANAL NR ASTATULA, FLA.
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

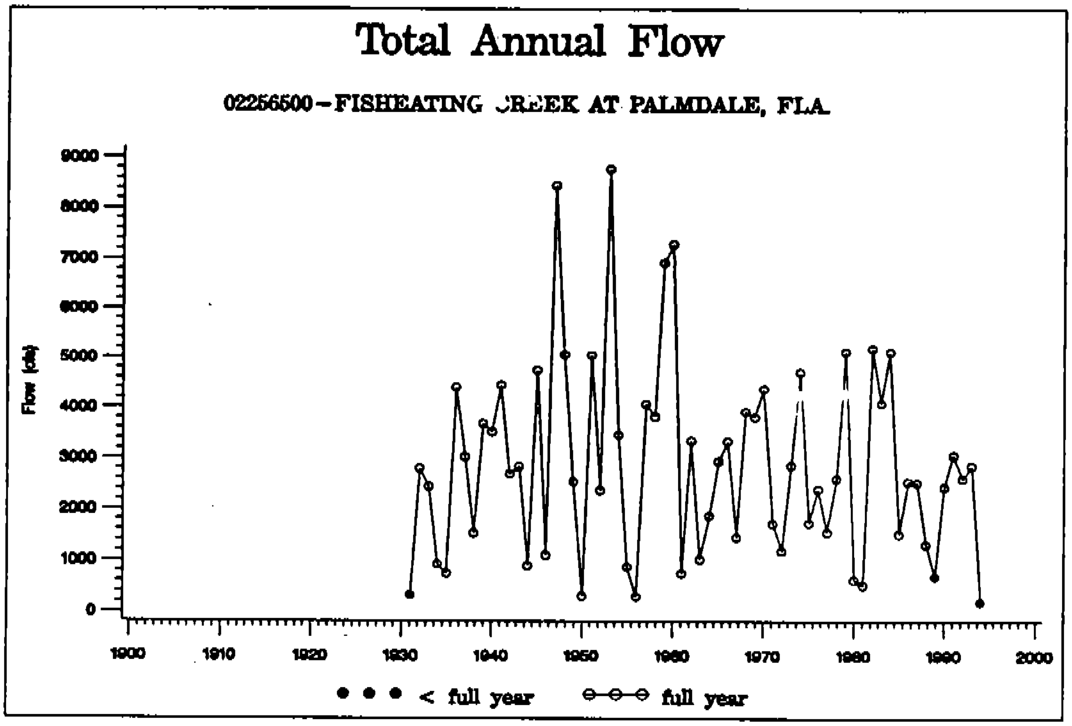

Average Monthly Flow
02237700 – APOPKA – BEAUCLAIR CANAL NR ASTATULA, FLA.
Flow (cfs)
120
110
100
90
80
70
60
50
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

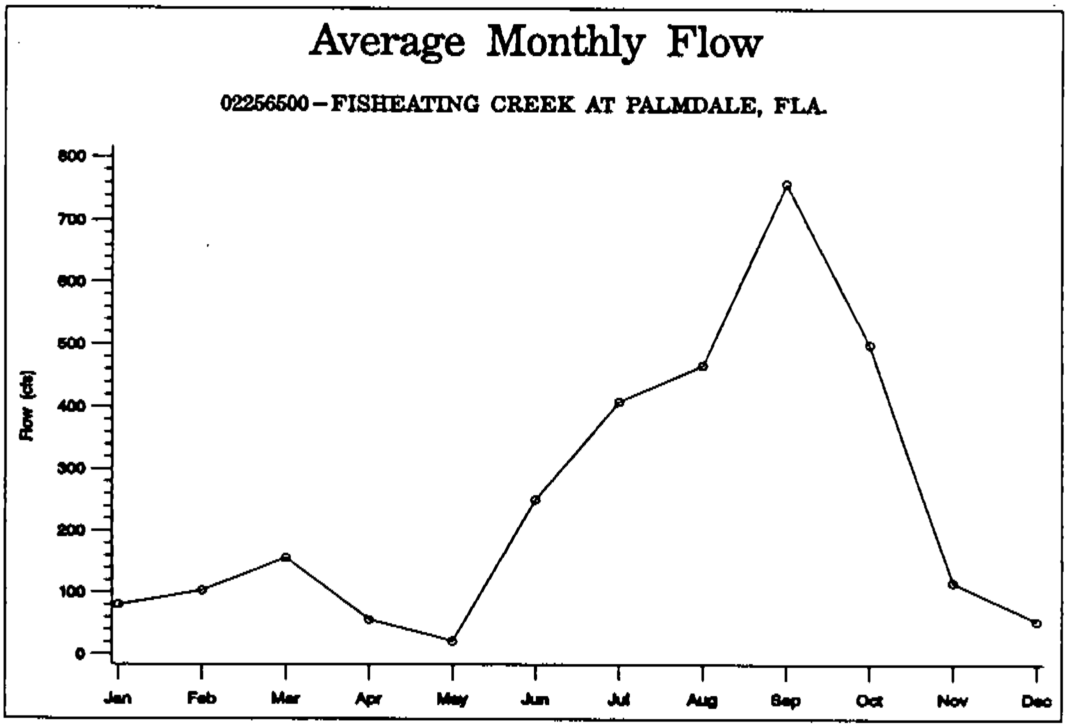

Total Annual Flow
02238000 – HAINES CREEK AT LISBON, FLA.
Flow (cfs)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

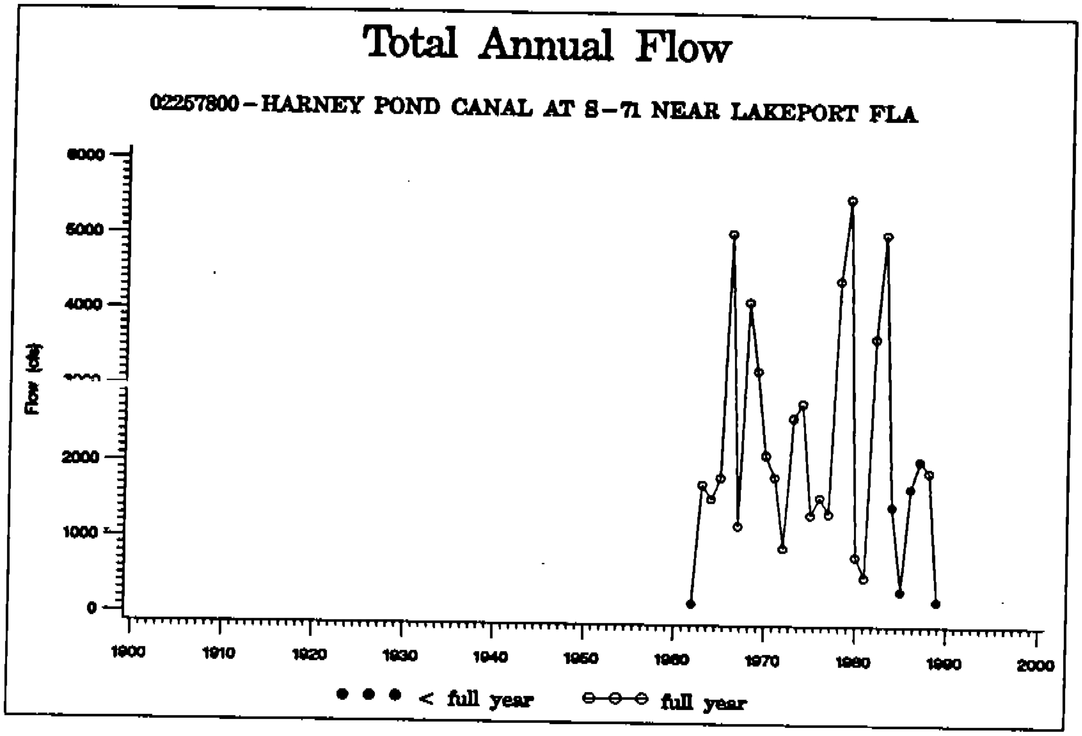

Average Monthly Flow
02238000 – HAINES CREEK AT LISBON, FLA.
Flow (cfs)
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

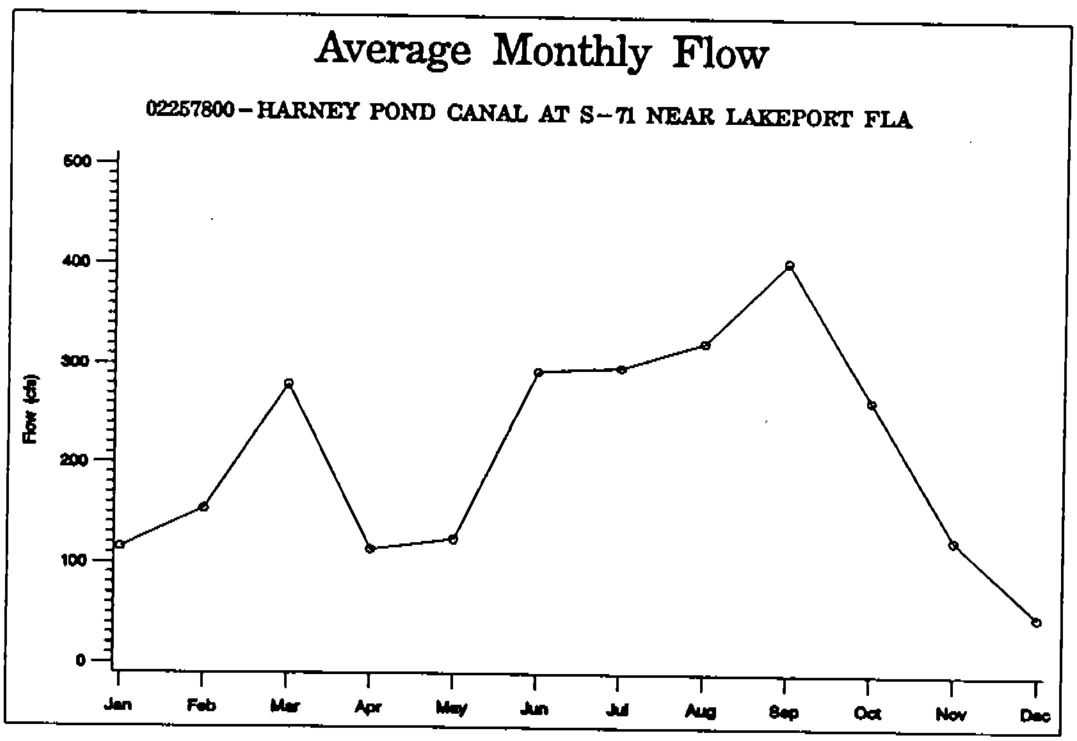

Total Annual Flow
02256000 – FISHEATING CREEK NR VENUS, FL
Flow (cfs)
0
1000
2000
3000
4000
5000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

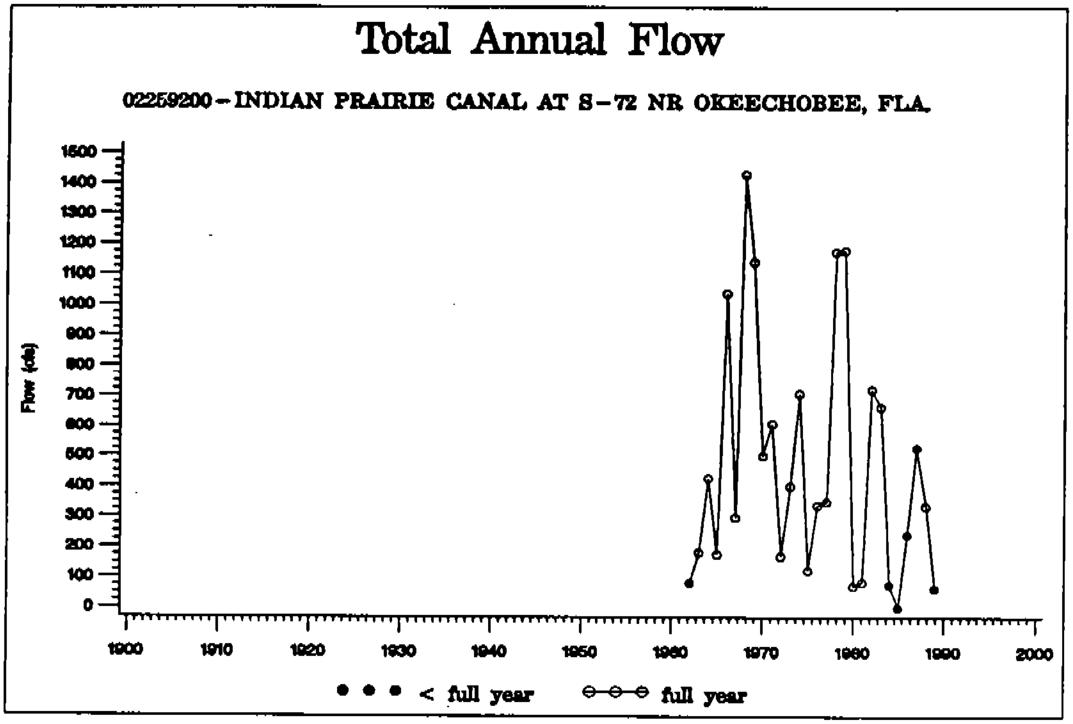

Average Monthly Flow
02256000 – FISHEATING CREEK NR VENUS, FL
Flow (cfs)
0
100
200
300
400
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

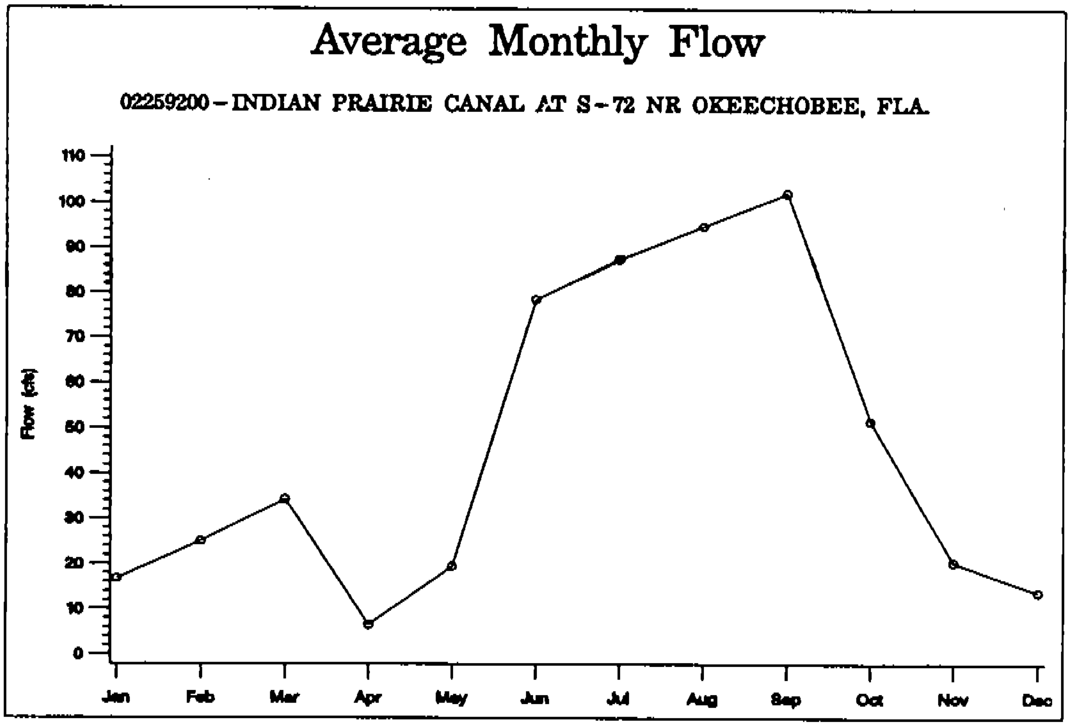

Total Annual Flow
02256500 - FISHEATING CREEK AT PALMDALE, FLA.
Flow (cfs)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

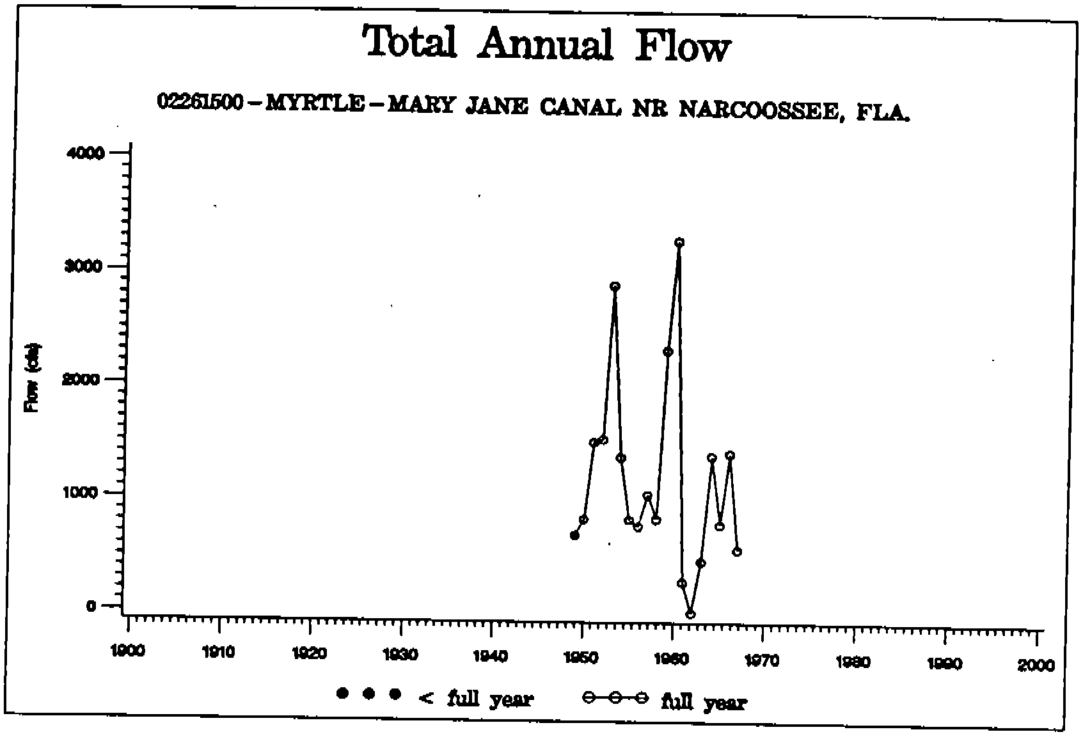

Average Monthly Flow
02256500 - FISHEATING CREEK AT PALMDALE, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

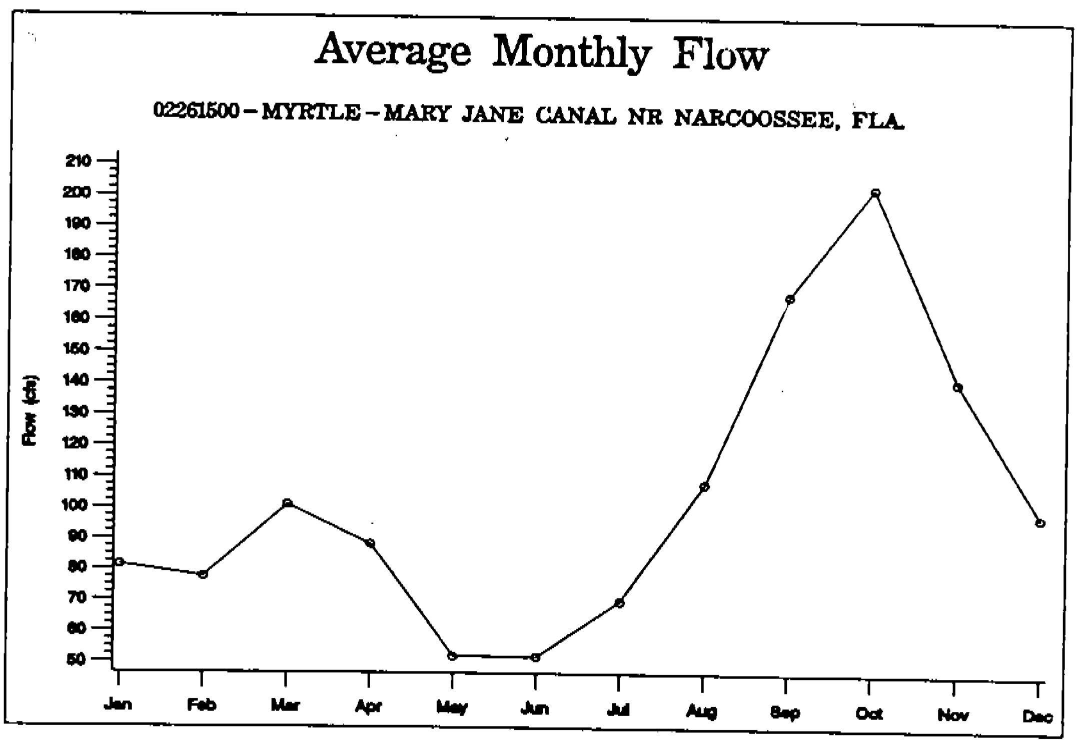

Total Annual Flow
02257800 - HARNEY POND CANAL AT S-71 NEAR LAKEPORT FLA
Flow (cfs)
0
1000
2000
4000
5000
6000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
full year

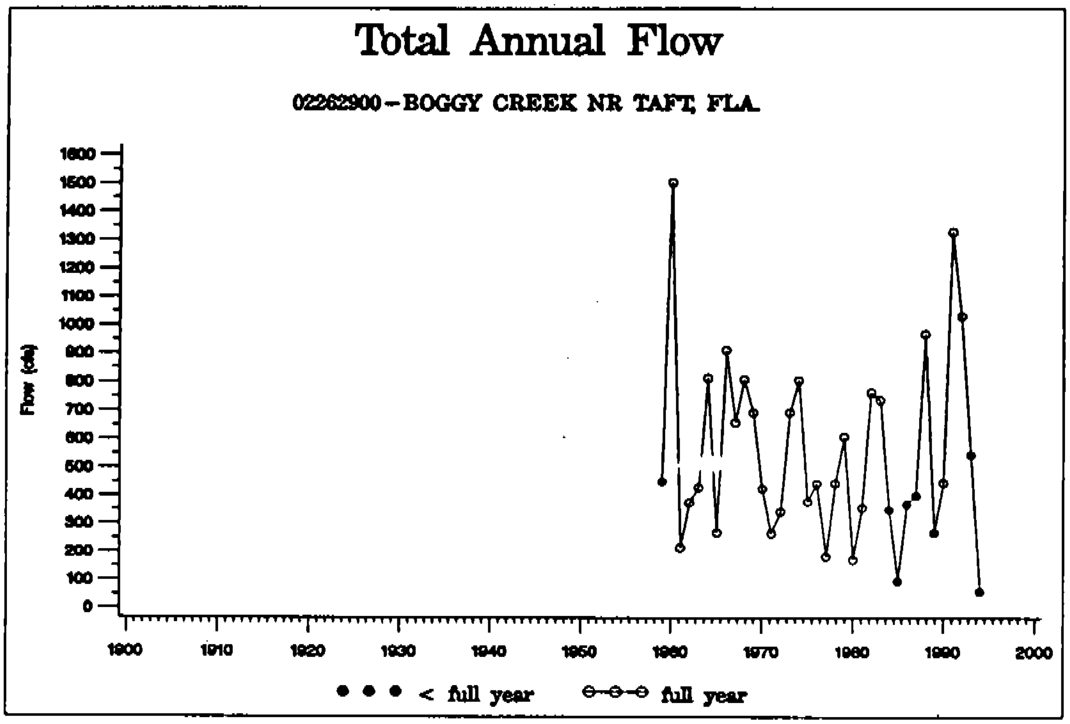

Average Monthly Flow
02257800 - HARNEY POND CANAL AT S-71 NEAR LAKEPORT FLA
Flow (cfs)
0
100
200
300
400
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

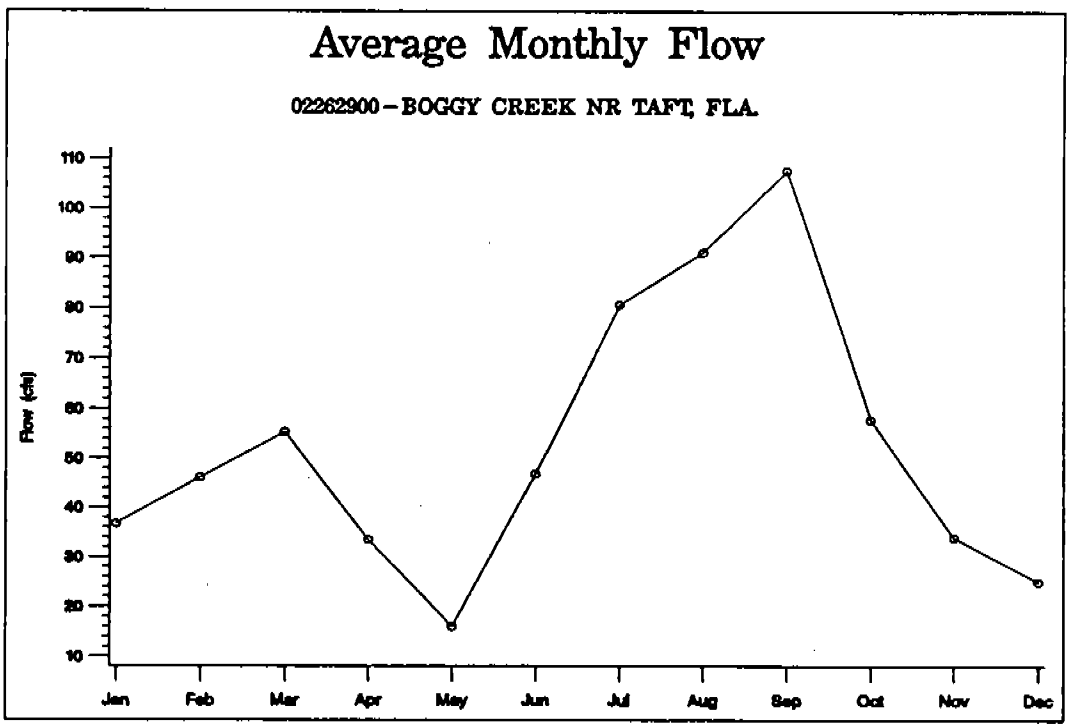

Total Annual Flow
02259200 - INDIAN PRAIRIE CANAL AT S-72 NR OKEECHOBEE, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

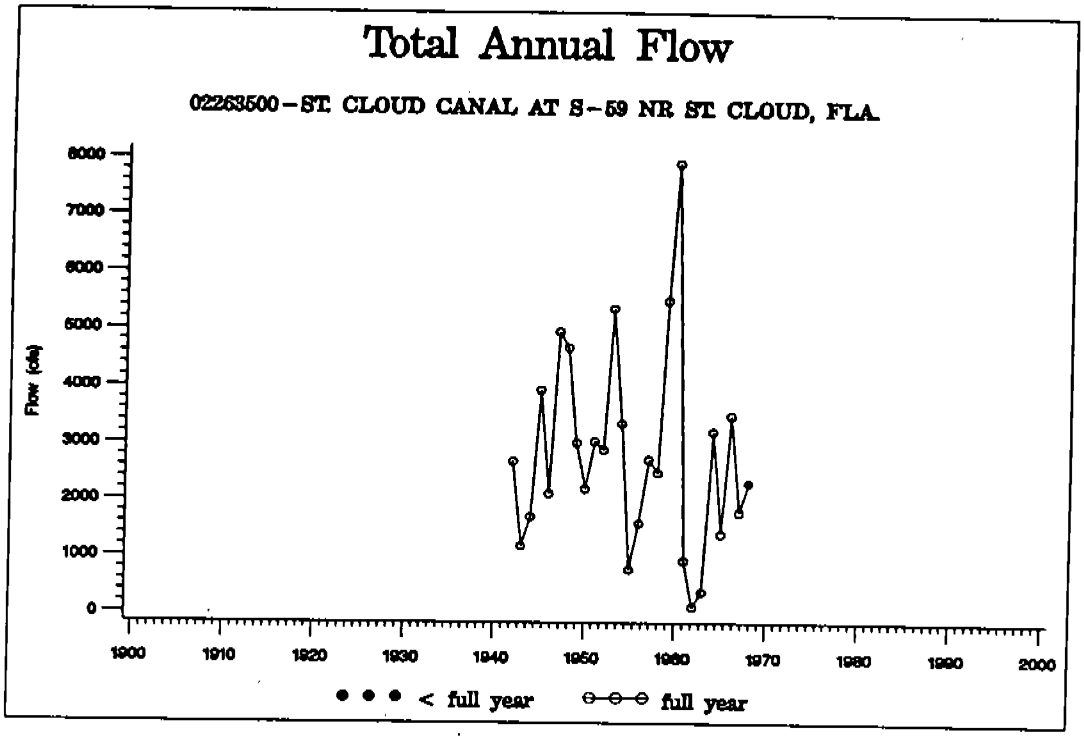

Average Monthly Flow
02259200 - INDIAN PRAIRIE CANAL AT S-72 NR OKEECHOBEE, FLA.
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
110
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

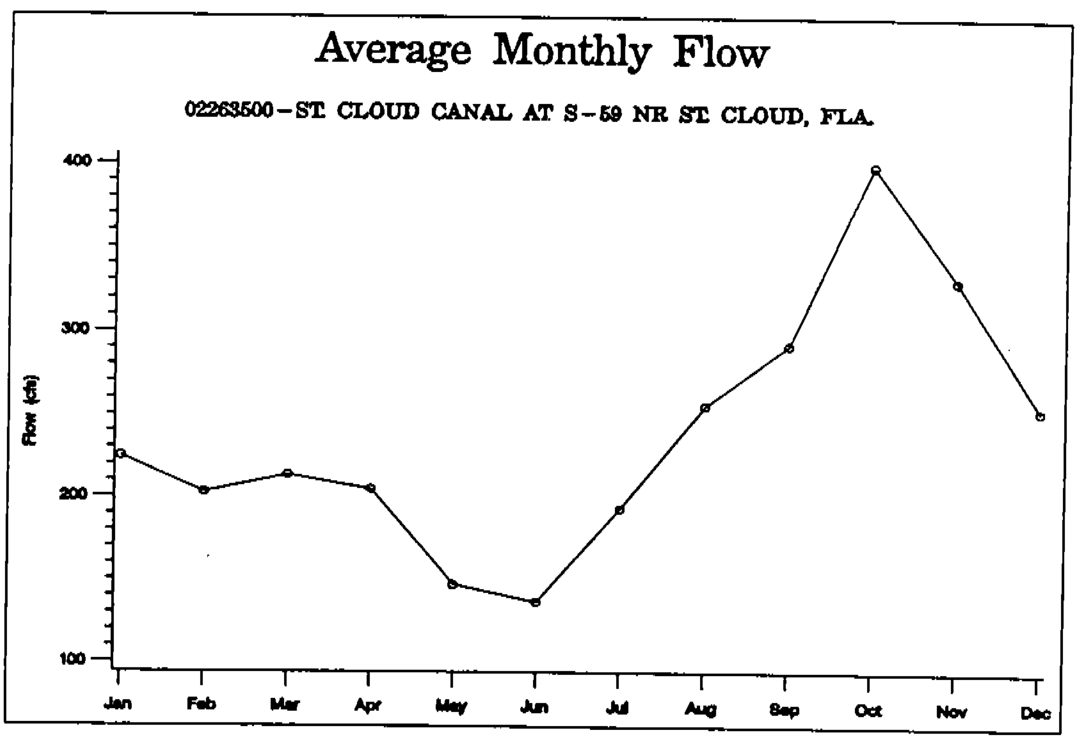

Total Annual Flow
02261500 - MYRTLE - MARY JANE CANAL NR NARCOOSSEE, FLA.
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

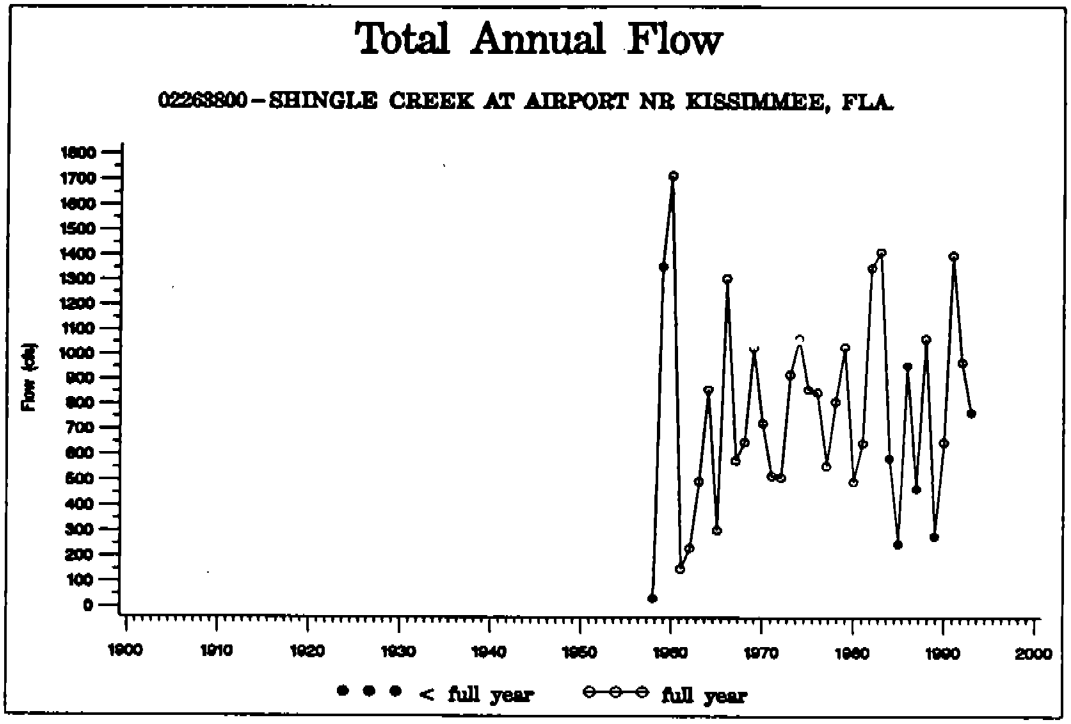

Average Monthly Flow
02261500 - MYRTLE - MARY JANE CANAL NR NARCOOSSEE, FLA.
Flow (cfs)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

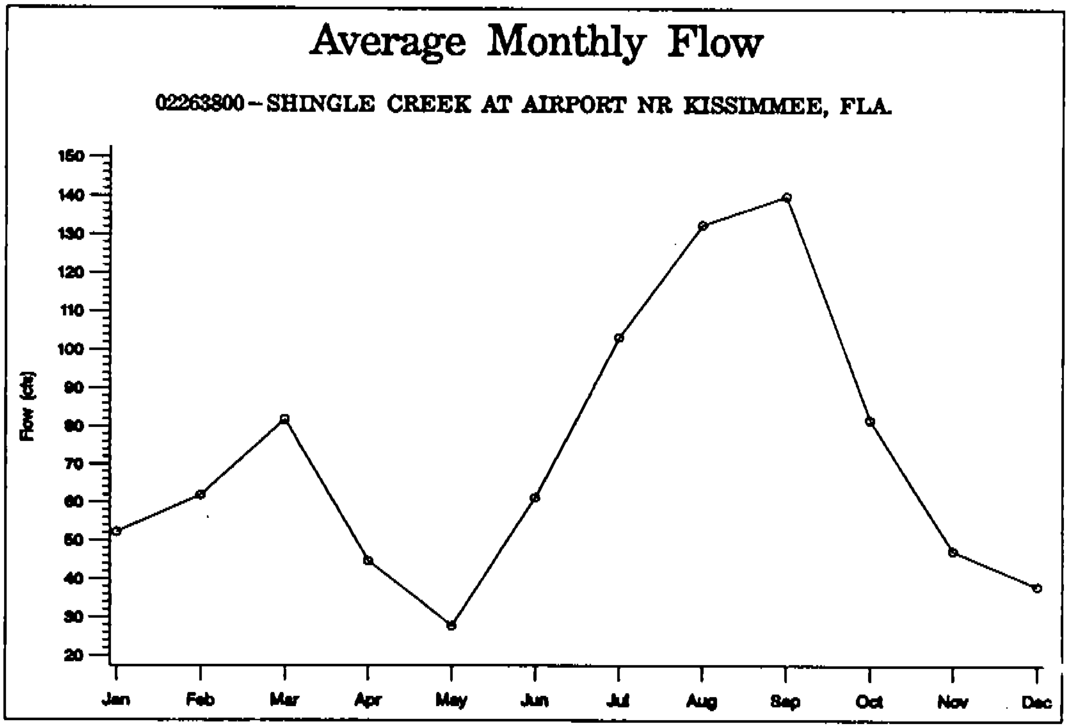

Total Annual Flow
02262900–BOGGY CREEK NR TAFT, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

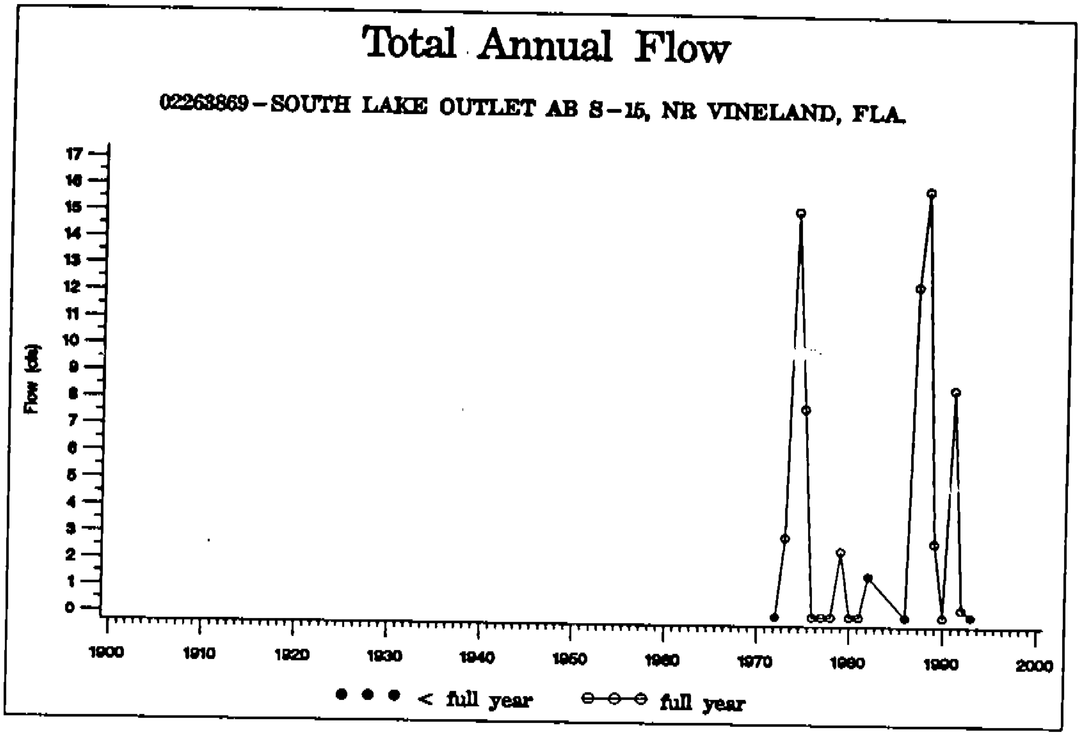

Average Monthly Flow
02262900–BOGGY CREEK NR TAFT, FLA.
Flow (cfs)
10
20
30
40
50
60
70
80
90
100
110
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

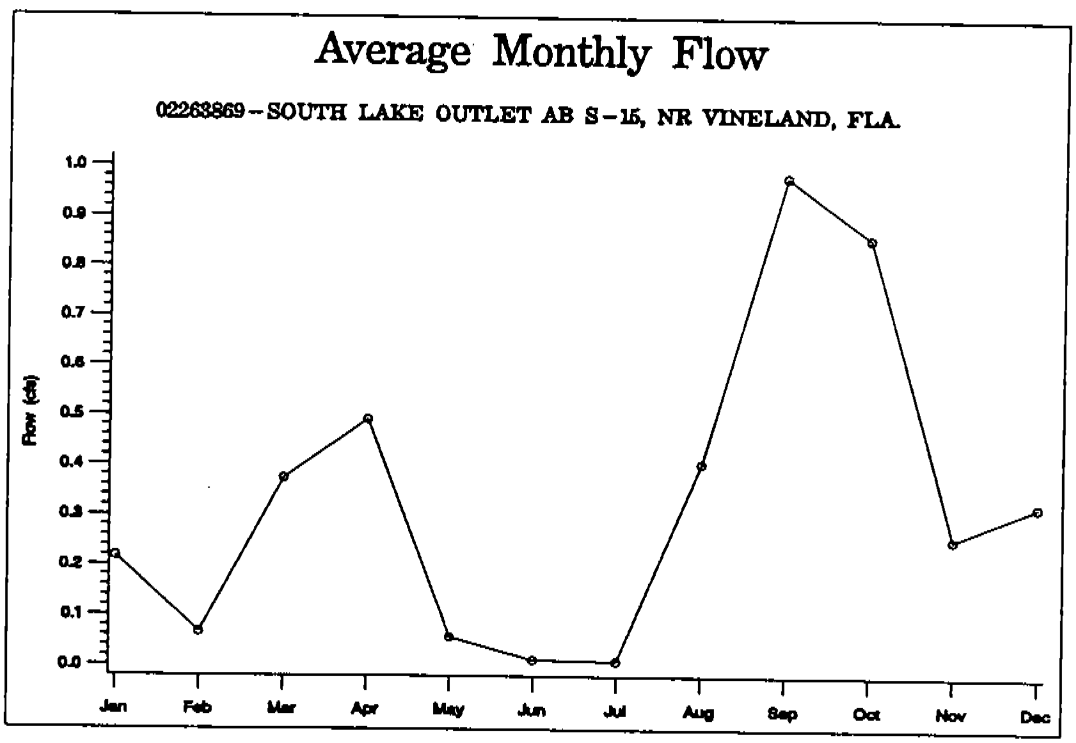

Total Annual Flow
02263500 - ST. CLOUD CANAL AT S-59 NR ST. CLOUD, FLA.
Flow (cfs)
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

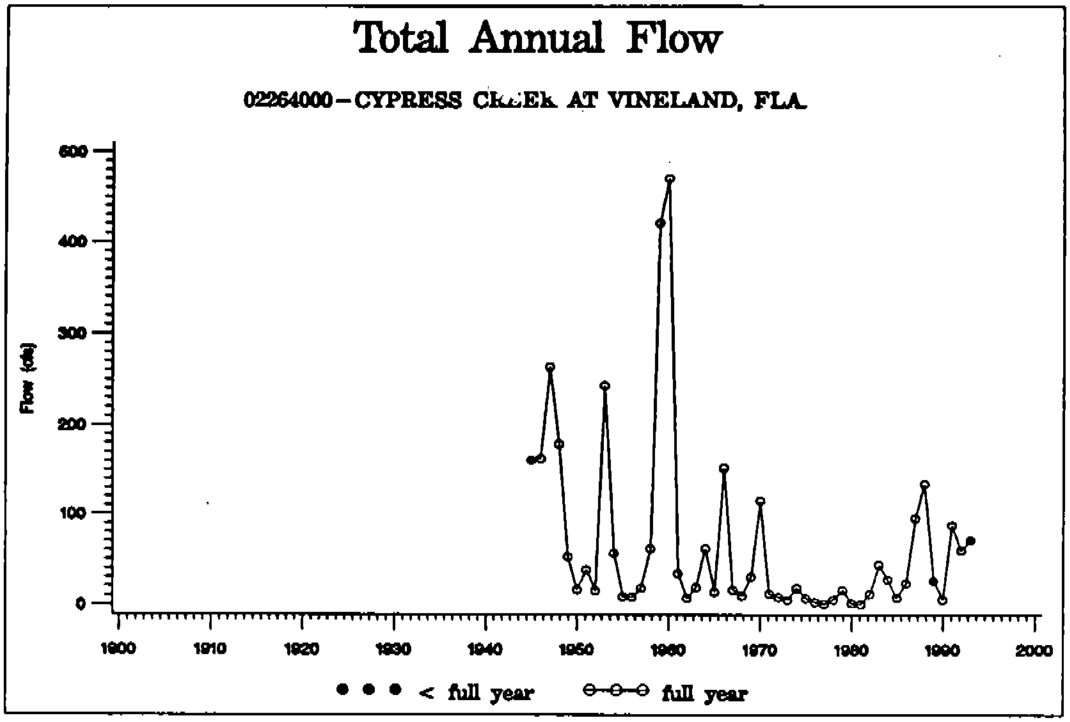

Average Monthly Flow
02263500 - ST. CLOUD CANAL AT S-59 NR ST. CLOUD, FLA.
Flow (cfs)
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

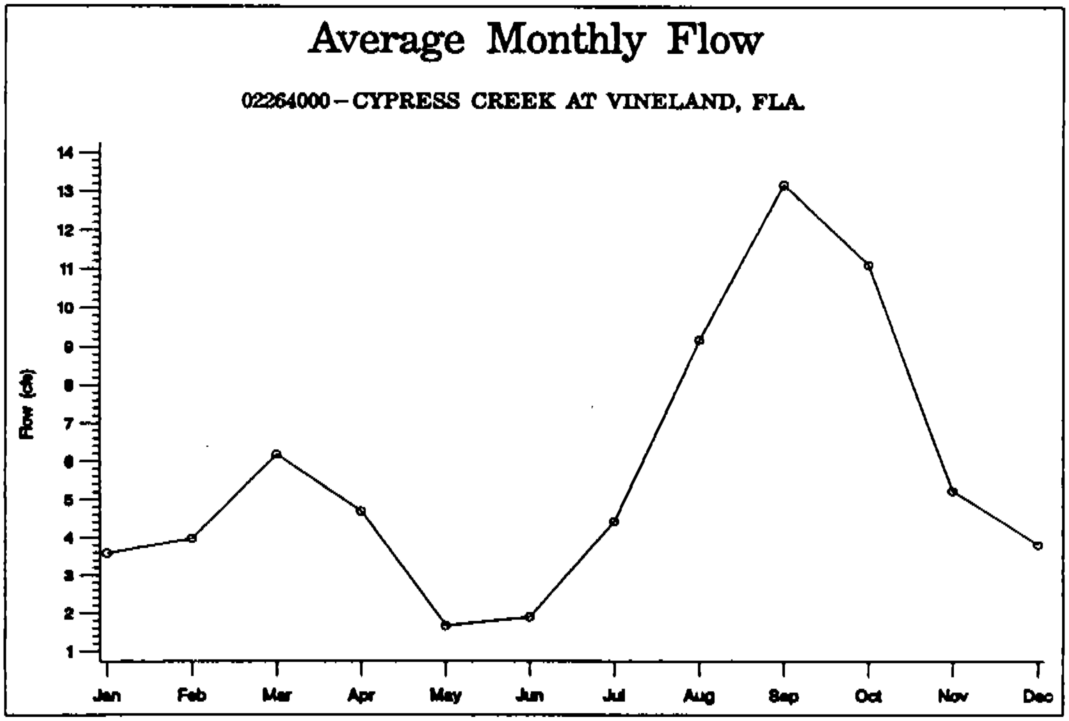

Total Annual Flow
02263800 - SHINGLE CREEK AT AIRPORT NR KISSIMMEE, FLA.
Flow (cfs)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

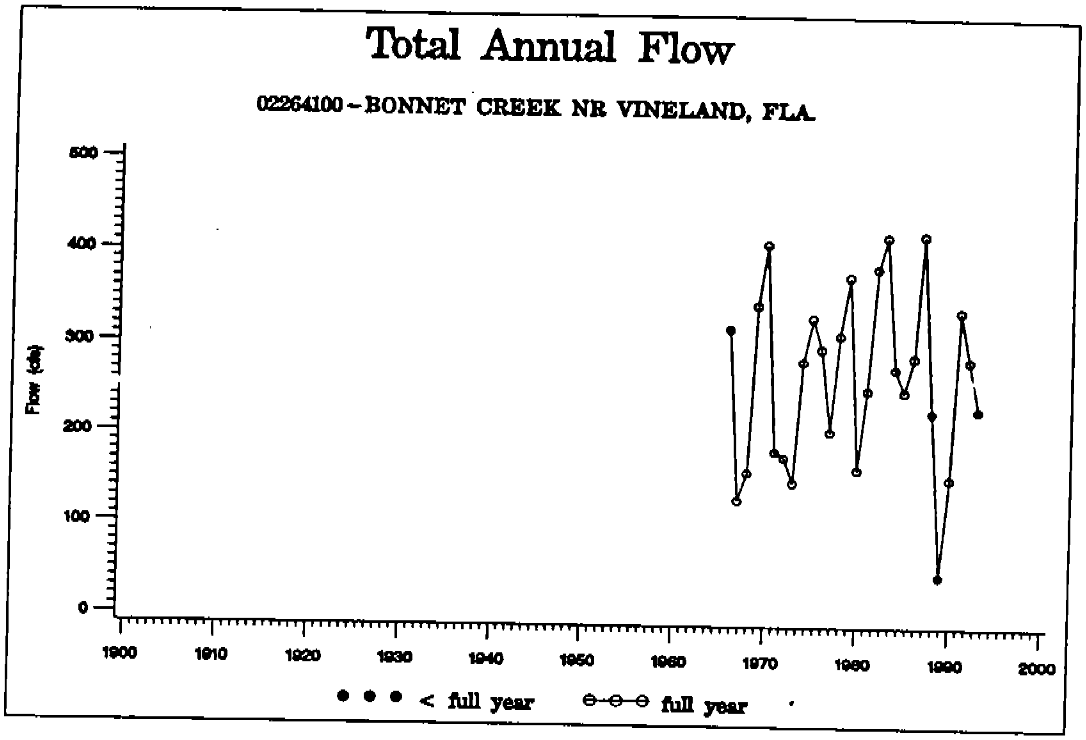

Average Monthly Flow
02263800 - SHINGLE CREEK AT AIRPORT NR KISSIMMEE, FLA.
Flow (cfs)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02263869 - SOUTH LAKE OUTLET AB S-15, NR VINELAND, FLA.
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

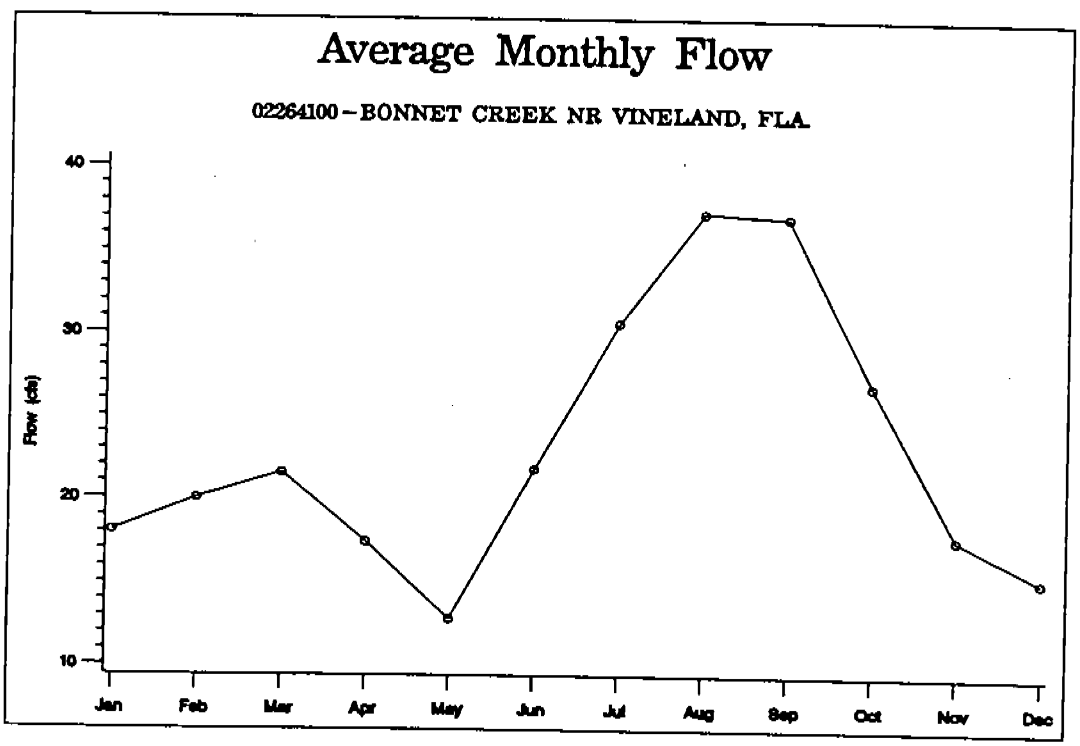

Average Monthly Flow
02263869 - SOUTH LAKE OUTLET AB S-15, NR VINELAND, FLA.
Flow (cfs)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02264000 – CYPRESS CREEK AT VINELAND, FLA.
Flow (cfs)
0
100
200
300
400
500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

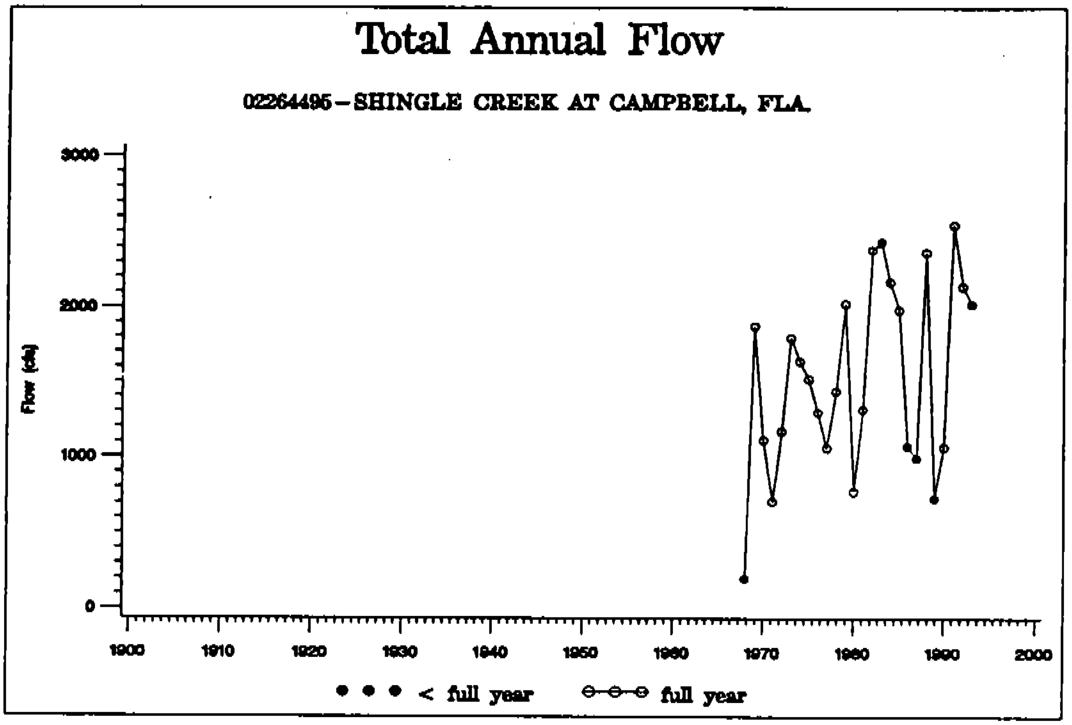

Average Monthly Flow
02264000 – CYPRESS CREEK AT VINELAND, FLA.
Flow (cfs)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

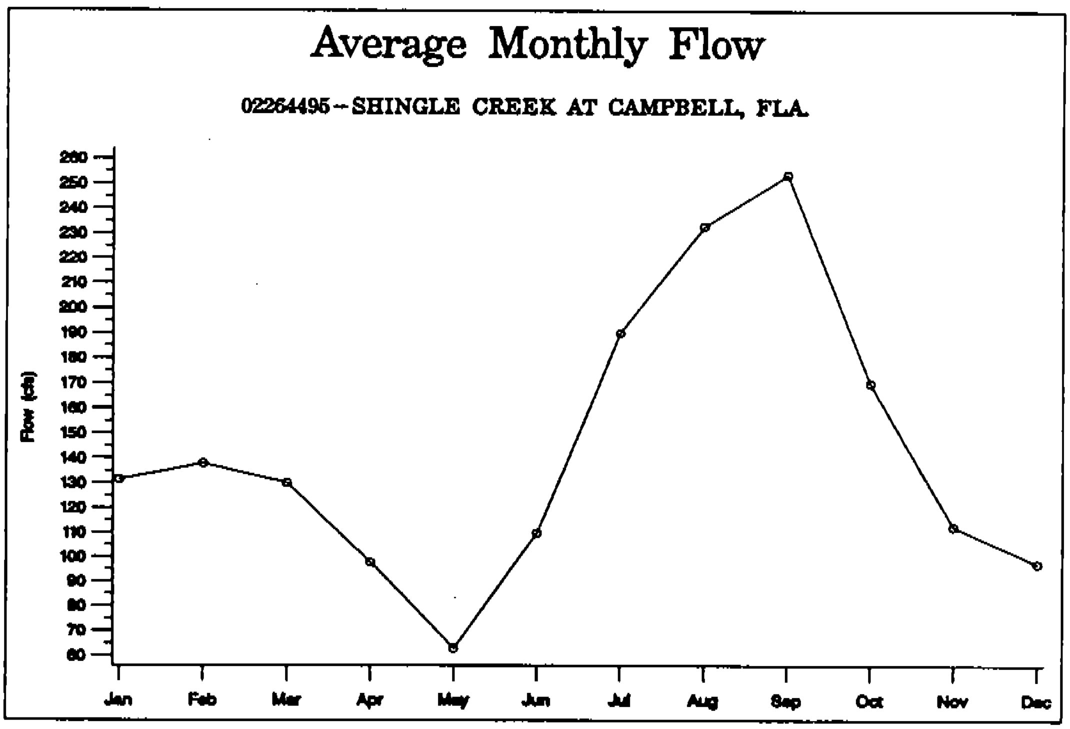


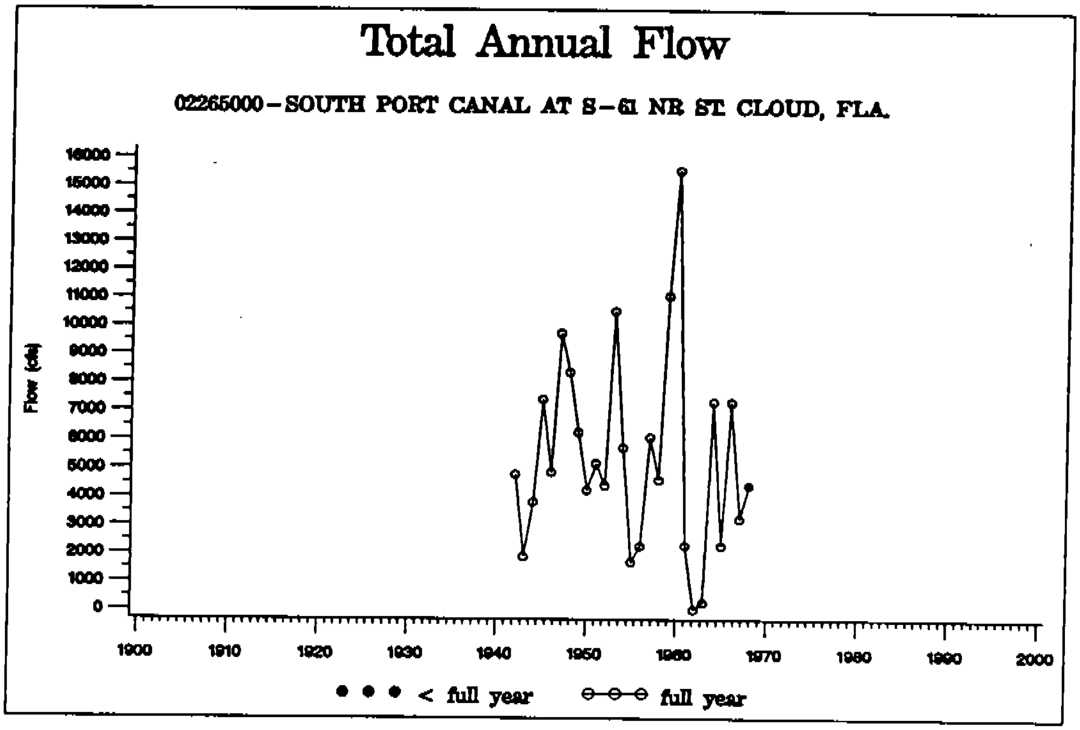
Total Annual Flow
02264100 – BONNET CREEK NR VINELAND, FLA.
Flow (cfs)
0
100
200
300
400
500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

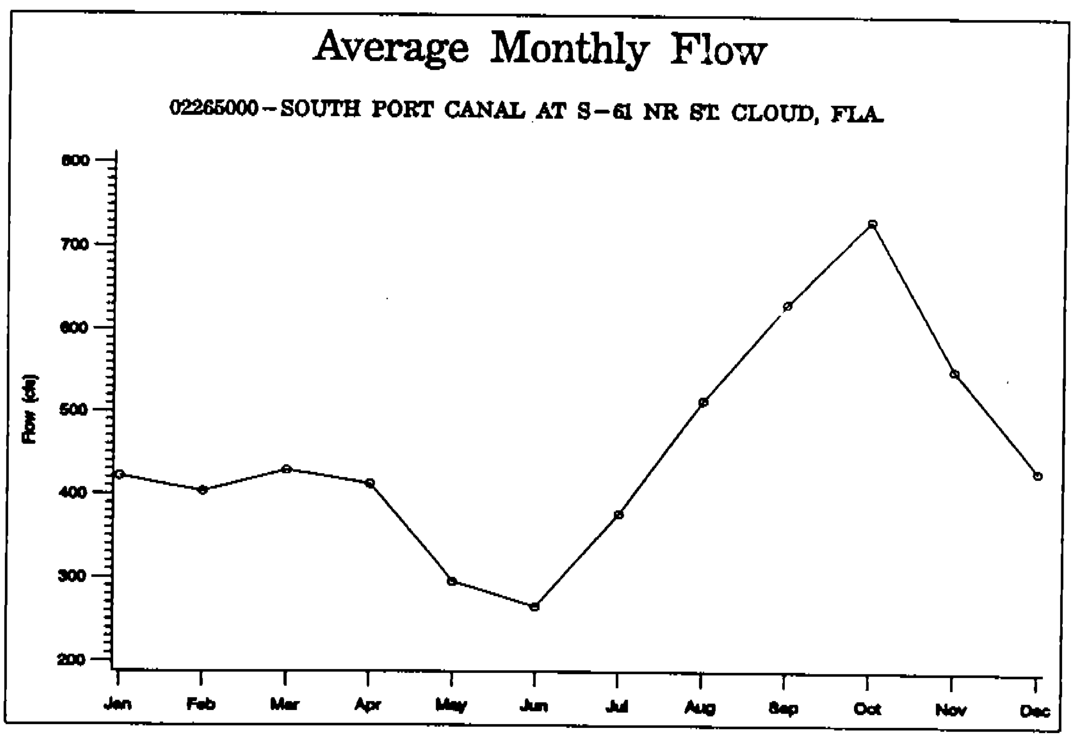


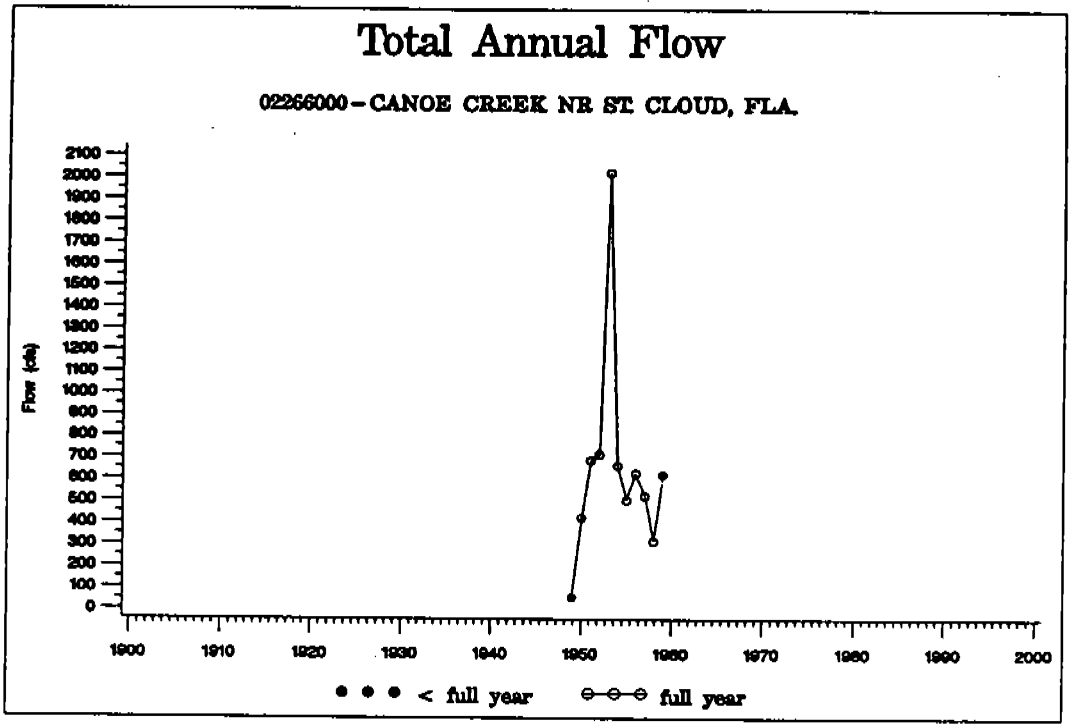
Average Monthly Flow
02264100 – BONNET CREEK NR VINELAND, FLA.
Flow (cfs)
10
20
30
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

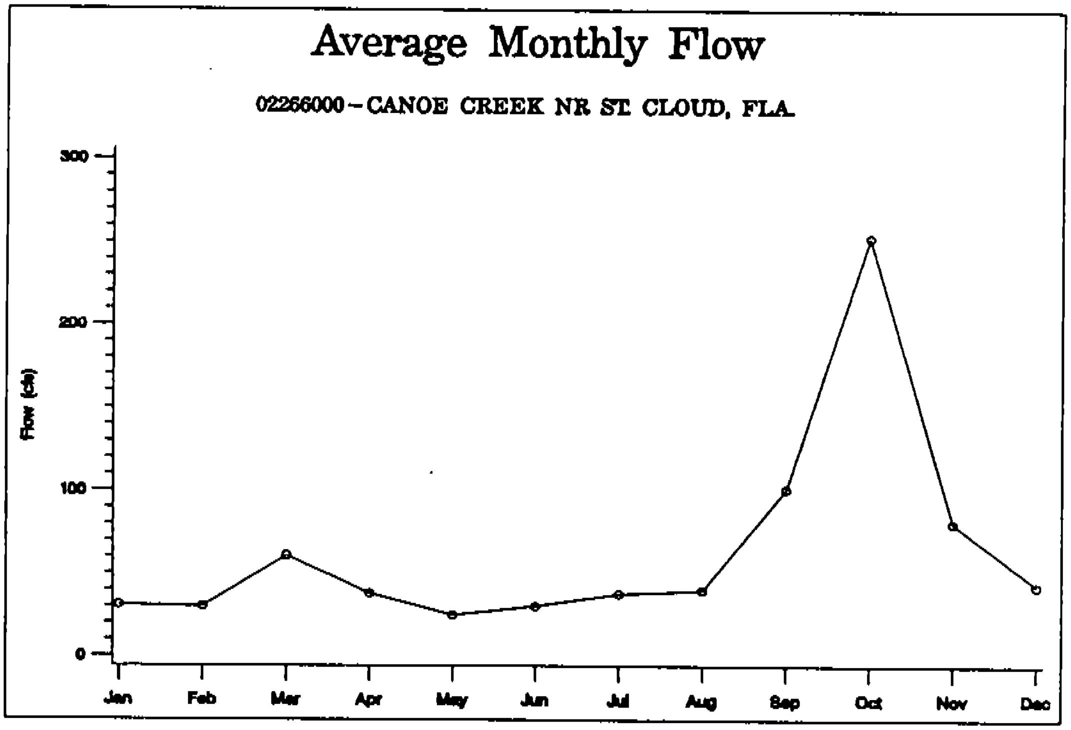

Total Annual Flow
02264495 – SHINGLE CREEK AT CAMPBELL, FLA.
3000
2000
1000
0
Flow (cfs)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

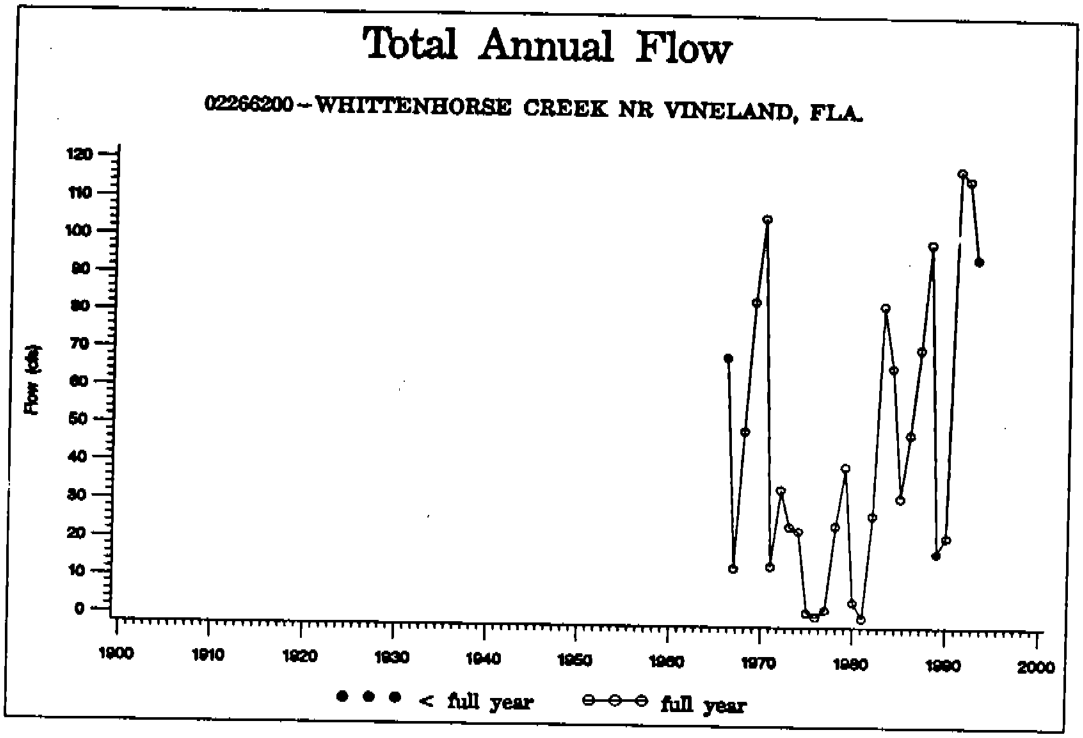

Average Monthly Flow
02264495 – SHINGLE CREEK AT CAMPBELL, FLA.
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

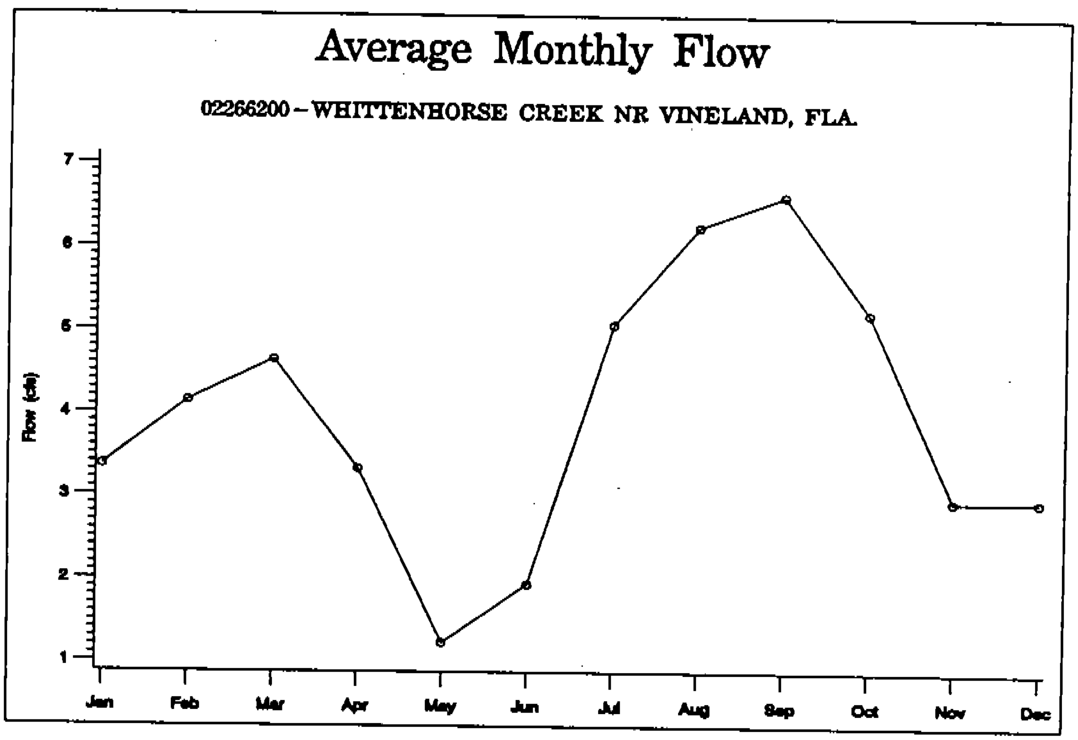

Total Annual Flow
02265000-SOUTH PORT CANAL AT S-61 NR ST. CLOUD, FLA.
Flow (cfs)
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

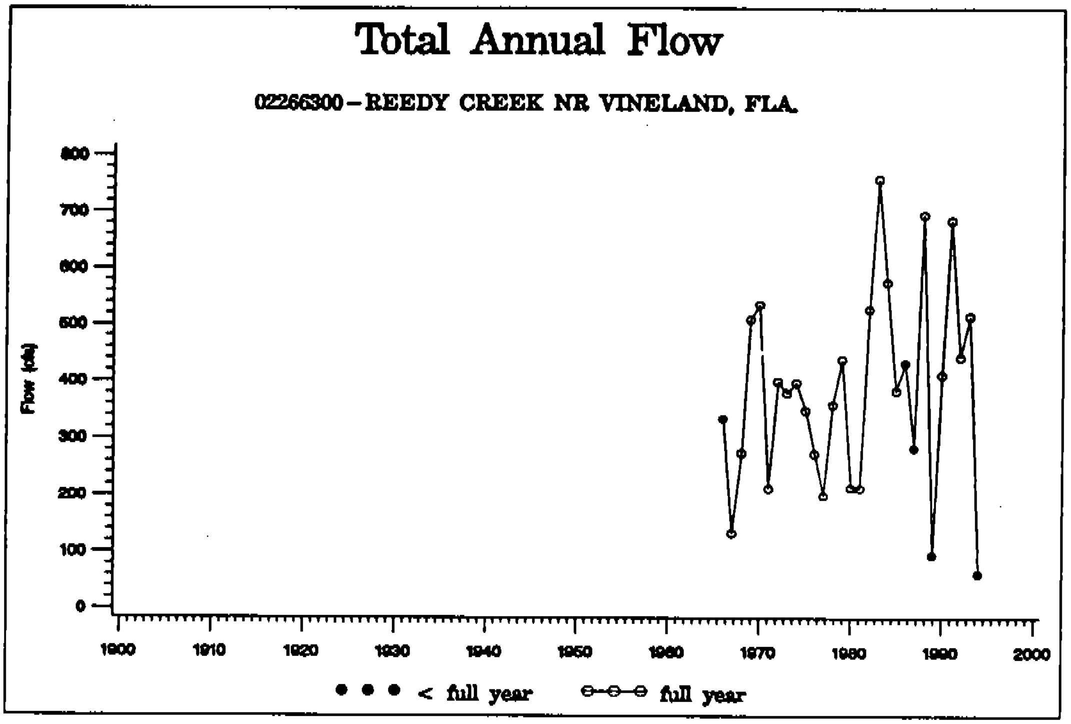

Average Monthly Flow
02265000-SOUTH PORT CANAL AT S-61 NR ST. CLOUD, FLA.
Flow (cfs)
800
700
600
500
400
300
200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02266000 – CANOE CREEK NR ST. CLOUD, FLA.
Flow (cfs)
● ● ● < full year
⊖–⊖–⊖ full year

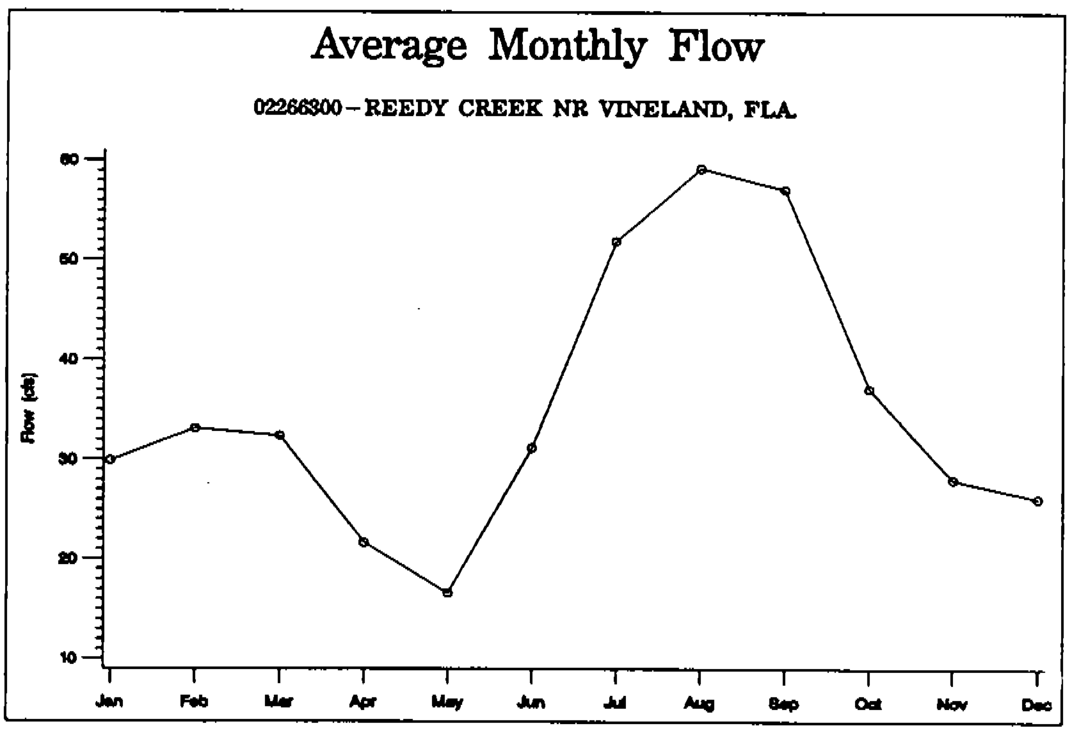

Average Monthly Flow
02266000 – CANOE CREEK NR ST. CLOUD, FLA.
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02266200 - WHITTENHORSE CREEK NR VINELAND, FLA.
Flow (cfs)
120
110
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

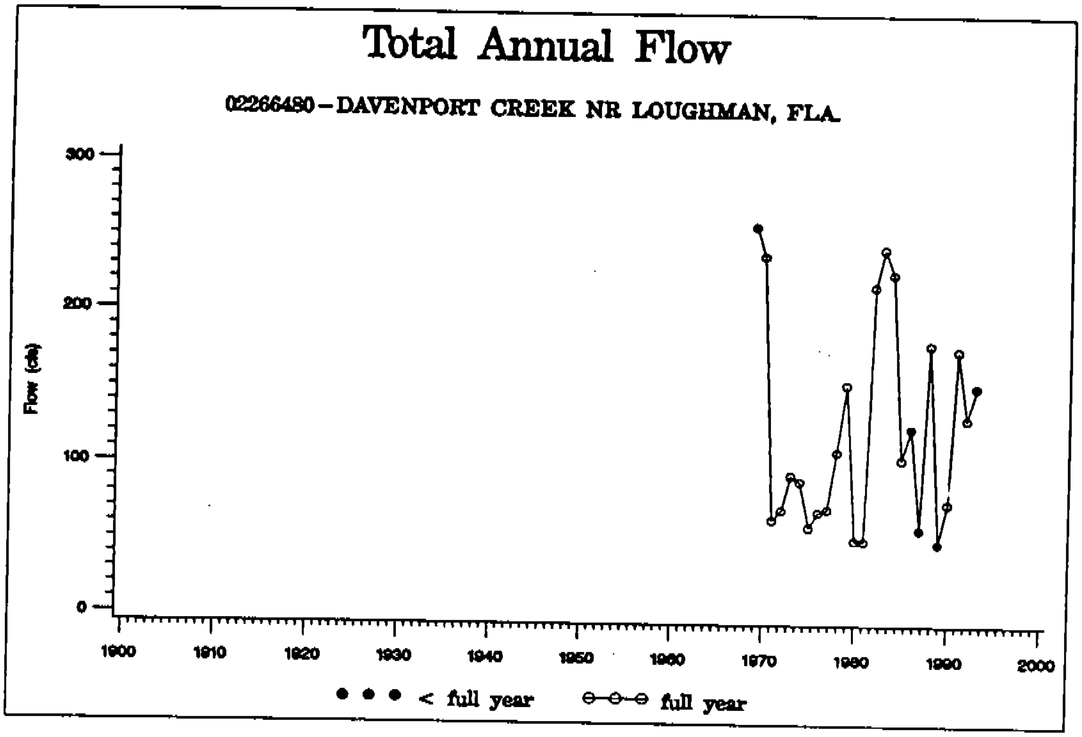

Average Monthly Flow
02266200 - WHITTENHORSE CREEK NR VINELAND, FLA.
Flow (cfs)
7
6
5
4
3
2
1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



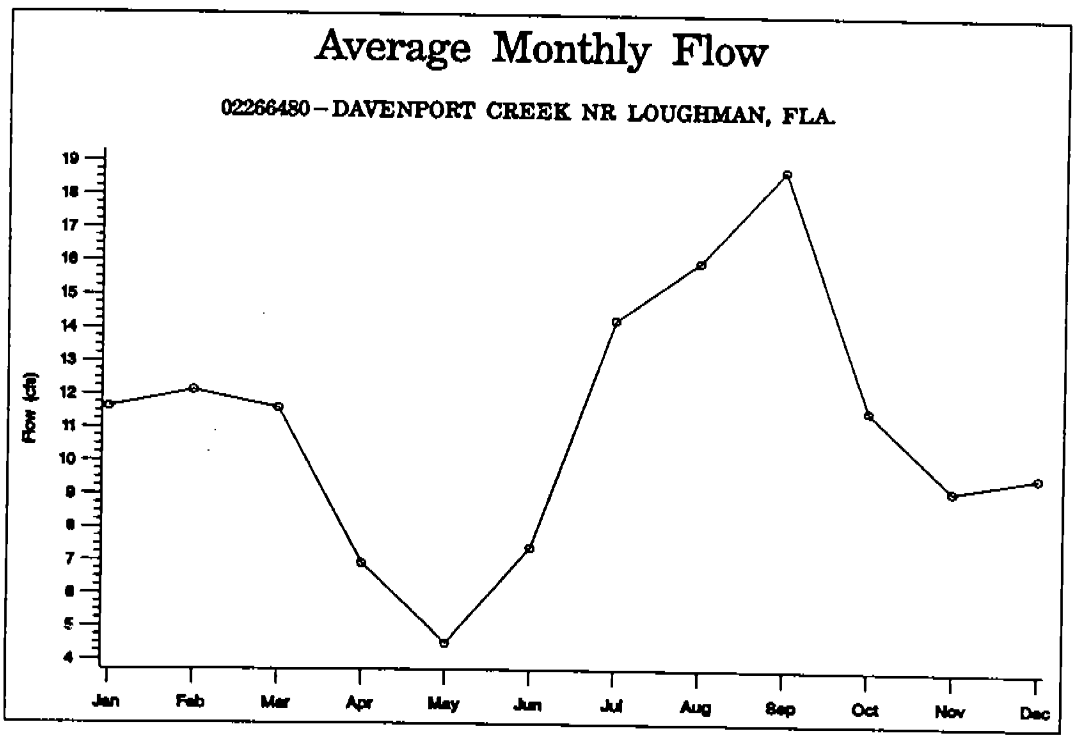
Total Annual Flow
02266300 – REEDY CREEK NR VINELAND, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



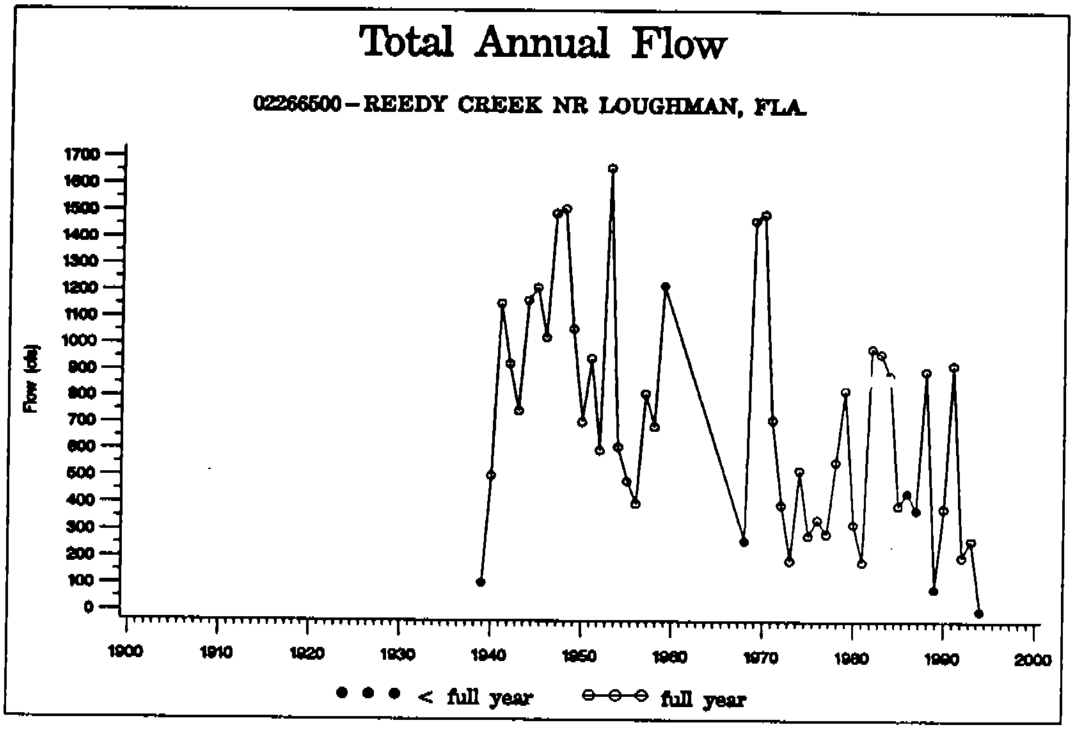
Average Monthly Flow
02266300 – REEDY CREEK NR VINELAND, FLA.
Flow (cfs)
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

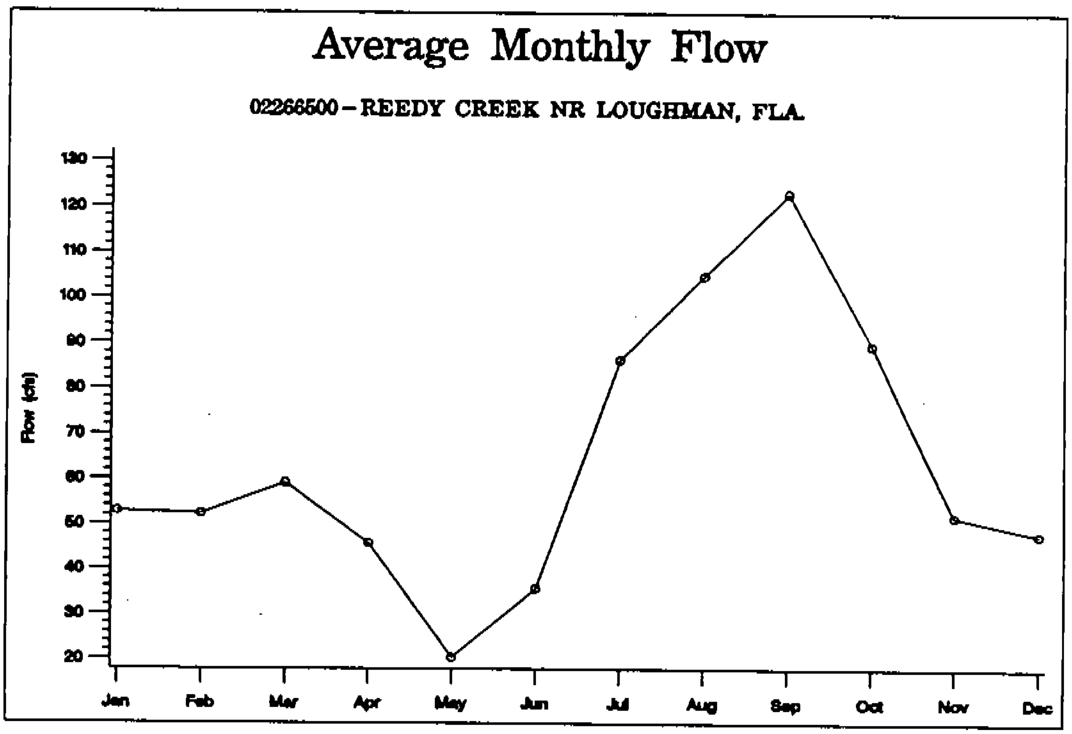


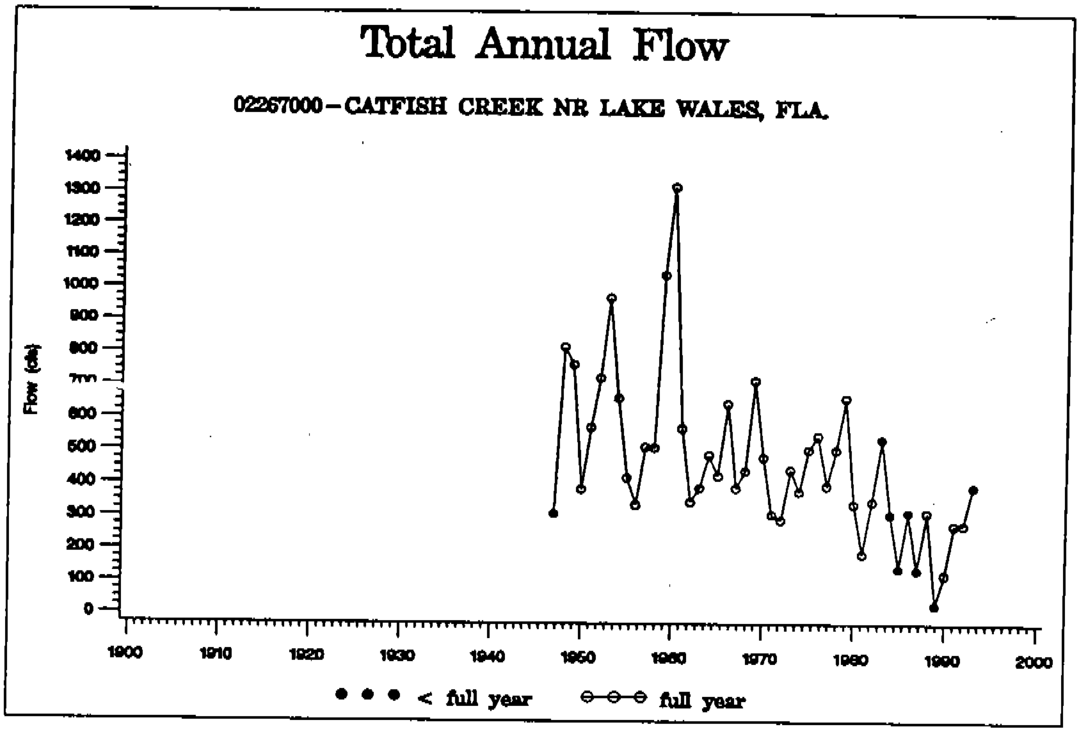
Total Annual Flow
02266480 – DAVENPORT CREEK NR LOUGHMAN, FLA.
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖–⊖–⊖ full year

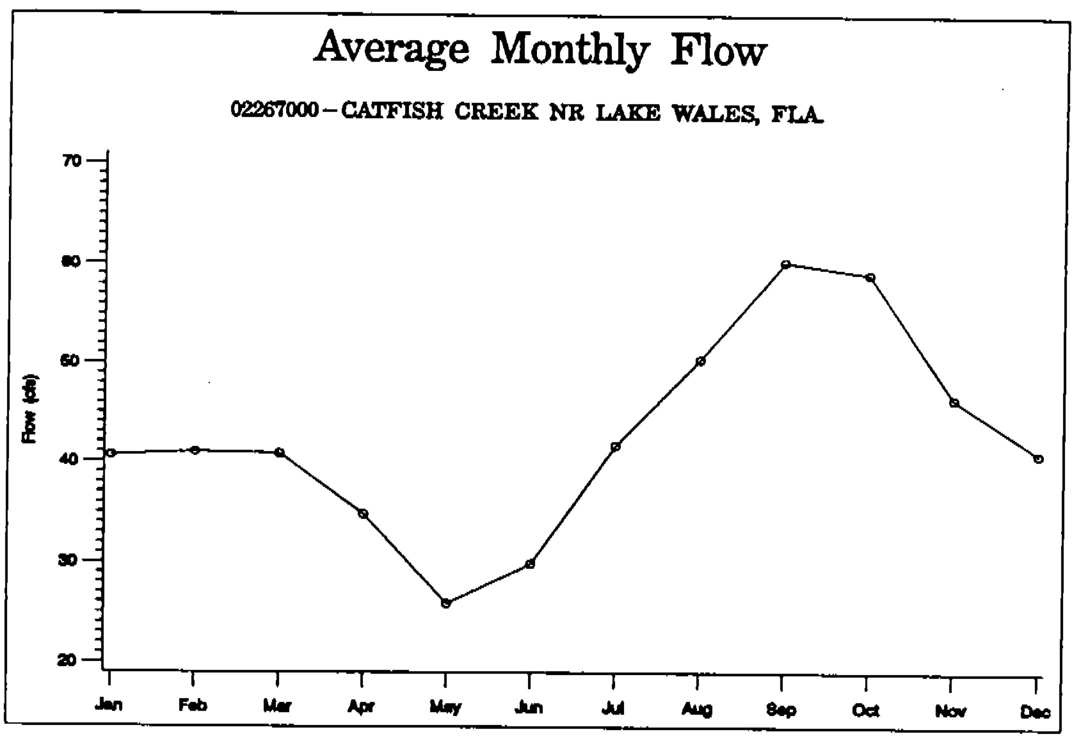


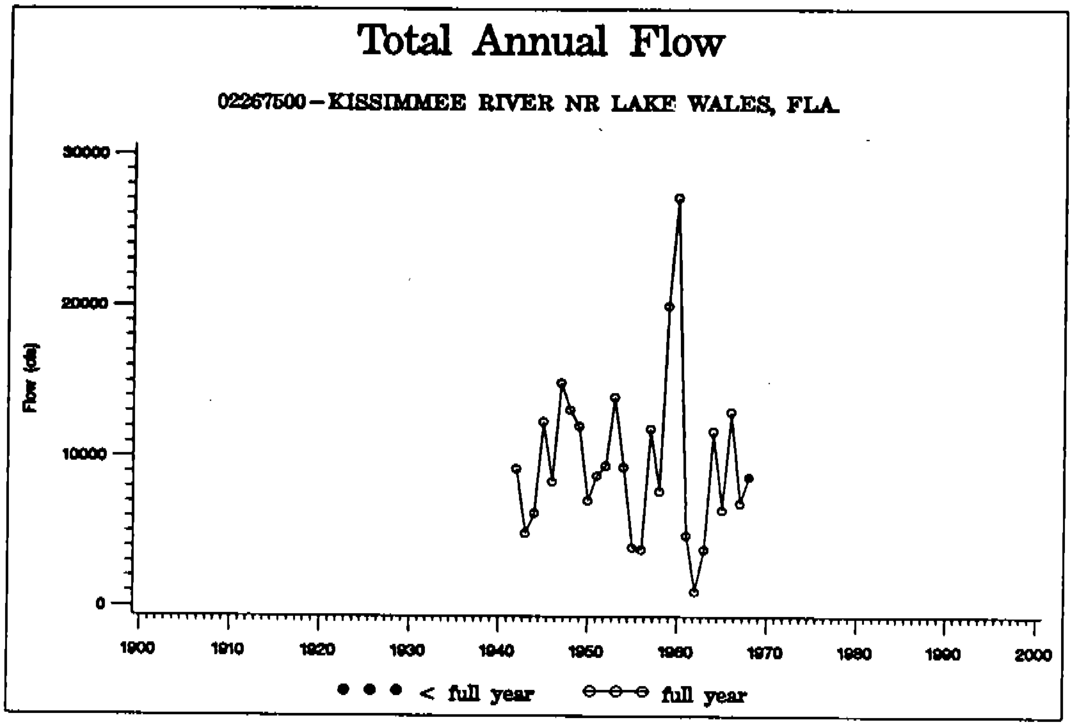
Average Monthly Flow
02266480 – DAVENPORT CREEK NR LOUGHMAN, FLA.
Flow (cfs)
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02266500 - REEDY CREEK NR LOUGHMAN, FLA.
Flow (cfs)
• • • < full year
full year

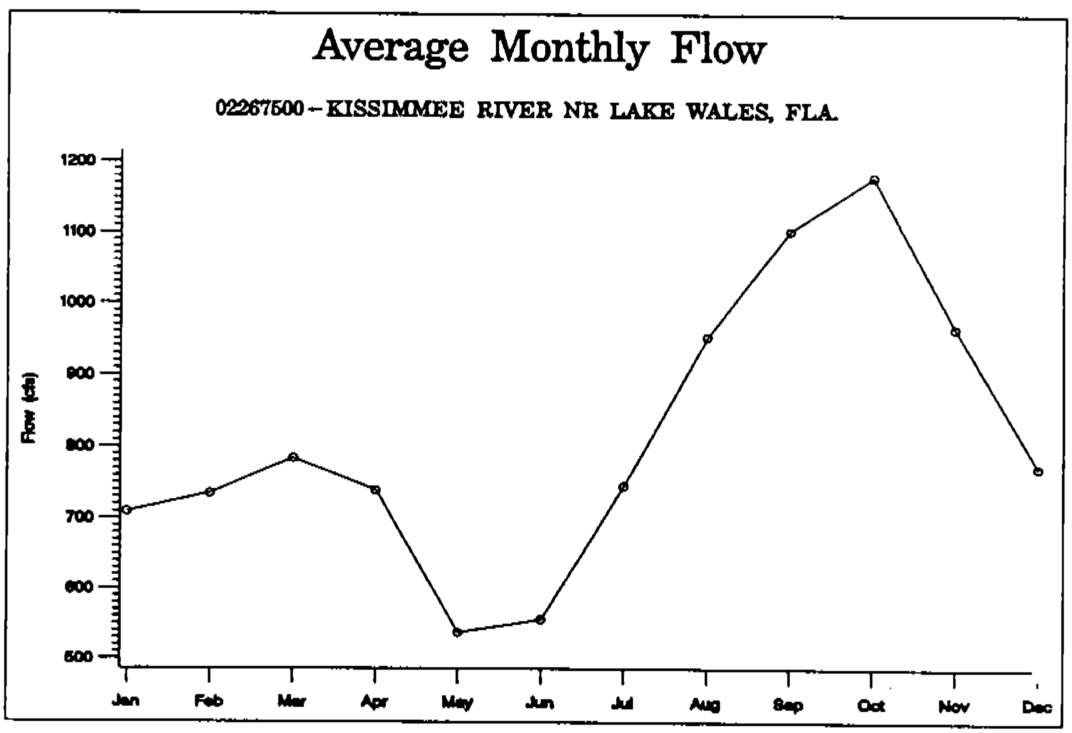

Average Monthly Flow
02266500 - REEDY CREEK NR LOUGHMAN, FLA.
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02267000 - CATFISH CREEK NR LAKE WALES, FLA.
Flow (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

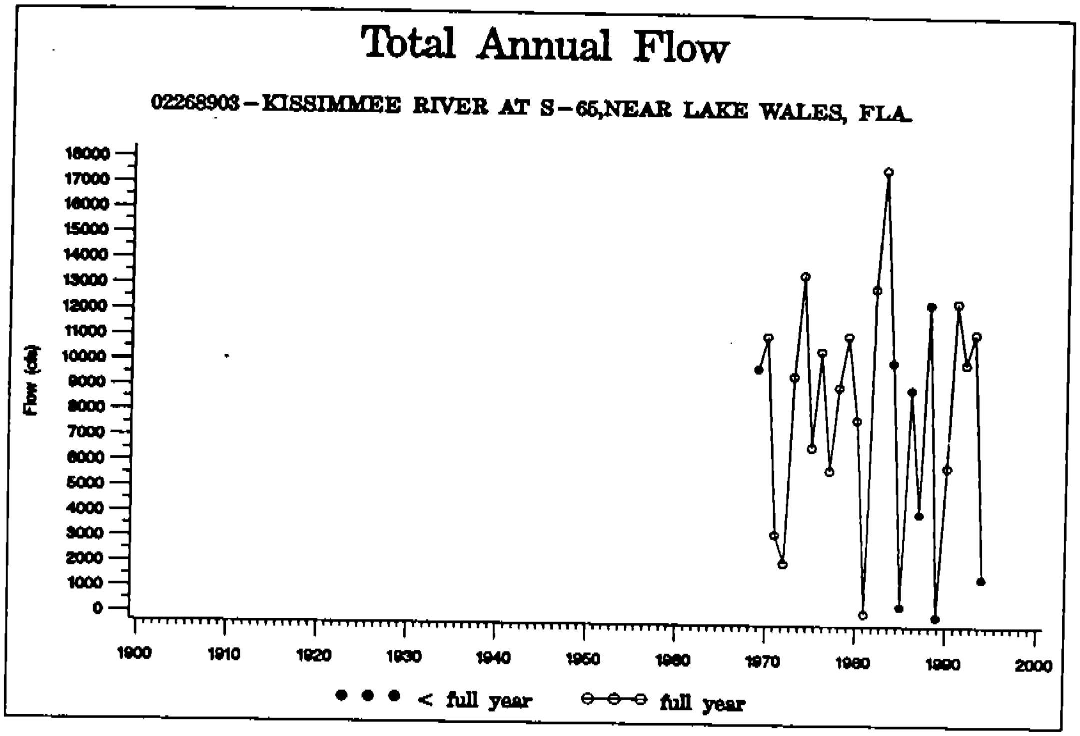

Average Monthly Flow
02267000 - CATFISH CREEK NR LAKE WALES, FLA.
Flow (cfs)
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

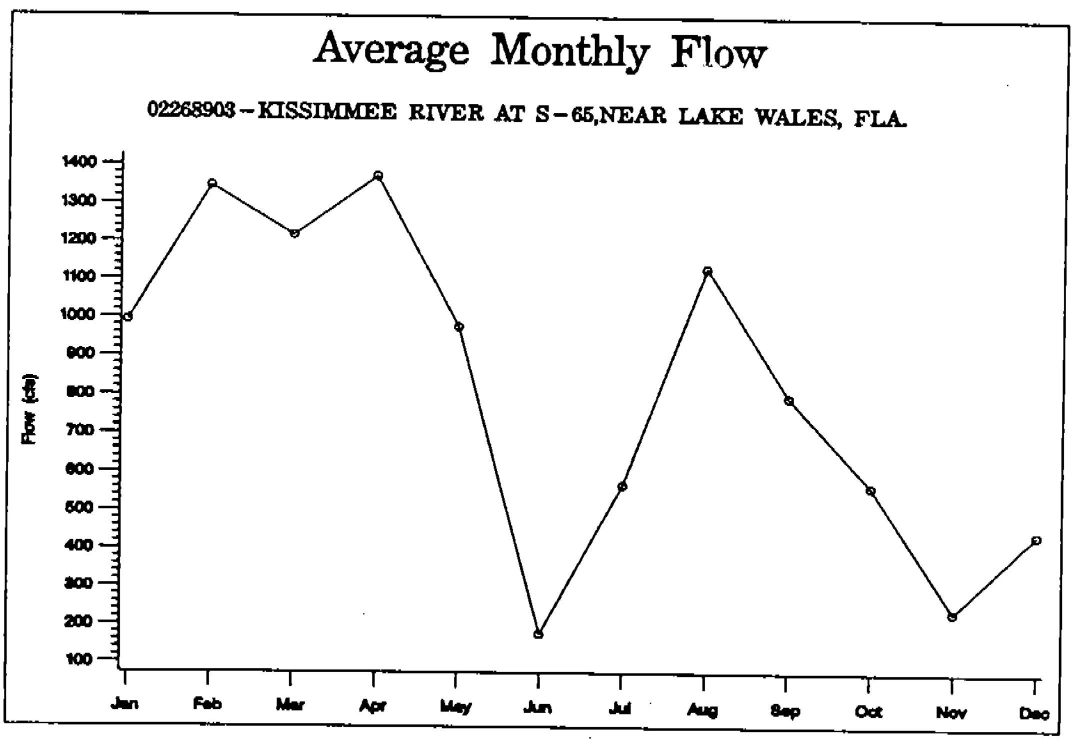


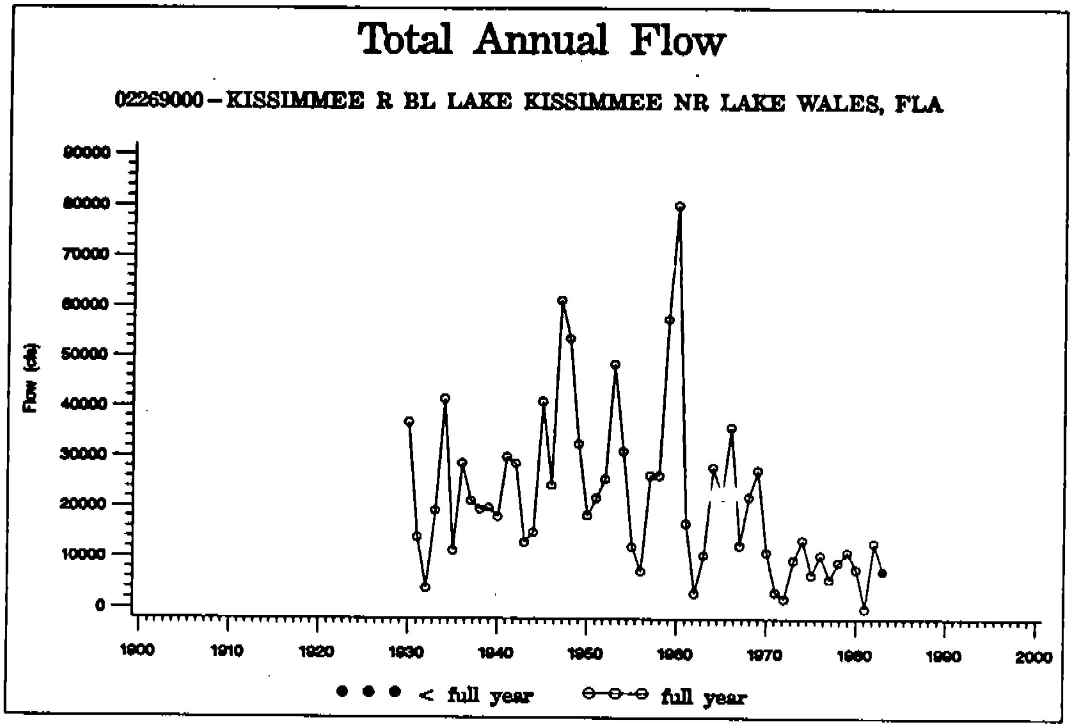
Total Annual Flow
02267500 – KISSIMMEE RIVER NR LAKE WALES, FLA.
Flow (cfs)
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



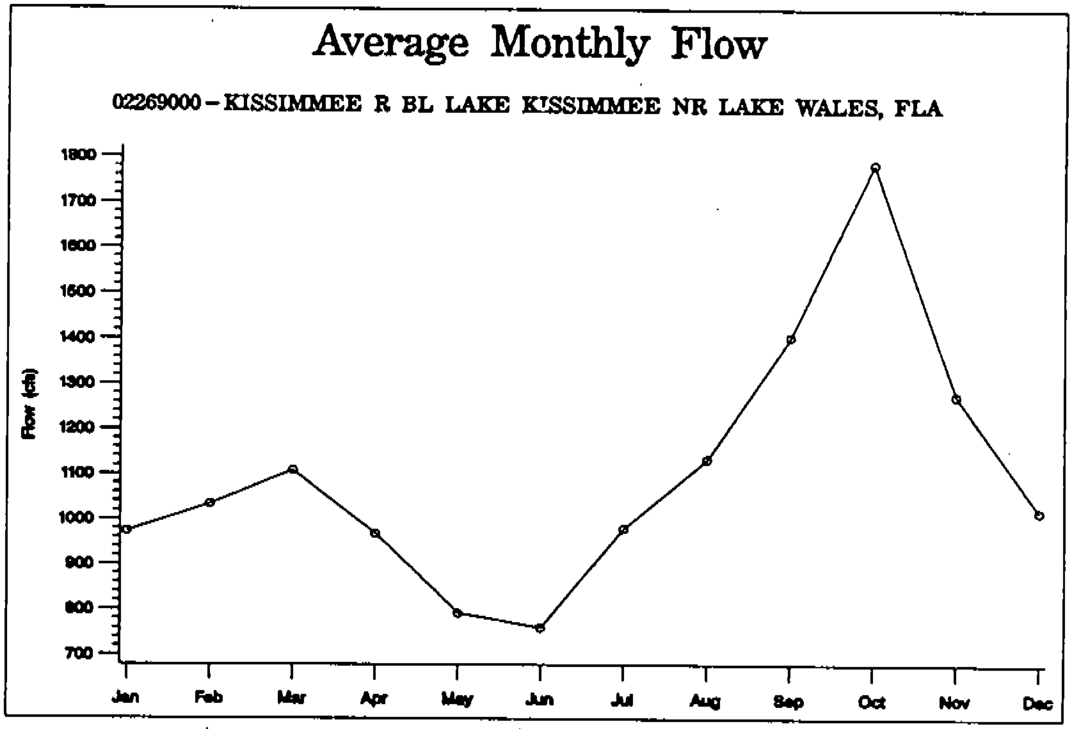
Average Monthly Flow
02267500 – KISSIMMEE RIVER NR LAKE WALES, FLA.
Flow (cfs)
1200
1100
1000
900
800
700
600
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02268903 - KISSIMMEE RIVER AT S-65,NEAR LAKE WALES, FLA.
Flow (cfs)
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

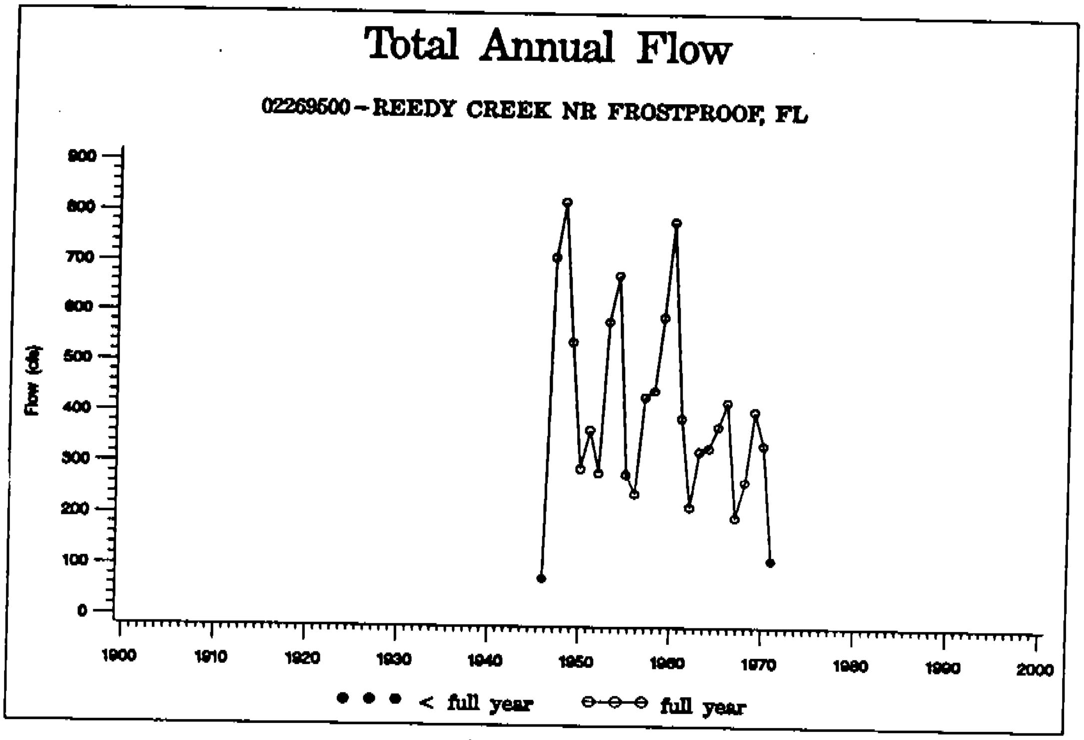

Average Monthly Flow
02268903 - KISSIMMEE RIVER AT S-65,NEAR LAKE WALES, FLA.
Flow (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

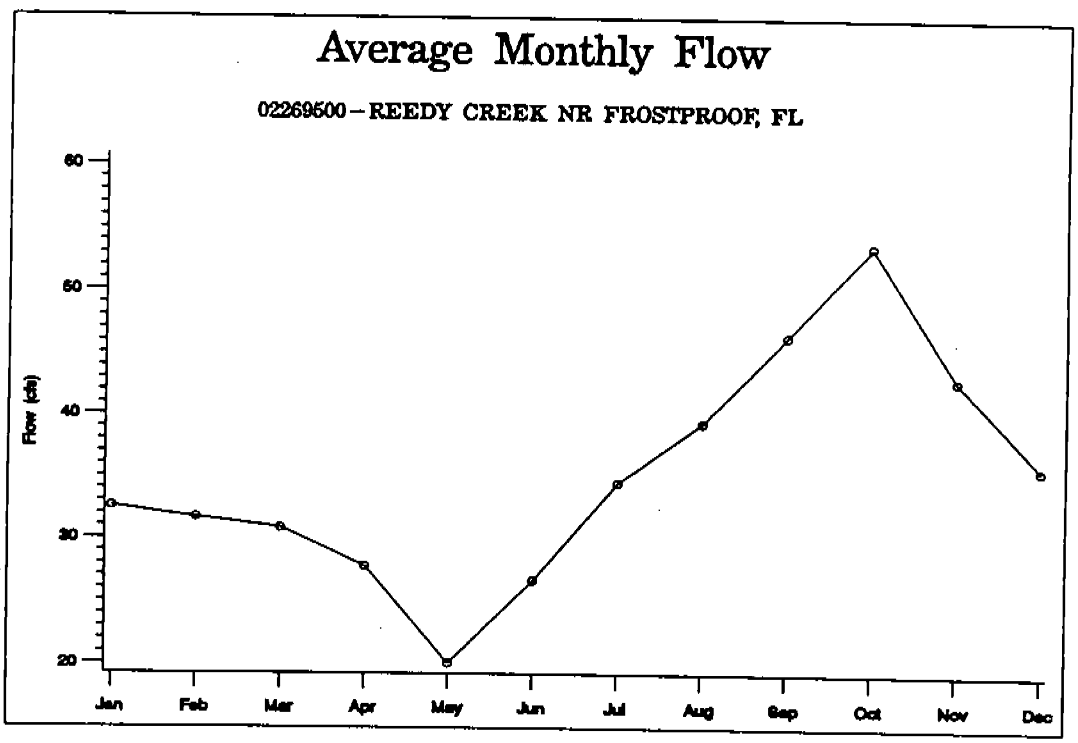


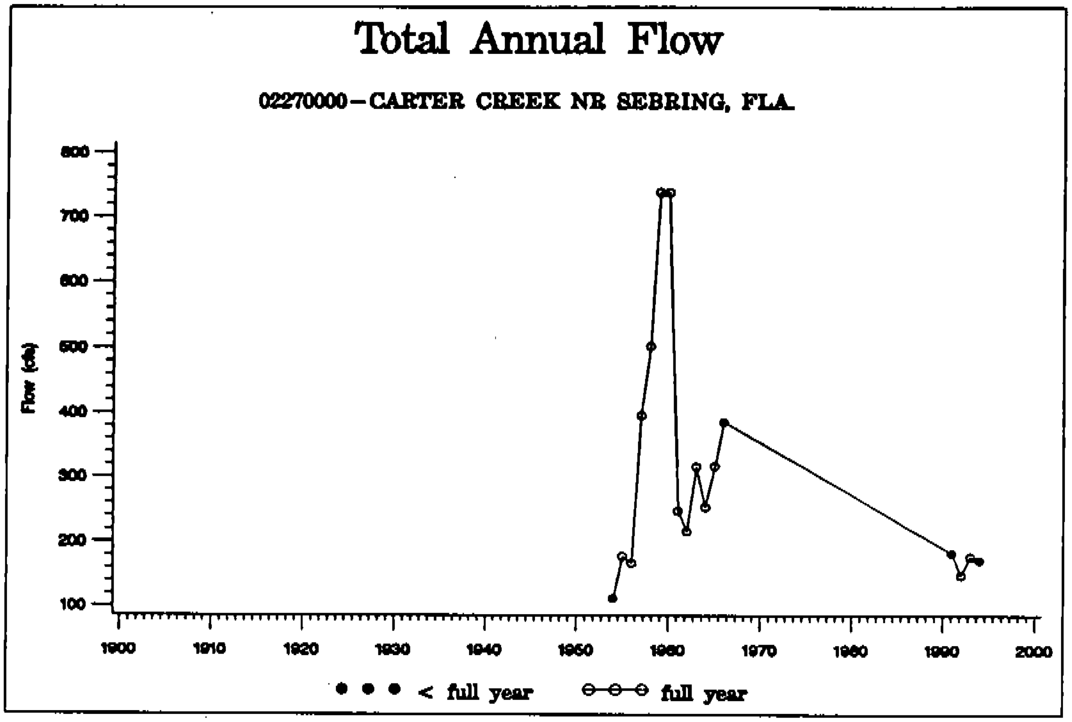
Total Annual Flow
02269000 - KISSIMMEE R BL LAKE KISSIMMEE NR LAKE WALES, FLA
Flow (cfs)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

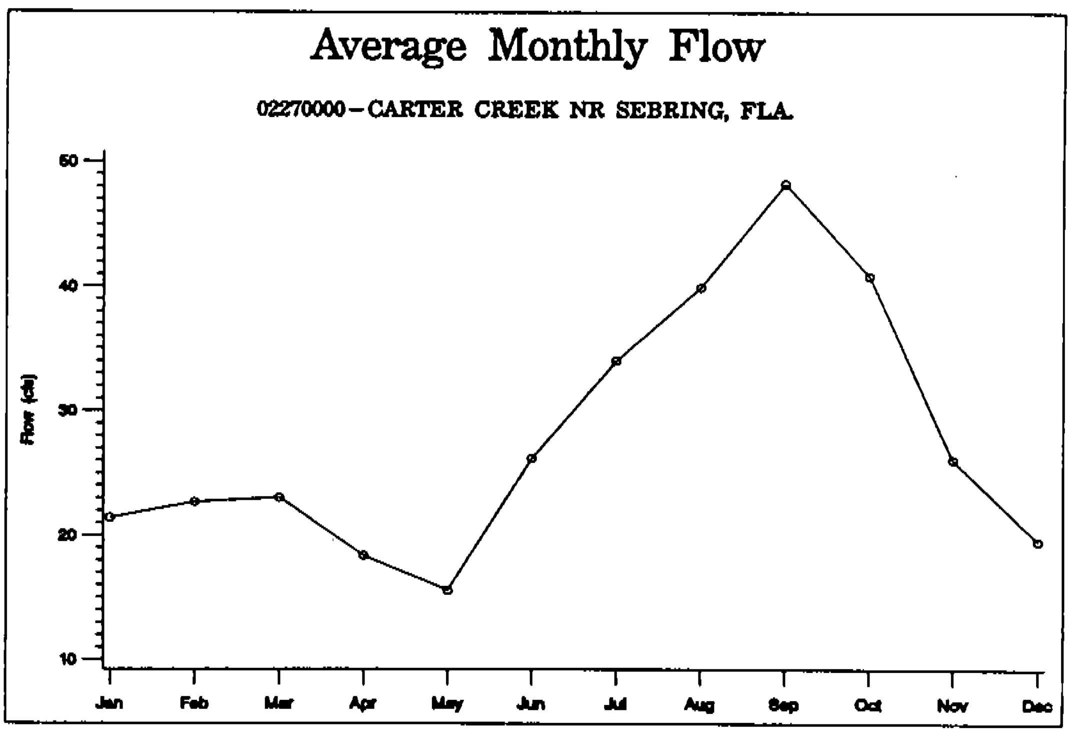


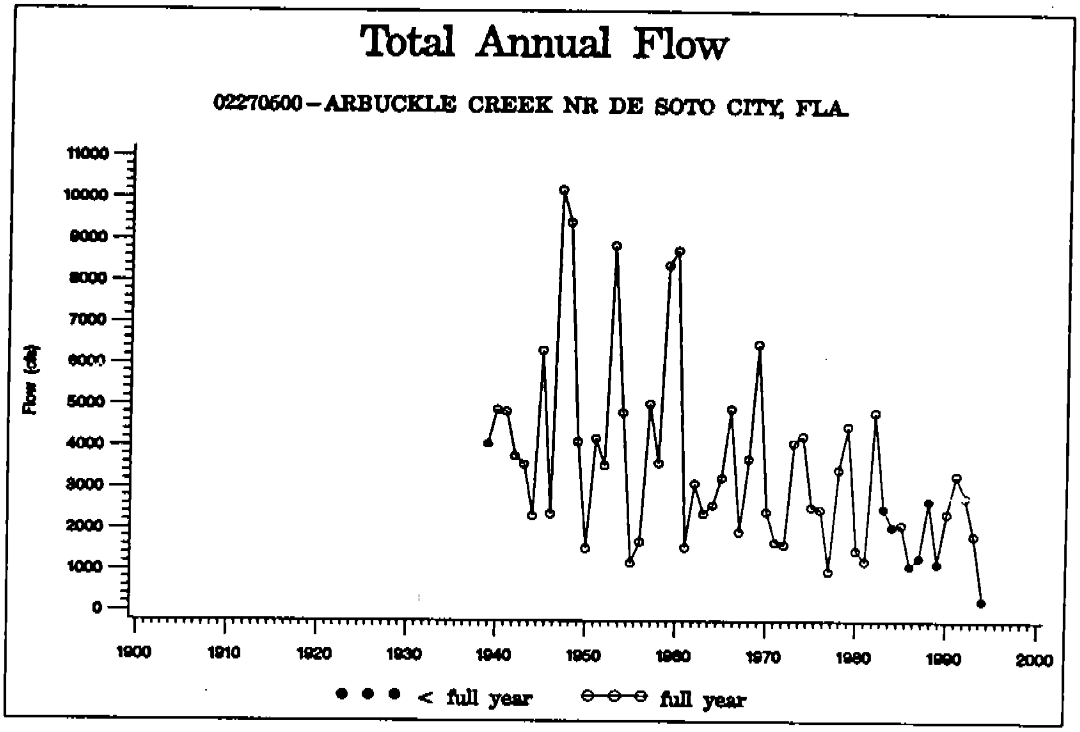
Average Monthly Flow
02269000 - KISSIMMEE R BL LAKE KISSIMMEE NR LAKE WALES, FLA
Flow (cfs)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

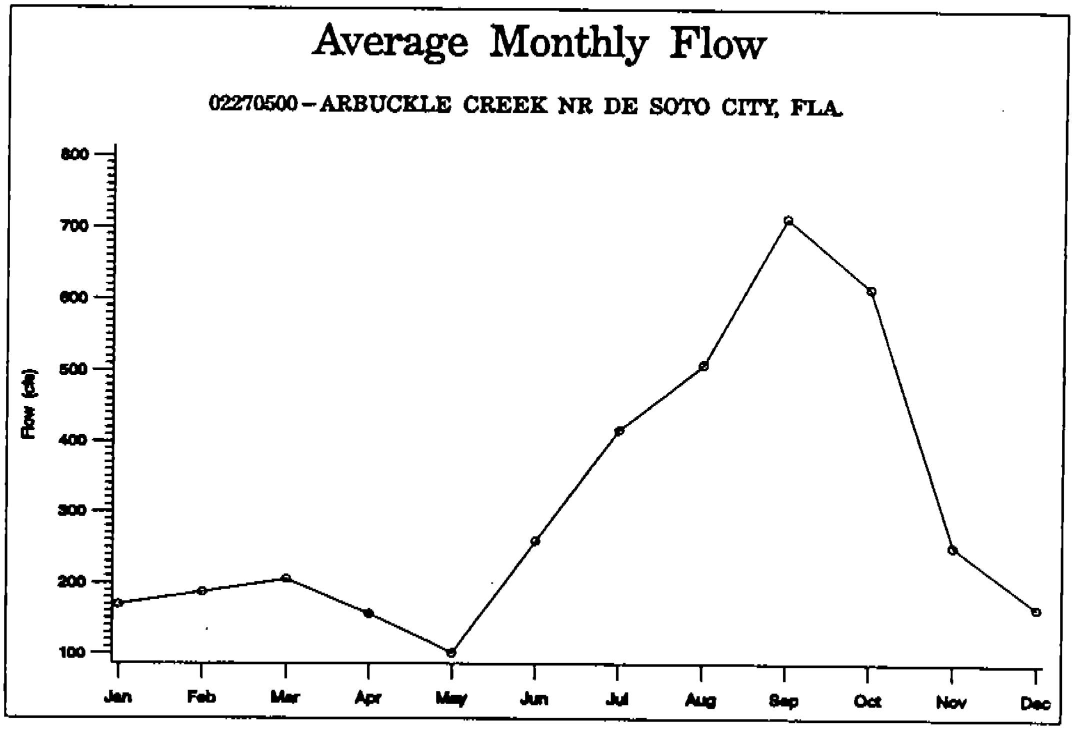

Total Annual Flow
02269500 - REEDY CREEK NR FROSTPROOF, FL
Flow (cfs)
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
o-o-o full year

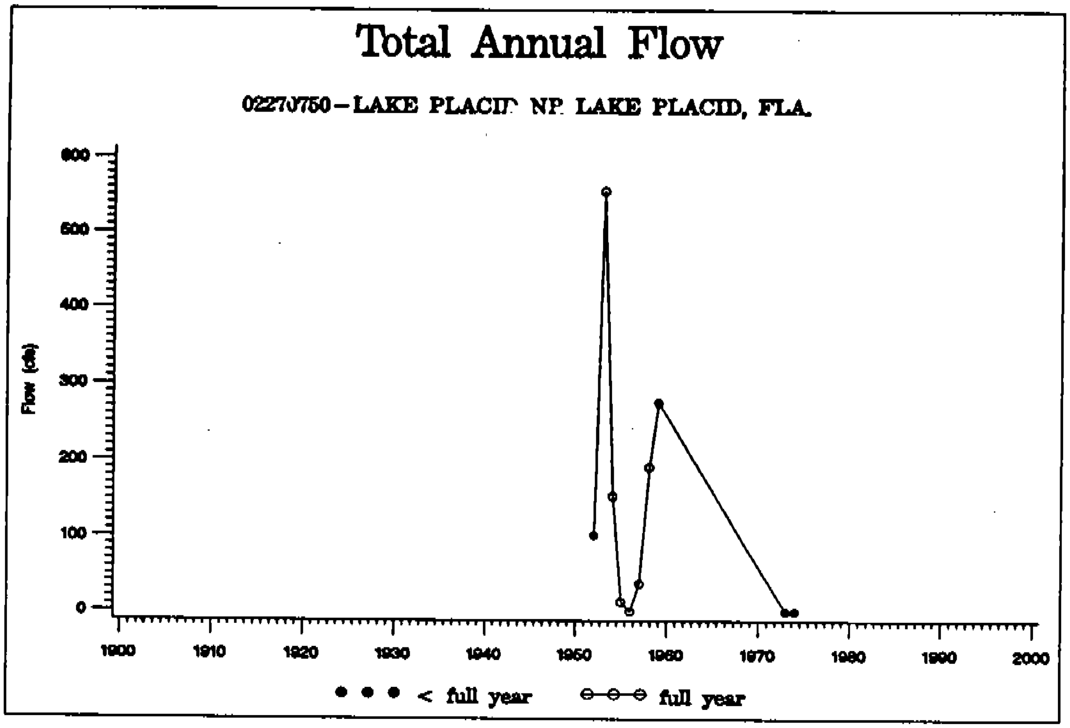

Average Monthly Flow
02269500 - REEDY CREEK NR FROSTPROOF, FL
Flow (cfs)
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

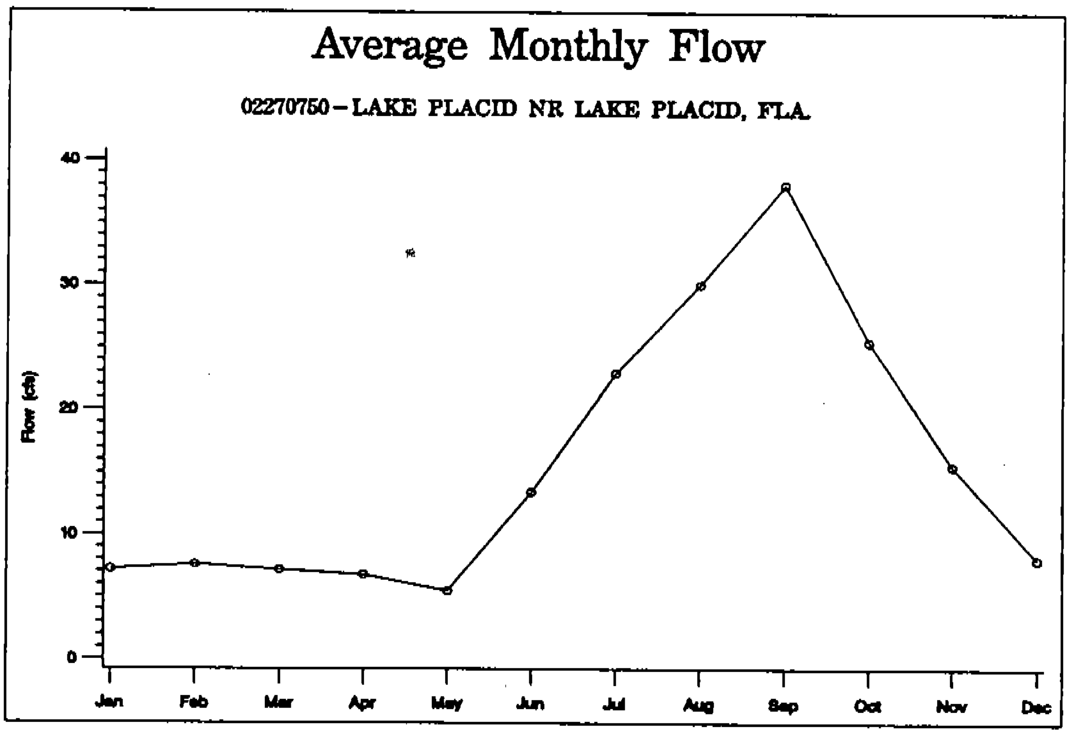

Total Annual Flow
02270000-CARTER CREEK NR SEBRING, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

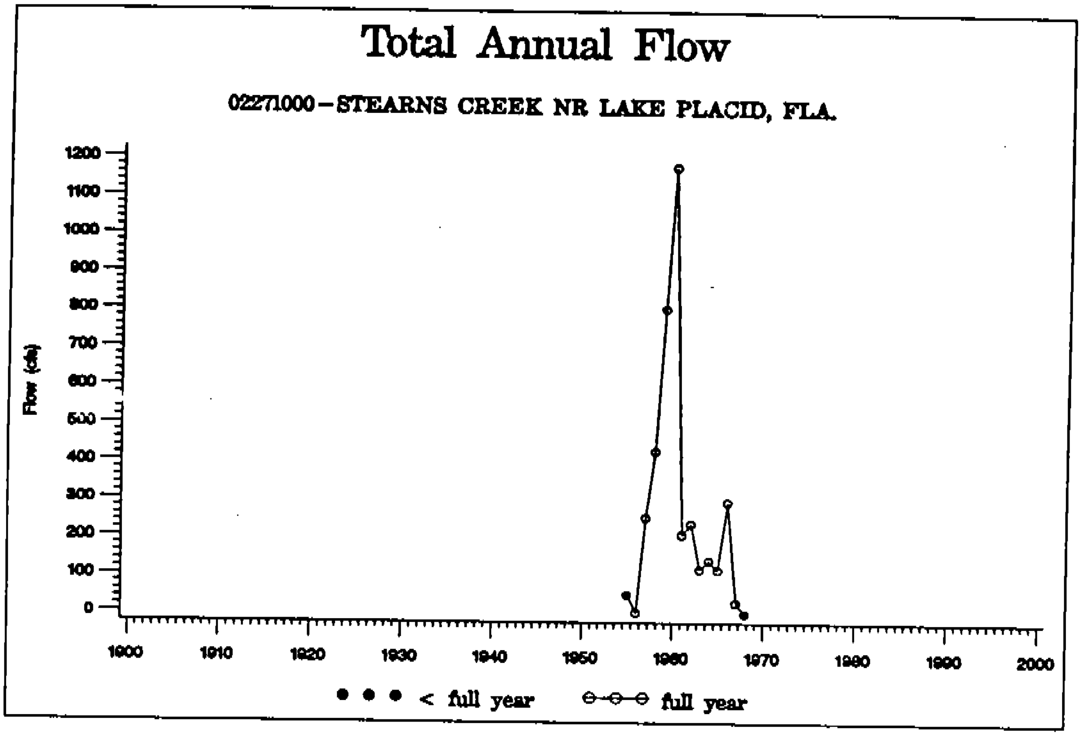

Average Monthly Flow
02270000-CARTER CREEK NR SEBRING, FLA.
Flow (cfs)
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

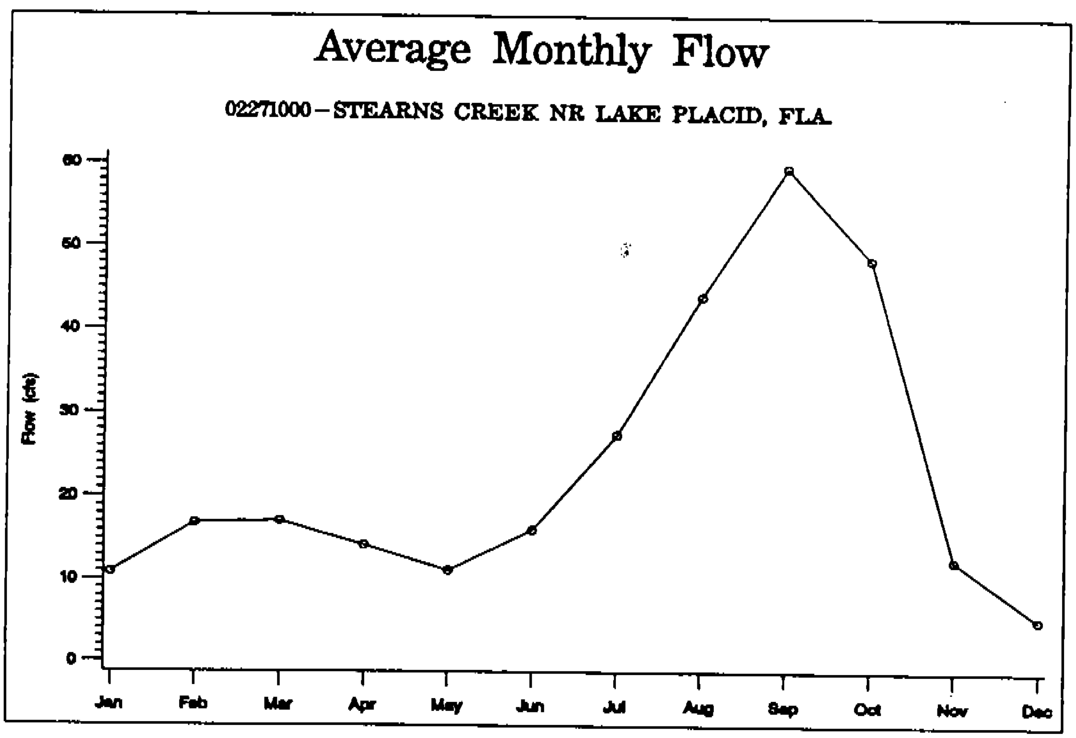

Total Annual Flow
02270500 - ARBUCKLE CREEK NR DE SOTO CITY, FLA.
Flow (cfs)
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

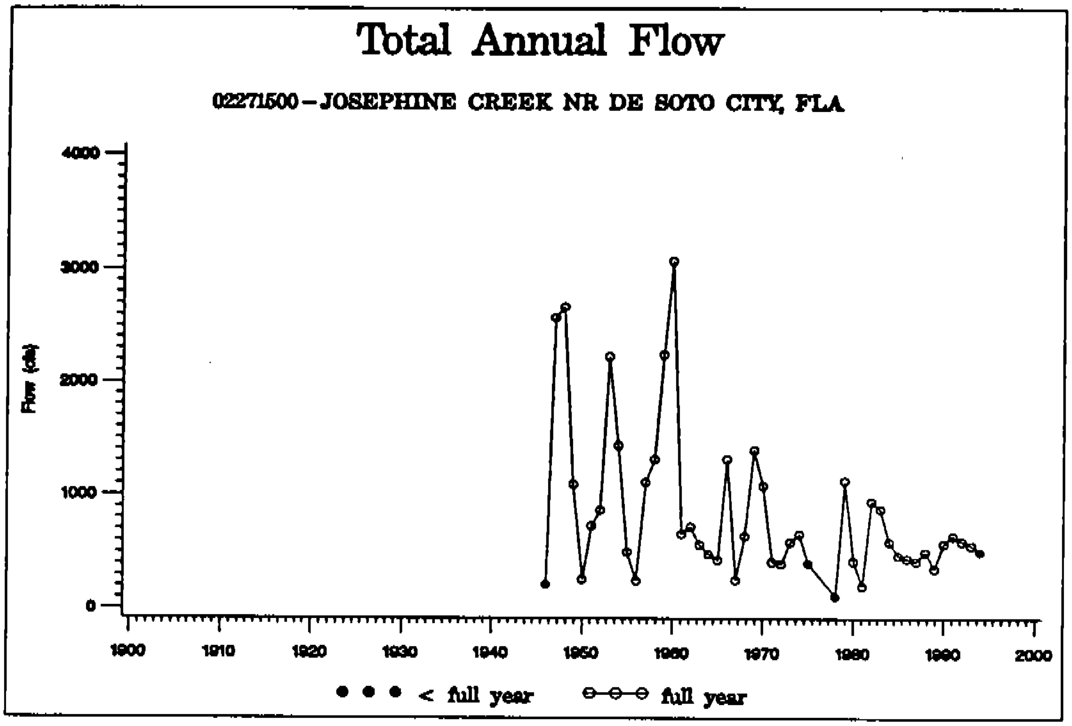

Average Monthly Flow
02270500 - ARBUCKLE CREEK NR DE SOTO CITY, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

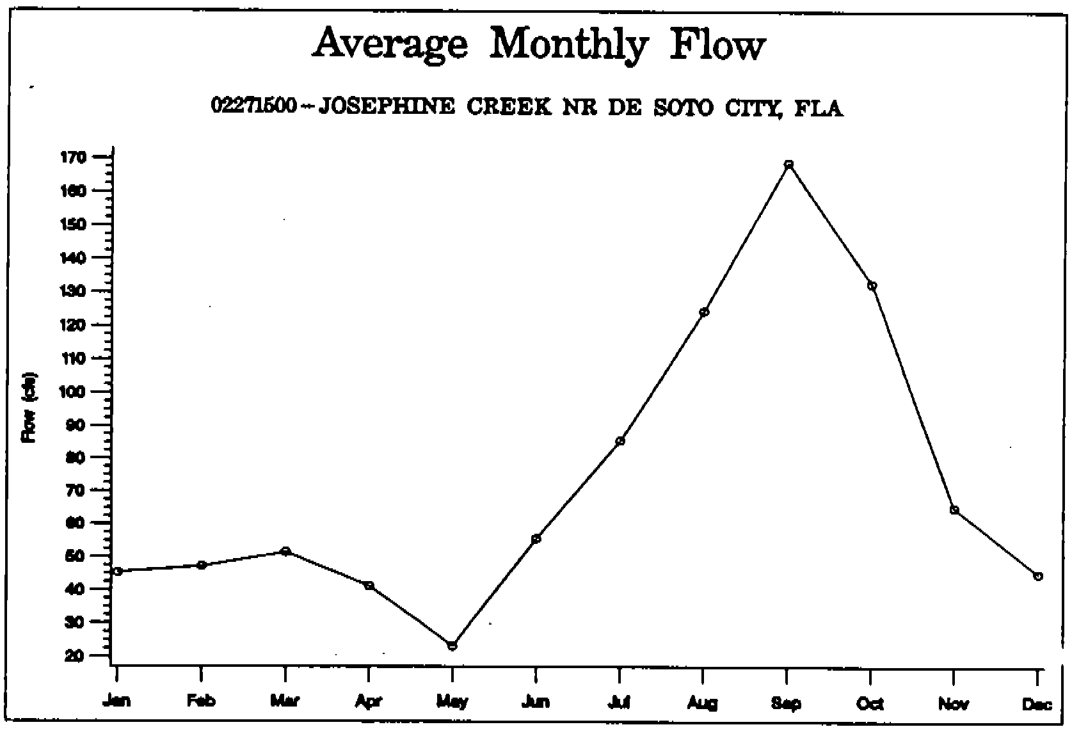

Total Annual Flow
02270750-LAKE PLACID NR LAKE PLACID, FLA.
Flow (cfs)
0
100
200
300
400
500
600
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

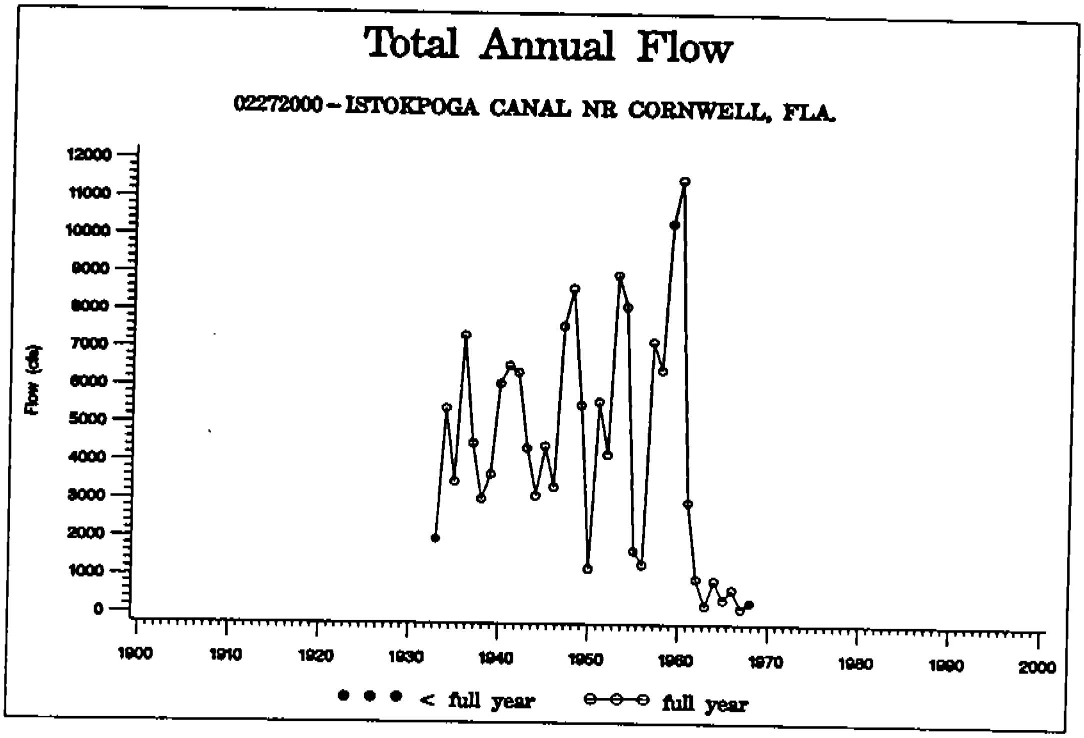

Average Monthly Flow
02270750-LAKE PLACID NR LAKE PLACID, FLA.
Flow (cfs)
0
10
20
30
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

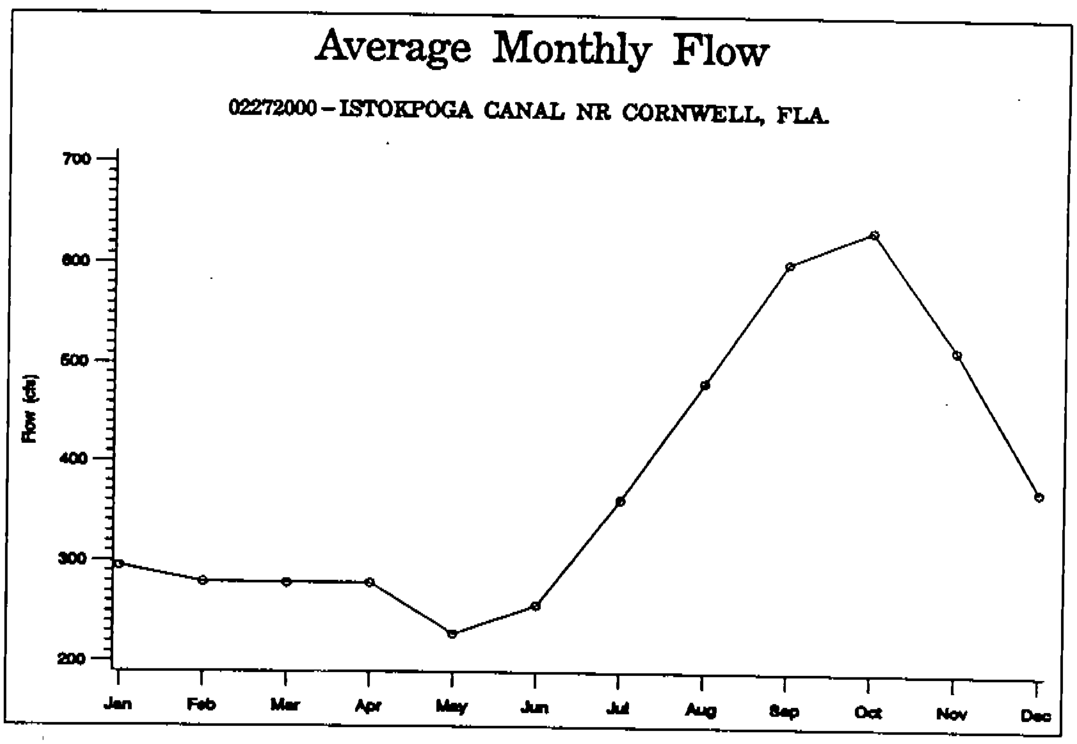

Total Annual Flow
02271000 – STEARNS CREEK NR LAKE PLACID, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

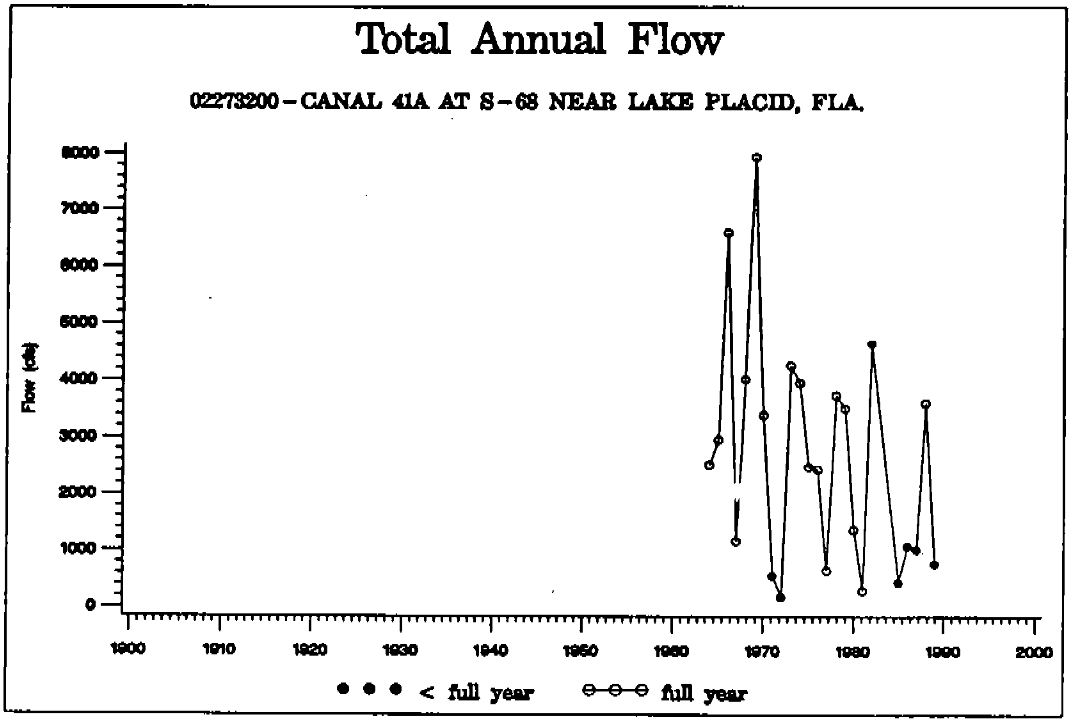

Average Monthly Flow
02271000 – STEARNS CREEK NR LAKE PLACID, FLA.
Flow (cfs)
0
10
20
30
40
50
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

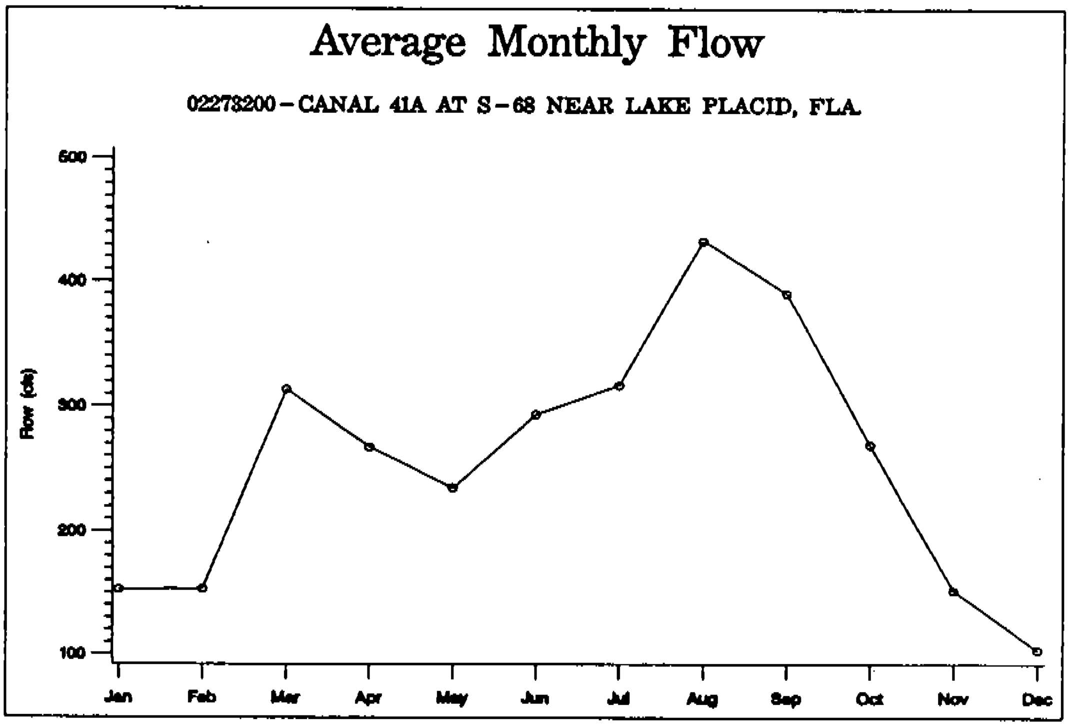

Total Annual Flow
02271500 – JOSEPHINE CREEK NR DE SOTO CITY, FLA
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

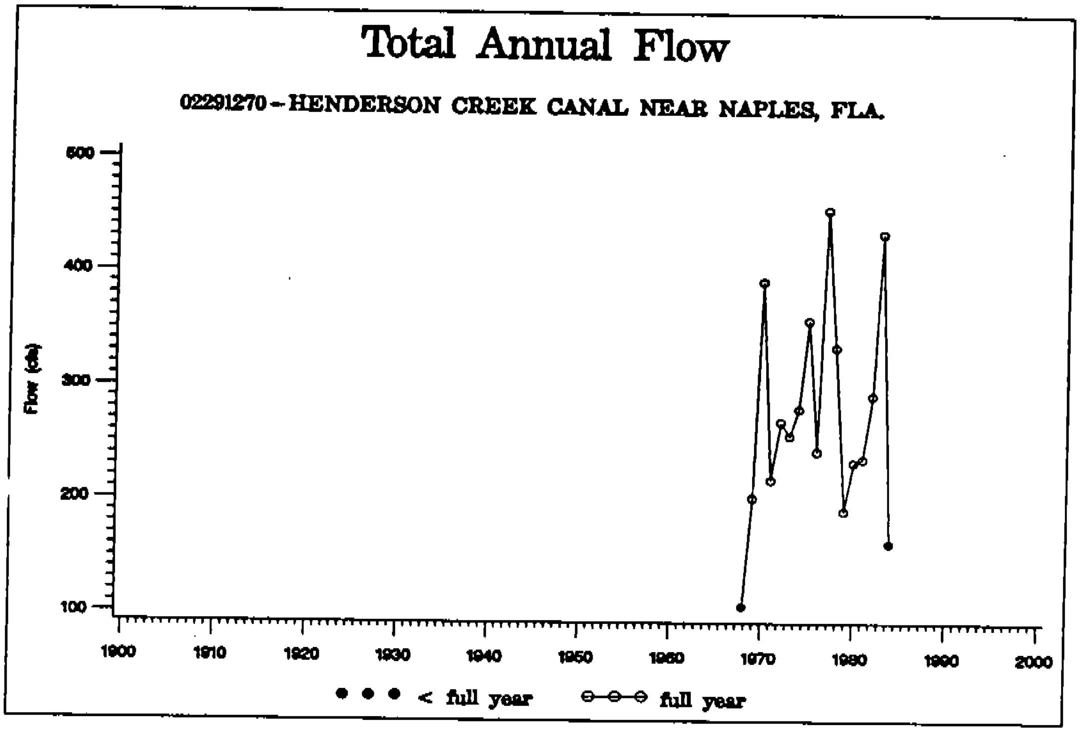

Average Monthly Flow
02271500 – JOSEPHINE CREEK NR DE SOTO CITY, FLA
Flow (cfs)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02272000 – ISTOKPOGA CANAL NR CORNWELL, FLA.
Flow (cfs)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

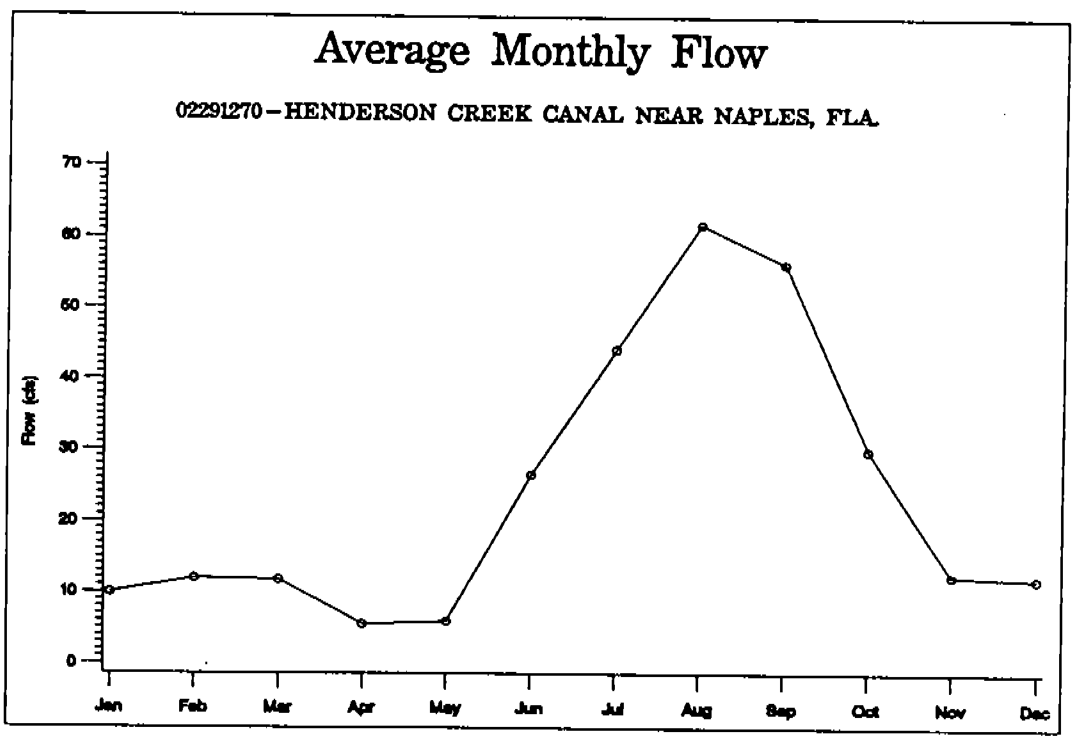

Average Monthly Flow
02272000 – ISTOKPOGA CANAL NR CORNWELL, FLA.
Flow (cfs)
700
600
500
400
300
200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02273200 - CANAL 41A AT S-68 NEAR LAKE PLACID, FLA.
Flow (cfs)
0
1000
2000
3000
4000
5000
6000
7000
8000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

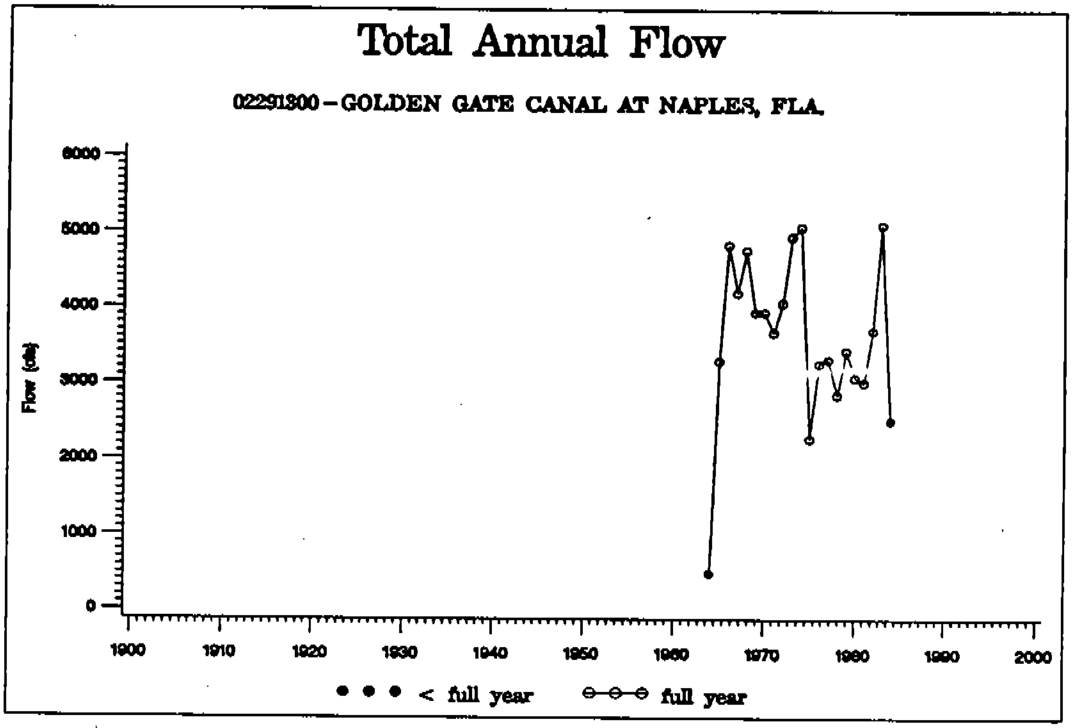

Average Monthly Flow
02273200 - CANAL 41A AT S-68 NEAR LAKE PLACID, FLA.
Flow (cfs)
100
200
300
400
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

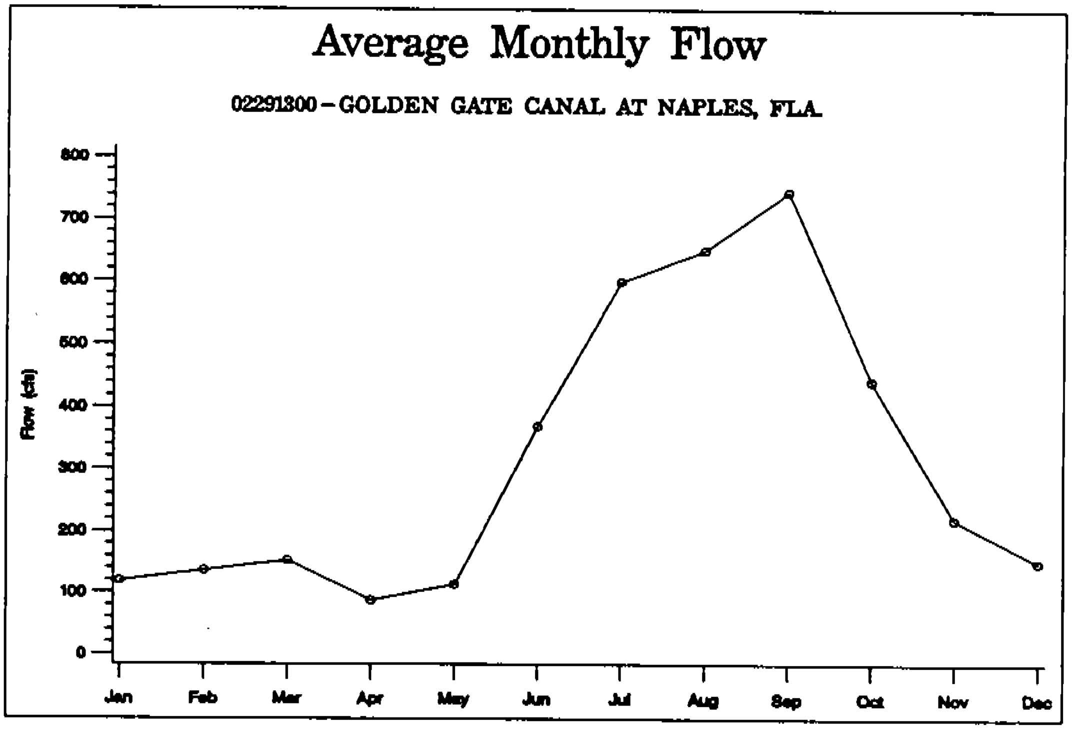


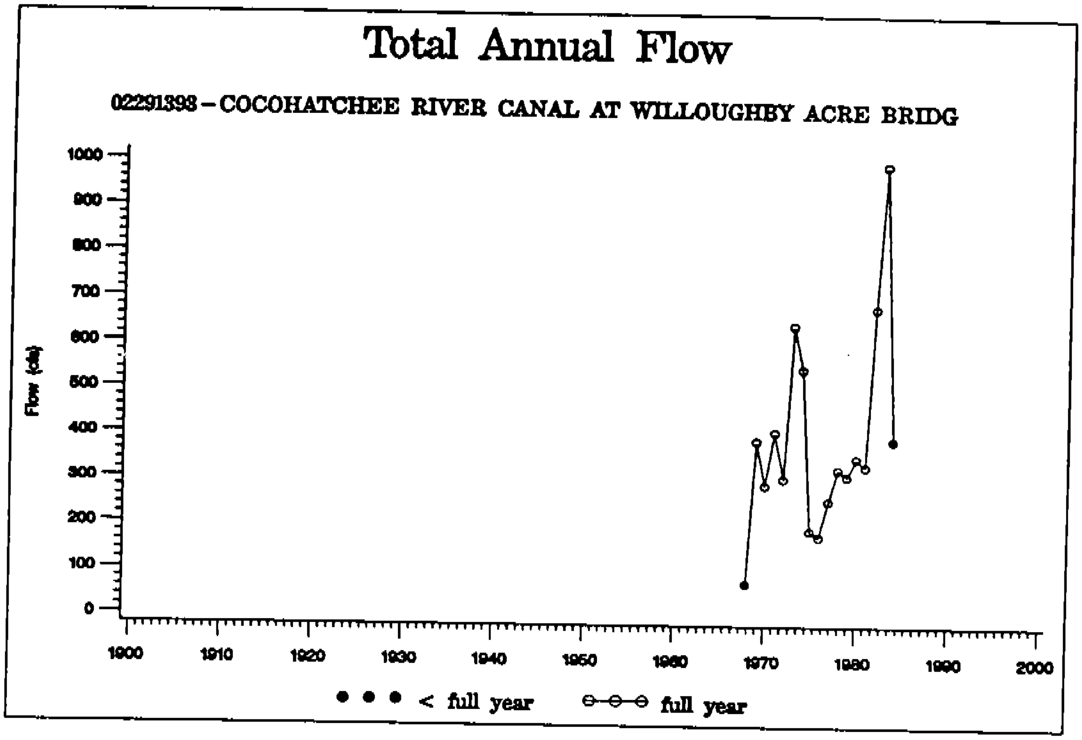
Total Annual Flow
02291270 – HENDERSON CREEK CANAL NEAR NAPLES, FLA.
Flow (cfs)
500
400
300
200
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

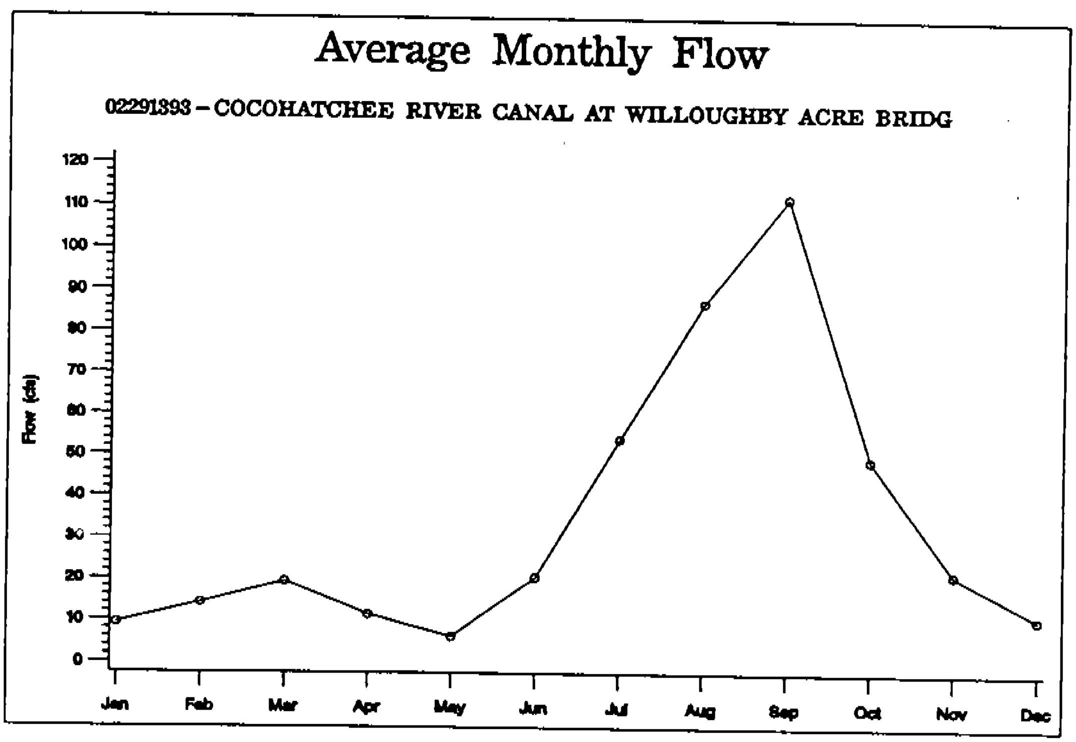


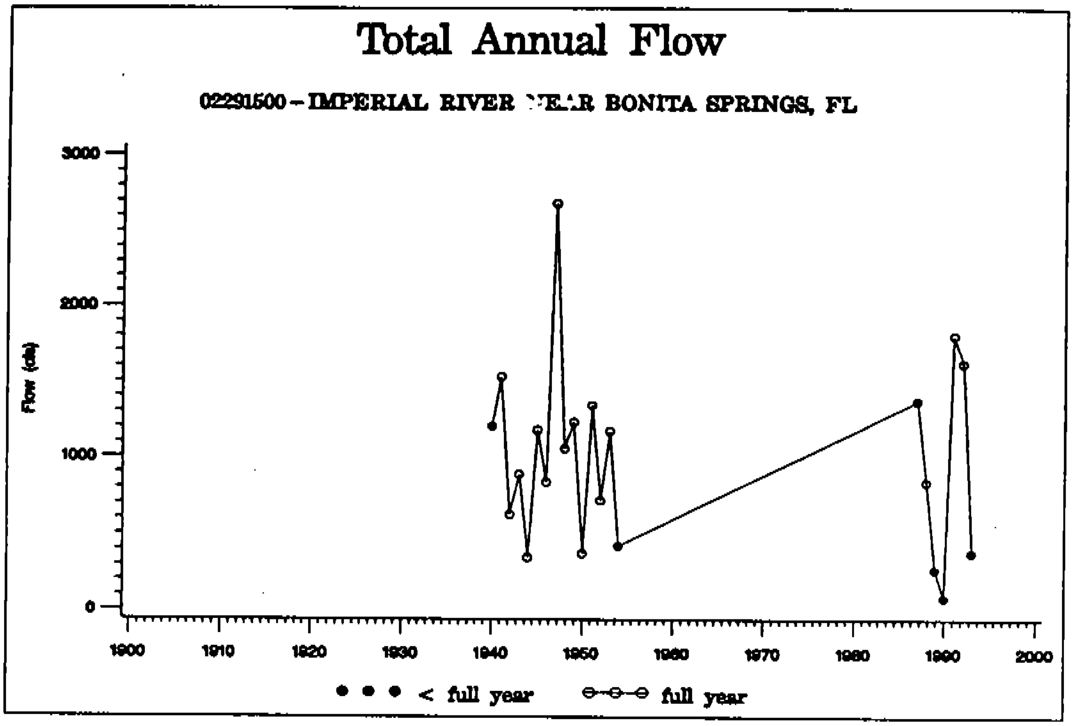
Average Monthly Flow
02291270 – HENDERSON CREEK CANAL NEAR NAPLES, FLA.
Flow (cfs)
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

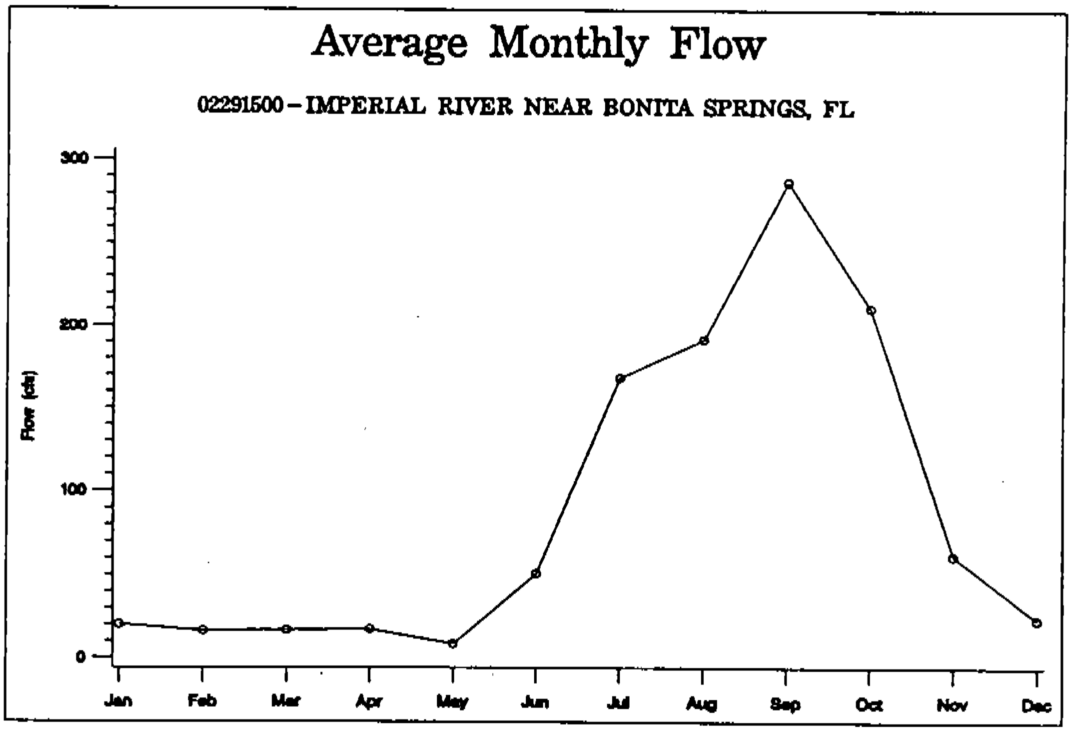

Total Annual Flow
02291300 - GOLDEN GATE CANAL AT NAPLES, FLA.
Flow (cfs)
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

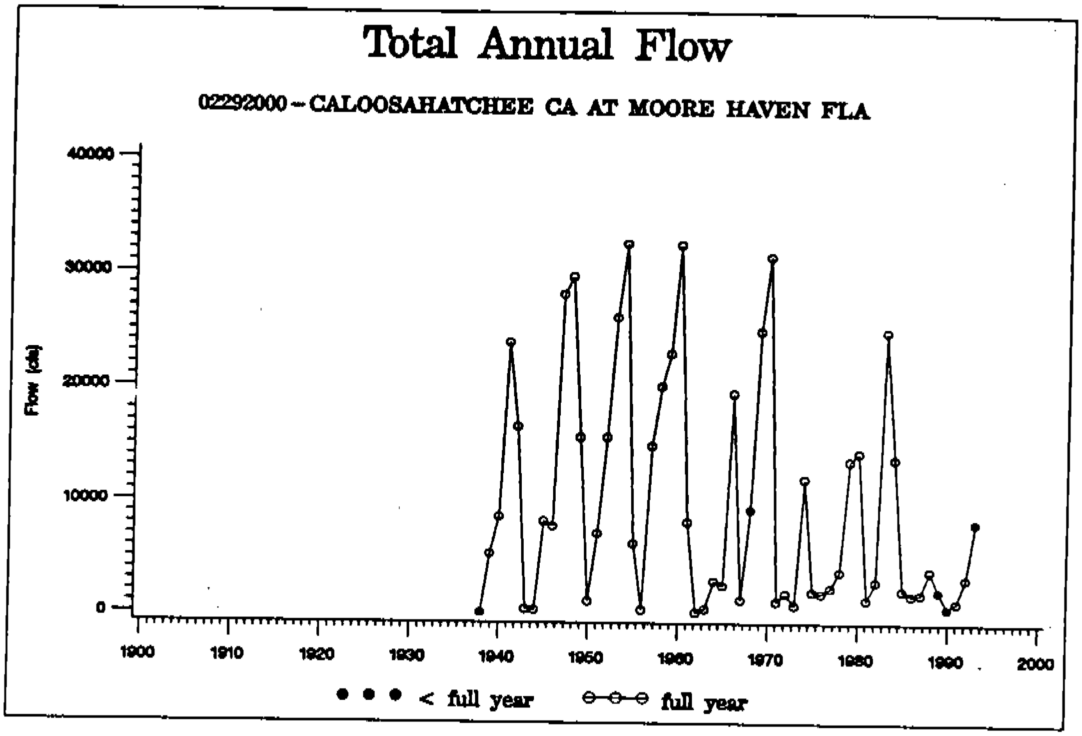

Average Monthly Flow
02291300 - GOLDEN GATE CANAL AT NAPLES, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

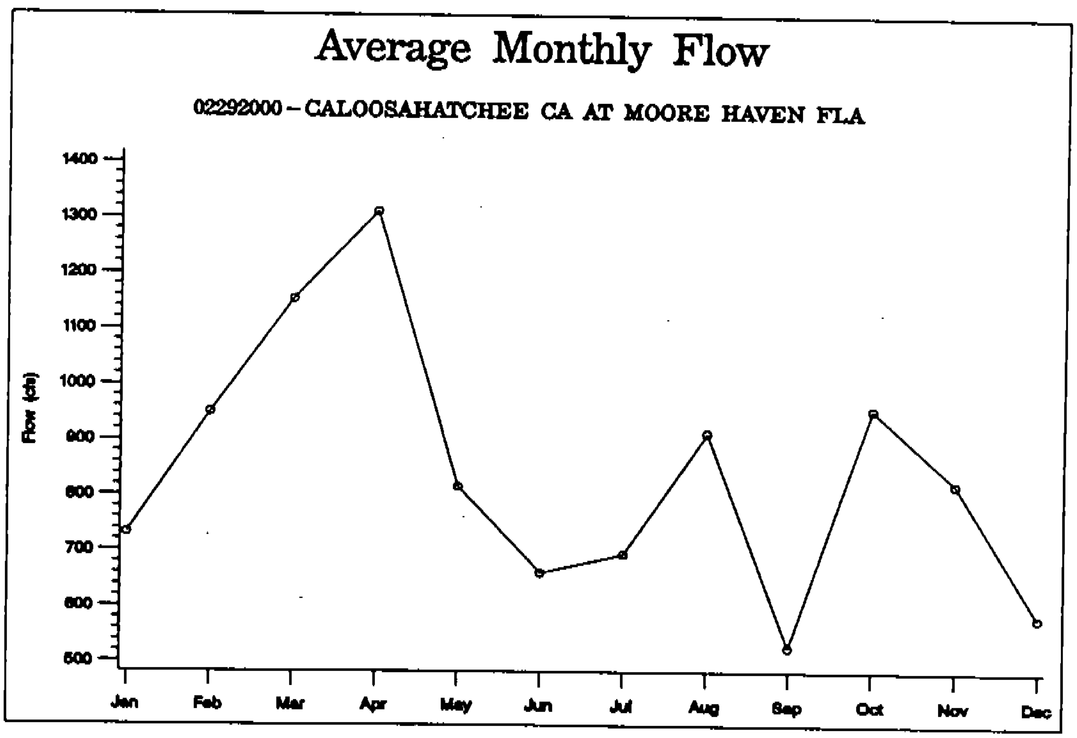

Total Annual Flow
02291393 - COCOHATCHEE RIVER CANAL AT WILLOUGHBY ACRE BRIDG
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

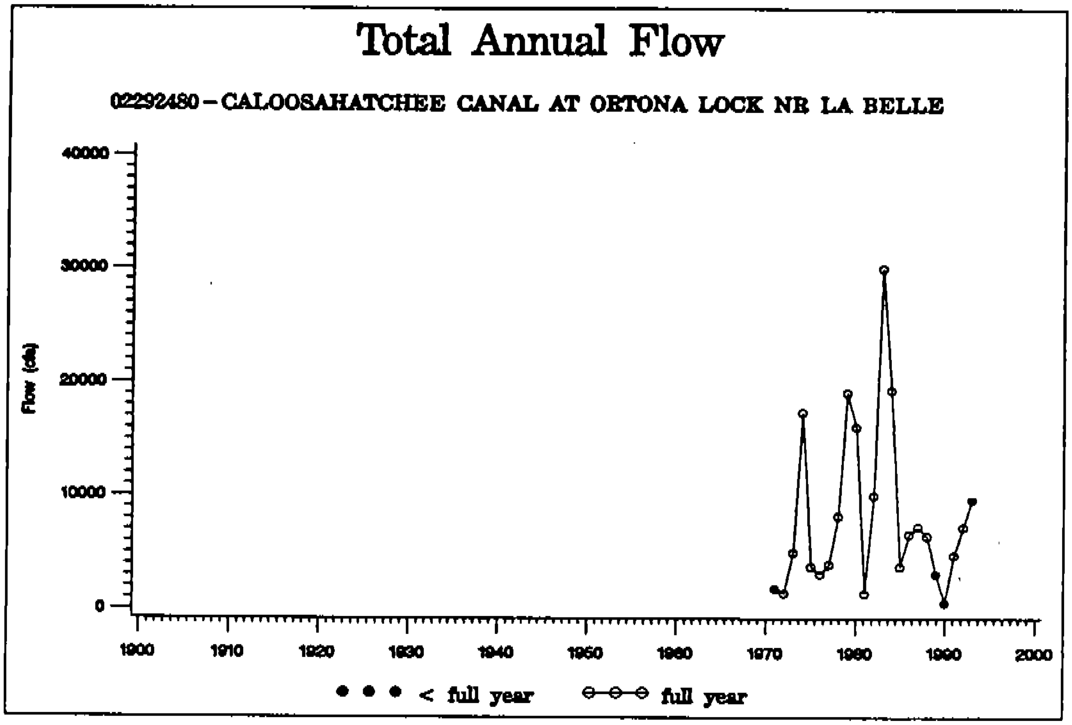

Average Monthly Flow
02291393 - COCOHATCHEE RIVER CANAL AT WILLOUGHBY ACRE BRIDG
Flow (cfs)
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

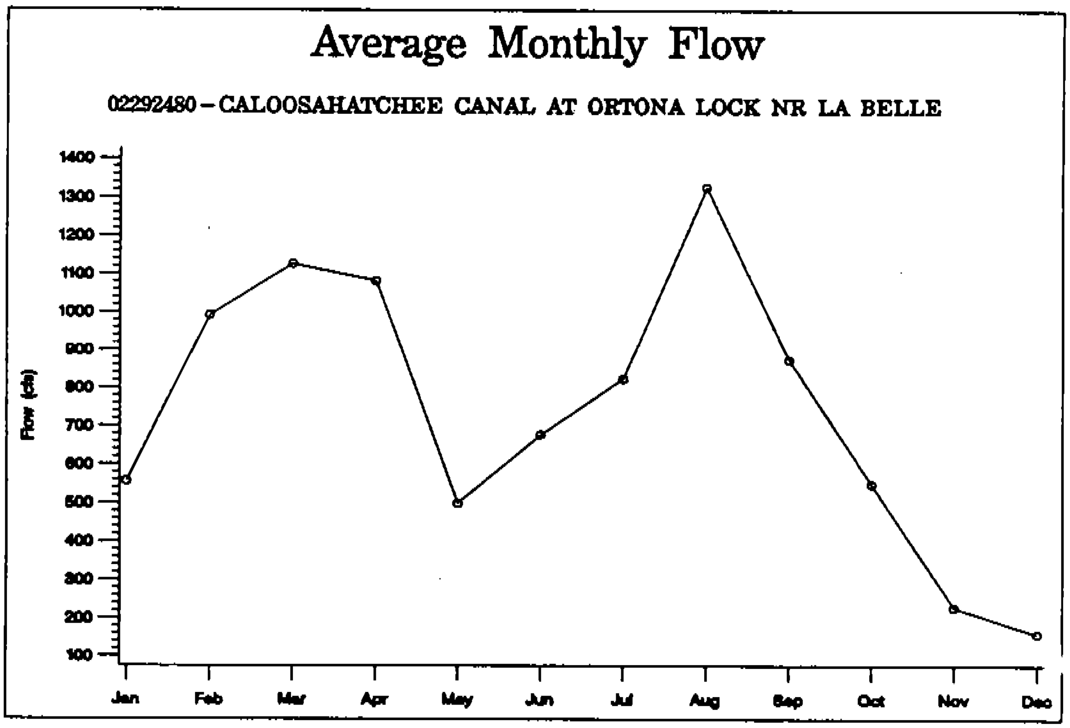

Total Annual Flow
02291500 - IMPERIAL RIVER NEAR BONITA SPRINGS, FL
3000
2000
1000
0
Flow (cfs)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

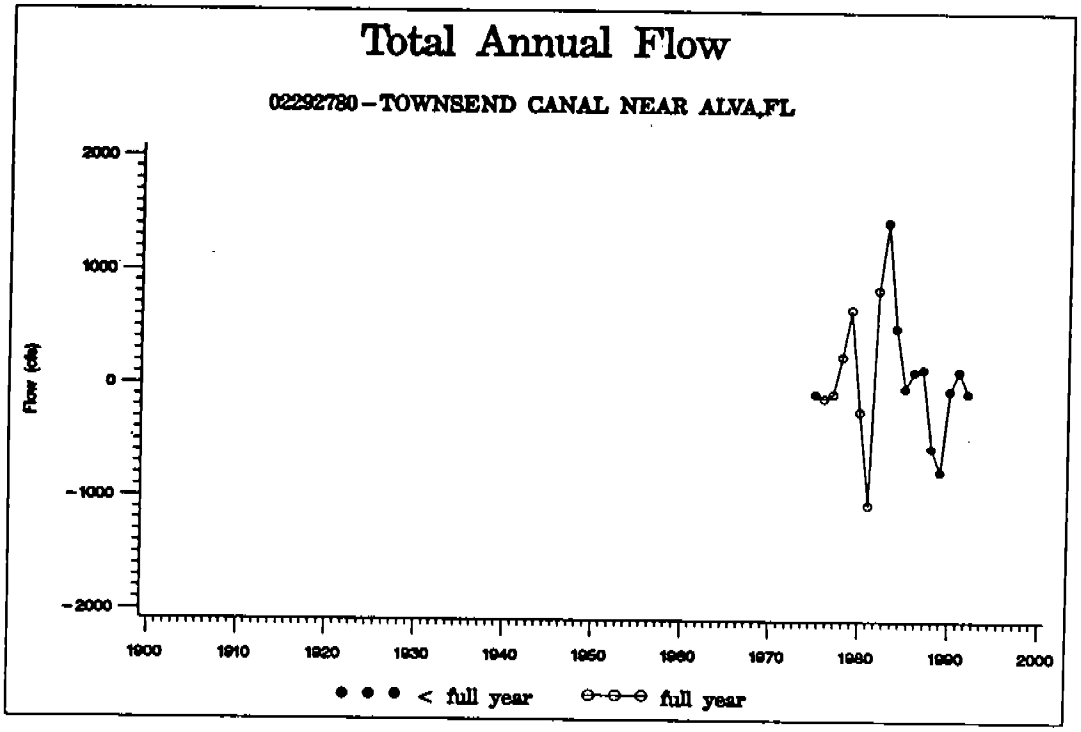

Average Monthly Flow
02291500 - IMPERIAL RIVER NEAR BONITA SPRINGS, FL
300
200
100
0
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

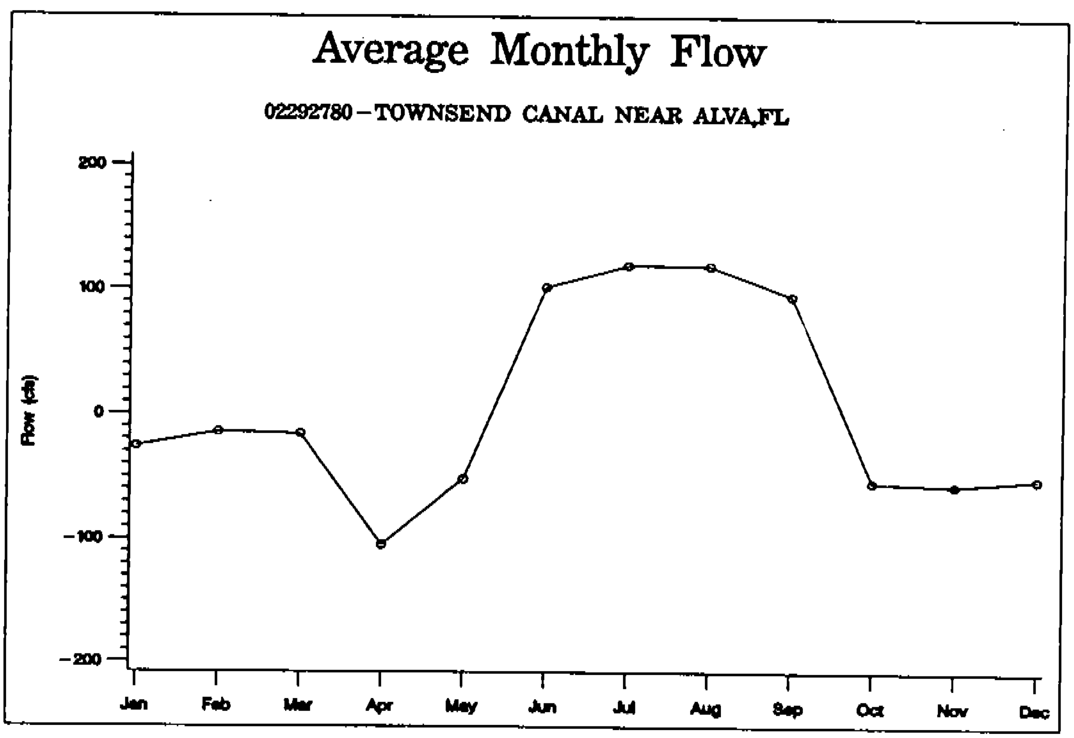

Total Annual Flow
02292000 – CALOOSAHATCHEE CA AT MOORE HAVEN FLA
Flow (cfs)
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
o-o-o full year

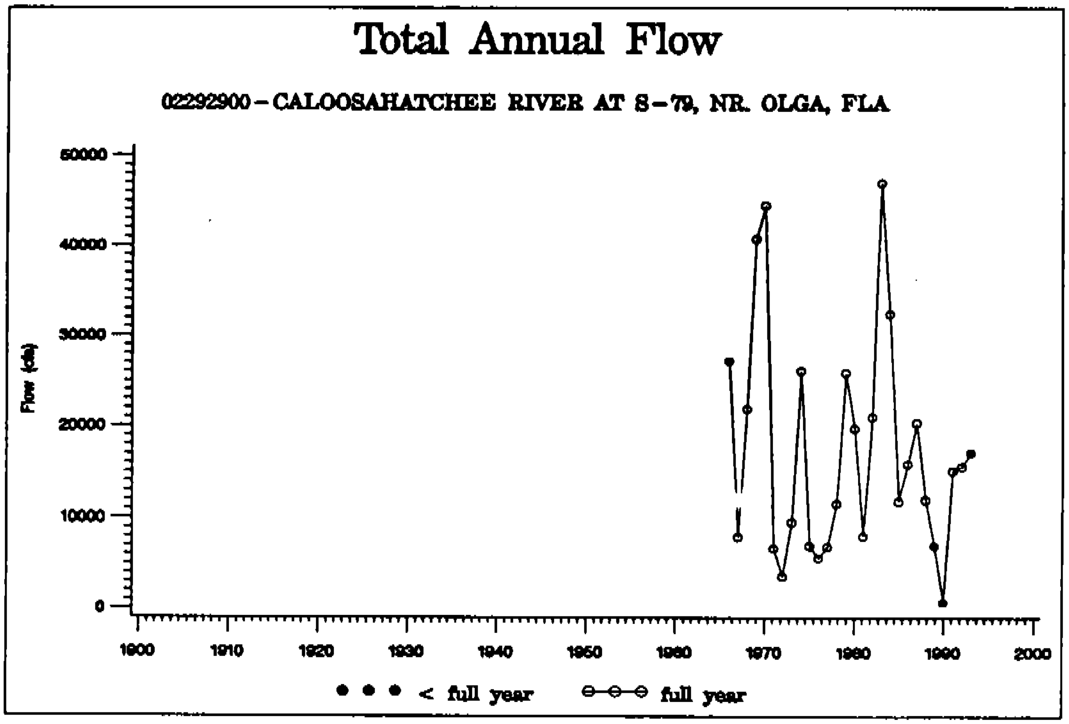

Average Monthly Flow
02292000 – CALOOSAHATCHEE CA AT MOORE HAVEN FLA
Flow (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

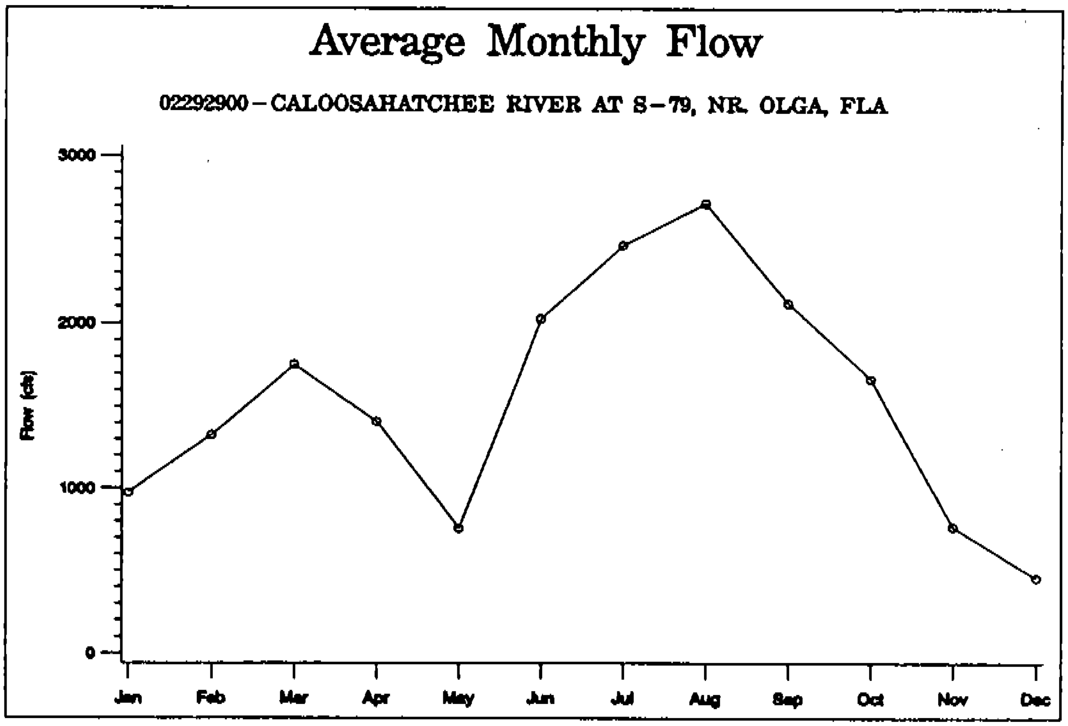

Total Annual Flow
02292480 - CALOOSAHATCHEE CANAL AT ORTONA LOCK NR LA BELLE
Flow (cfs)
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
full year

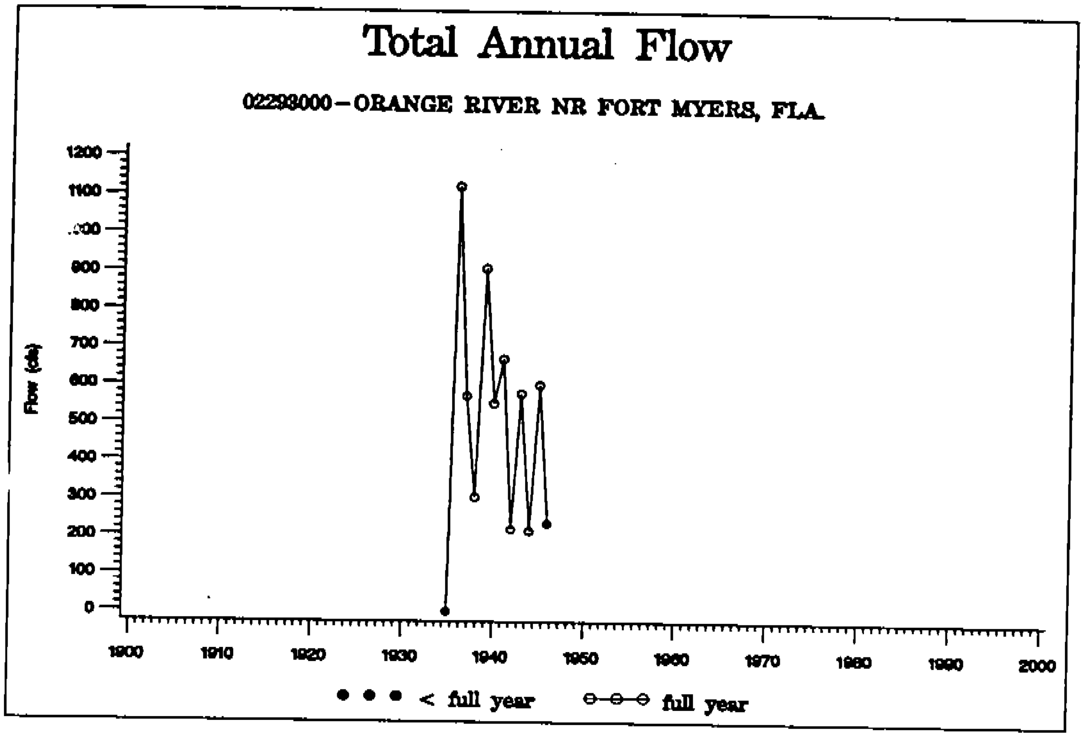

Average Monthly Flow
02292480 - CALOOSAHATCHEE CANAL AT ORTONA LOCK NR LA BELLE
Flow (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

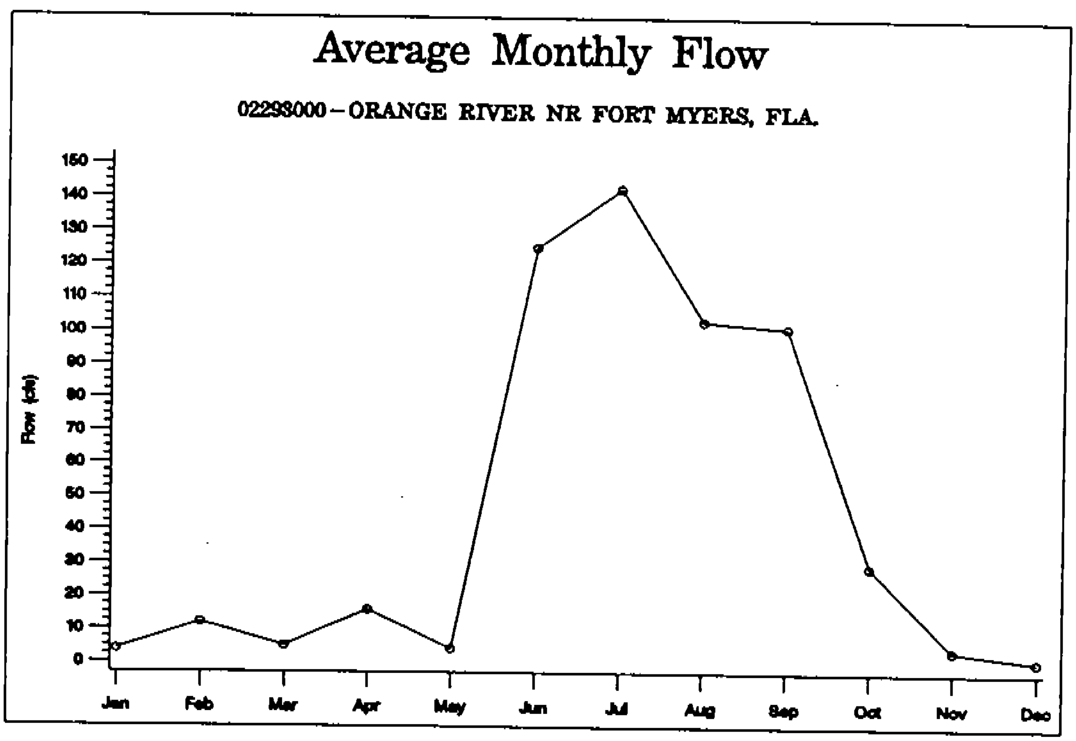

Total Annual Flow
02292780 – TOWNSEND CANAL NEAR ALVA,FL
Flow (cfs)
2000
1000
0
-1000
-2000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

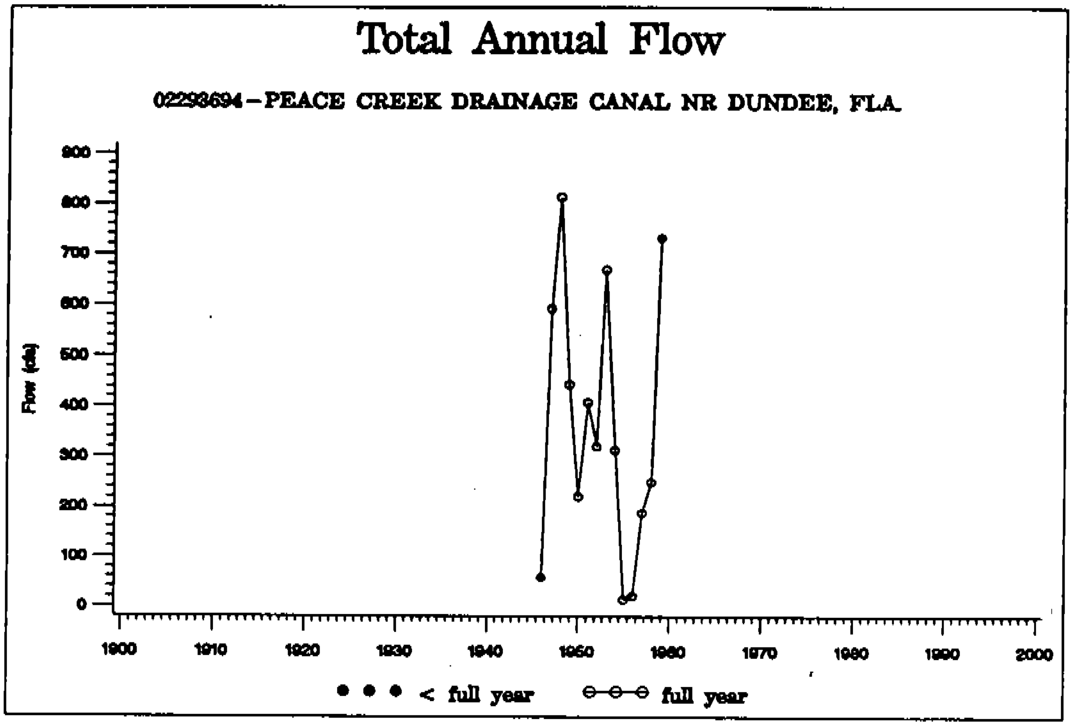

Average Monthly Flow
02292780 – TOWNSEND CANAL NEAR ALVA,FL
Flow (cfs)
200
100
0
-100
-200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

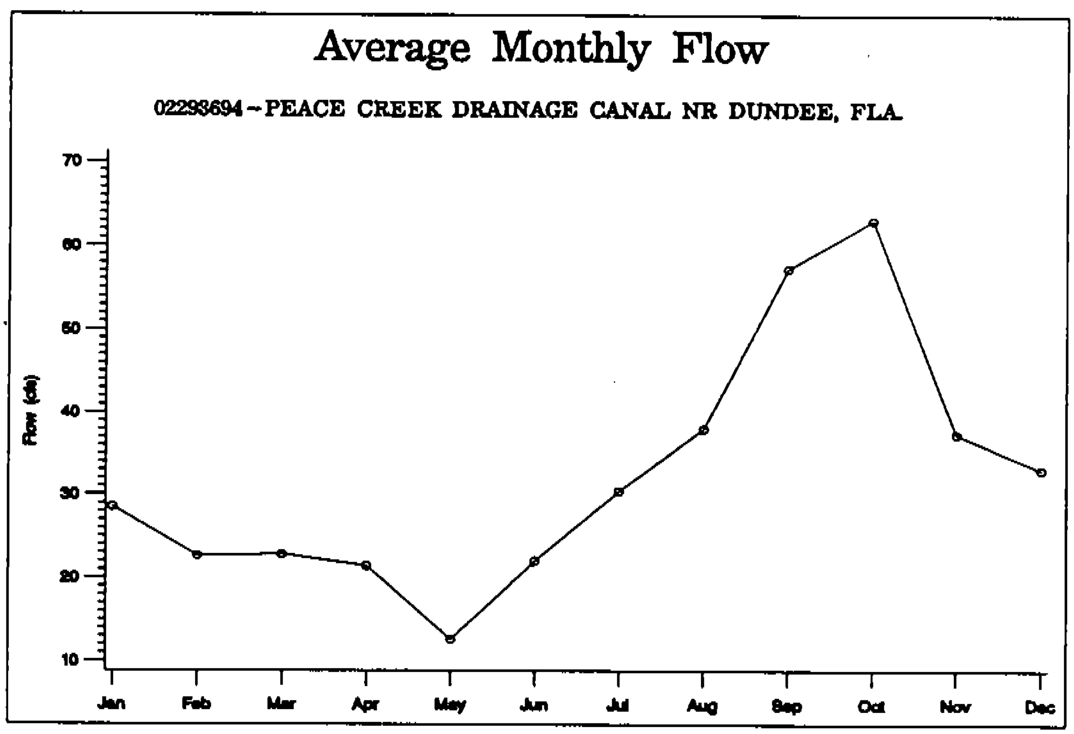

Total Annual Flow
02292900 - CALOOSAHATCHEE RIVER AT S-79, NR. OLGA, FLA
Flow (cfs)
50000
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

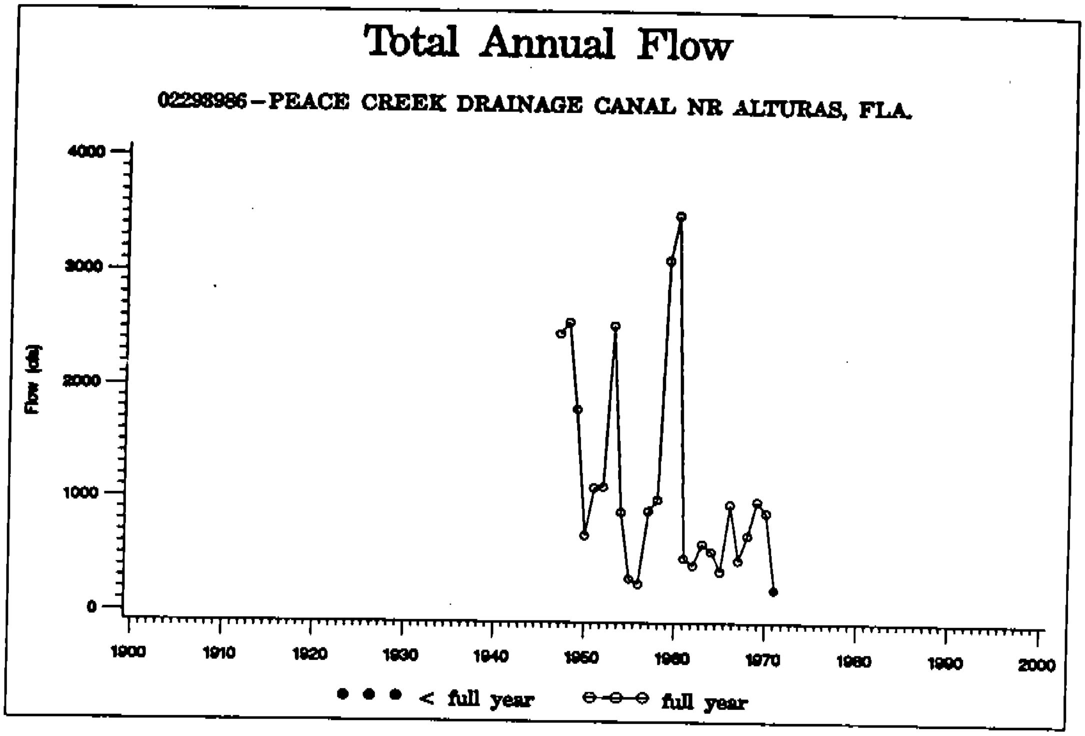

Average Monthly Flow
02292900 - CALOOSAHATCHEE RIVER AT S-79, NR. OLGA, FLA
Flow (cfs)
3000
2000
1000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

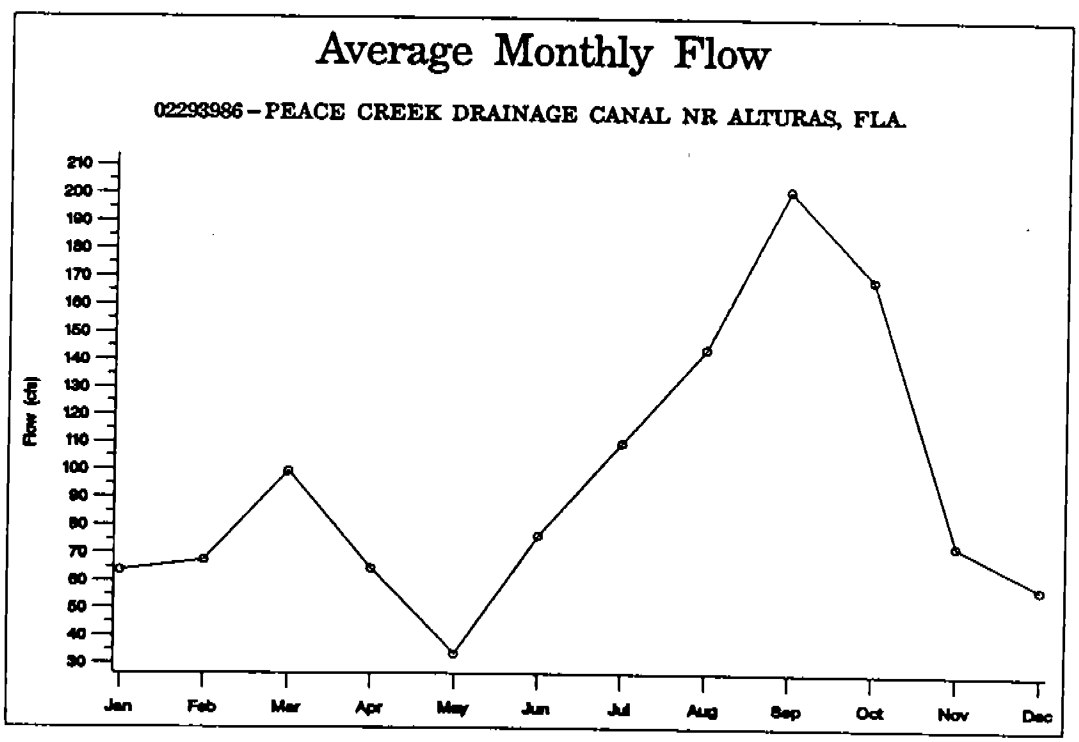

Total Annual Flow
02293000 – ORANGE RIVER NR FORT MYERS, FLA.
Flow (cfs)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

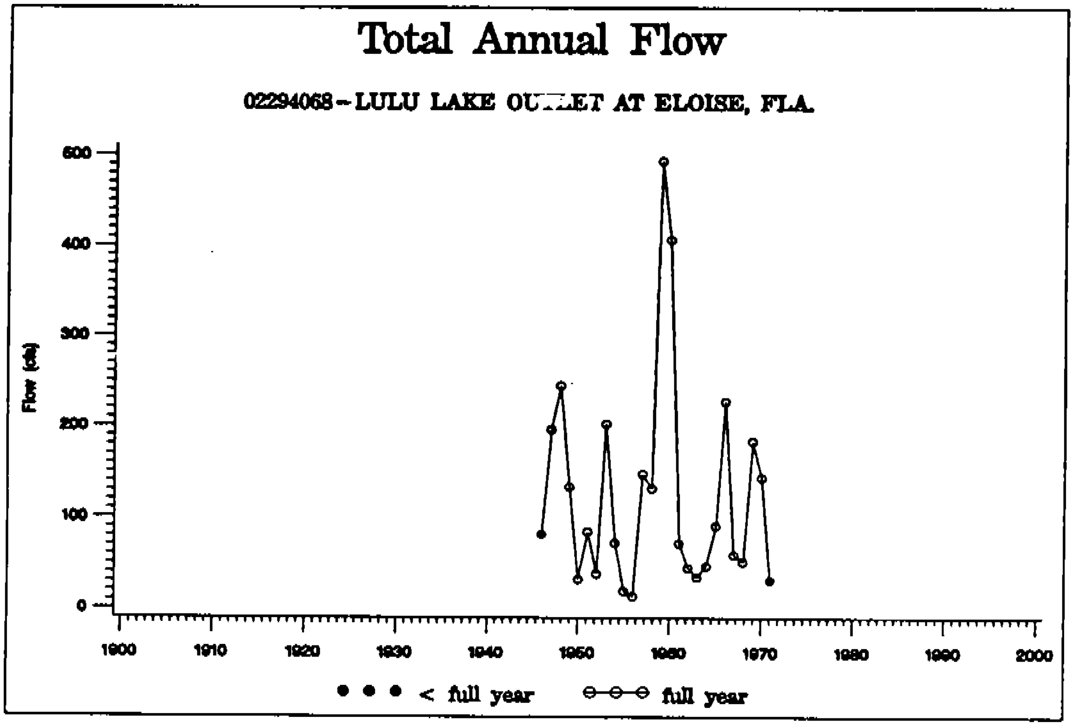

Average Monthly Flow
02293000 – ORANGE RIVER NR FORT MYERS, FLA.
Flow (cfs)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02293694 -- PEACE CREEK DRAINAGE CANAL NR DUNDEE, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

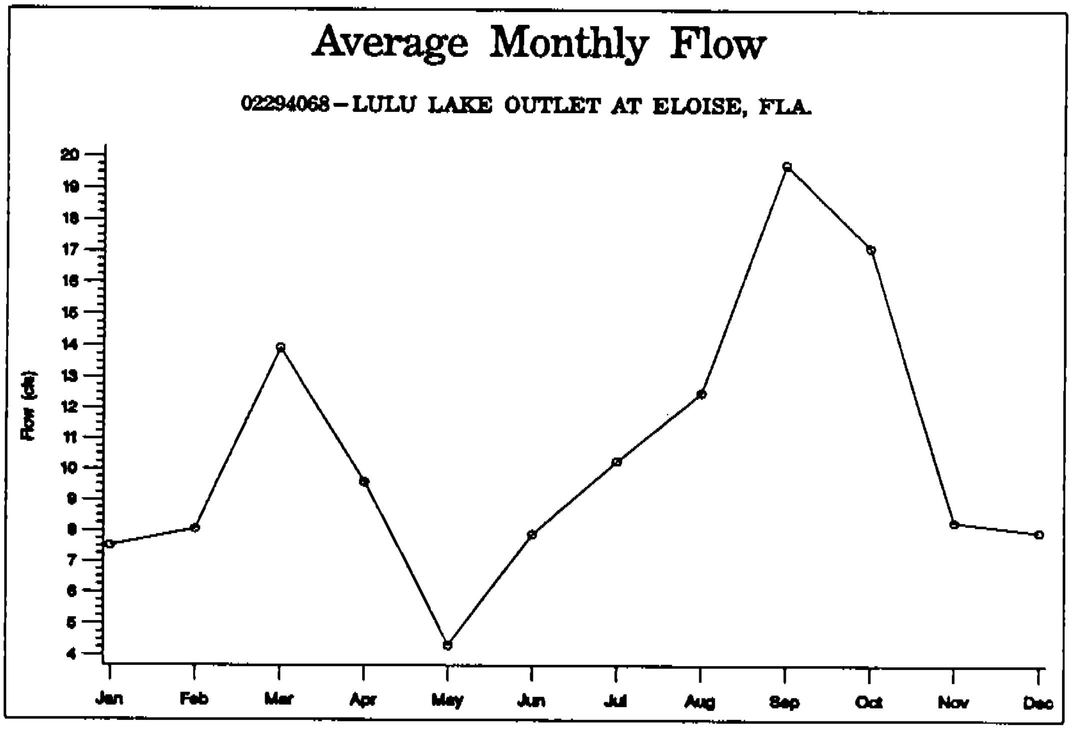

Average Monthly Flow
02293694 -- PEACE CREEK DRAINAGE CANAL NR DUNDEE, FLA.
Flow (cfs)
10
20
30
40
50
60
70
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02298986 – PEACE CREEK DRAINAGE CANAL NR ALTURAS, FLA.
Flow (cfs)
0
1000
2000
3000
4000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
• • • < full year
⊖-⊖-⊖ full year

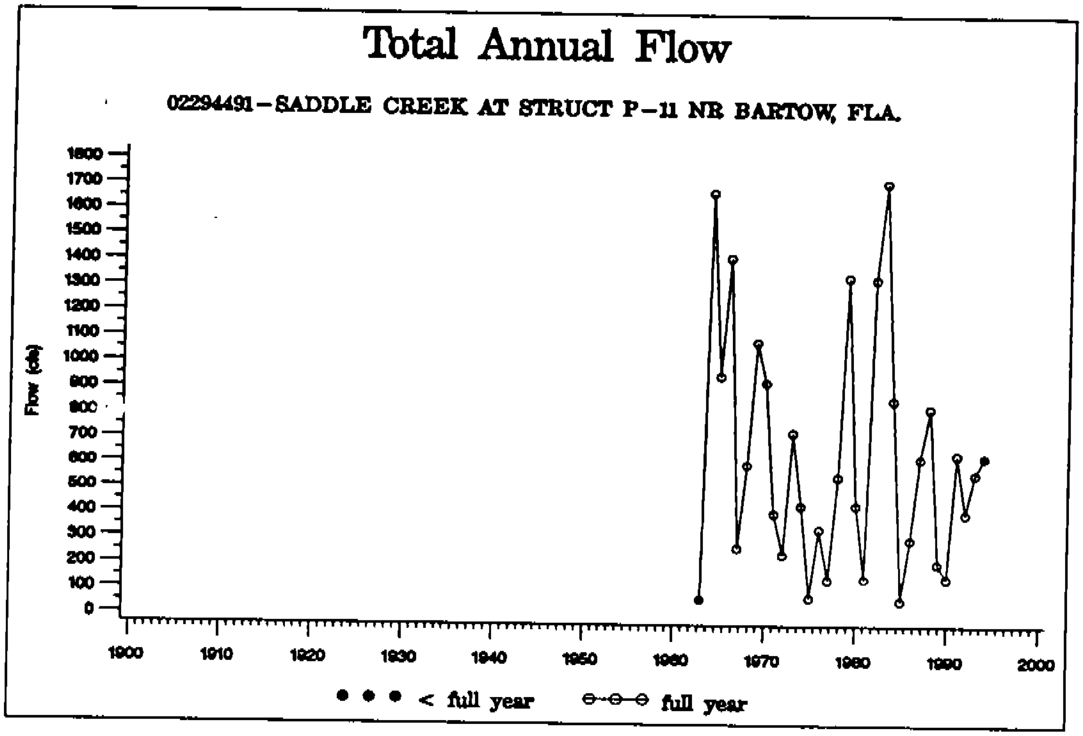

Average Monthly Flow
02293986 – PEACE CREEK DRAINAGE CANAL NR ALTURAS, FLA.
Flow (cfs)
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

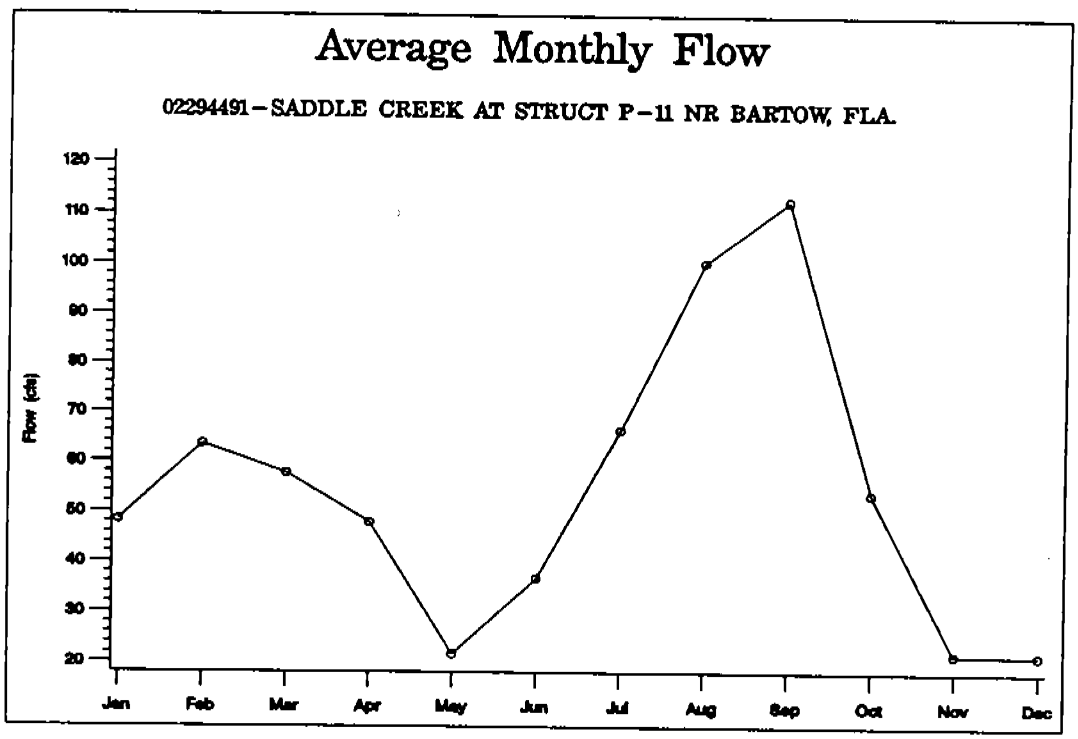


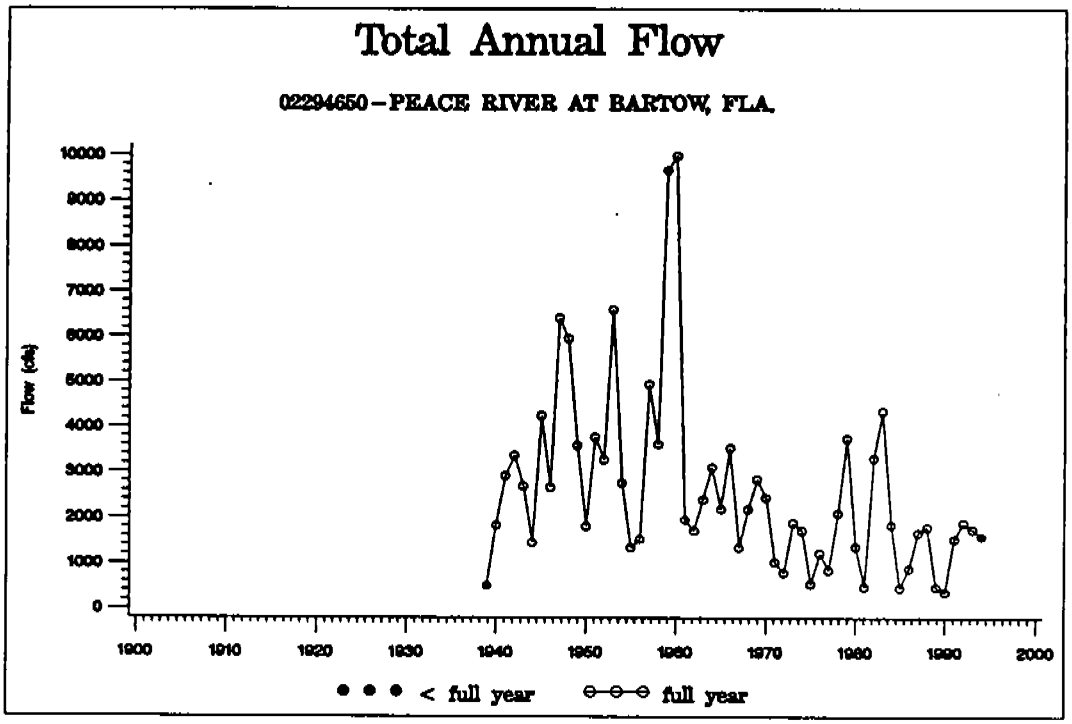
Total Annual Flow
02294068 - LULU LAKE OUTLET AT ELOISE, FLA.
Flow (cfs)
0
100
200
300
400
500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

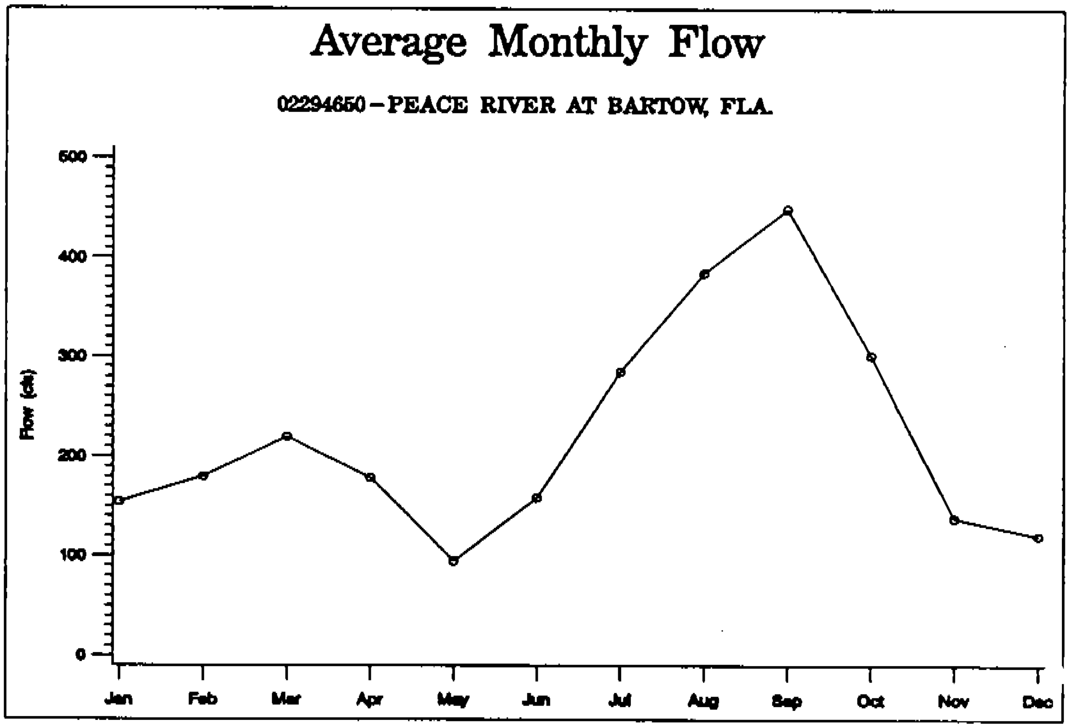


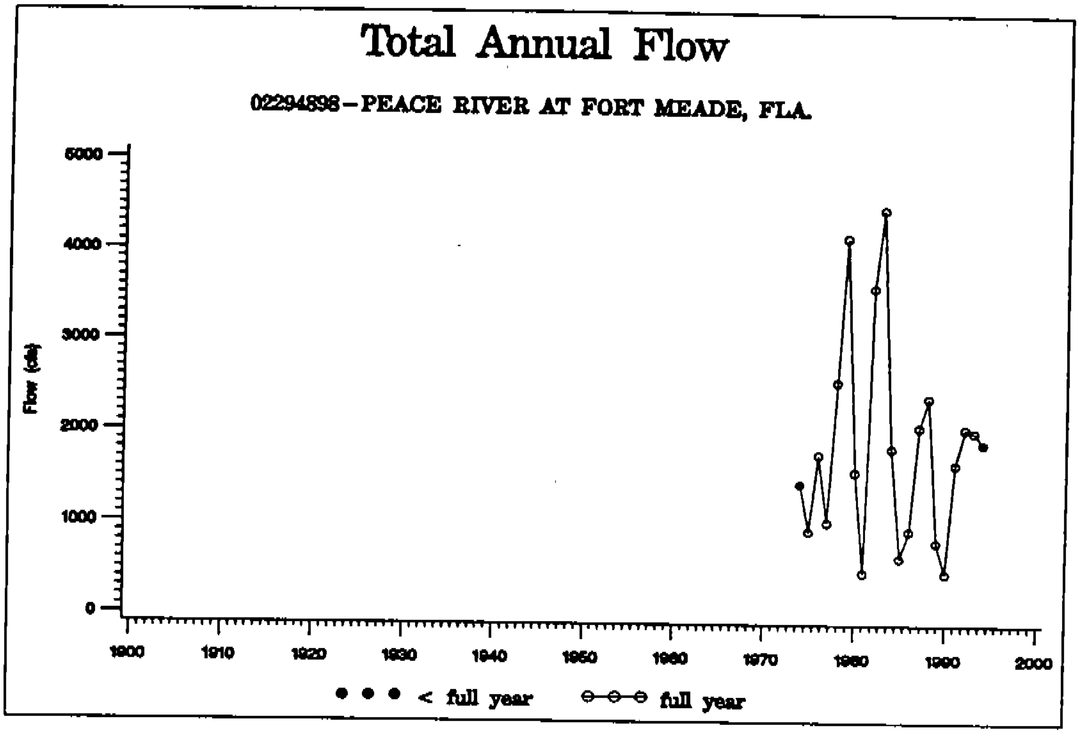
Average Monthly Flow
02294068 - LULU LAKE OUTLET AT ELOISE, FLA.
Flow (cfs)
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

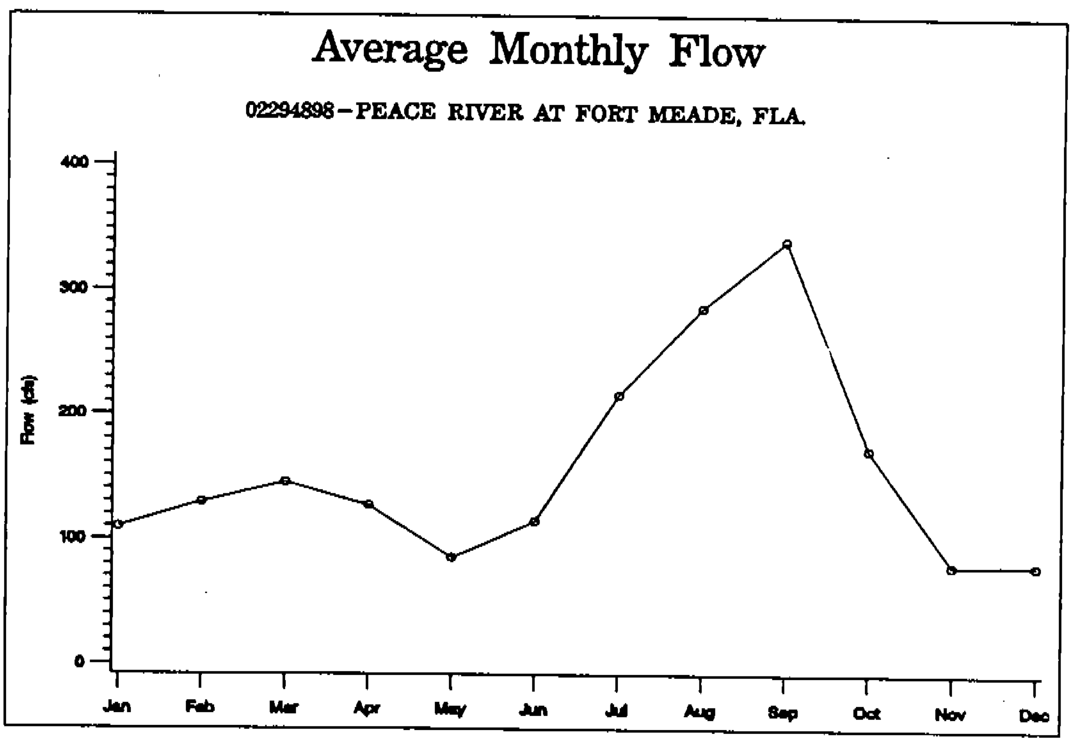

Total Annual Flow
02294491-SADDLE CREEK AT STRUCT P-11 NR BARTOW, FLA.
Flow (cfs)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

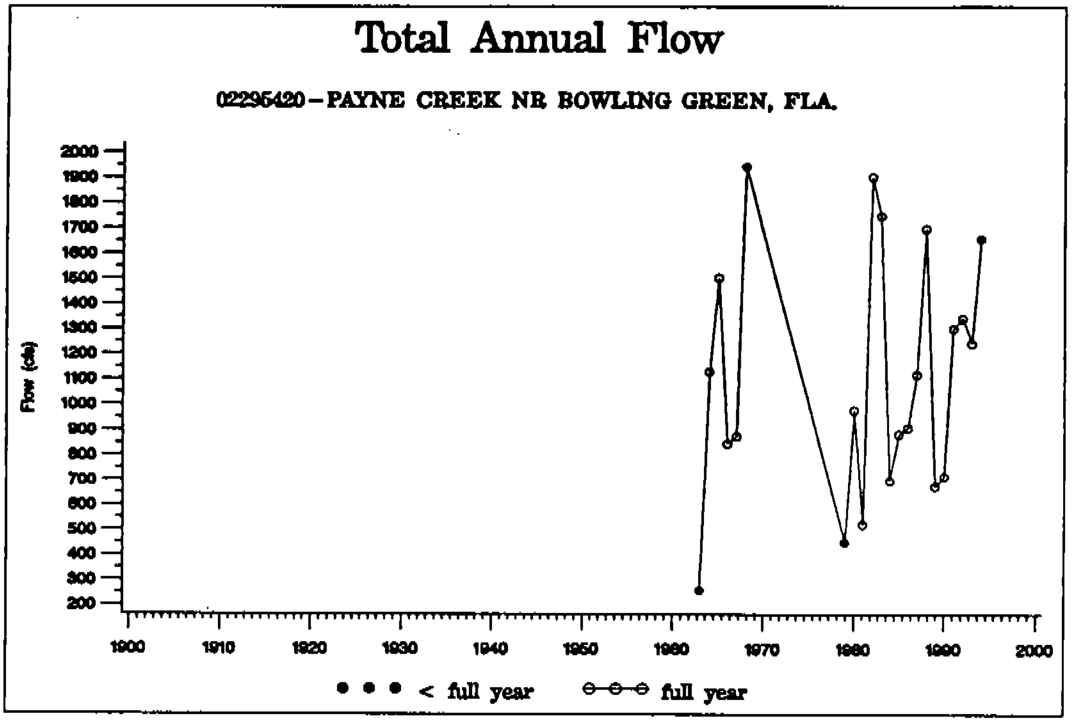

Average Monthly Flow
02294491-SADDLE CREEK AT STRUCT P-11 NR BARTOW, FLA.
Flow (cfs)
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

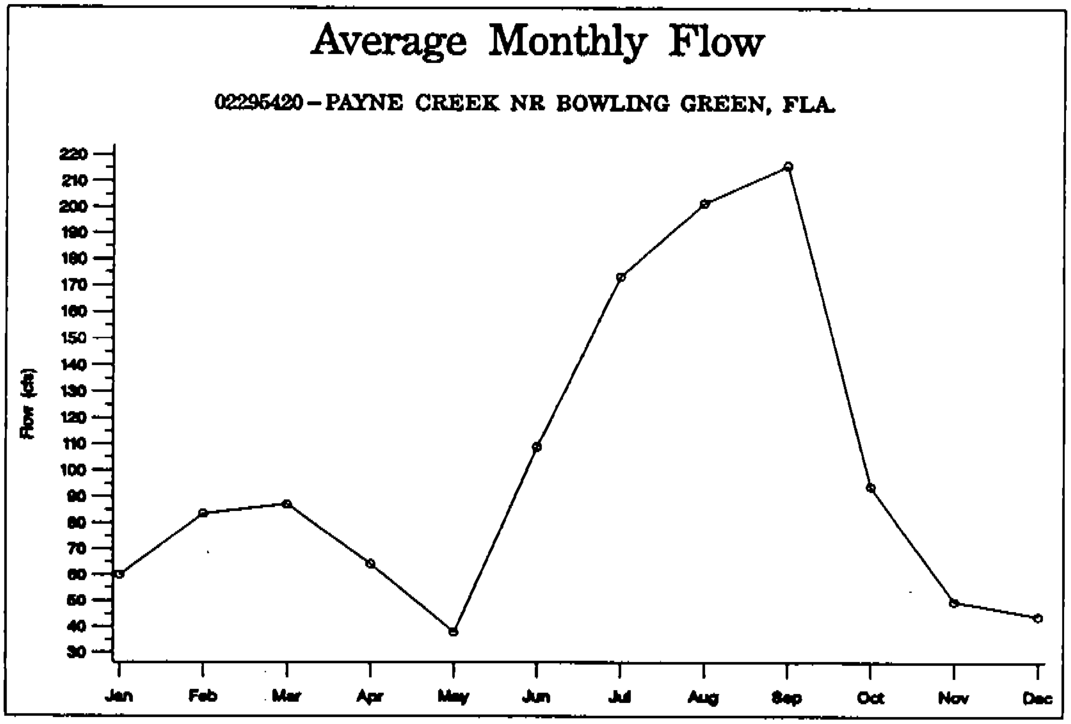

Total Annual Flow
02294650 - PEACE RIVER AT BARTOW, FLA.
Flow (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

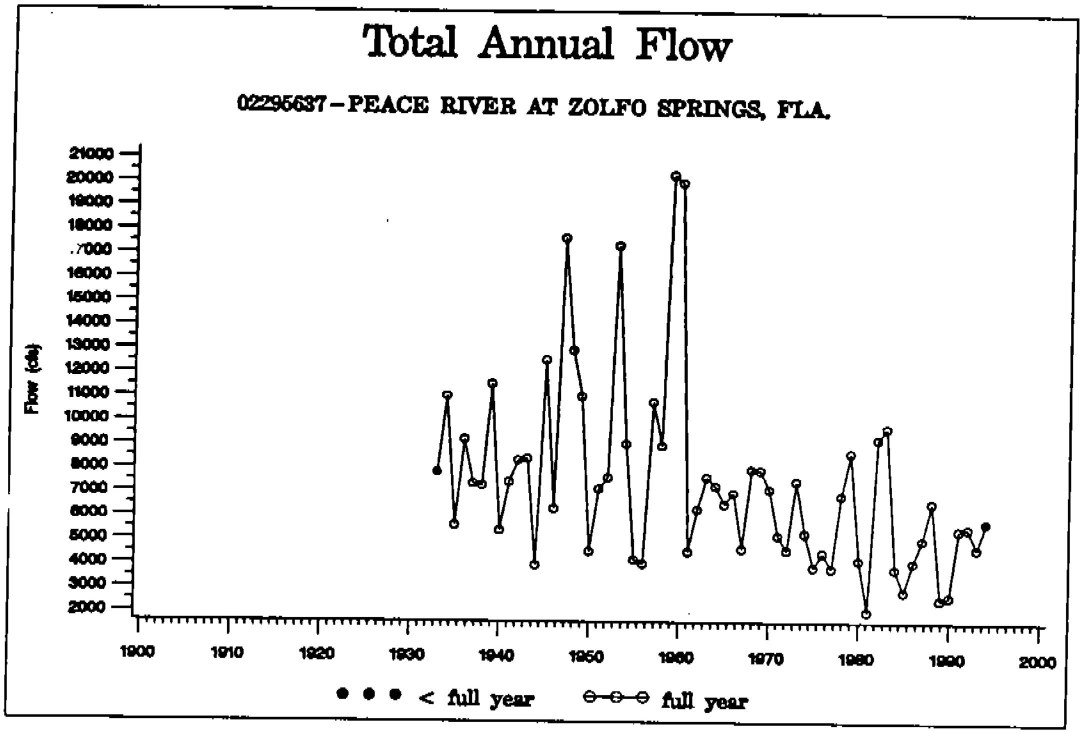

Average Monthly Flow
02294650 - PEACE RIVER AT BARTOW, FLA.
Flow (cfs)
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

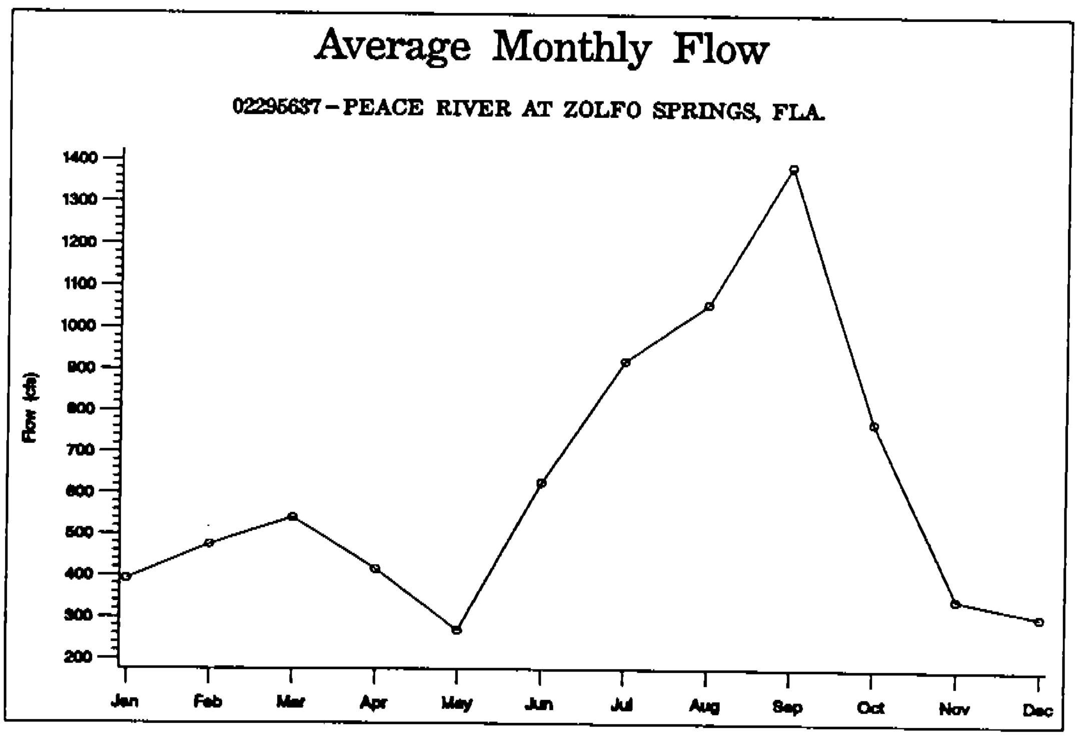

Total Annual Flow
02294898–PEACE RIVER AT FORT MEADE, FLA.
Flow (cfs)
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

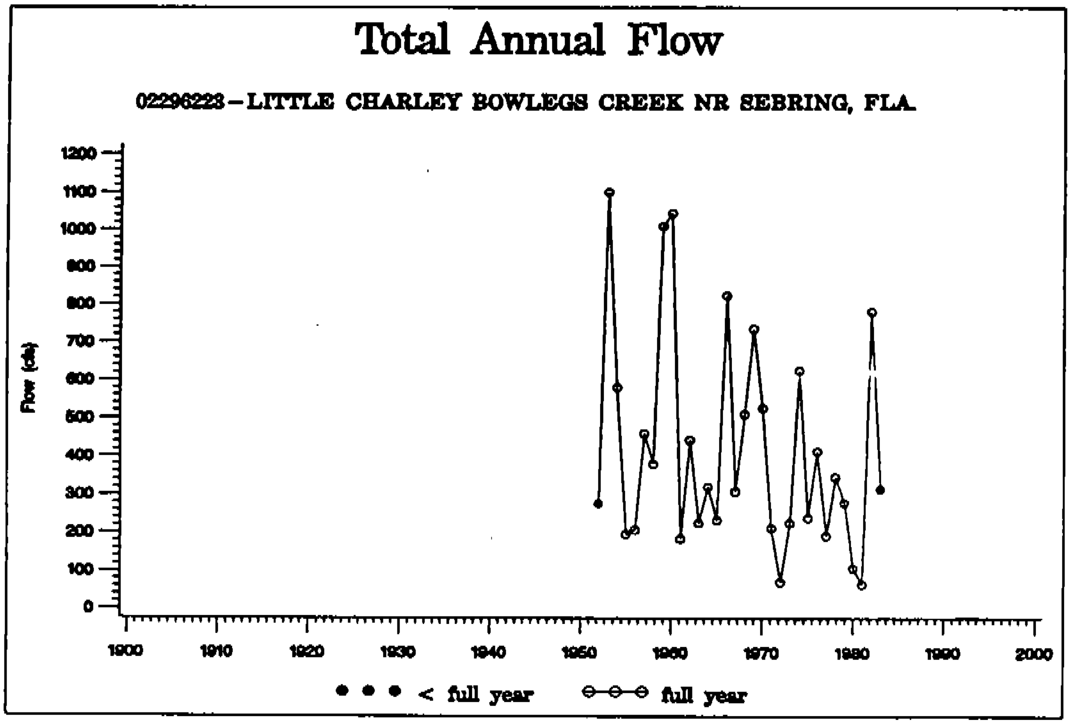

Average Monthly Flow
02294898–PEACE RIVER AT FORT MEADE, FLA.
Flow (cfs)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

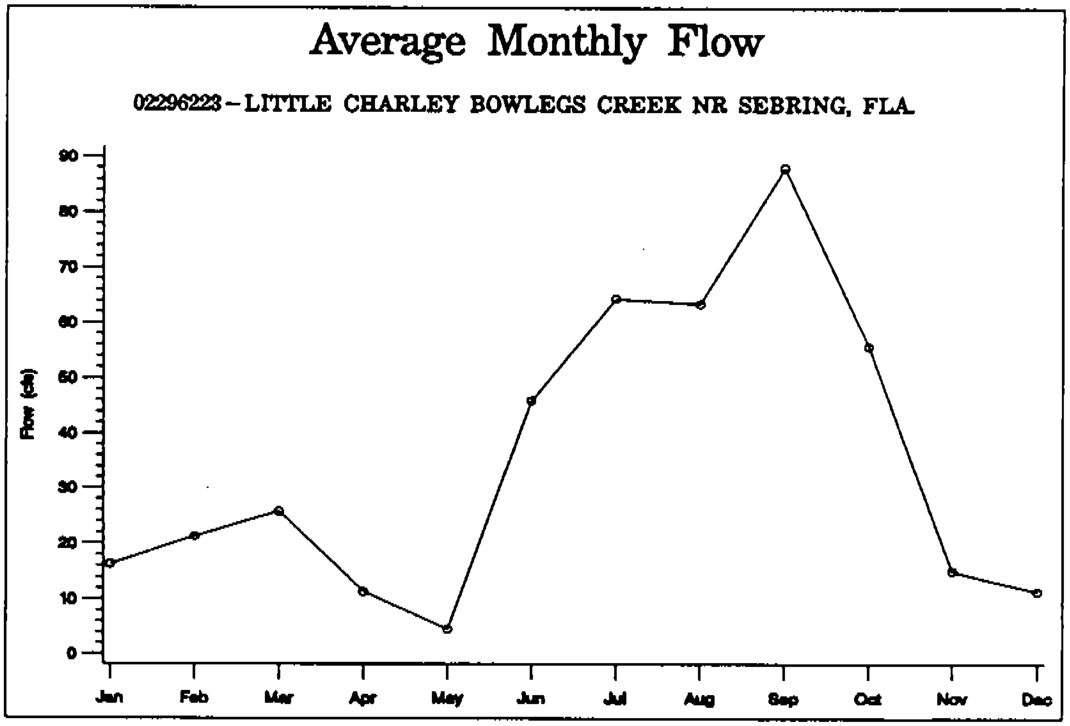

Total Annual Flow
02295420 - PAYNE CREEK NR BOWLING GREEN, FLA.
Flow (cfs)
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

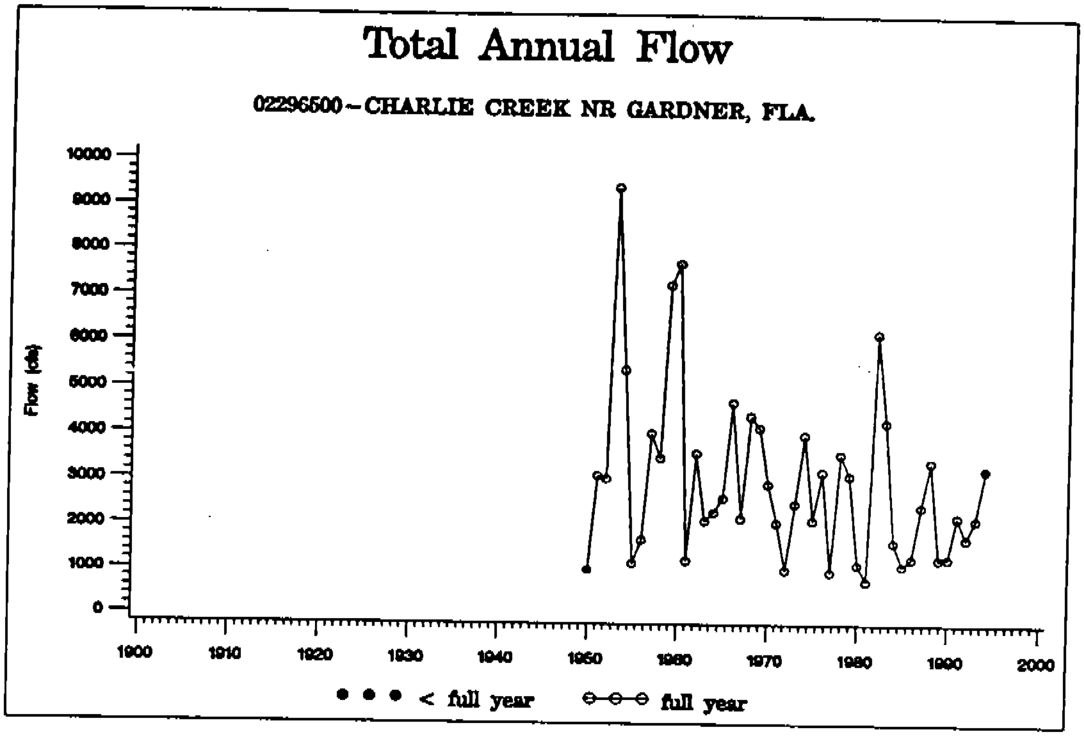

Average Monthly Flow
02295420 - PAYNE CREEK NR BOWLING GREEN, FLA.
Flow (cfs)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

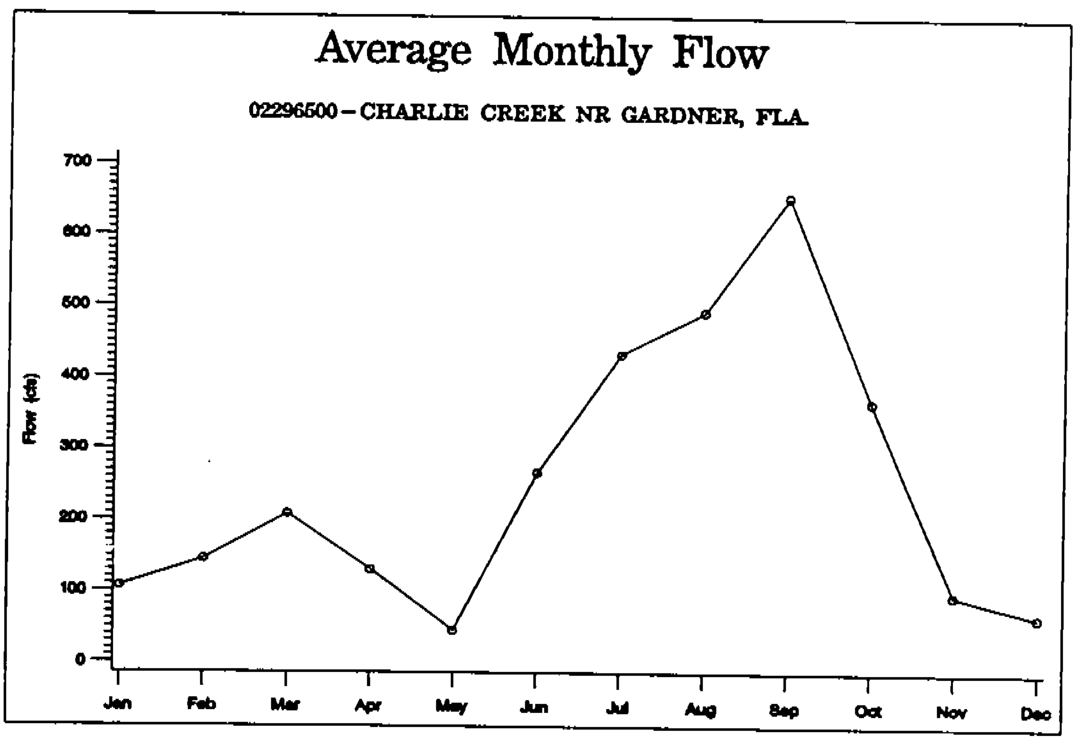

Total Annual Flow
02295637 - PEACE RIVER AT ZOLFO SPRINGS, FLA.
Flow (cfs)
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

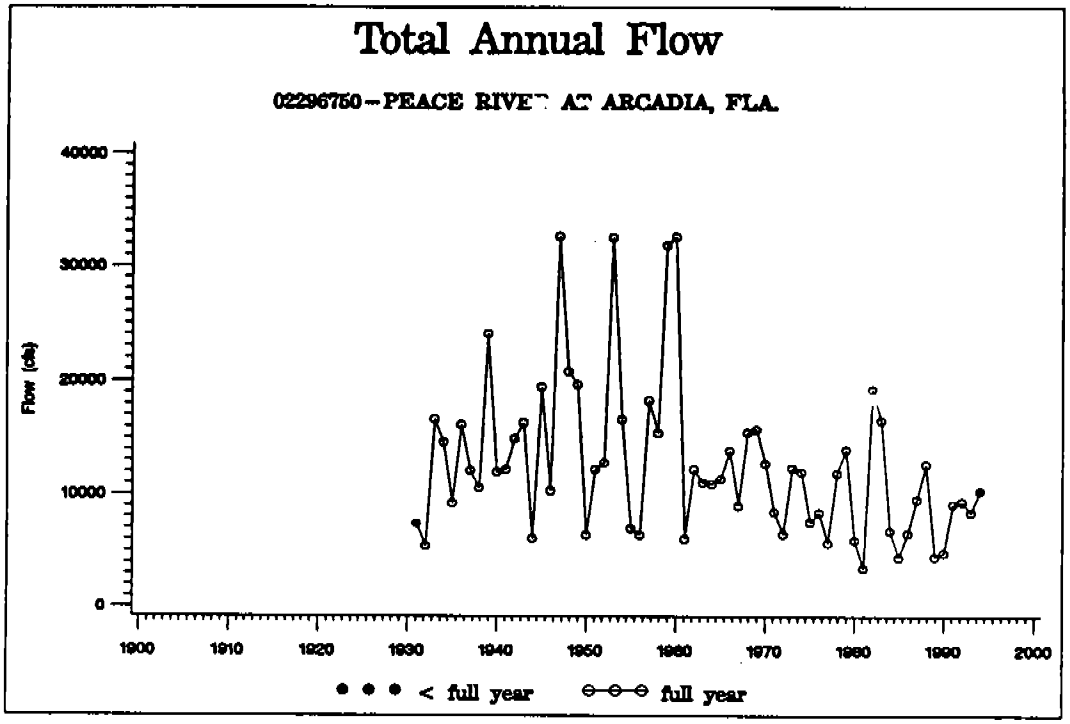

Average Monthly Flow
02295637 - PEACE RIVER AT ZOLFO SPRINGS, FLA.
Flow (cfs)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

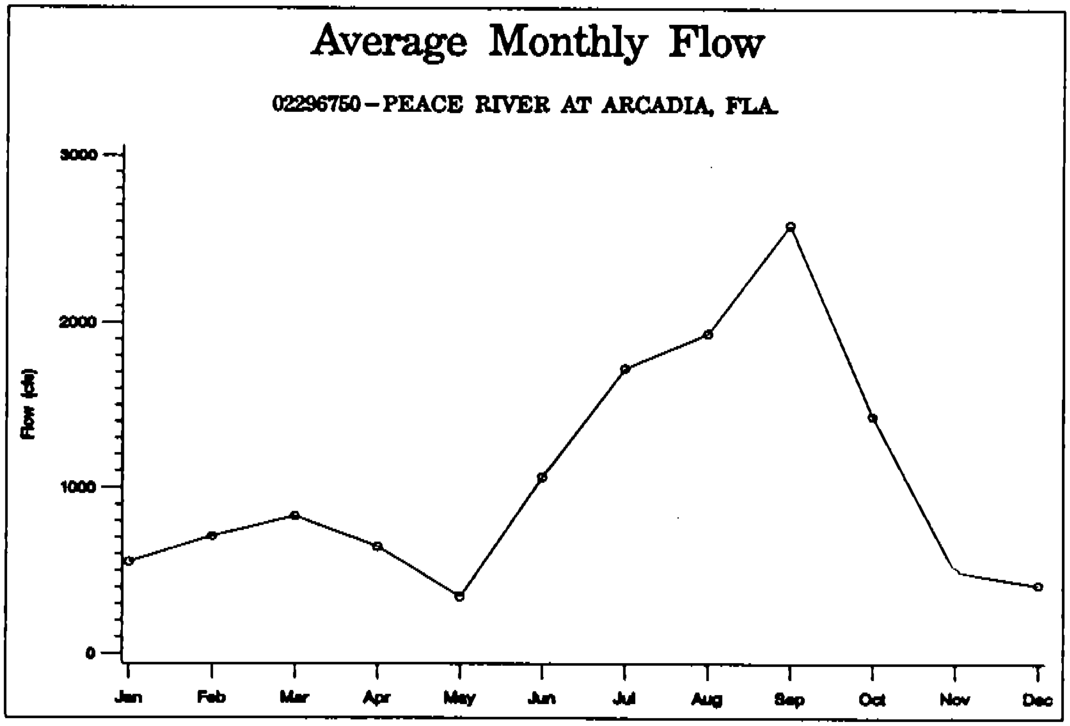

Total Annual Flow
02296223 - LITTLE CHARLEY BOWLEGS CREEK NR SEBRING, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

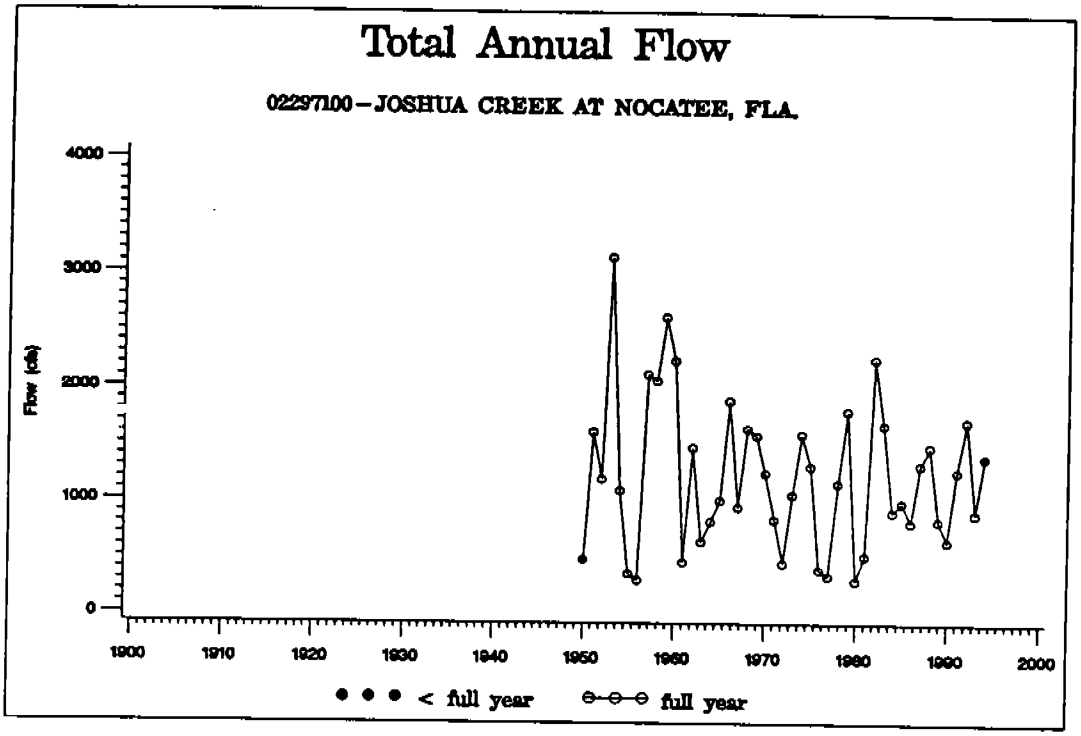

Average Monthly Flow
02296223 - LITTLE CHARLEY BOWLEGS CREEK NR SEBRING, FLA.
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02296500 – CHARLIE CREEK NR GARDNER, FLA.
Flow (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
• • • < full year
⊖-⊖-⊖ full year

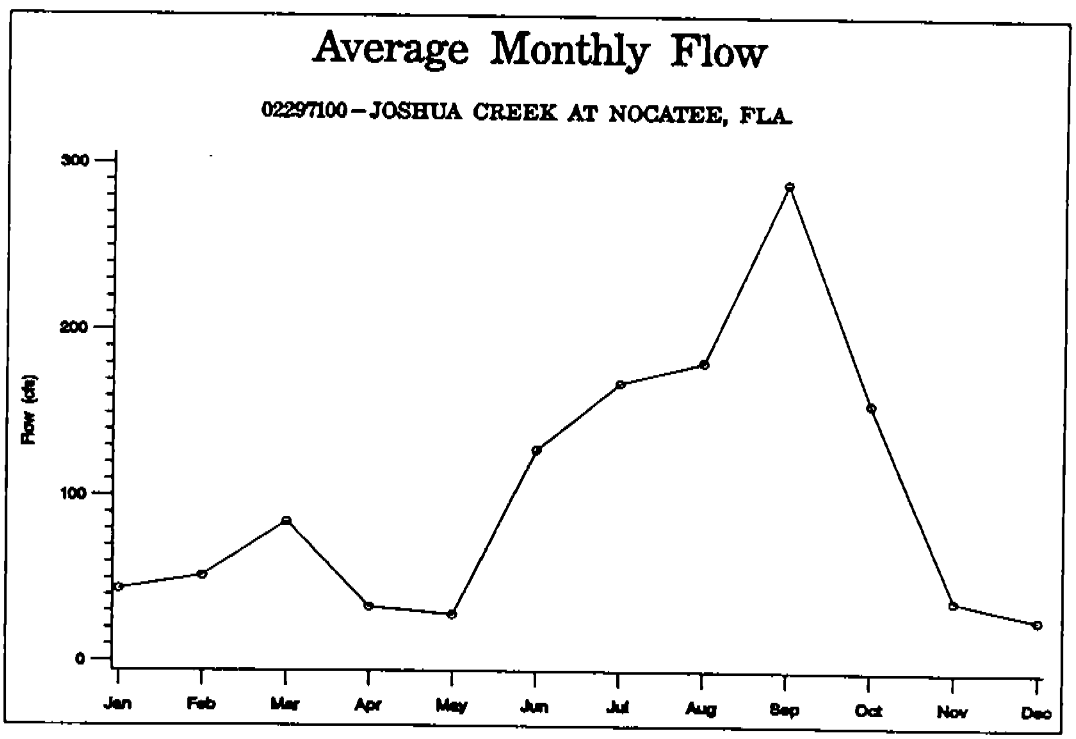

Average Monthly Flow
02296500 – CHARLIE CREEK NR GARDNER, FLA.
Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02296750 – PEACE RIVER AT ARCADIA, FLA.
Flow (cfs)
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

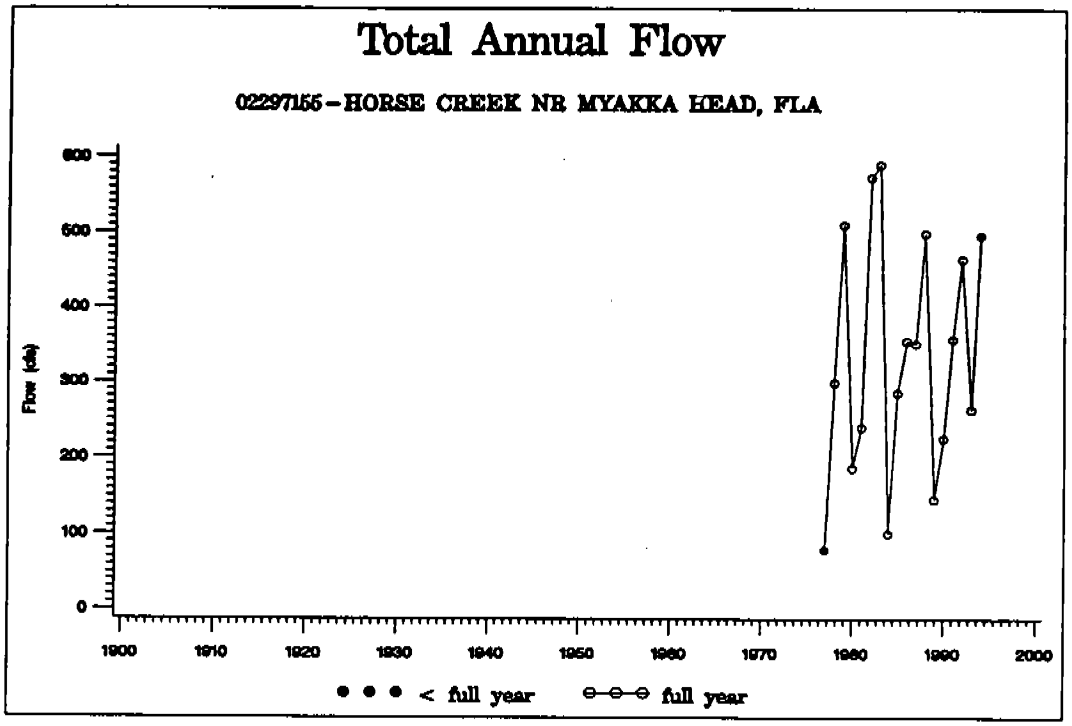

Average Monthly Flow
02296750 – PEACE RIVER AT ARCADIA, FLA.
Flow (cfs)
3000
2000
1000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

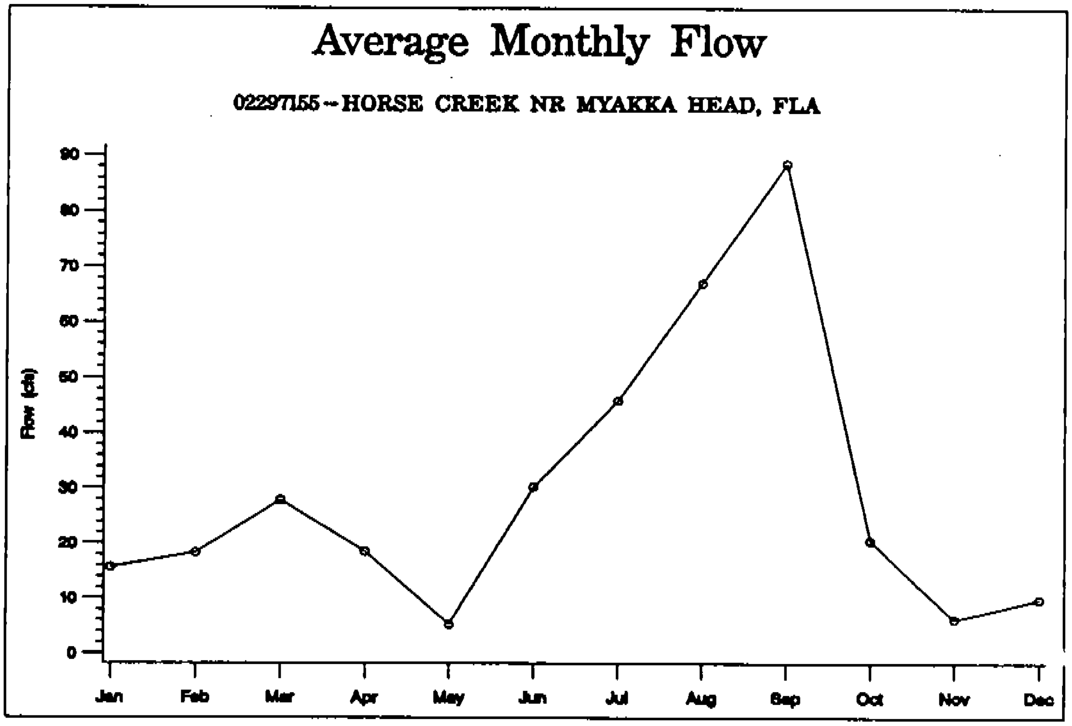


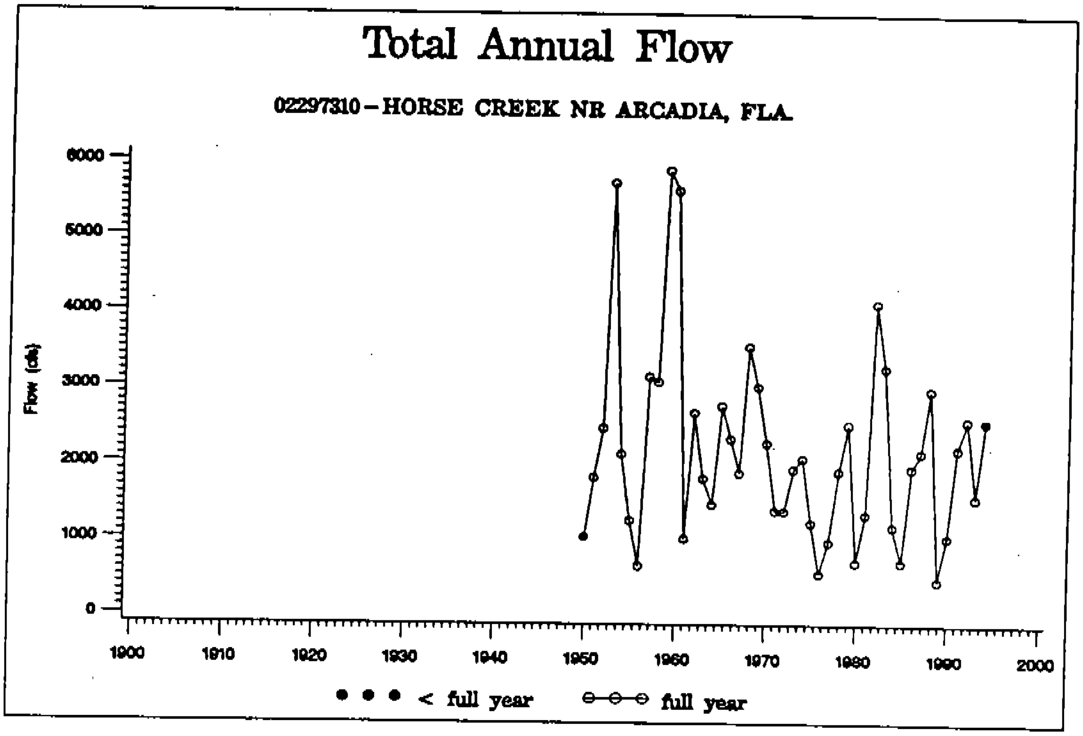
Total Annual Flow
02297100 – JOSHUA CREEK AT NOCATEE, FLA.
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

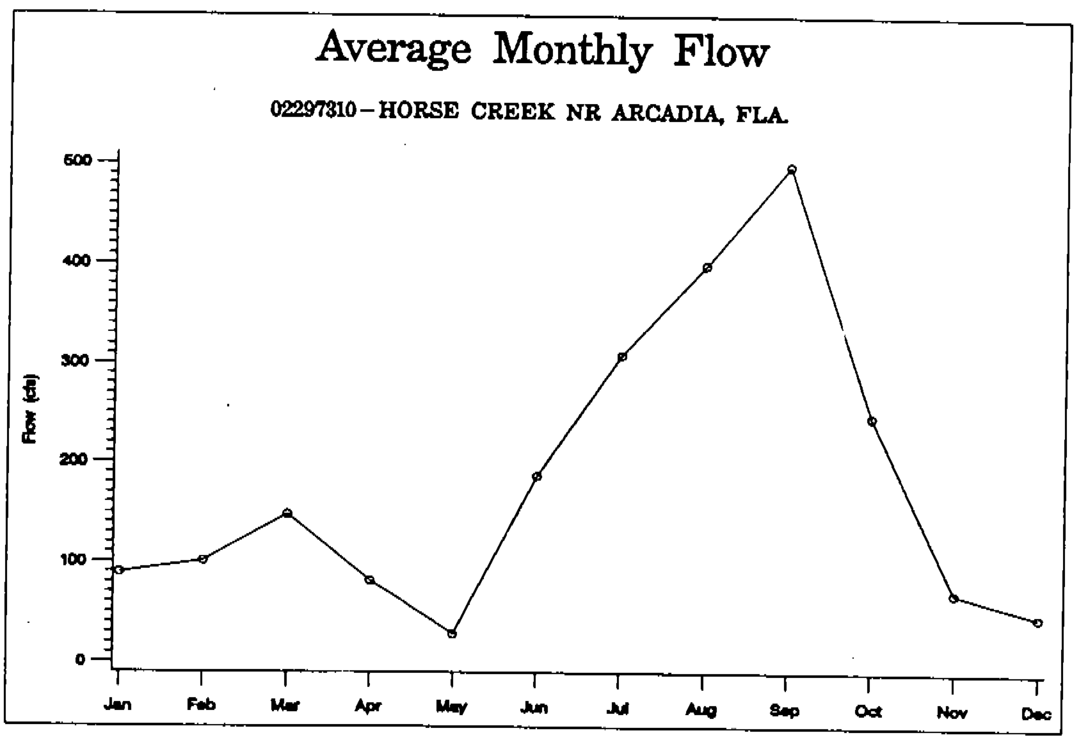


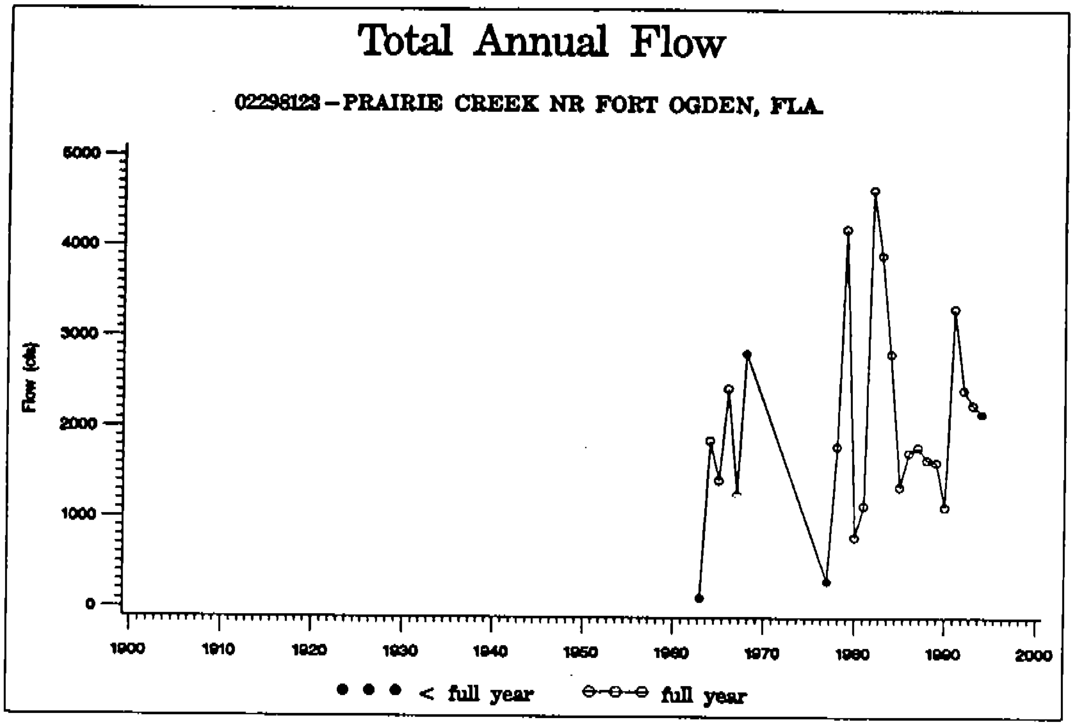
Average Monthly Flow
02297100 – JOSHUA CREEK AT NOCATEE, FLA.
Flow (cfs)
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02297155 – HORSE CREEK NR MYAKKA HEAD, FLA
Flow (cfs)
0
100
200
300
400
500
600
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

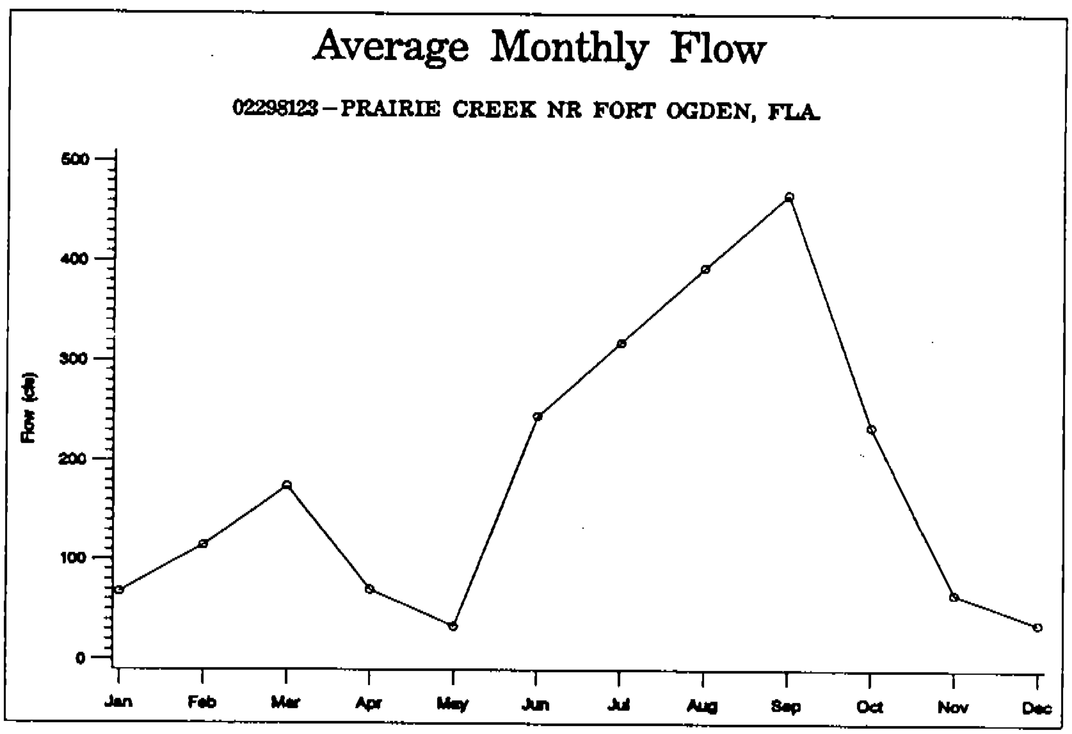

Average Monthly Flow
02297155 – HORSE CREEK NR MYAKKA HEAD, FLA
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02297310 – HORSE CREEK NR ARCADIA, FLA.
Flow (cfs)
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

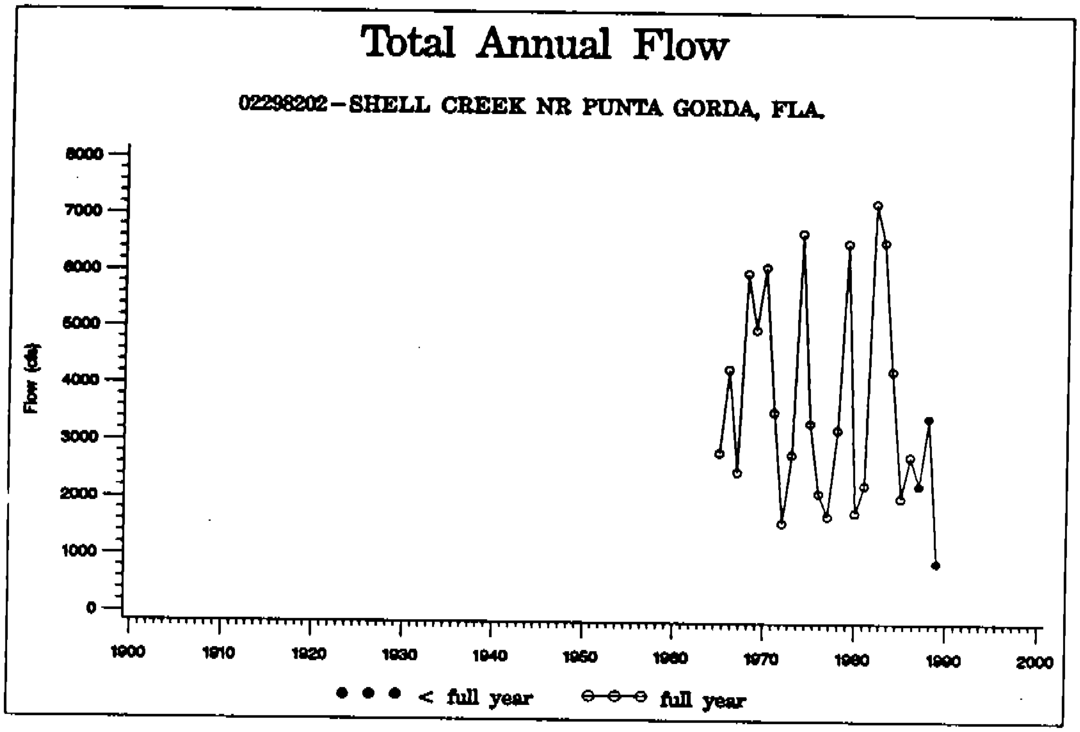

Average Monthly Flow
02297310 – HORSE CREEK NR ARCADIA, FLA.
Flow (cfs)
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



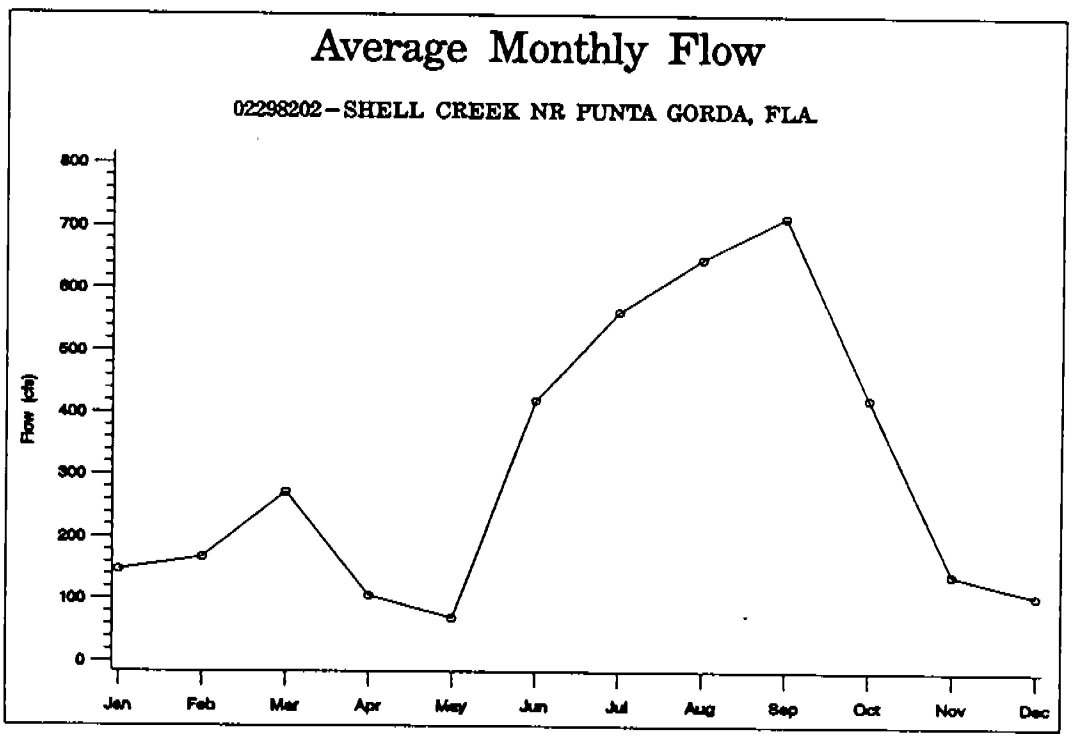
Total Annual Flow
02298123 – PRAIRIE CREEK NR FORT OGDEN, FLA.
Flow (cfs)
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



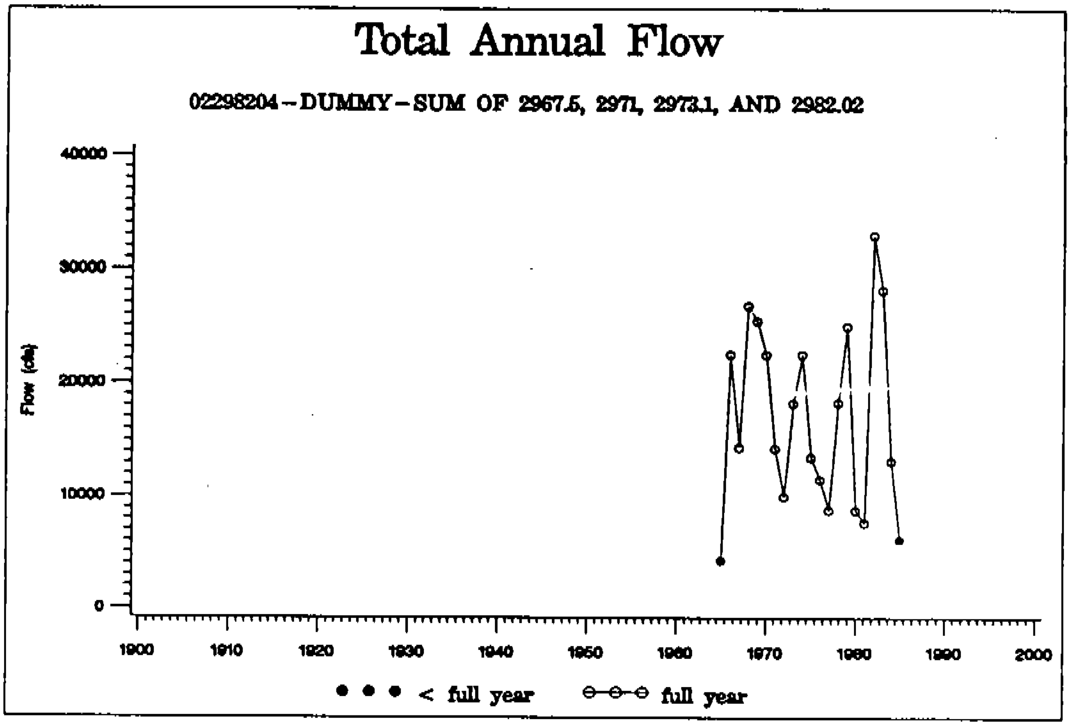
Average Monthly Flow
02298123 – PRAIRIE CREEK NR FORT OGDEN, FLA.
Flow (cfs)
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



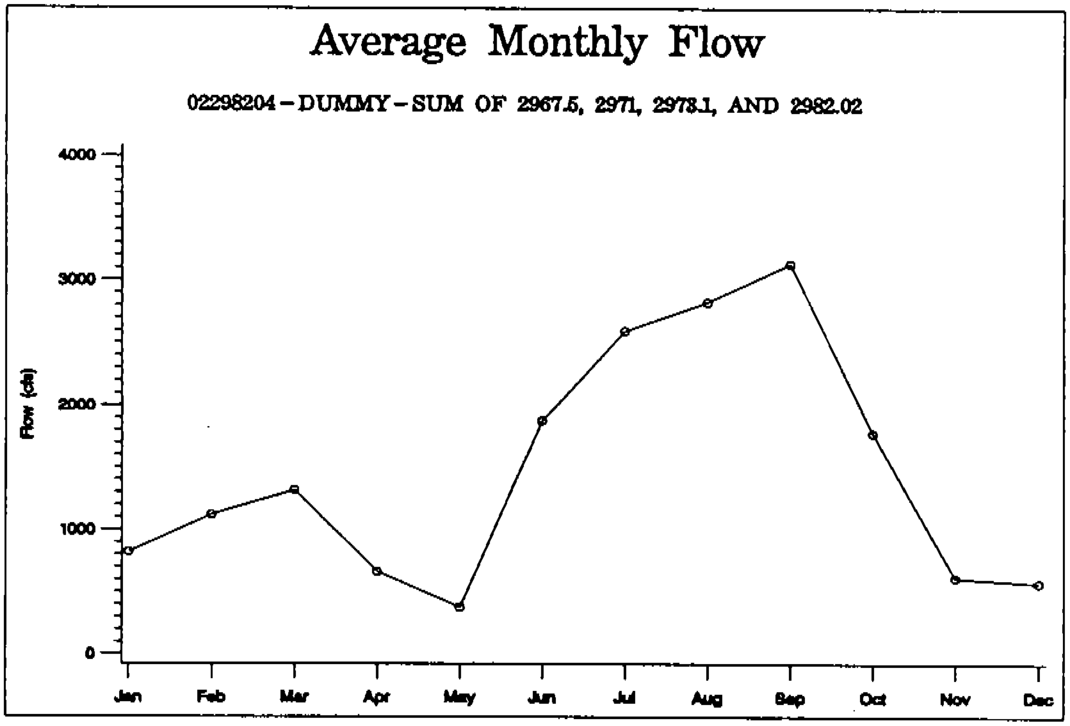
Total Annual Flow
02298202 – SHELL CREEK NR PUNTA GORDA, FLA.
Flow (cfs)
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



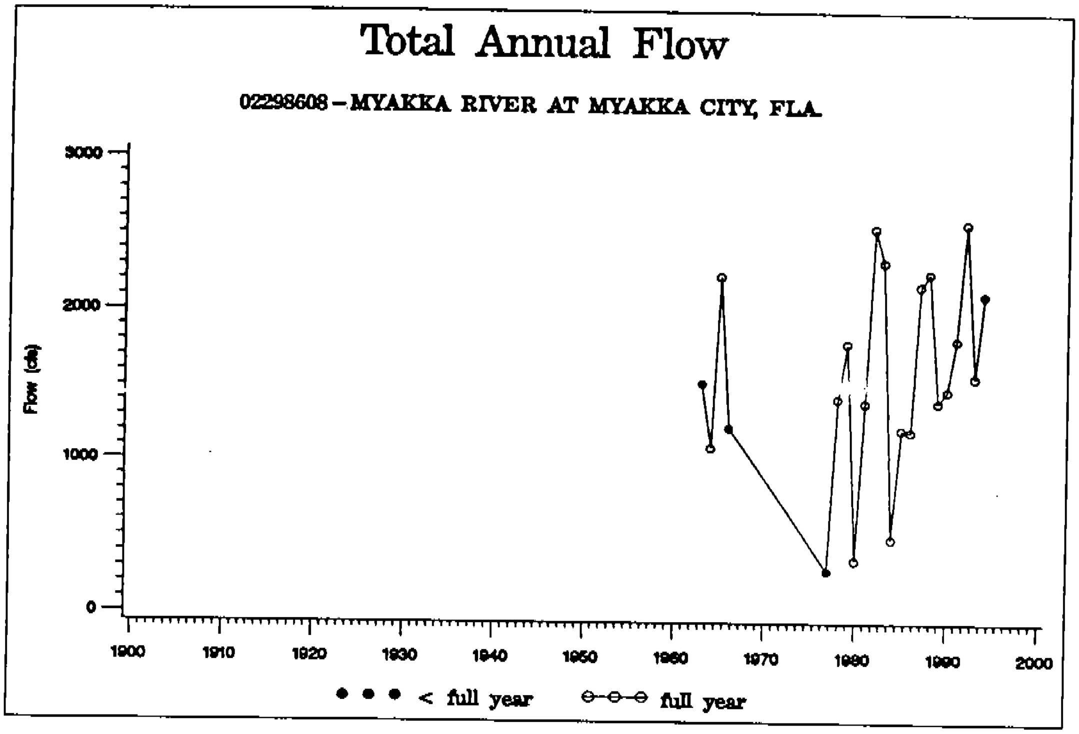
Average Monthly Flow
02298202 – SHELL CREEK NR PUNTA GORDA, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

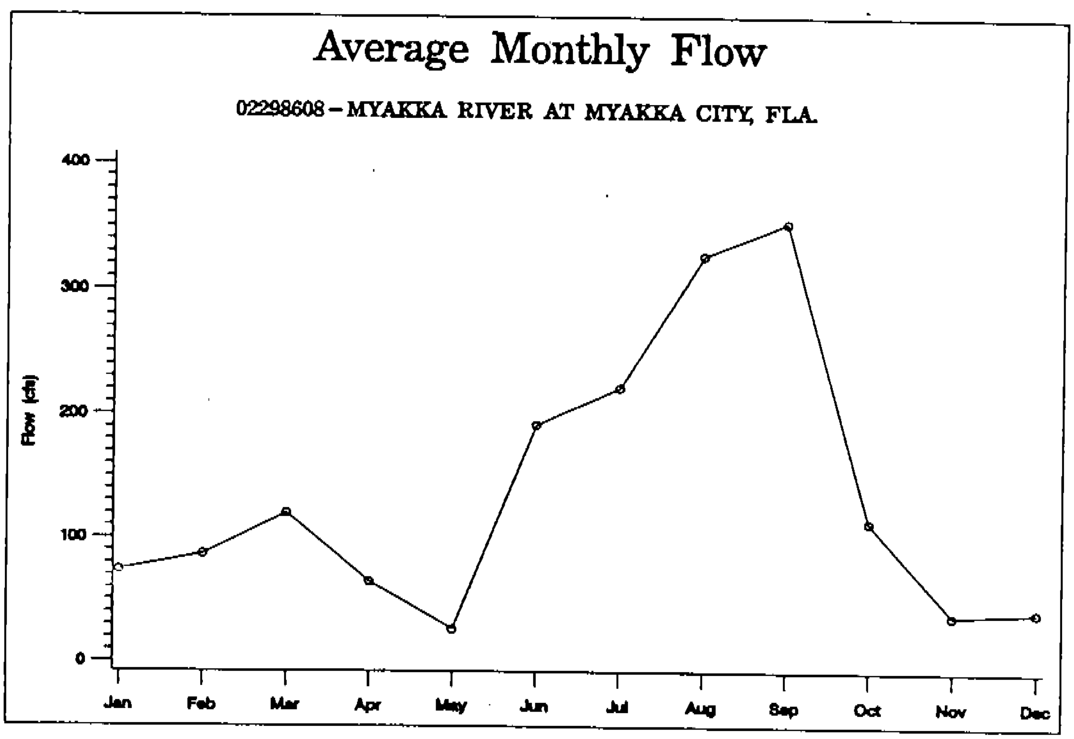


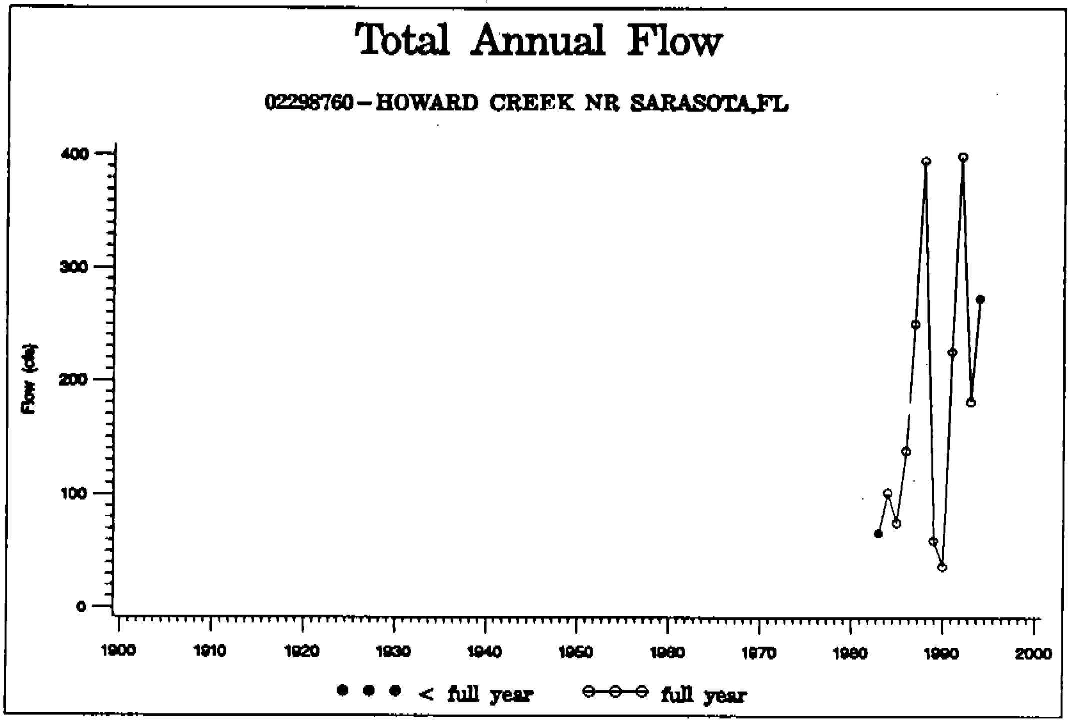
Total Annual Flow
02298204 - DUMMY - SUM OF 2967.5, 2971, 2973.1, AND 2982.02
40000
30000
20000
10000
0
Flow (cfs)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

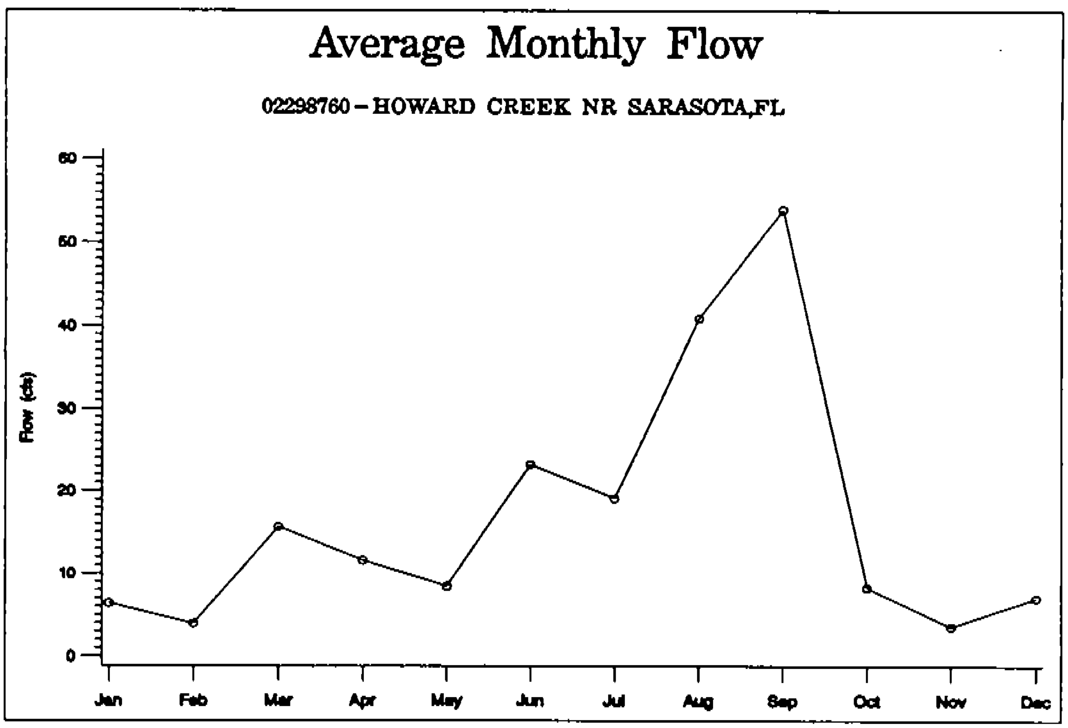


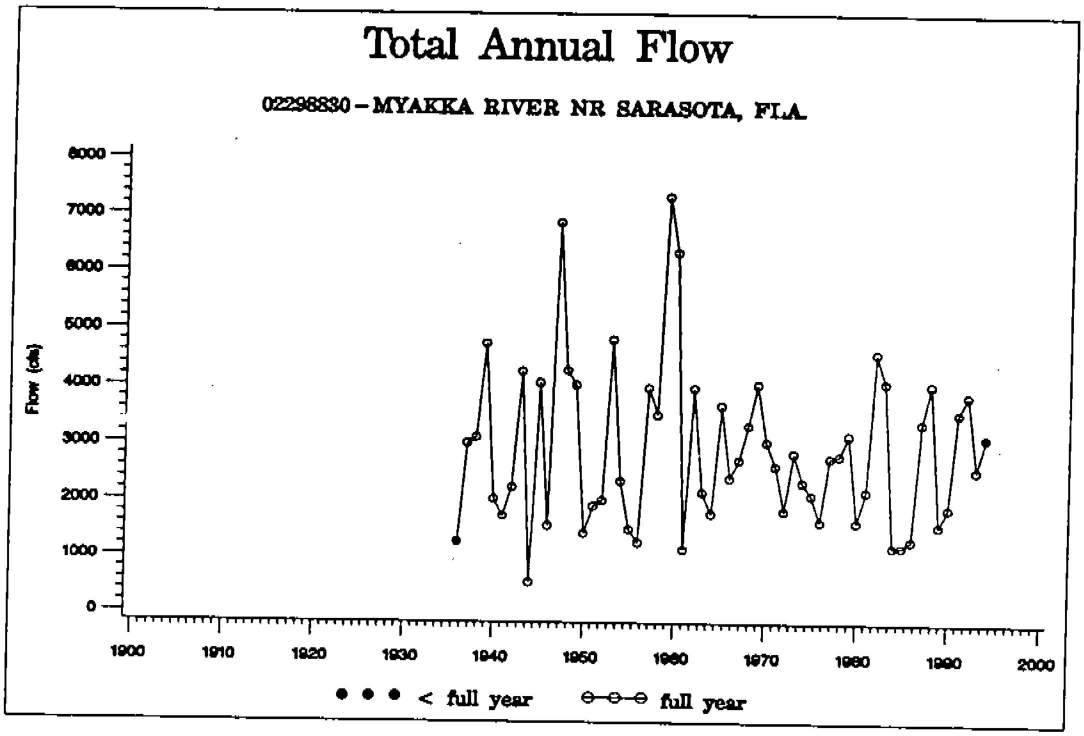
Average Monthly Flow
02298204 - DUMMY - SUM OF 2967.5, 2971, 2973.1, AND 2982.02
4000
3000
2000
1000
0
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02298608 - MYAKKA RIVER AT MYAKKA CITY, FLA.
Flow (cfs)
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

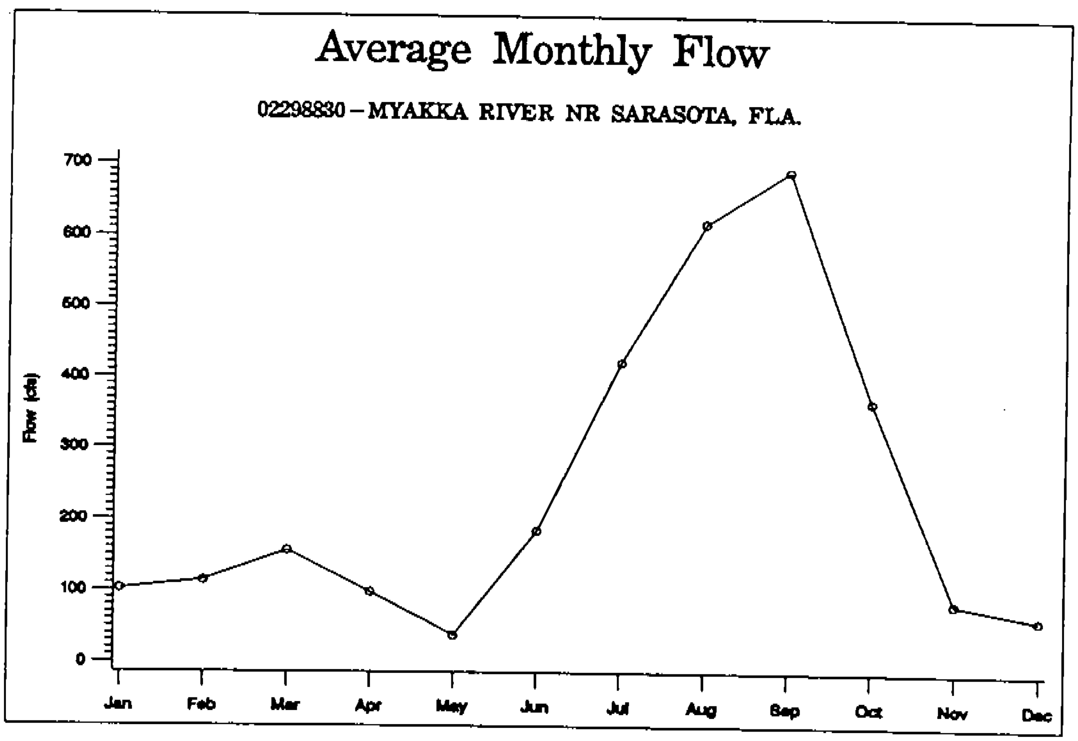

Average Monthly Flow
02298608 - MYAKKA RIVER AT MYAKKA CITY, FLA.
Flow (cfs)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02298760 - HOWARD CREEK NR SARASOTA,FL
Flow (cfs)
0
100
200
300
400
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

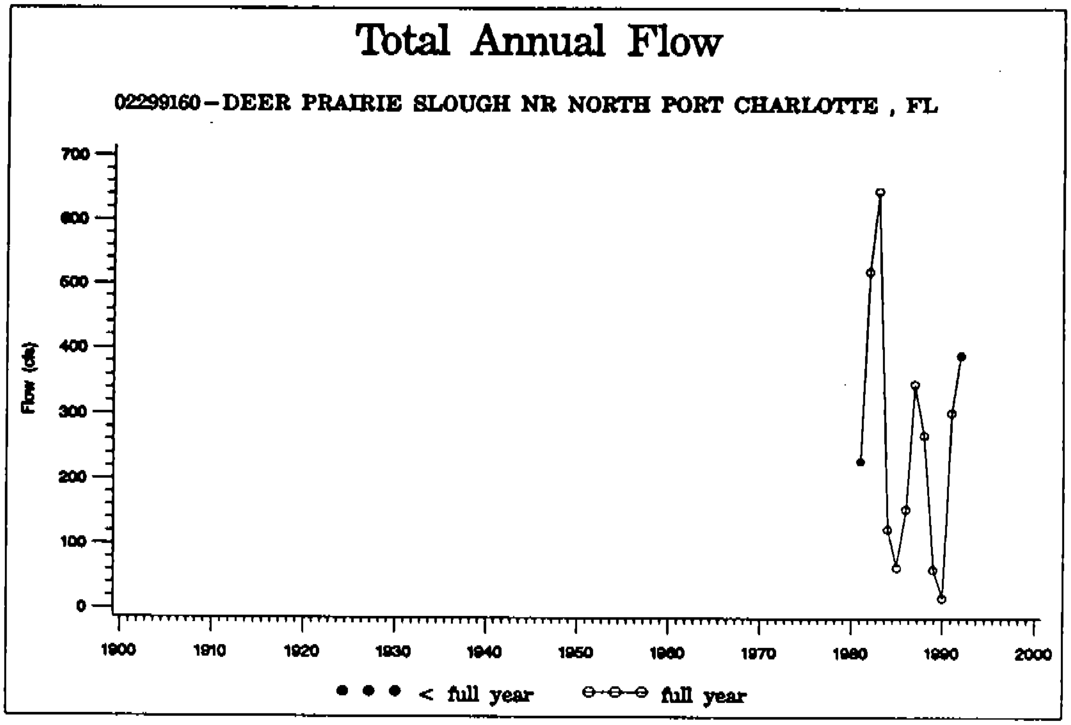

Average Monthly Flow
02298760 - HOWARD CREEK NR SARASOTA,FL
Flow (cfs)
0
10
20
30
40
50
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

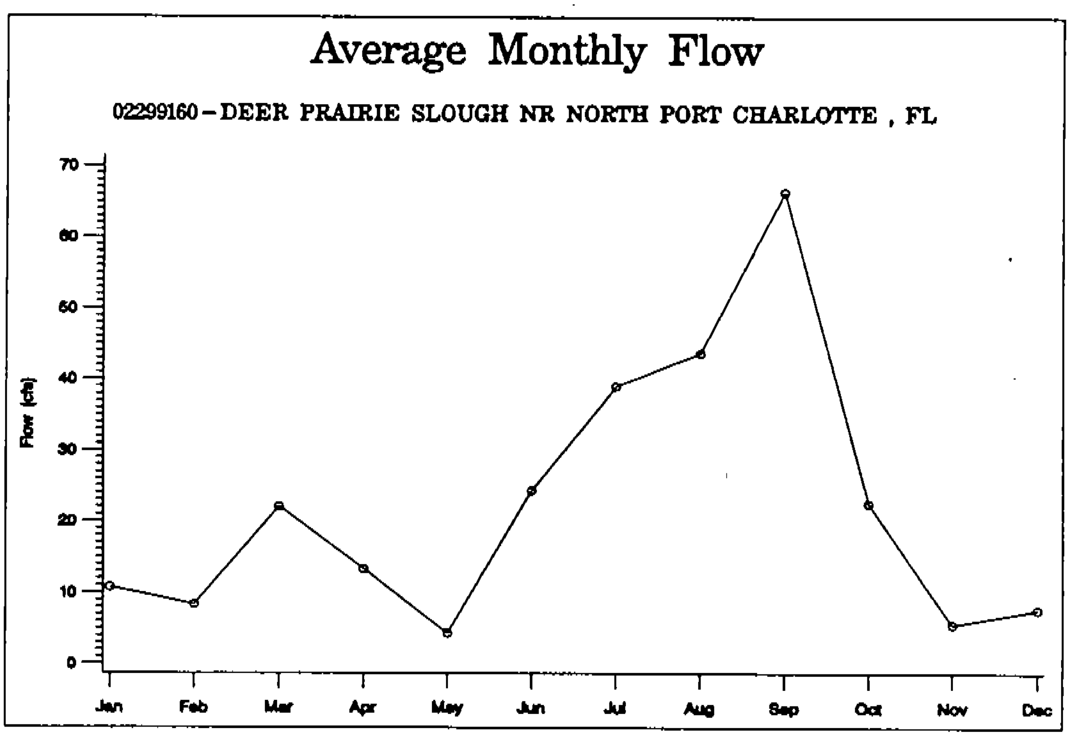


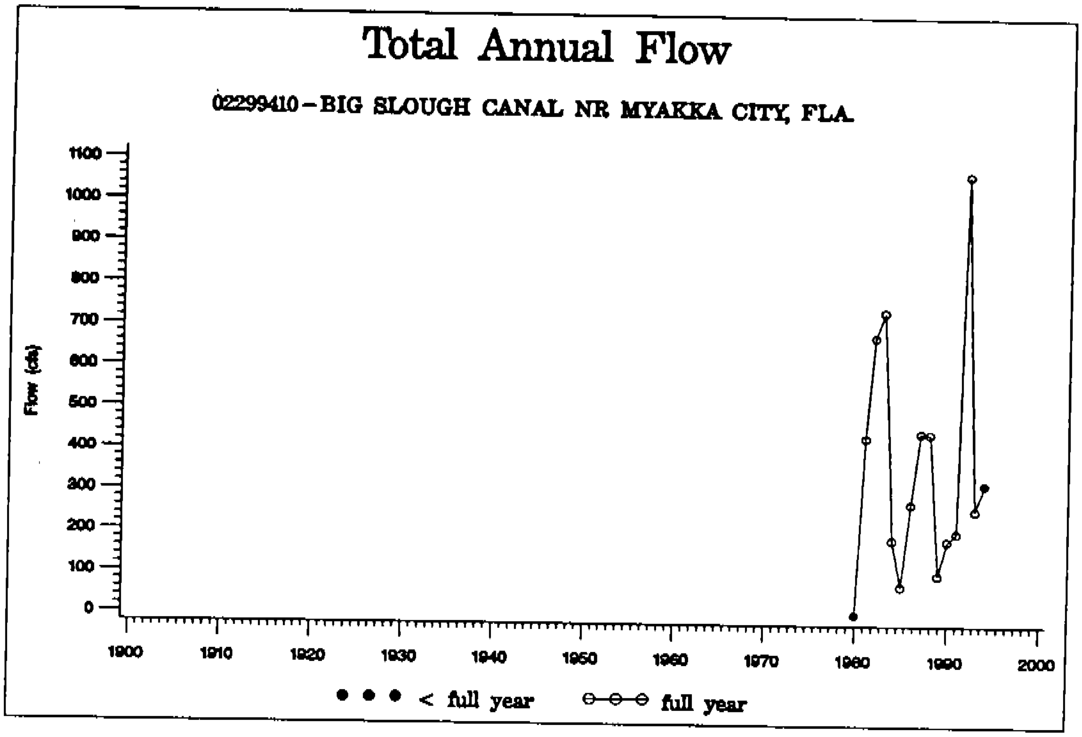
Total Annual Flow
02298830 – MYAKKA RIVER NR SARASOTA, FLA.
Flow (cfs)
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

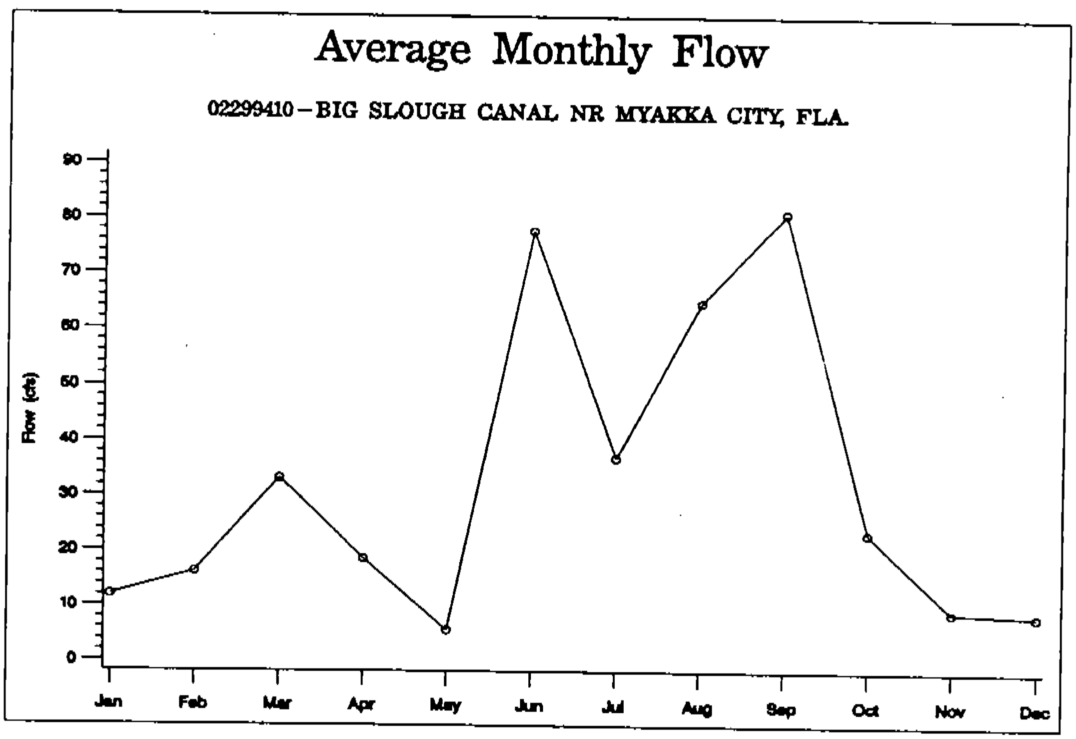


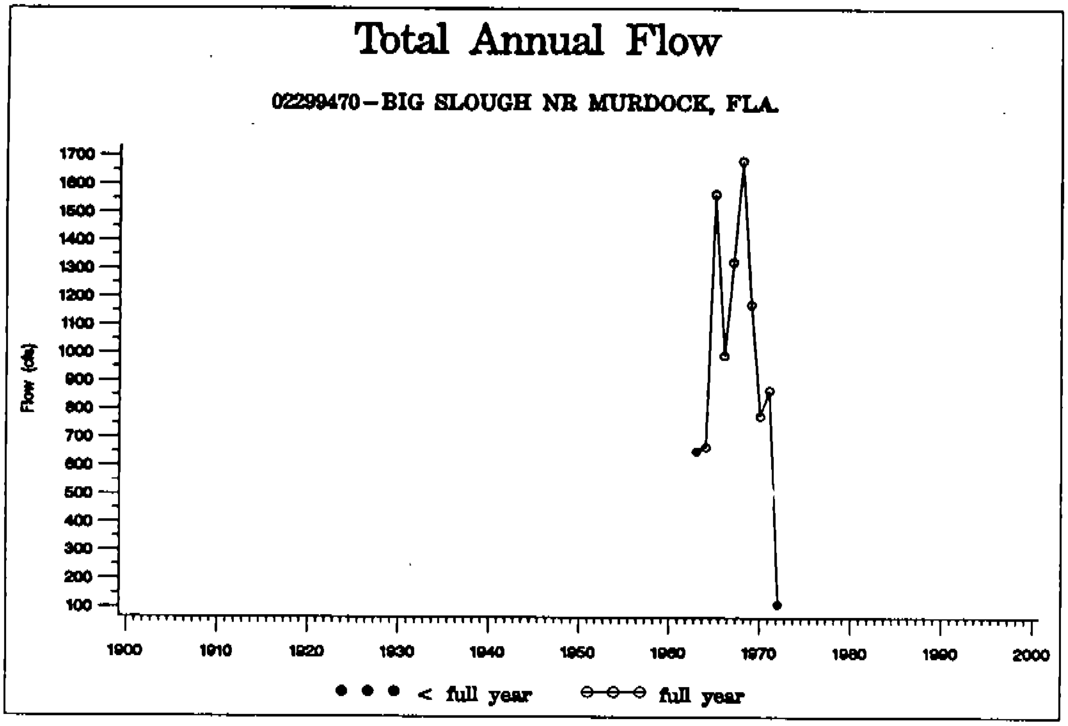
Average Monthly Flow
02298830 – MYAKKA RIVER NR SARASOTA, FLA.
Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

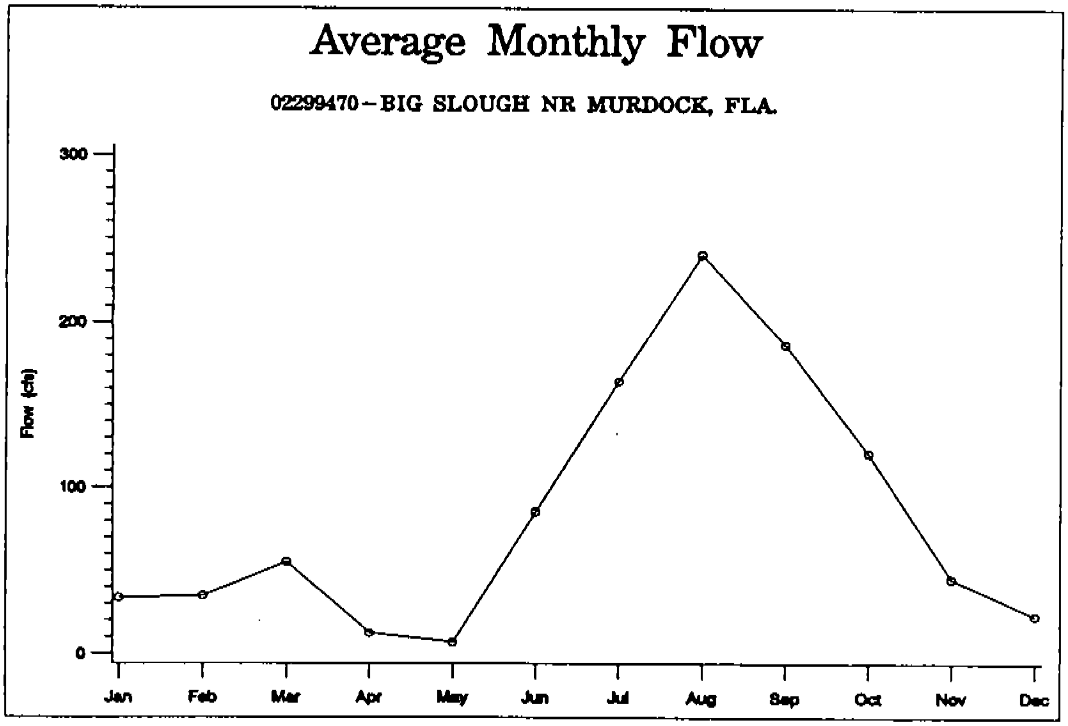

Total Annual Flow
02299160-DEER PRAIRIE SLOUGH NR NORTH PORT CHARLOTTE , FL
Flow (cfs)
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

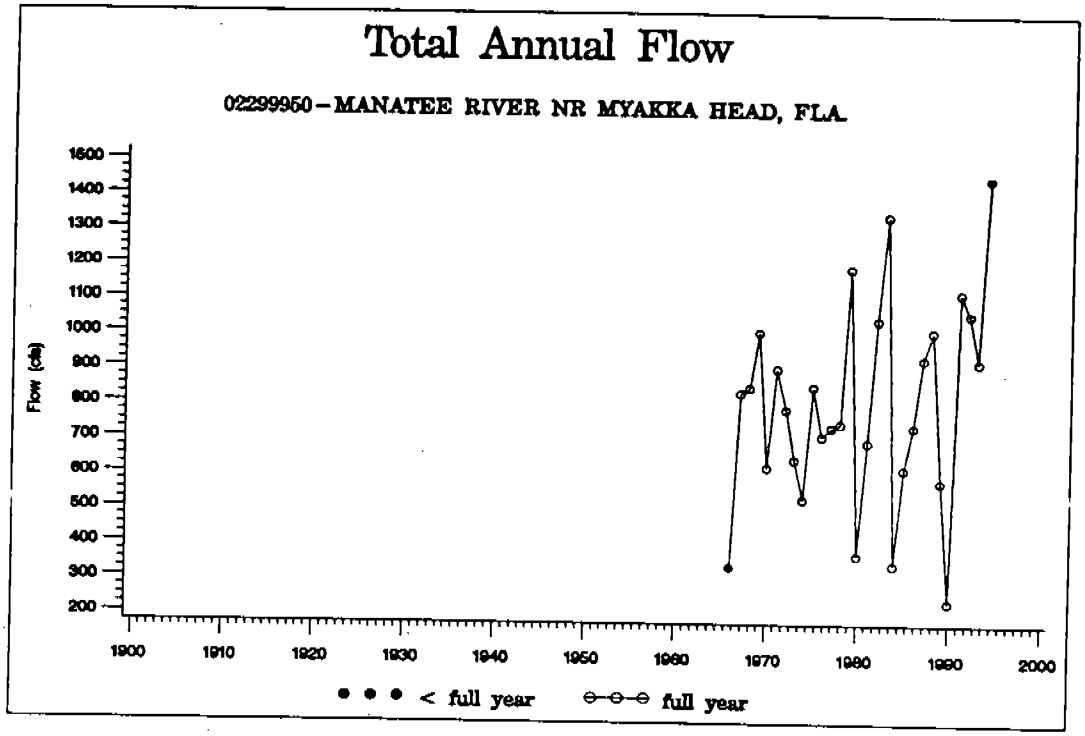

Average Monthly Flow
02299160-DEER PRAIRIE SLOUGH NR NORTH PORT CHARLOTTE , FL
Flow (cfs)
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

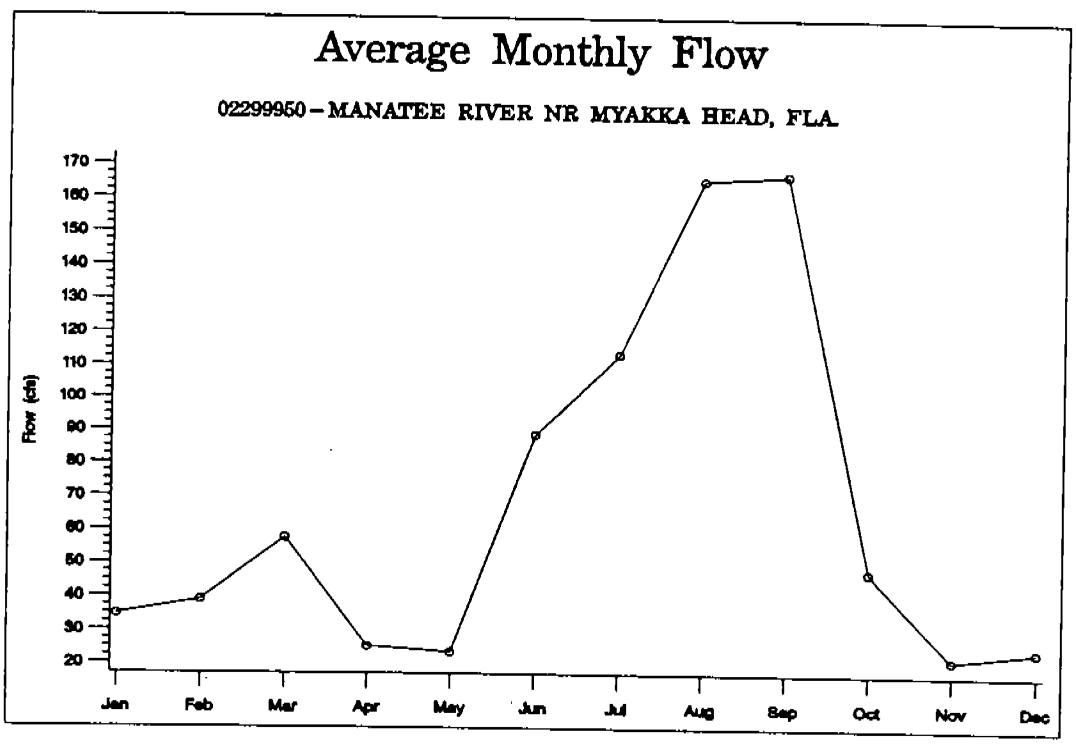

Total Annual Flow
02299410 – BIG SLOUGH CANAL NR MYAKKA CITY, FLA.
Flow (cfs)
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

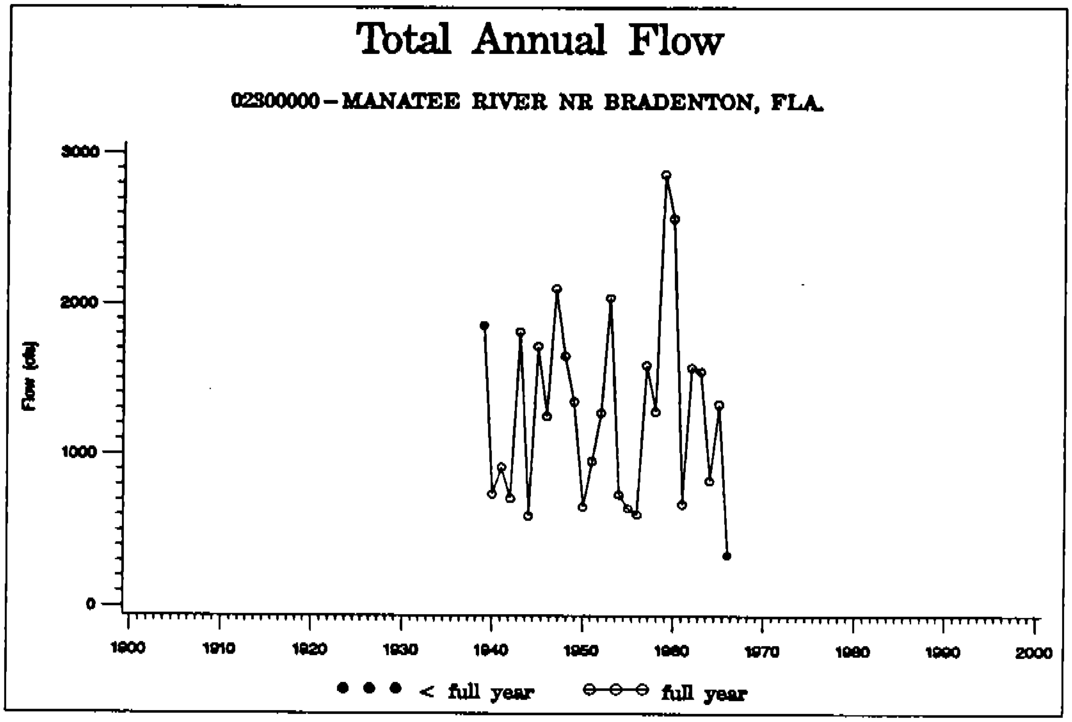

Average Monthly Flow
02299410 – BIG SLOUGH CANAL NR MYAKKA CITY, FLA.
Flow (cfs)
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

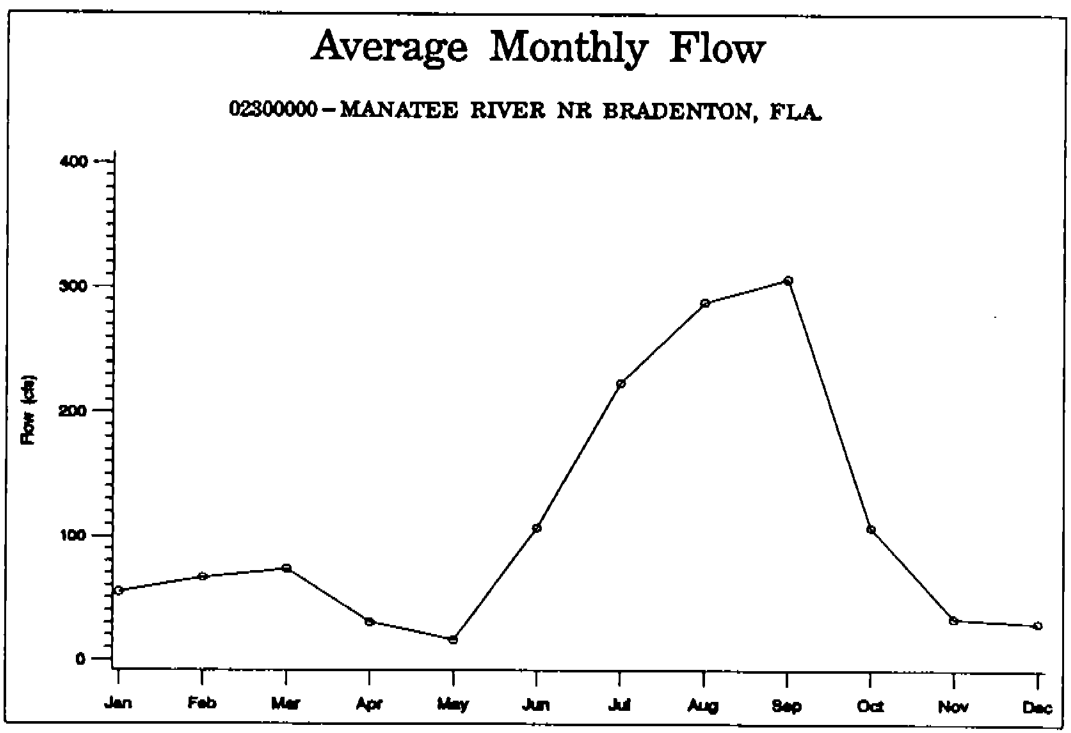

Total Annual Flow
02299470-BIG SLOUGH NR MURDOCK, FLA.
Flow (cfs)
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

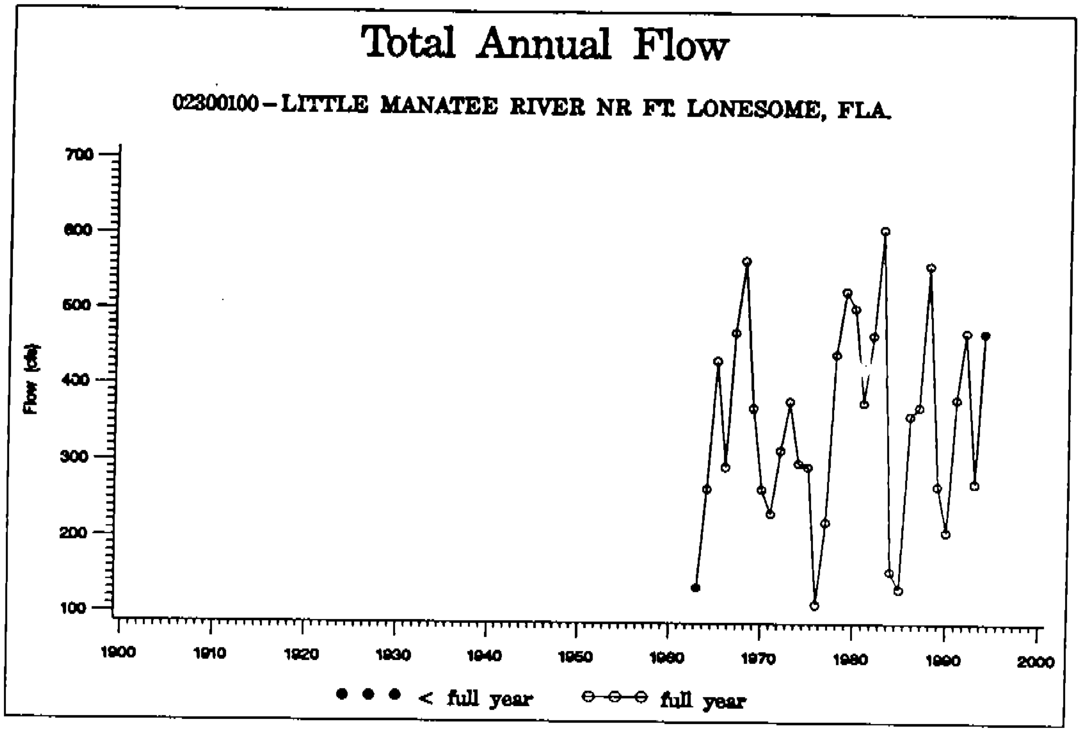

Average Monthly Flow
02299470-BIG SLOUGH NR MURDOCK, FLA.
Flow (cfs)
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

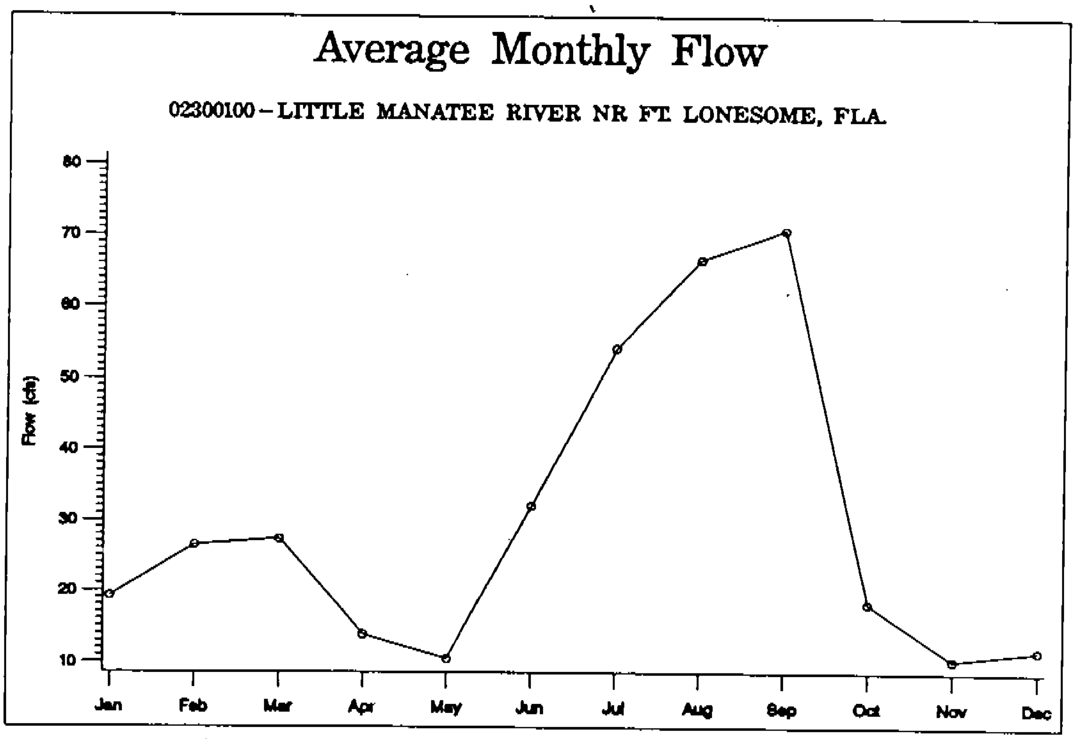

Total Annual Flow
02299950 – MANATEE RIVER NR MYAKKA HEAD, FLA.
Flow (cfs)
1600
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

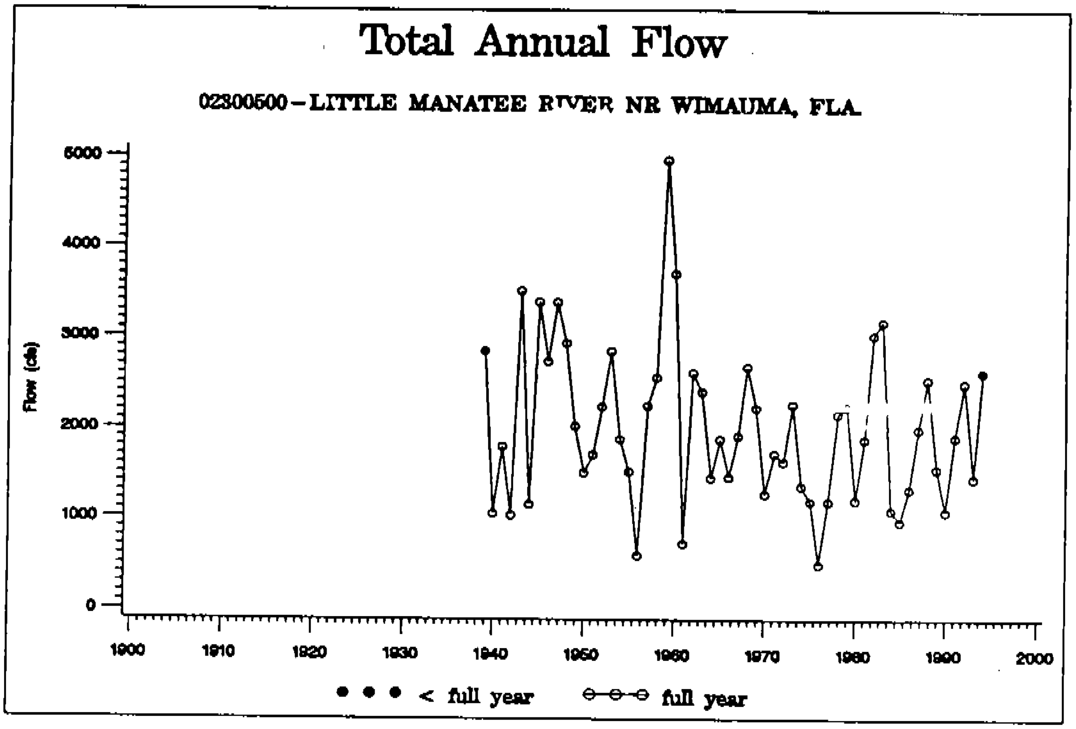

Average Monthly Flow
02299950 – MANATEE RIVER NR MYAKKA HEAD, FLA.
Flow (cfs)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02300000 – MANATEE RIVER NR BRADENTON, FLA.
Flow (cfs)
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

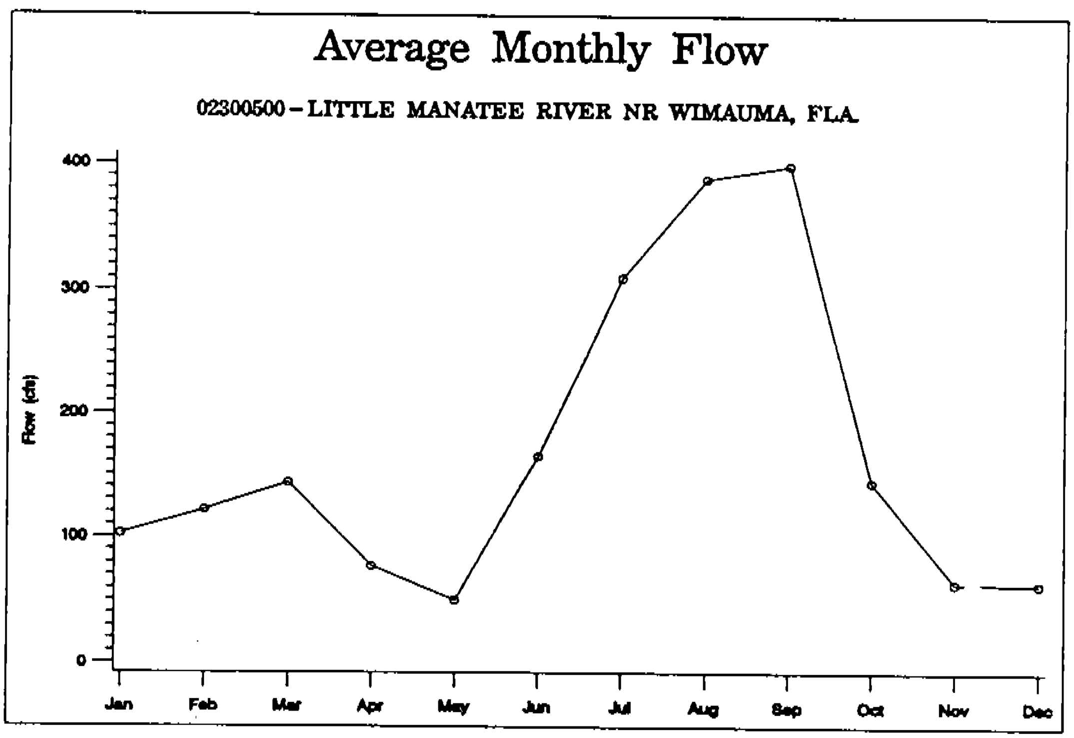

Average Monthly Flow
02300000 – MANATEE RIVER NR BRADENTON, FLA.
Flow (cfs)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02300100 – LITTLE MANATEE RIVER NR FT. LONESOME, FLA.
Flow (cfs)
700
600
500
400
300
200
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖⊖⊖ full year

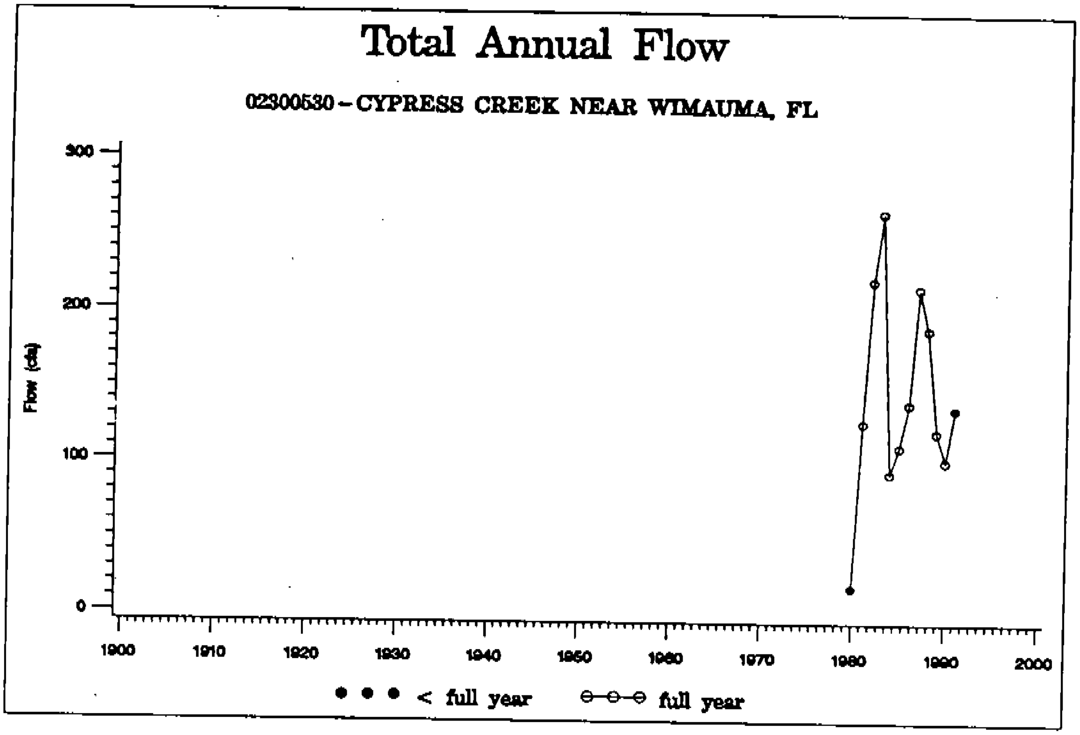

Average Monthly Flow
02300100 – LITTLE MANATEE RIVER NR FT. LONESOME, FLA.
Flow (cfs)
80
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

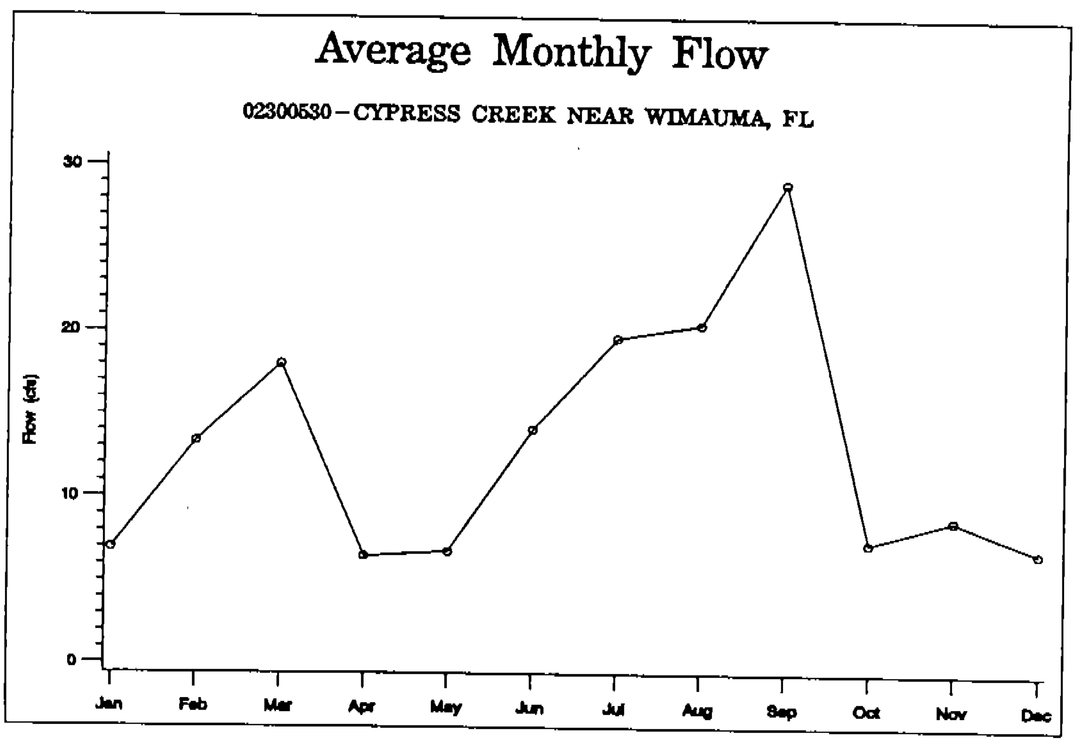


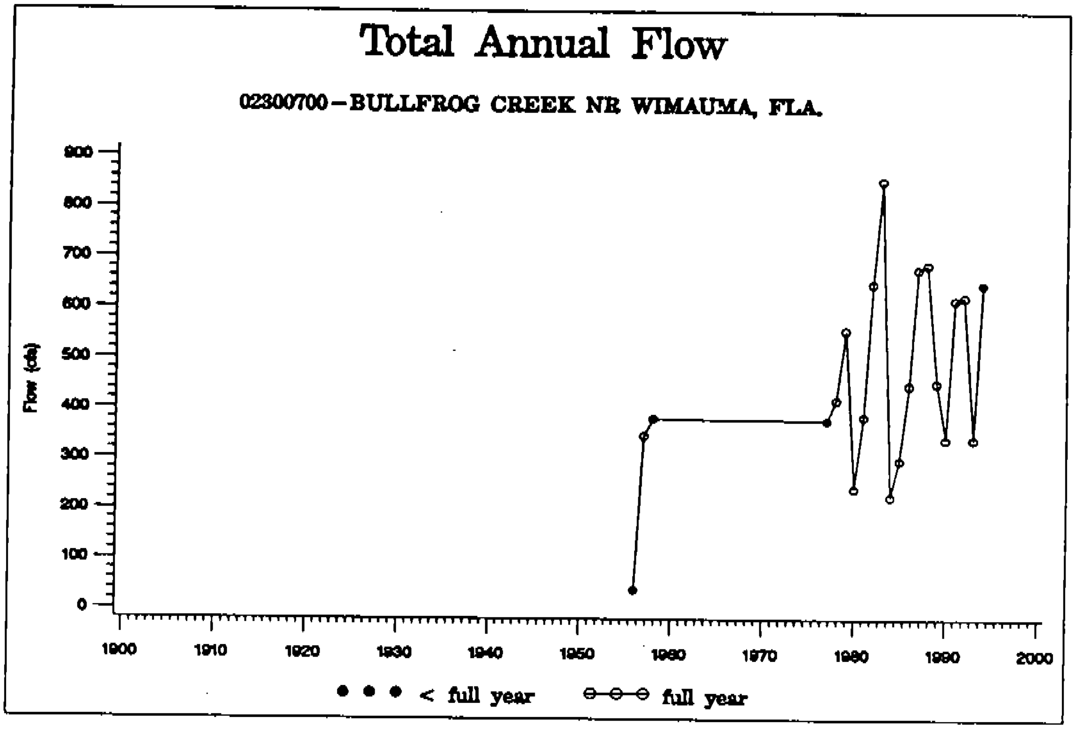
Total Annual Flow
02300500-LITTLE MANATEE RIVER NR WIMAUMA, FLA.
Flow (cfs)
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

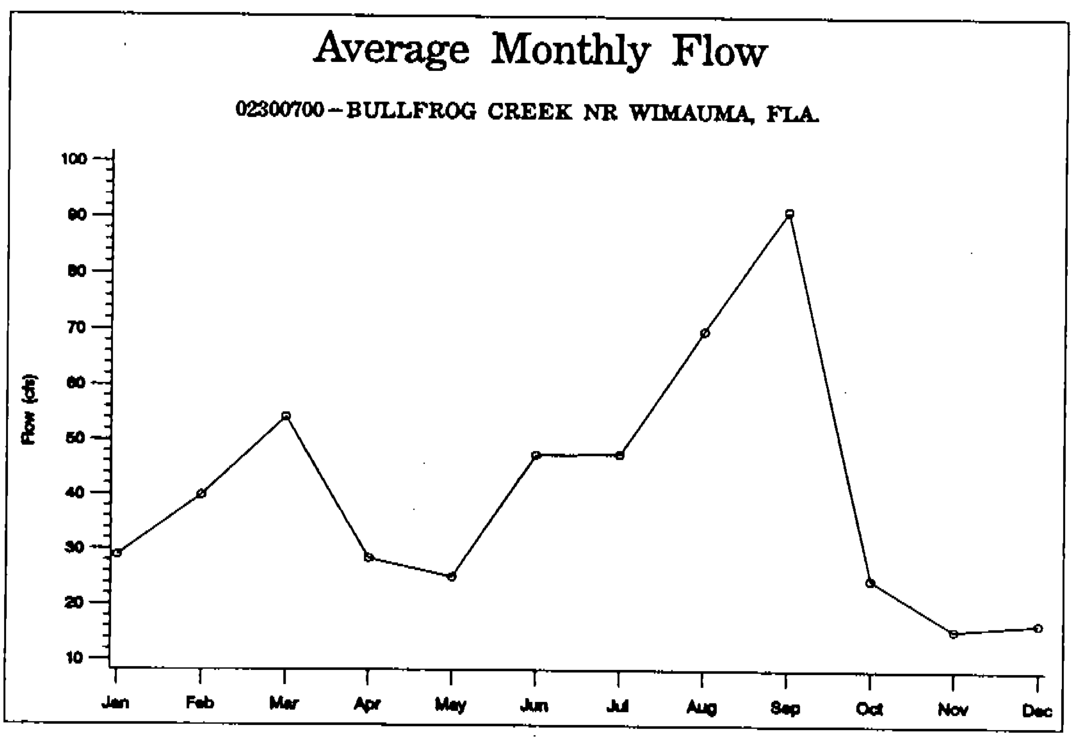


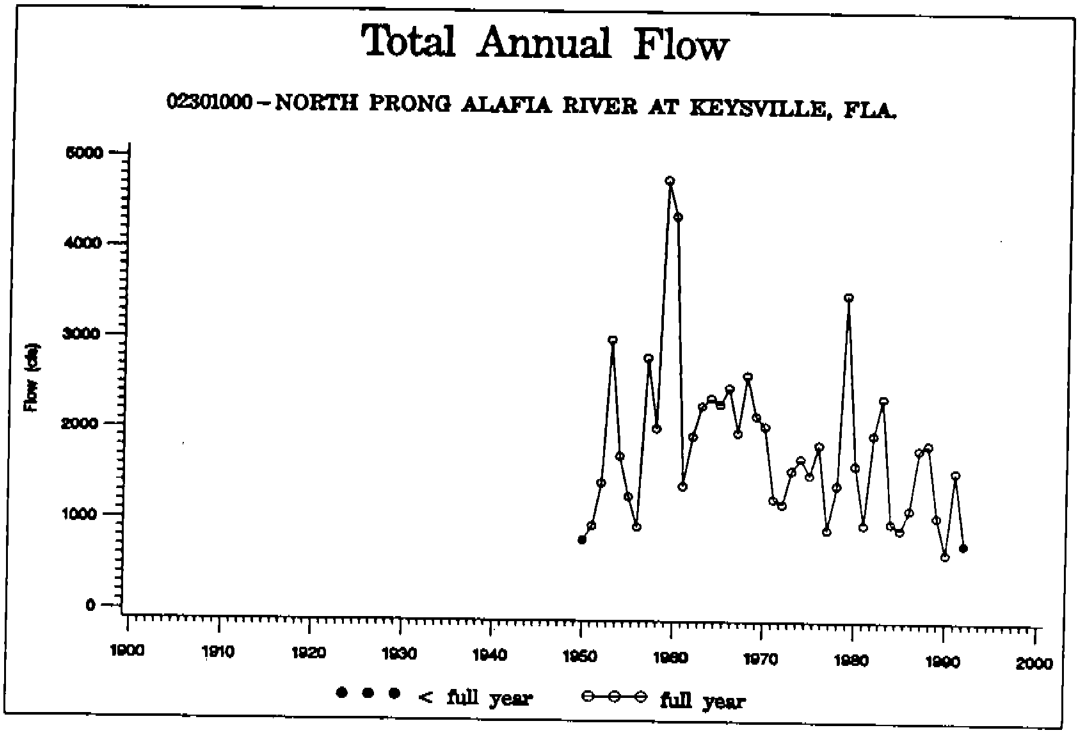
Average Monthly Flow
02300500-LITTLE MANATEE RIVER NR WIMAUMA, FLA.
Flow (cfs)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

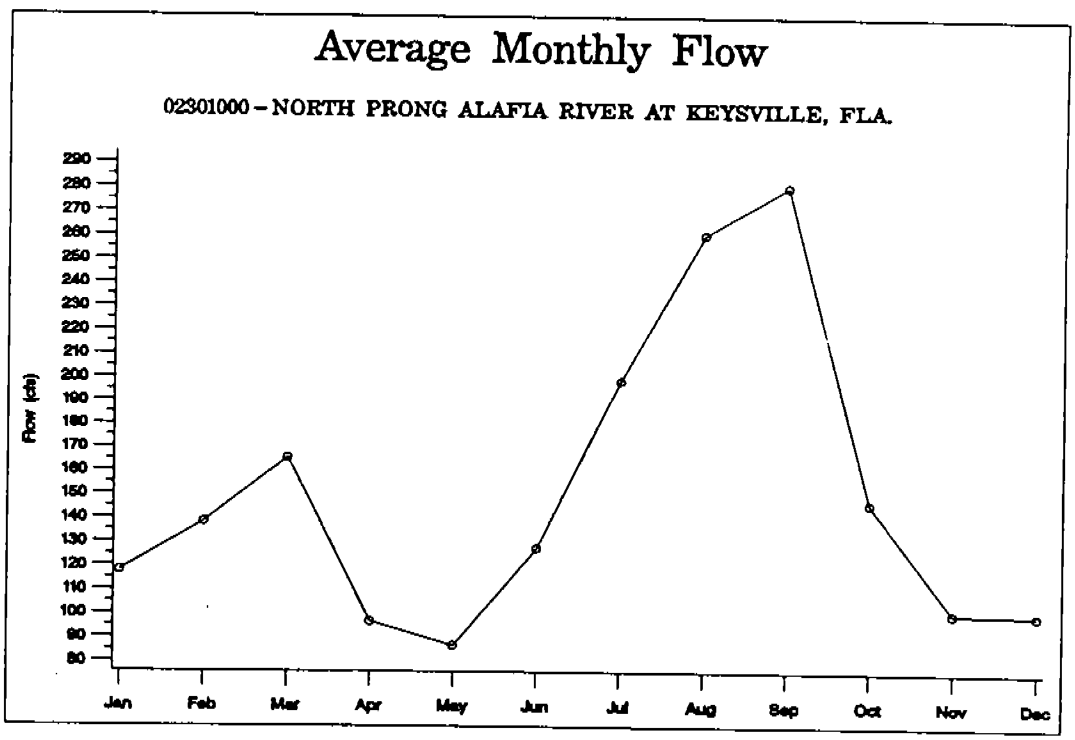

Total Annual Flow
02300530 - CYPRESS CREEK NEAR WIMAUMA, FL
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

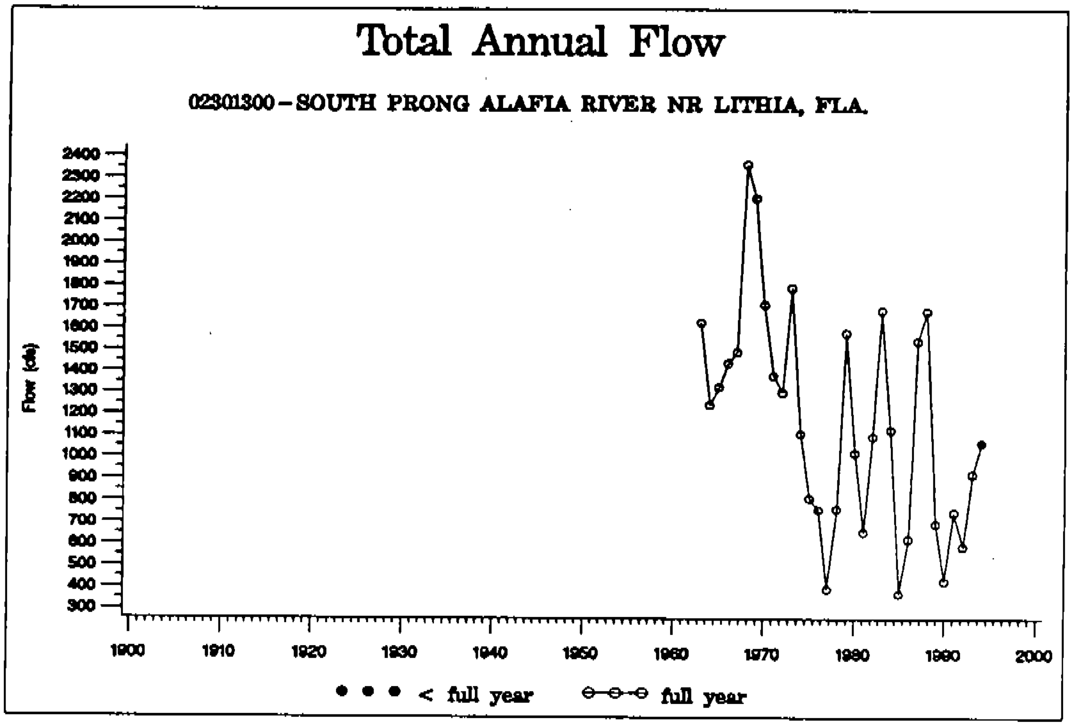

Average Monthly Flow
02300530 - CYPRESS CREEK NEAR WIMAUMA, FL
Flow (cfs)
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

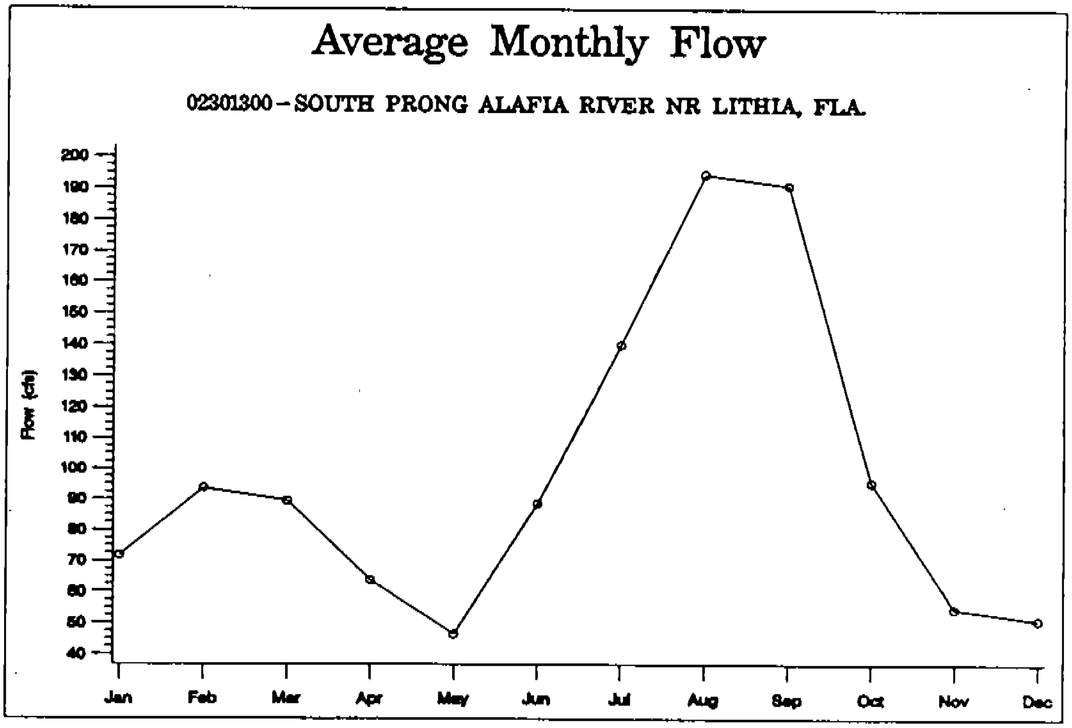

Total Annual Flow
02300700—BULLFROG CREEK NR WIMAUMA, FLA.
Flow (cfs)
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

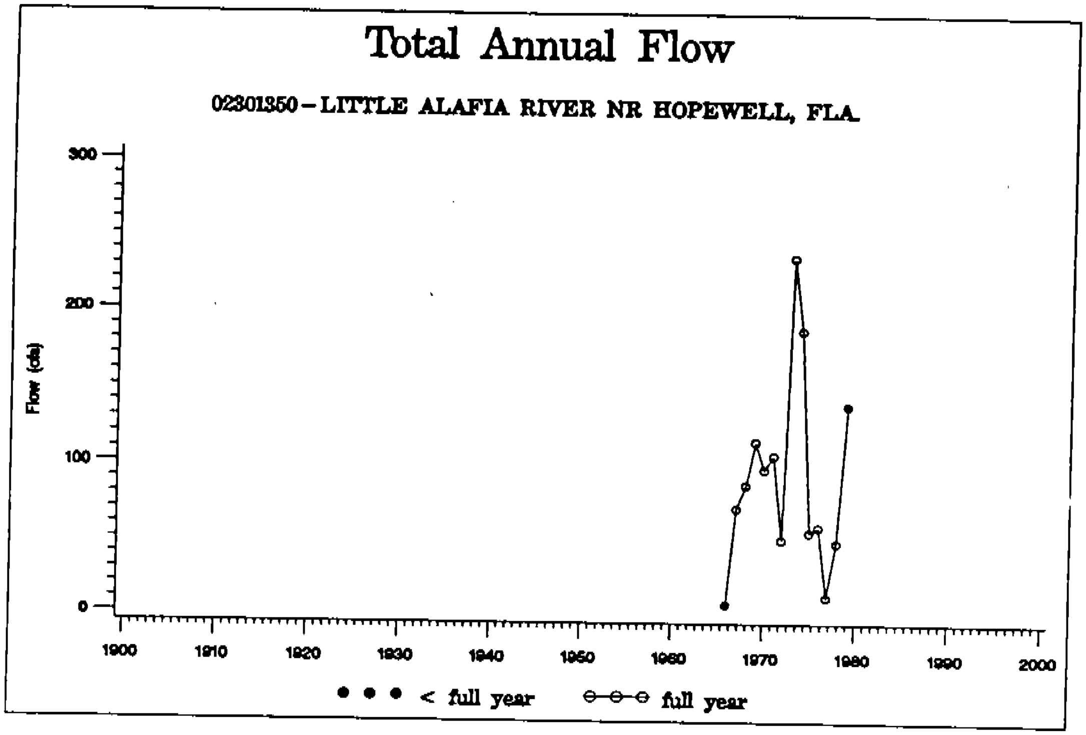

Average Monthly Flow
02300700—BULLFROG CREEK NR WIMAUMA, FLA.
Flow (cfs)
100
90
80
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

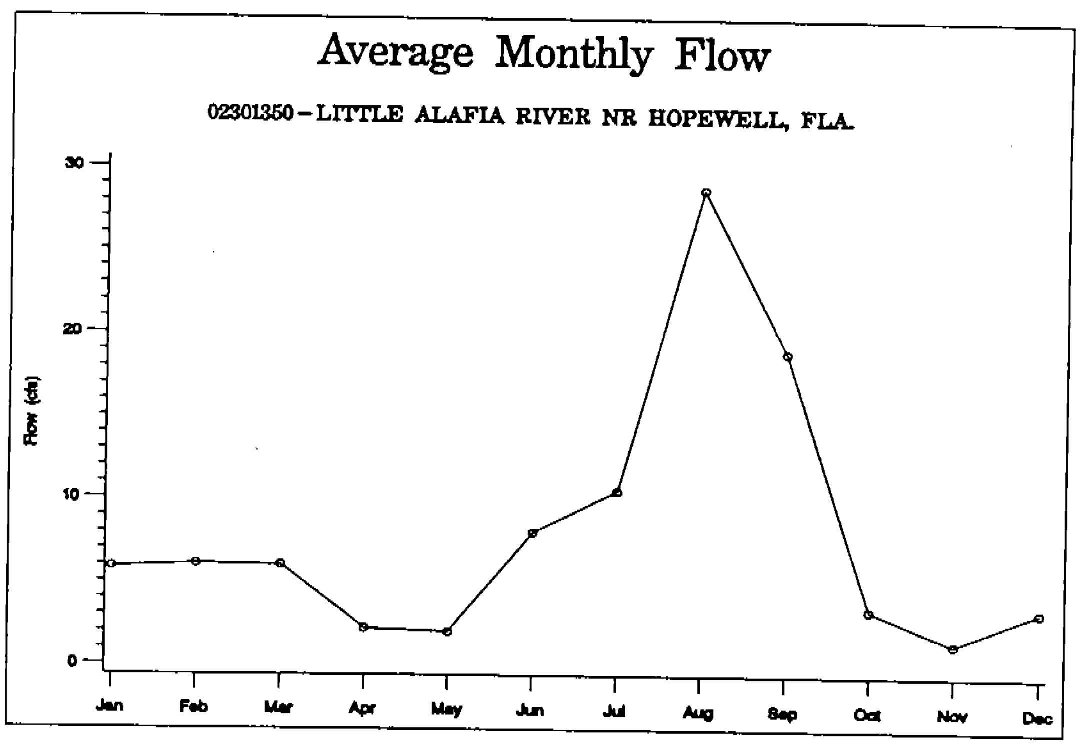

Total Annual Flow
02301000 - NORTH PRONG ALAFIA RIVER AT KEYSVILLE, FLA.
Flow (cfs)
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

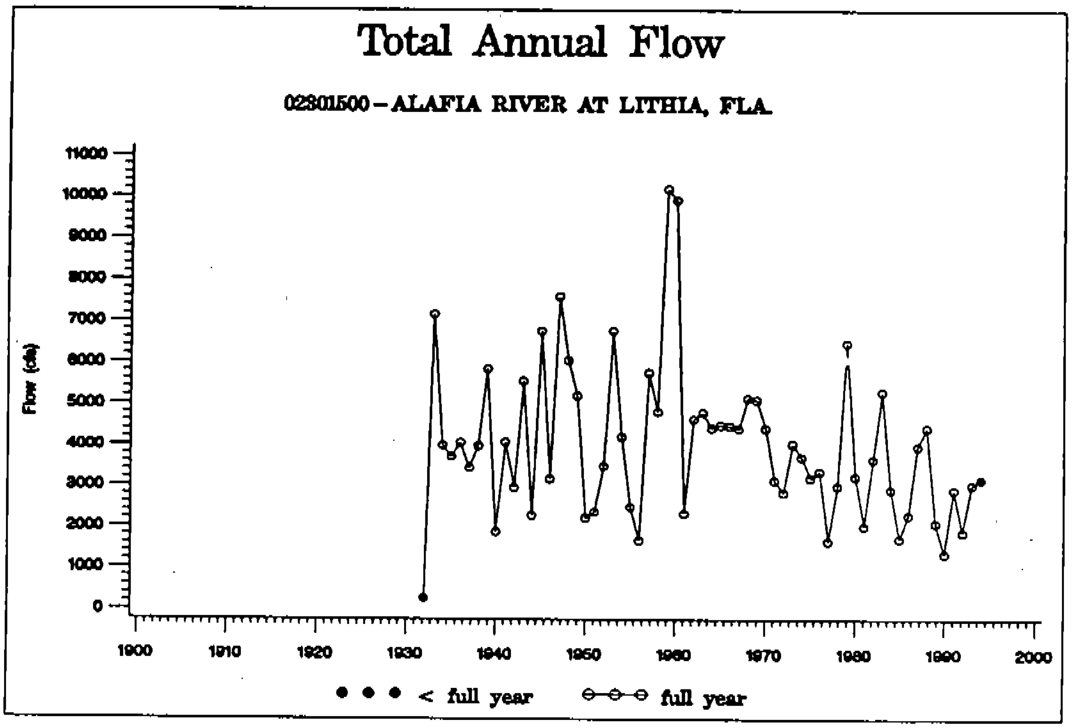

Average Monthly Flow
02301000 - NORTH PRONG ALAFIA RIVER AT KEYSVILLE, FLA.
Flow (cfs)
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02301300 - SOUTH PRONG ALAFIA RIVER NR LITHIA, FLA.
Flow (cfs)
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

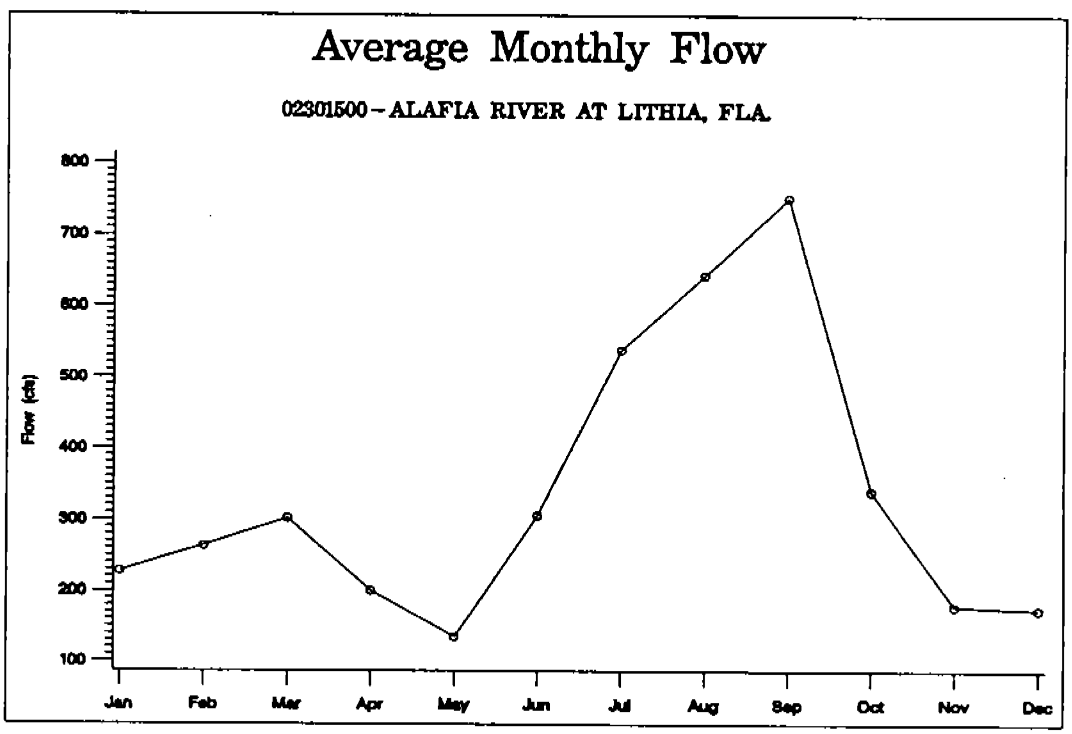

Average Monthly Flow
02301300 - SOUTH PRONG ALAFIA RIVER NR LITHIA, FLA.
Flow (cfs)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02301350 - LITTLE ALAFIA RIVER NR HOPEWELL, FLA.
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

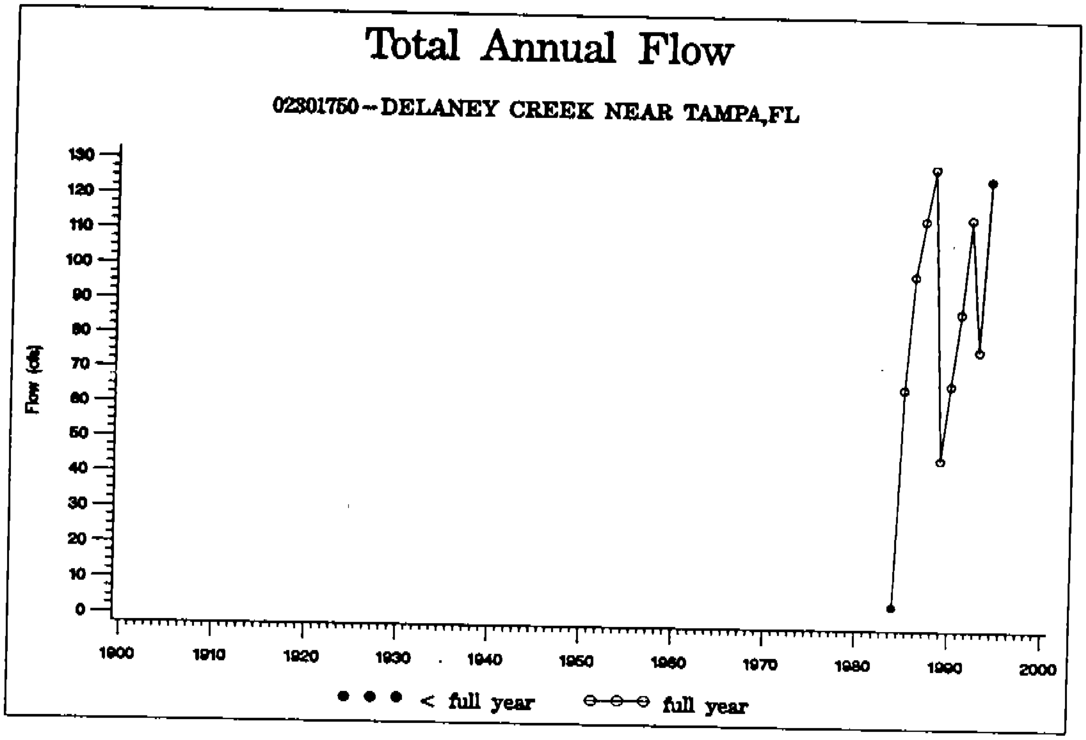

Average Monthly Flow
02301350 - LITTLE ALAFIA RIVER NR HOPEWELL, FLA.
Flow (cfs)
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

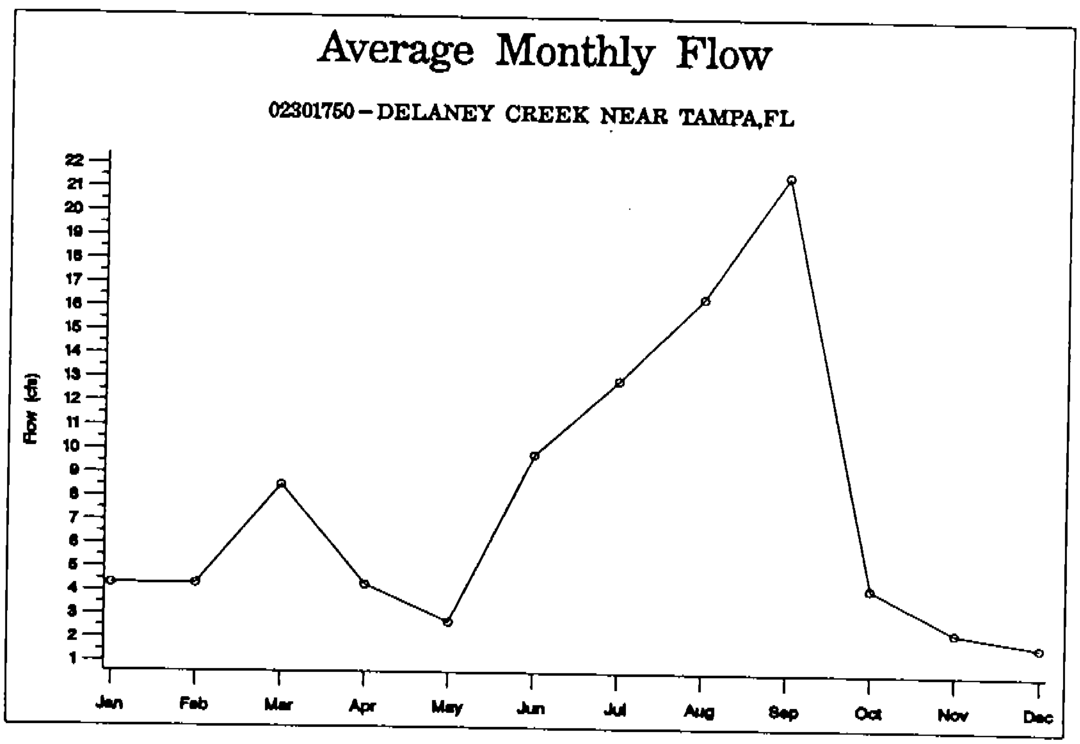


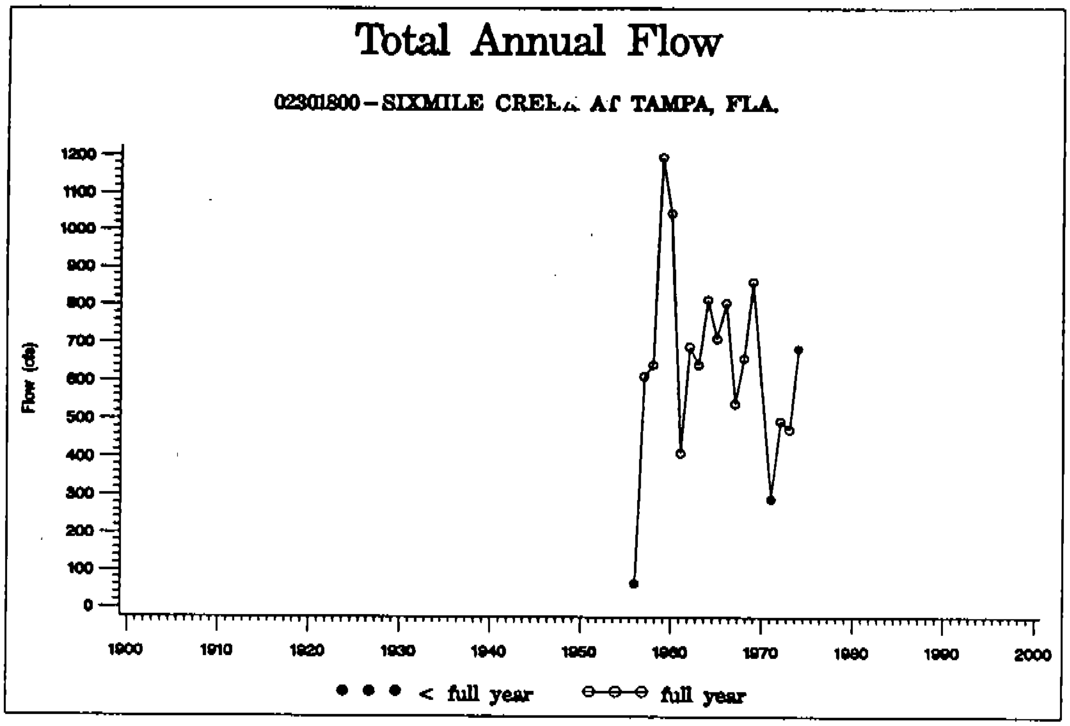
Total Annual Flow
02301500 - ALAFIA RIVER AT LITHIA, FLA.
Flow (cfs)
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



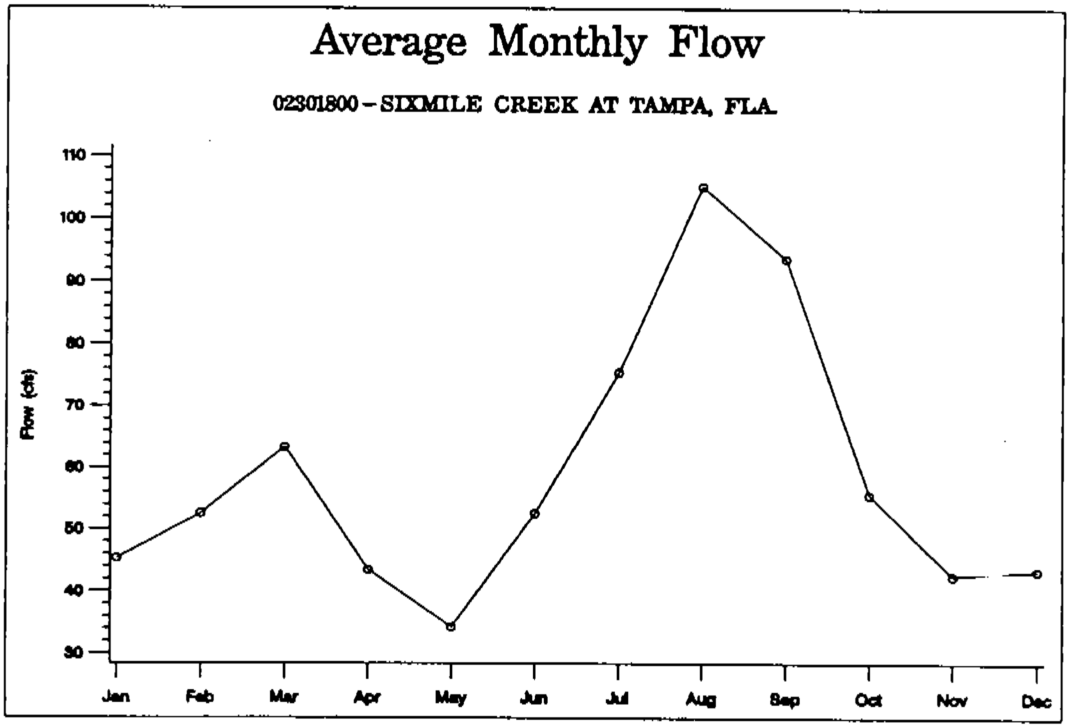
Average Monthly Flow
02301500 - ALAFIA RIVER AT LITHIA, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02301750 – DELANEY CREEK NEAR TAMPA,FL
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

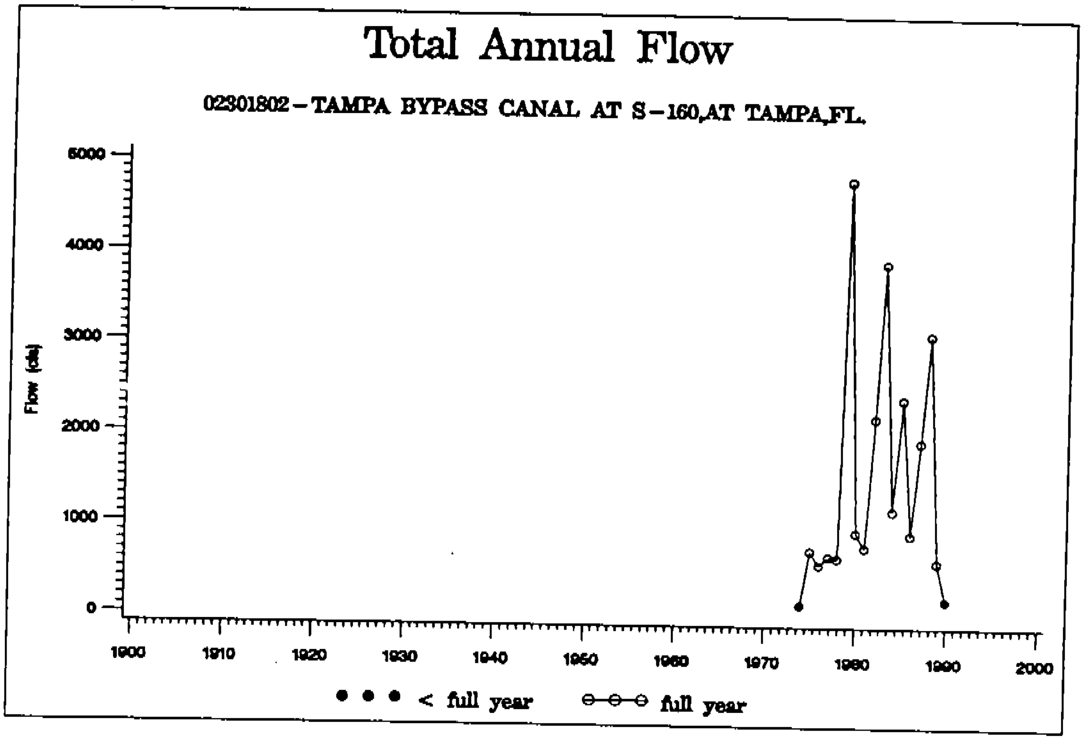

Average Monthly Flow
02301750 – DELANEY CREEK NEAR TAMPA,FL
Flow (cfs)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

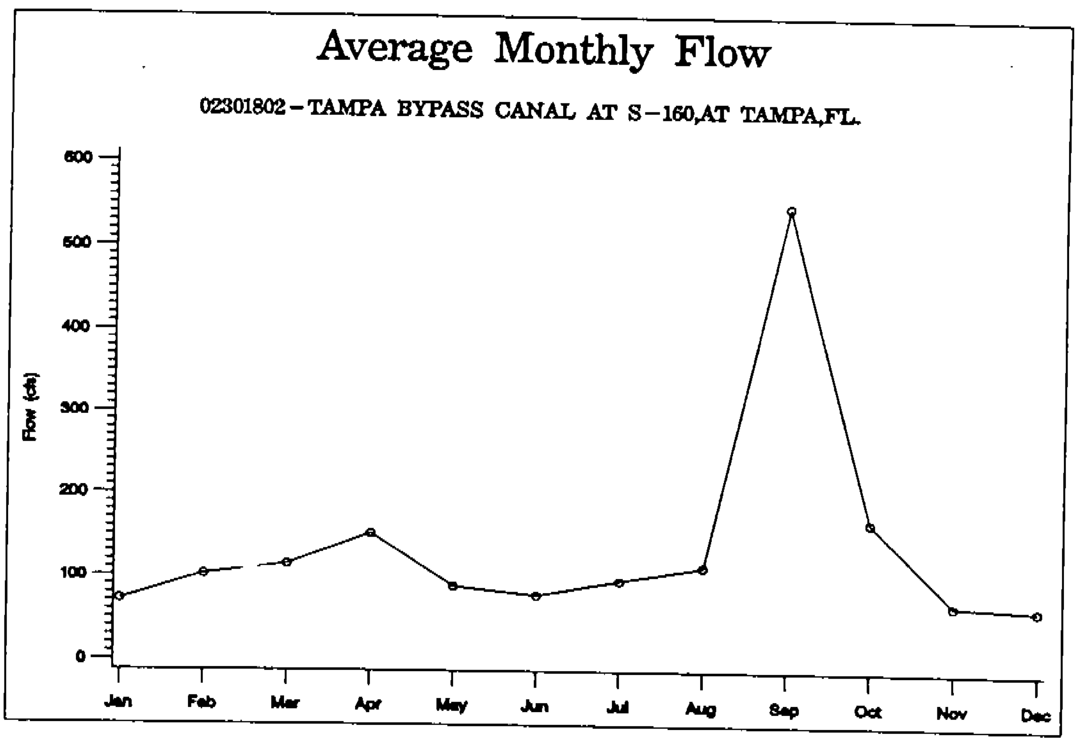


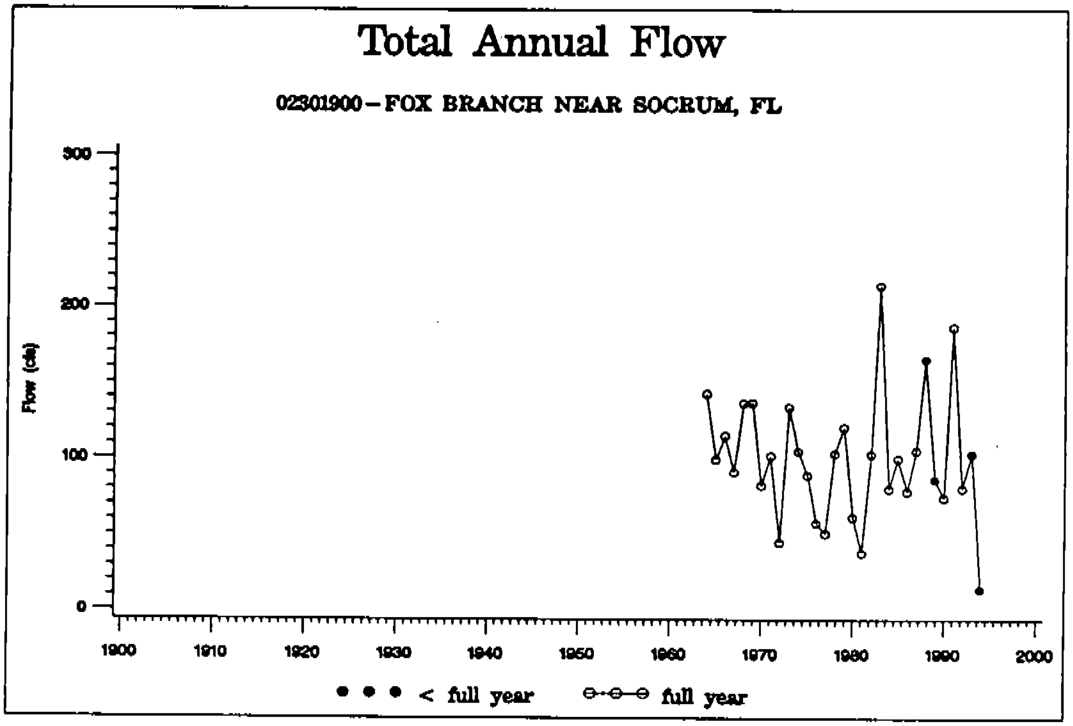
Total Annual Flow
02301800 - SIXMILE CREEK AT TAMPA, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖-⊖-⊖ full year

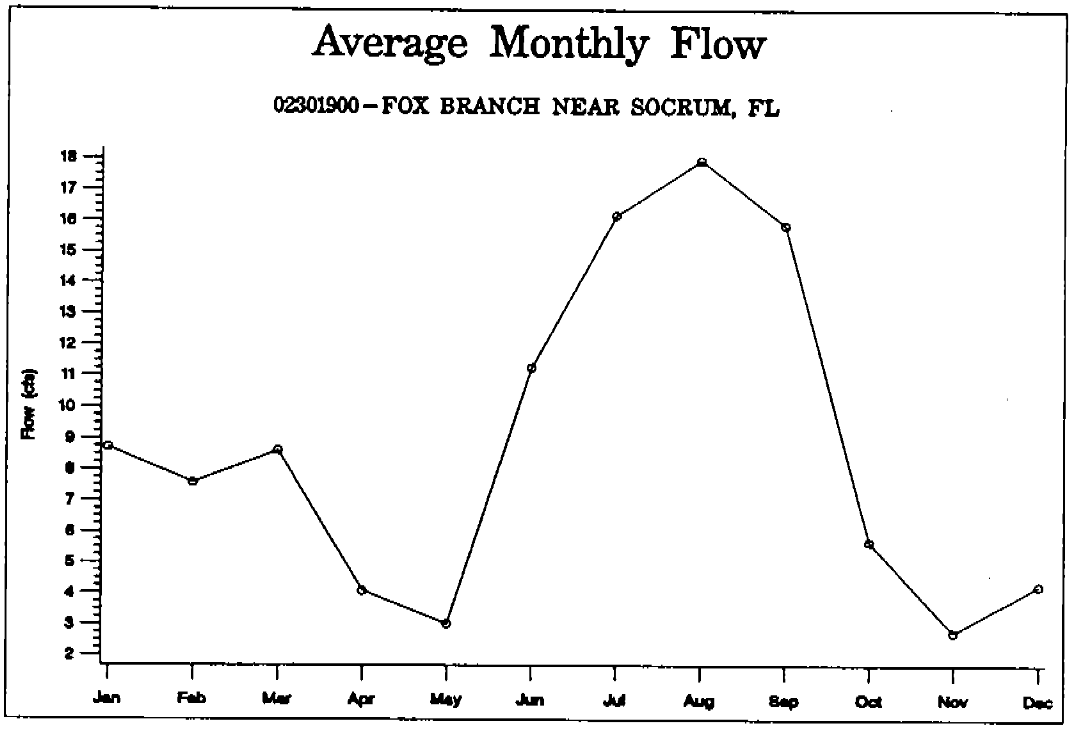


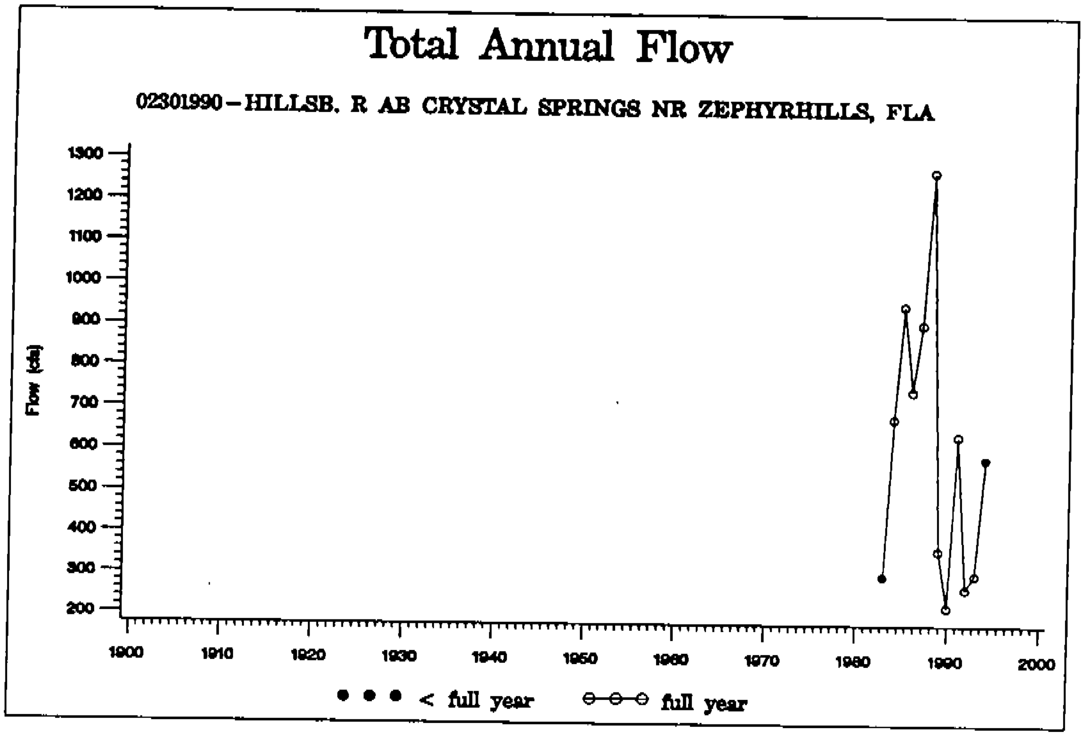
Average Monthly Flow
02301800 - SIXMILE CREEK AT TAMPA, FLA.
Flow (cfs)
30
40
50
60
70
80
90
100
110
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

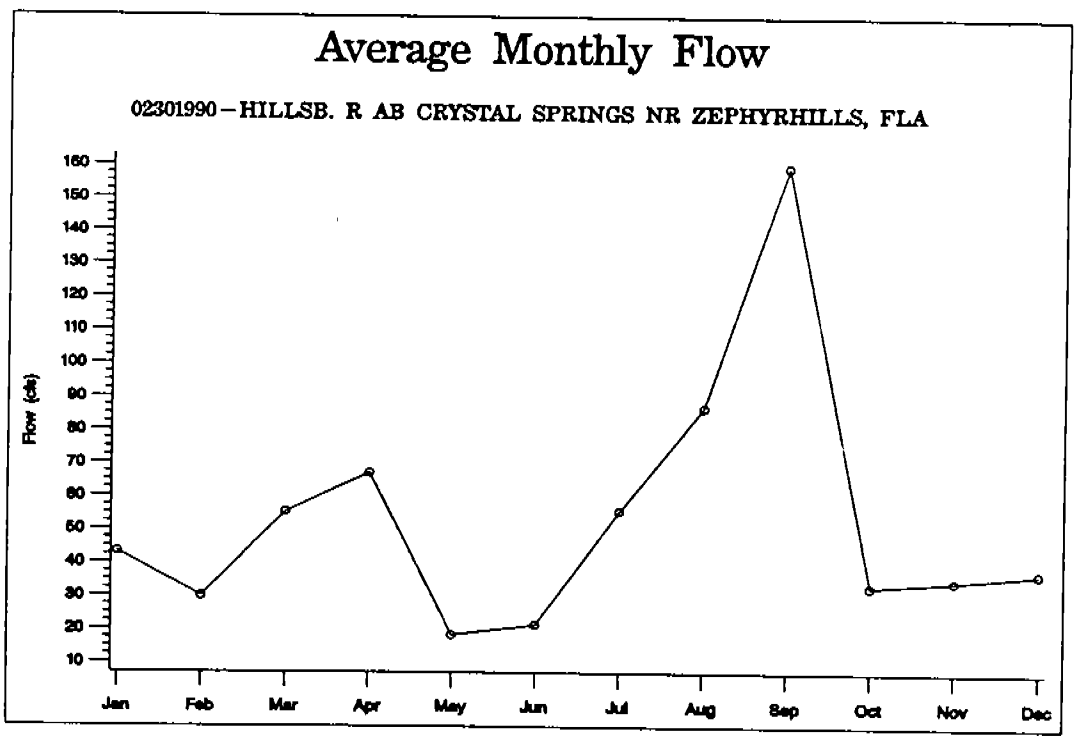

Total Annual Flow
02301802 - TAMPA BYPASS CANAL AT S-160,AT TAMPA,FL.
Flow (cfs)
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

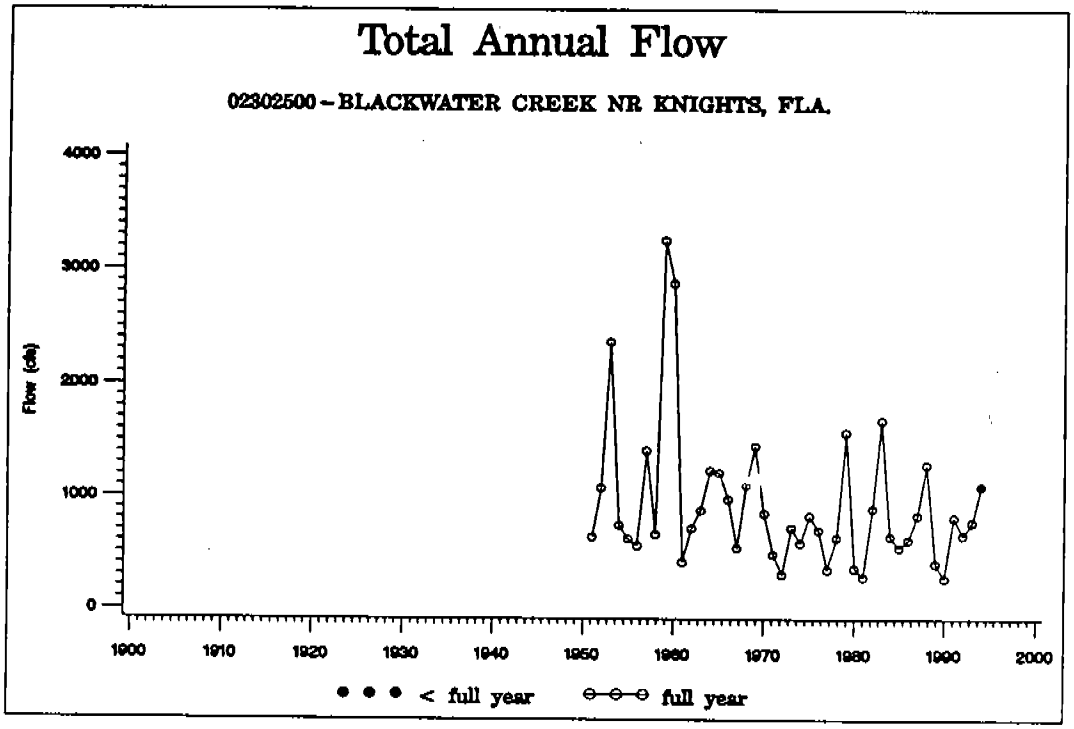

Average Monthly Flow
02301802 - TAMPA BYPASS CANAL AT S-160,AT TAMPA,FL.
Flow (cfs)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

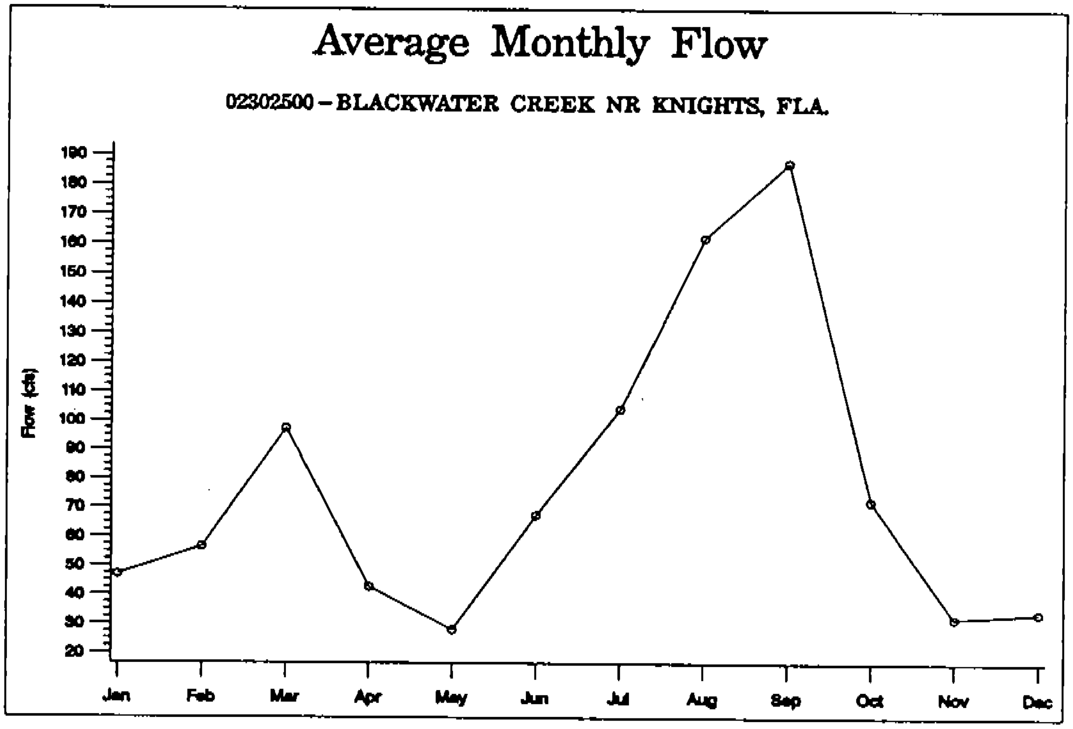

Total Annual Flow
02301900 – FOX BRANCH NEAR SOCRUM, FL
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

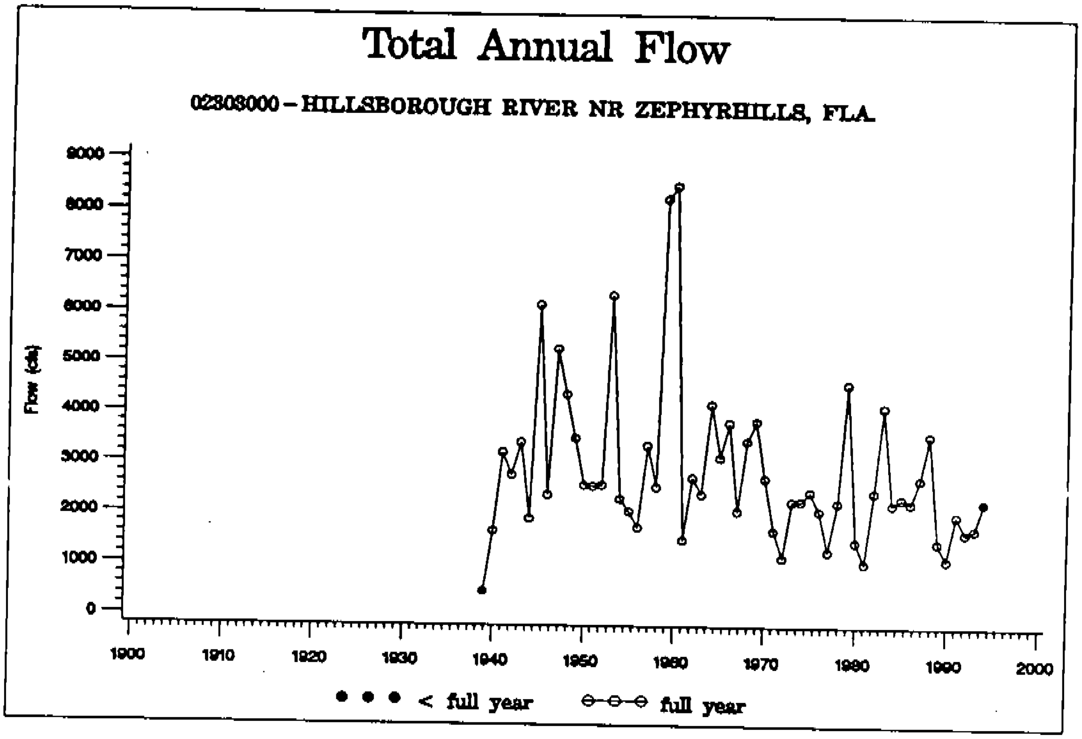

Average Monthly Flow
02301900 – FOX BRANCH NEAR SOCRUM, FL
Flow (cfs)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

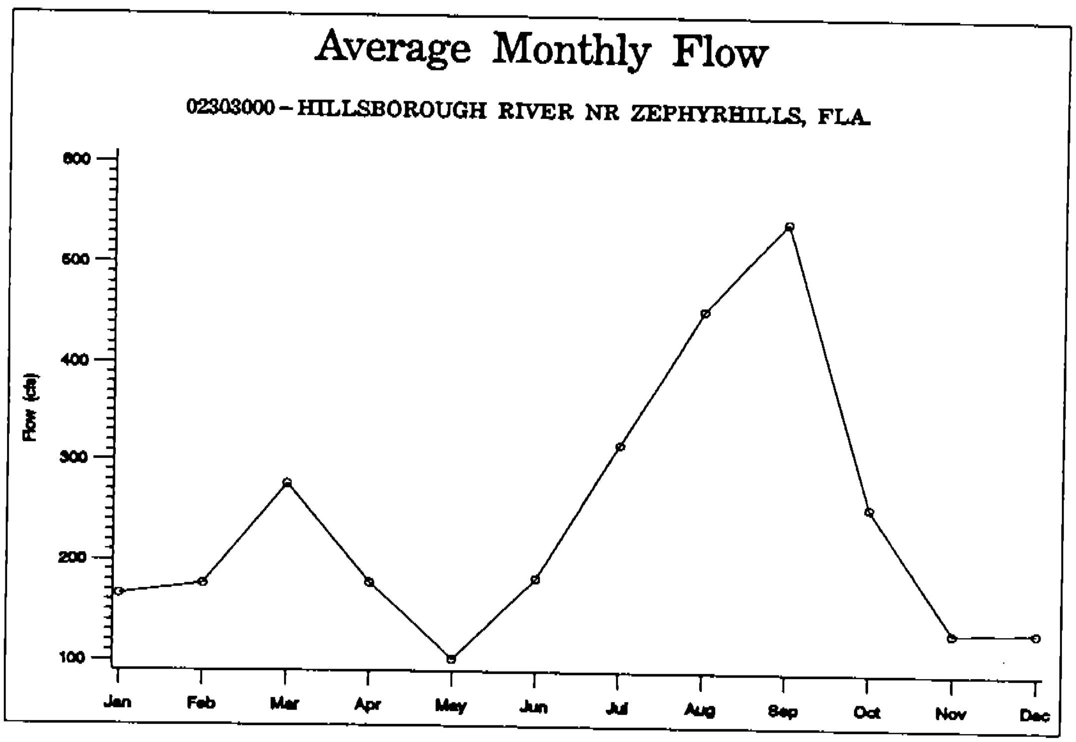

Total Annual Flow
02301990—HILLSB. R AB CRYSTAL SPRINGS NR ZEPHYRHILLS, FLA
Flow (cfs)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

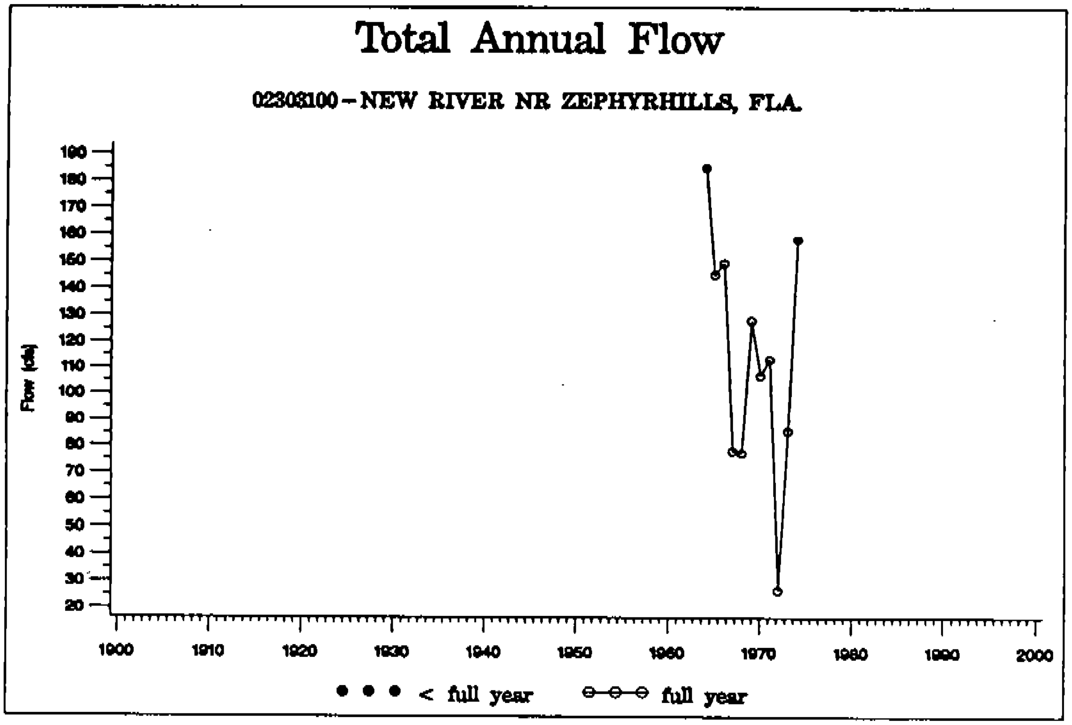

Average Monthly Flow
02301990—HILLSB. R AB CRYSTAL SPRINGS NR ZEPHYRHILLS, FLA
Flow (cfs)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

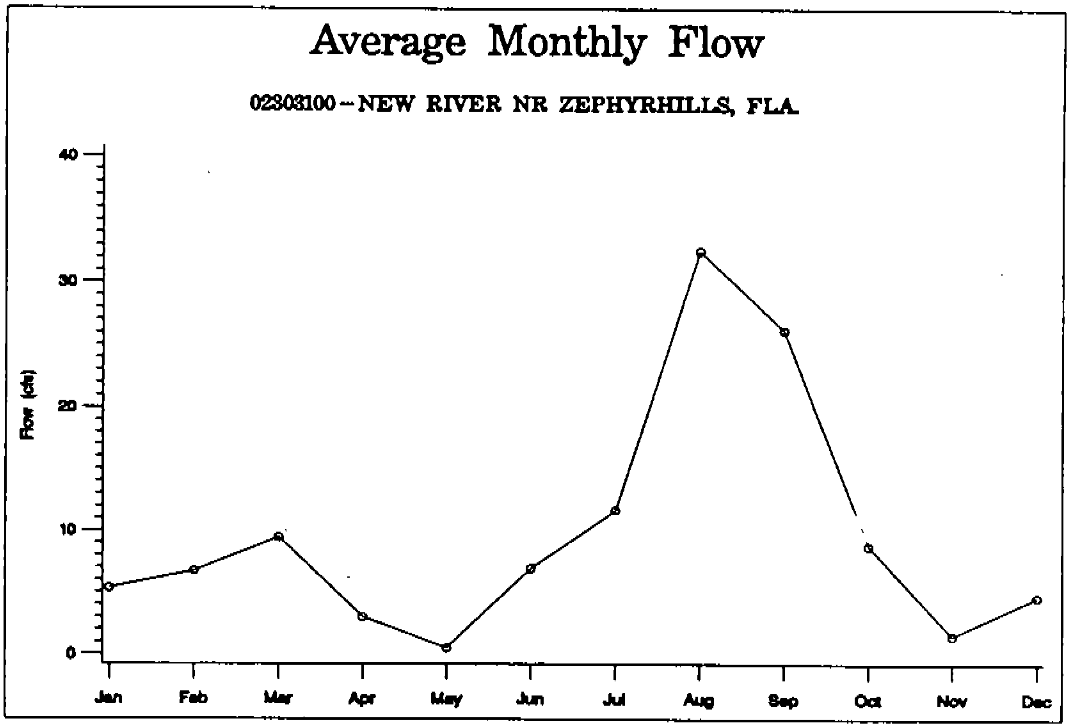

Total Annual Flow
02302500 – BLACKWATER CREEK NR KNIGHTS, FLA.
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖–⊖–⊖ full year

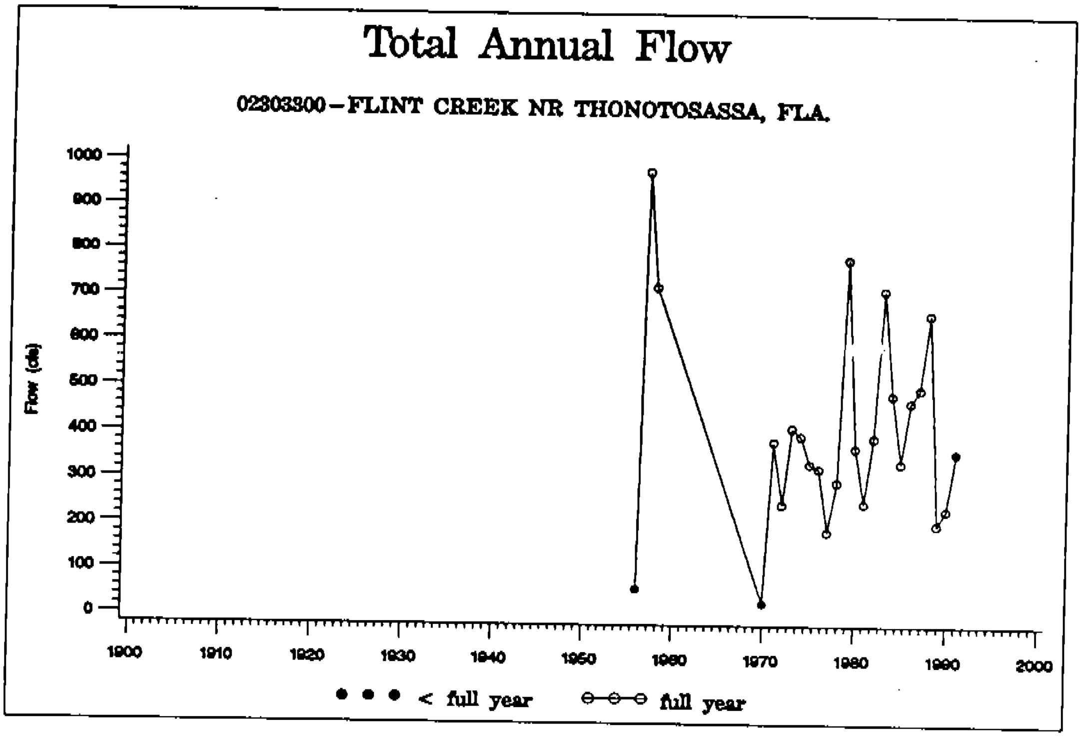

Average Monthly Flow
02302500 – BLACKWATER CREEK NR KNIGHTS, FLA.
Flow (cfs)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

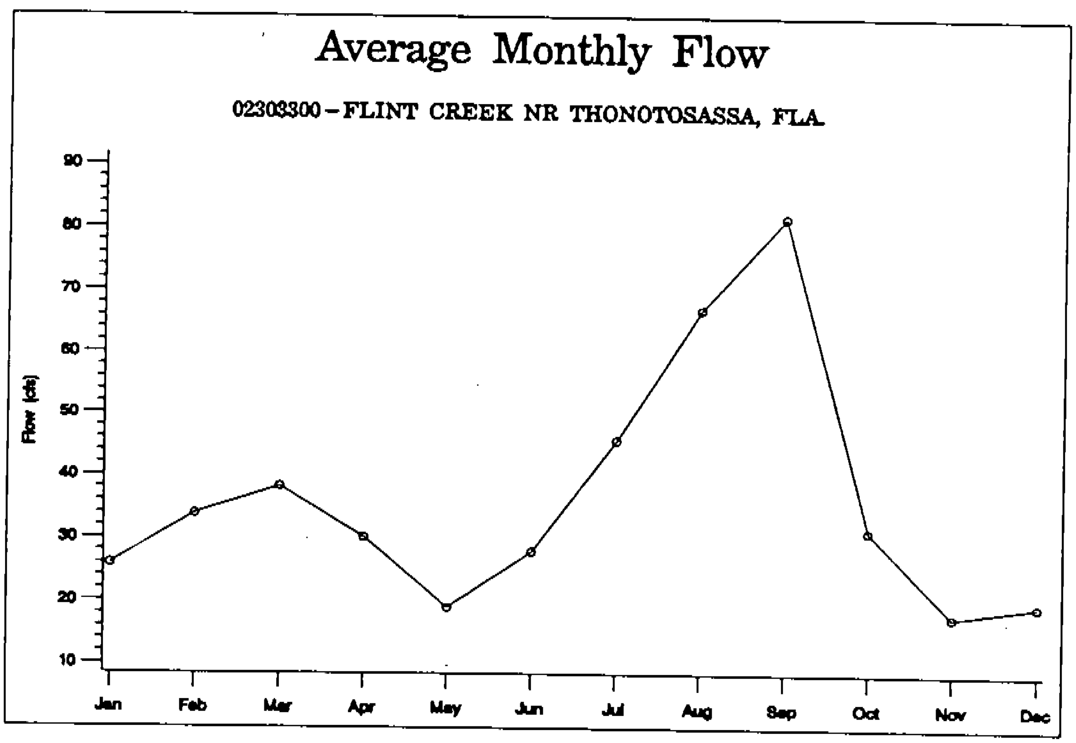

Total Annual Flow
02303000 - HILLSBOROUGH RIVER NR ZEPHYRHILLS, FLA.
Flow (cfs)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

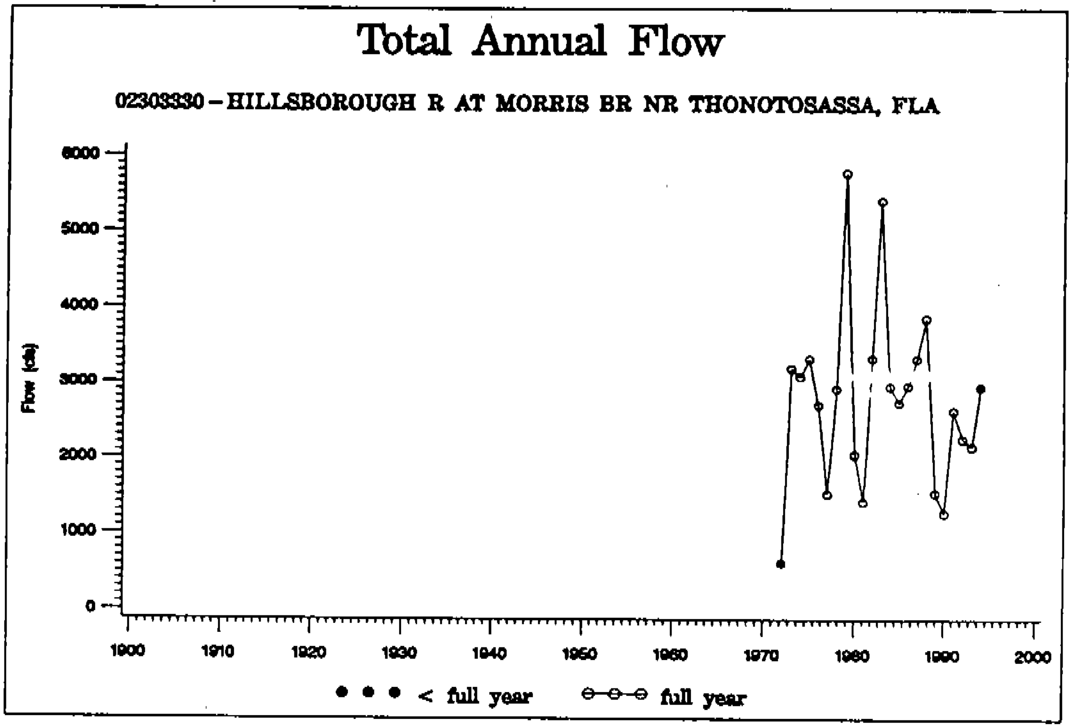

Average Monthly Flow
02303000 - HILLSBOROUGH RIVER NR ZEPHYRHILLS, FLA.
Flow (cfs)
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02303100 – NEW RIVER NR ZEPHYRHILLS, FLA.
Flow (cfs)
• • • < full year
full year

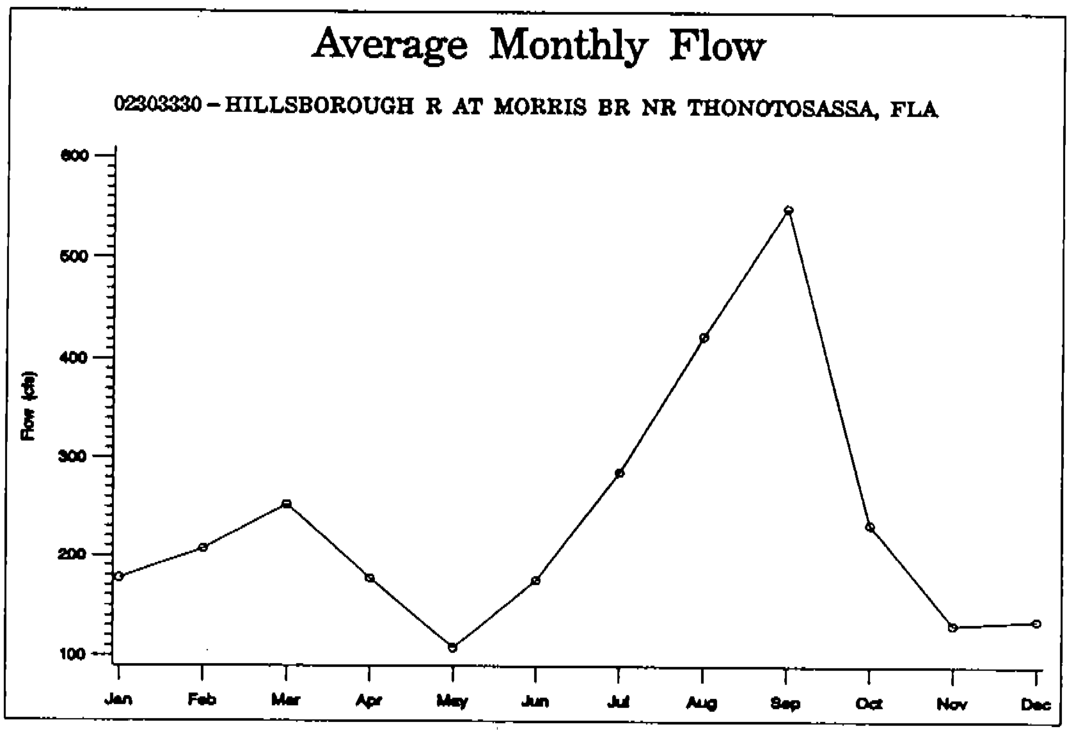

Average Monthly Flow
02303100 – NEW RIVER NR ZEPHYRHILLS, FLA.
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02303300 – FLINT CREEK NR THONOTOSASSA, FLA.
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
● ● ● < full year
⊖—⊖—⊖ full year

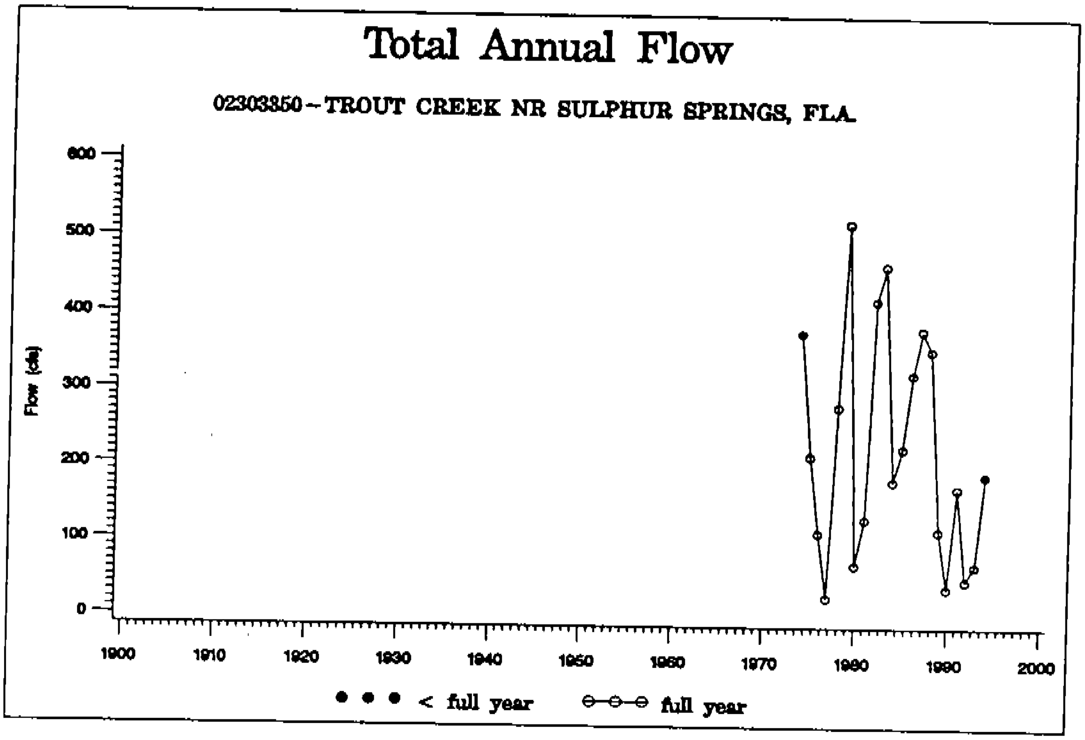

Average Monthly Flow
02303300 – FLINT CREEK NR THONOTOSASSA, FLA.
Flow (cfs)
90
80
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

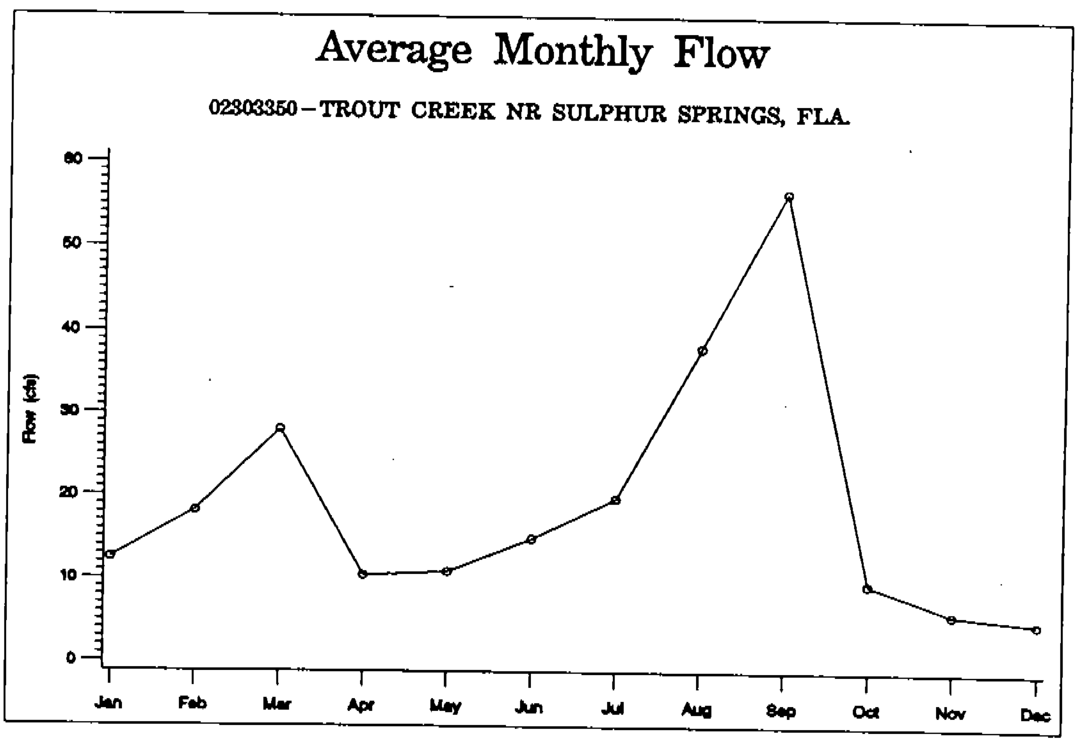


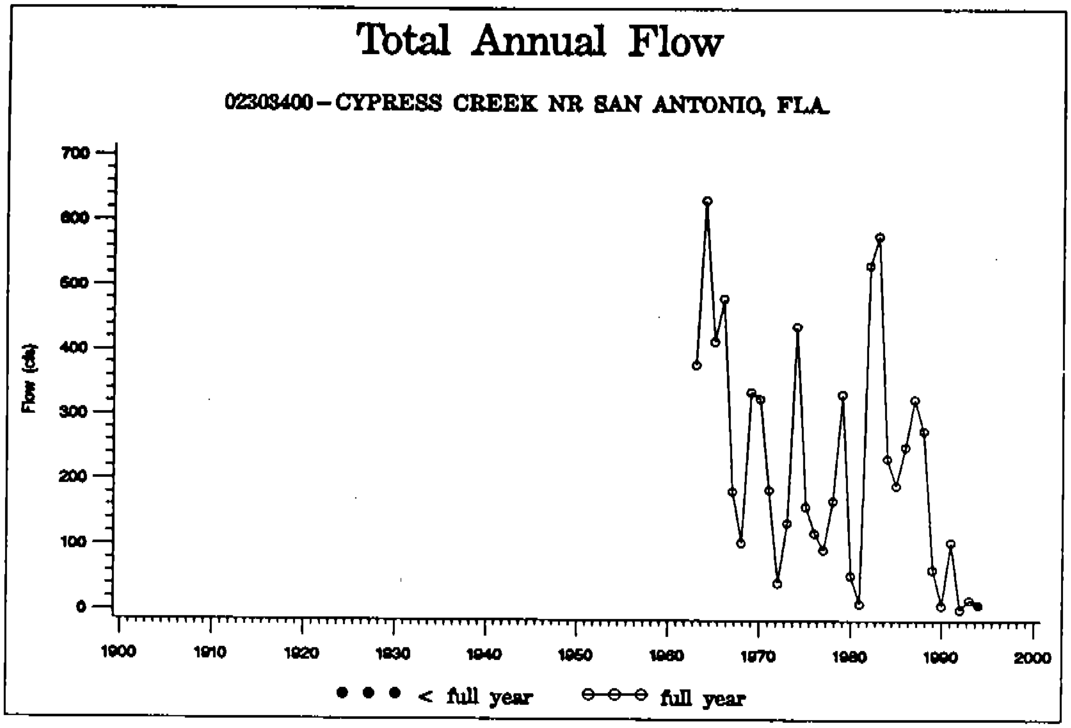
Total Annual Flow
02303330 – HILLSBOROUGH R AT MORRIS BR NR THONOTOSASSA, FLA
Flow (cfs)
0
1000
2000
3000
4000
5000
6000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

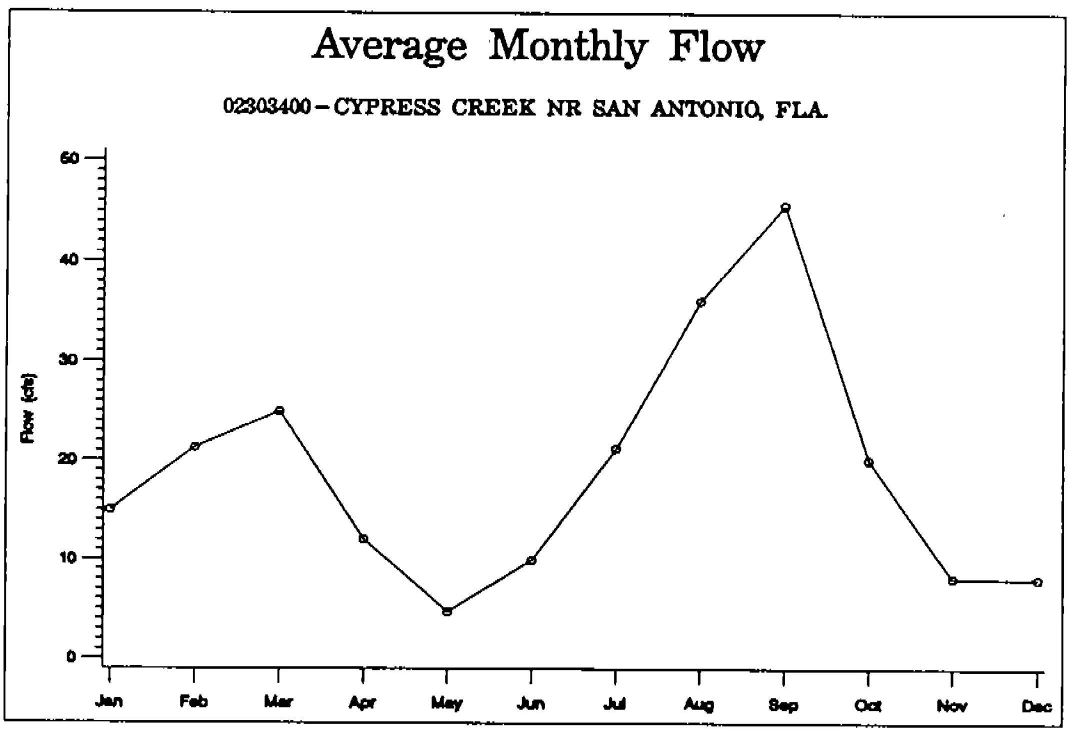


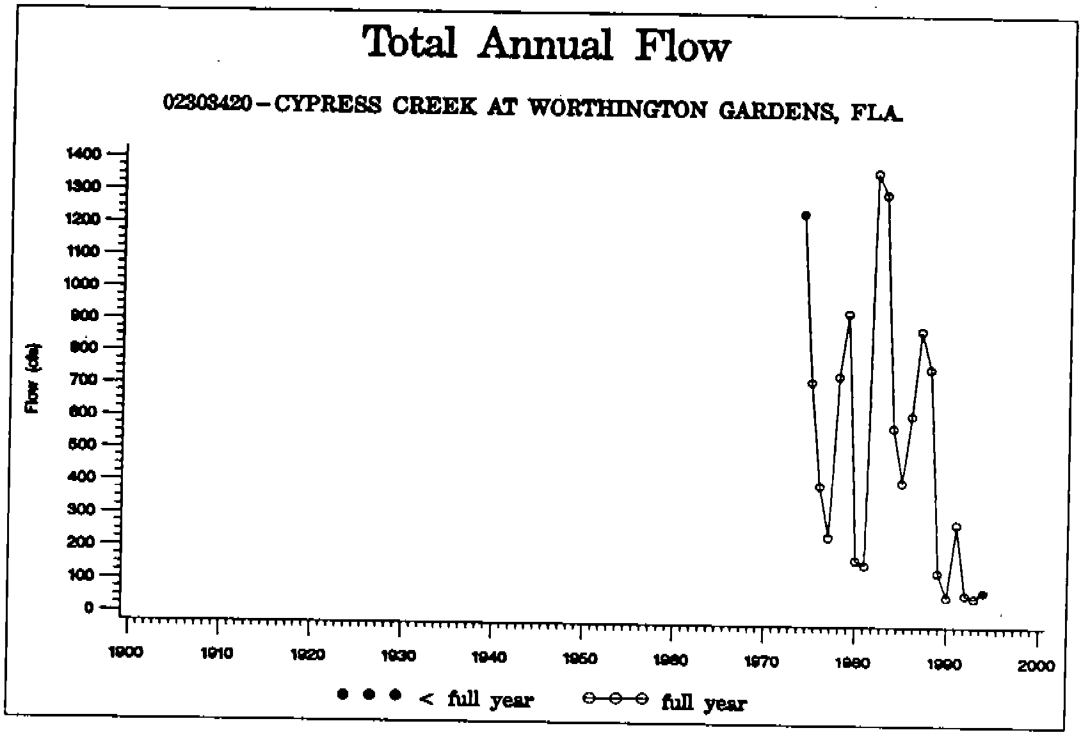
Average Monthly Flow
02303330 – HILLSBOROUGH R AT MORRIS BR NR THONOTOSASSA, FLA
Flow (cfs)
100
200
300
400
500
600
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

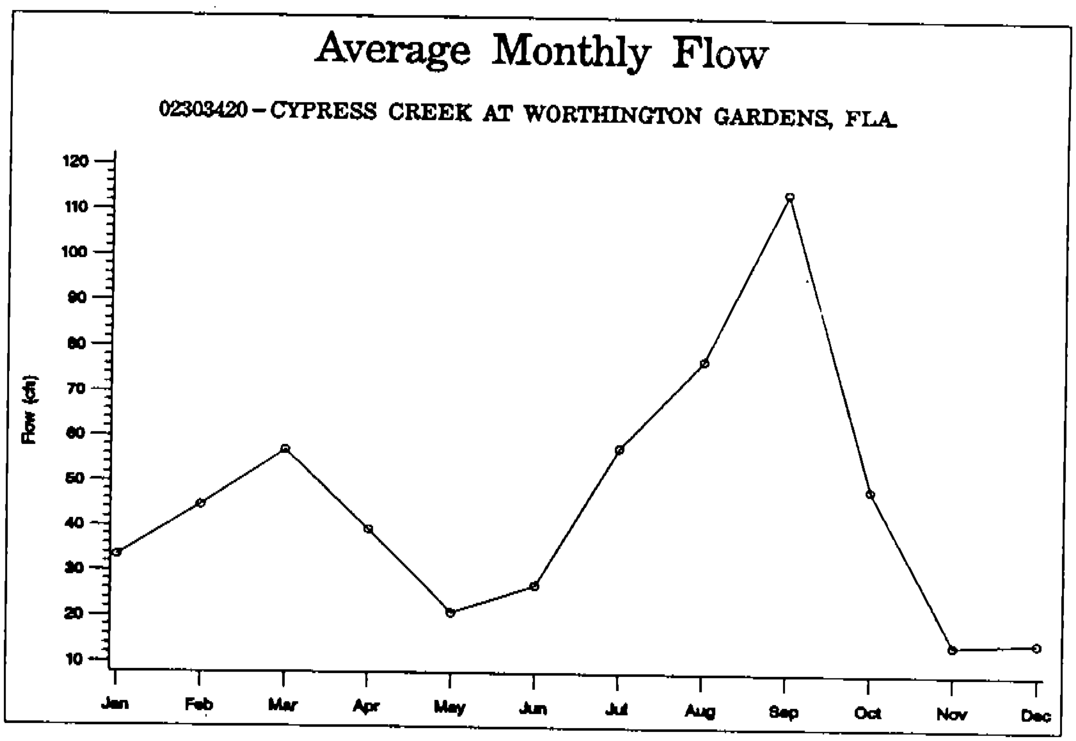

Total Annual Flow
02303350 – TROUT CREEK NR SULPHUR SPRINGS, FLA.
Flow (cfs)
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

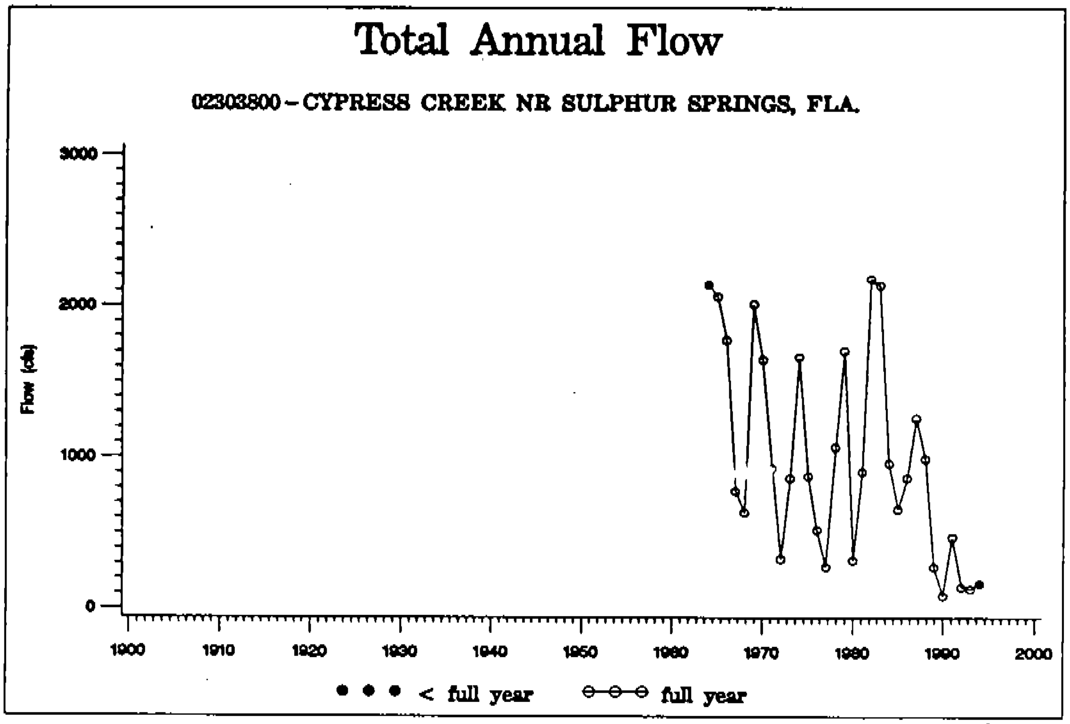

Average Monthly Flow
02303350 – TROUT CREEK NR SULPHUR SPRINGS, FLA.
Flow (cfs)
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

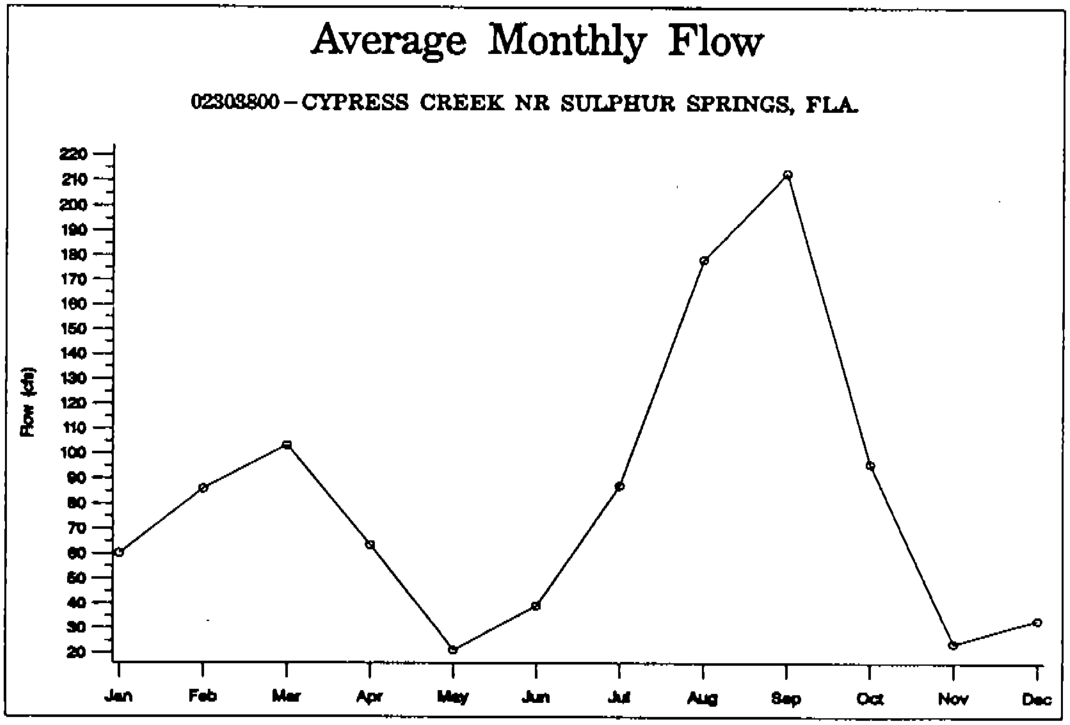

Total Annual Flow
02303400 – CYPRESS CREEK NR SAN ANTONIO, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

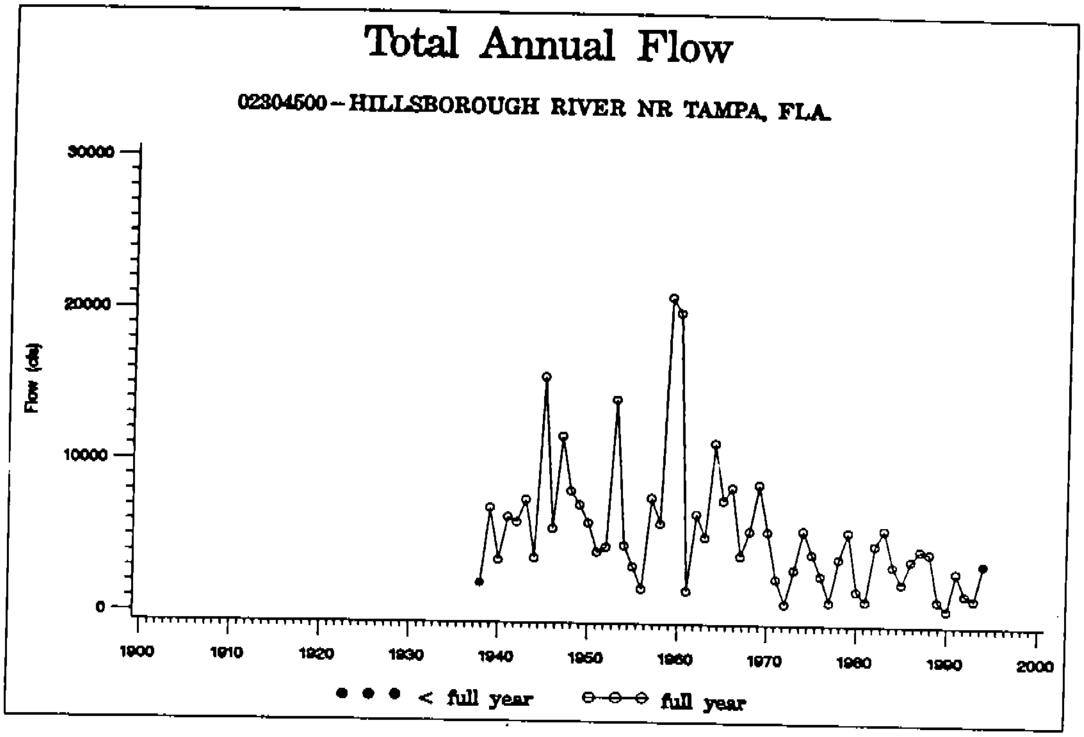

Average Monthly Flow
02303400 – CYPRESS CREEK NR SAN ANTONIO, FLA.
Flow (cfs)
0
10
20
30
40
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

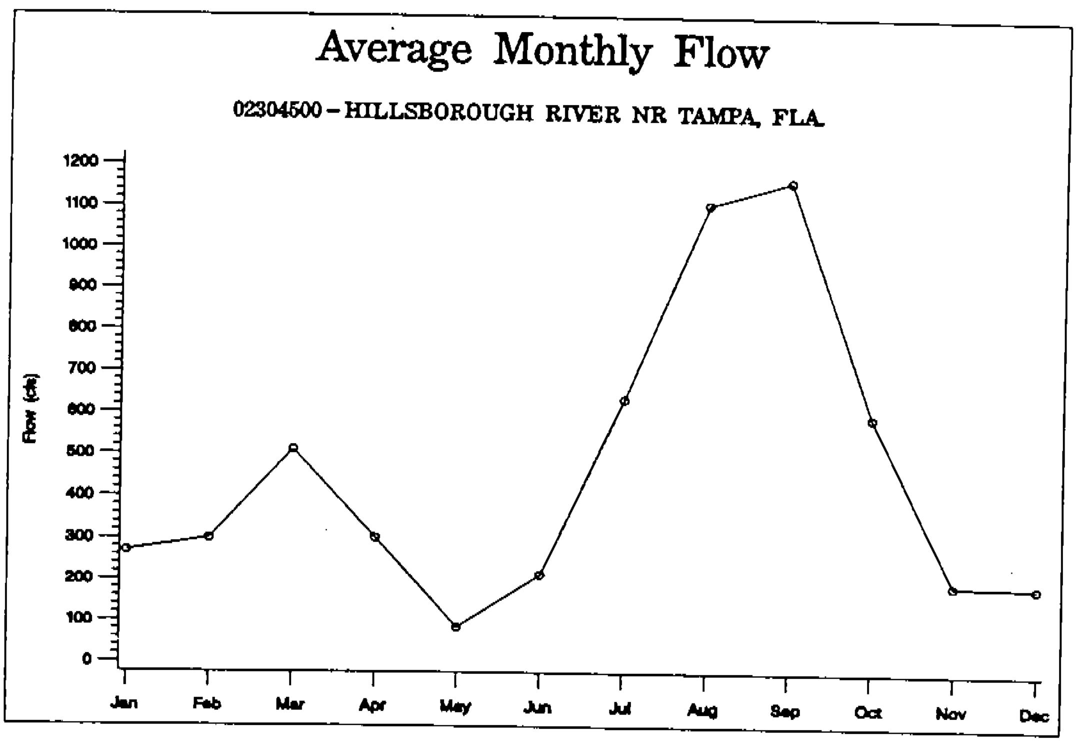

Total Annual Flow
02303420 – CYPRESS CREEK AT WORTHINGTON GARDENS, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

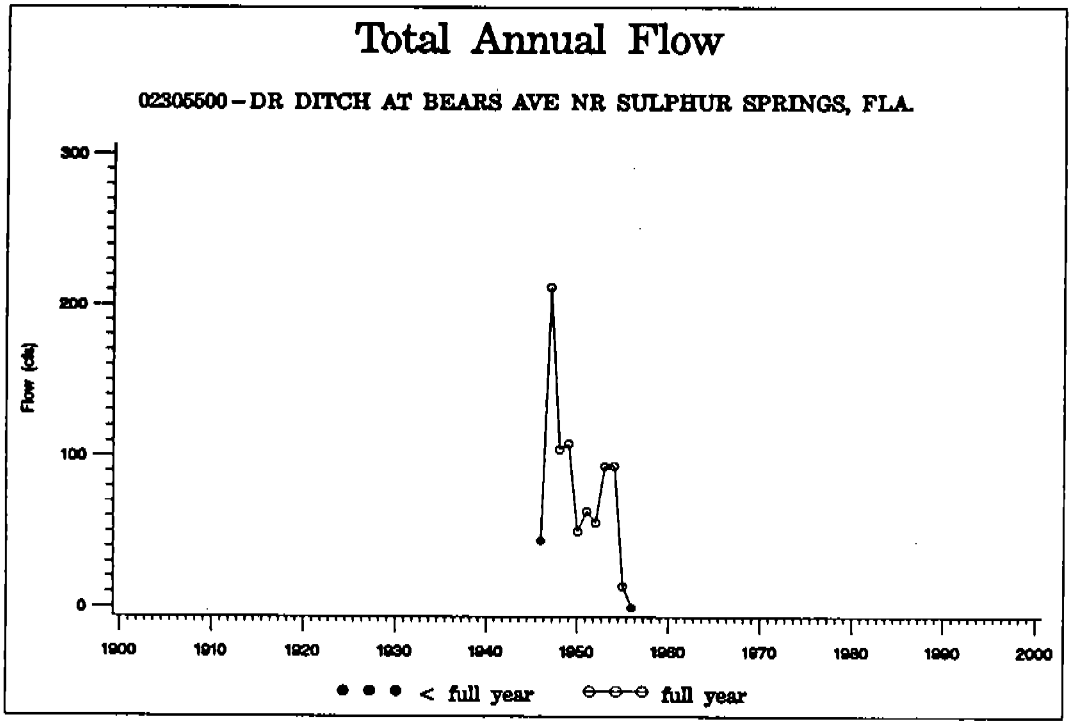

Average Monthly Flow
02303420 – CYPRESS CREEK AT WORTHINGTON GARDENS, FLA.
Flow (cfs)
10
20
30
40
50
60
70
80
90
100
110
120
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

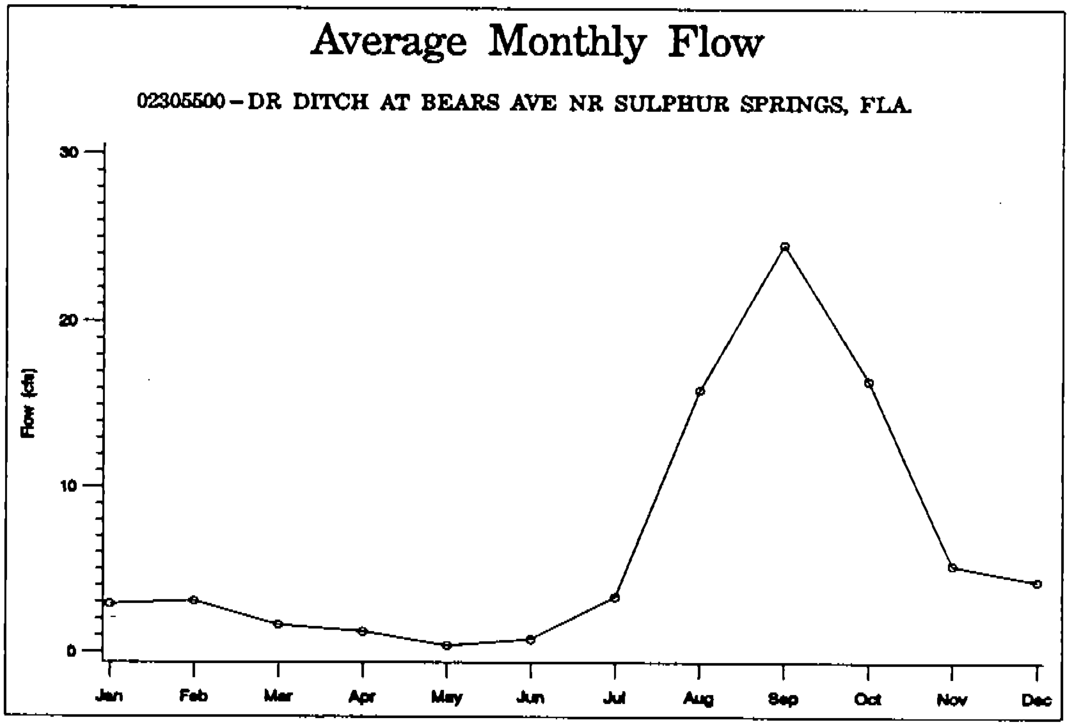

Total Annual Flow
02303800 – CYPRESS CREEK NR SULPHUR SPRINGS, FLA.
Flow (cfs)
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

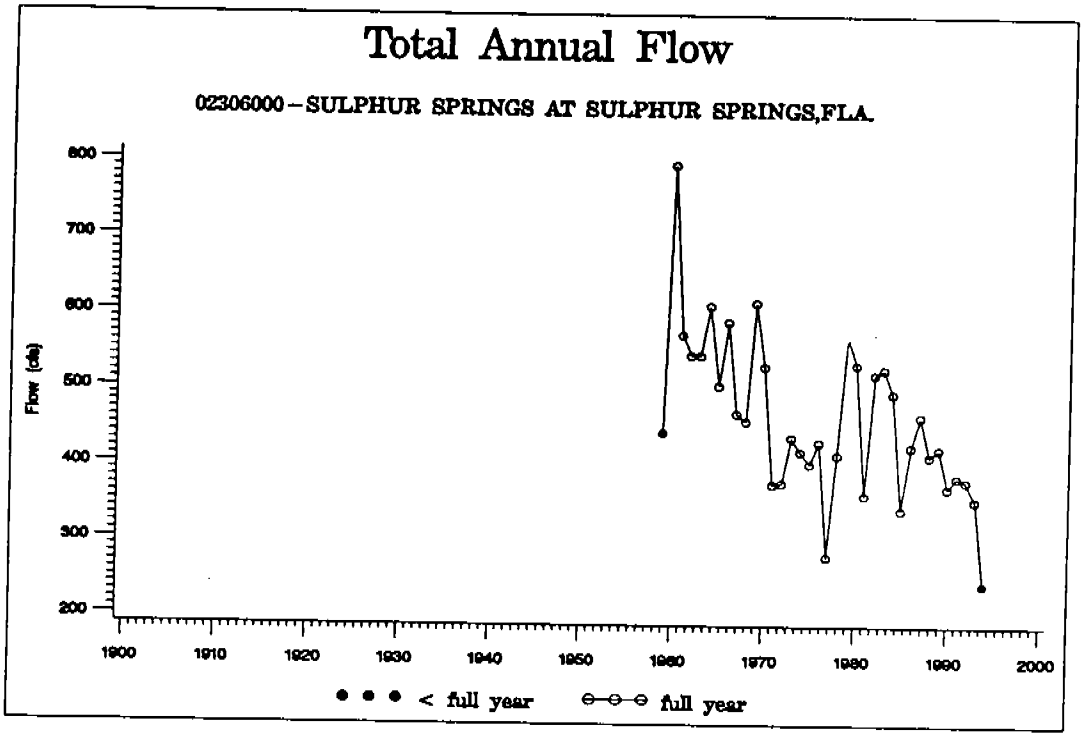

Average Monthly Flow
02303800 – CYPRESS CREEK NR SULPHUR SPRINGS, FLA.
Flow (cfs)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02304500 – HILLSBOROUGH RIVER NR TAMPA, FLA.
30000
20000
10000
0
Flow (cfs)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

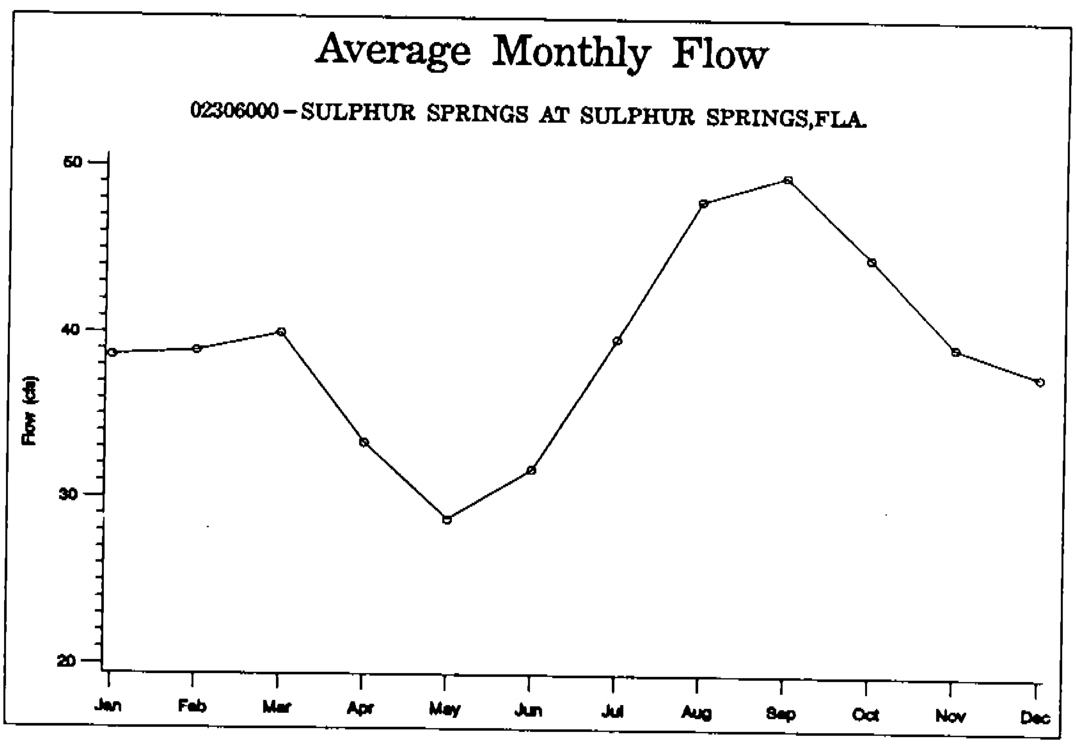

Average Monthly Flow
02304500 – HILLSBOROUGH RIVER NR TAMPA, FLA.
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02305500 - DR DITCH AT BEARS AVE NR SULPHUR SPRINGS, FLA.
Flow (cfs)
0
100
200
300
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

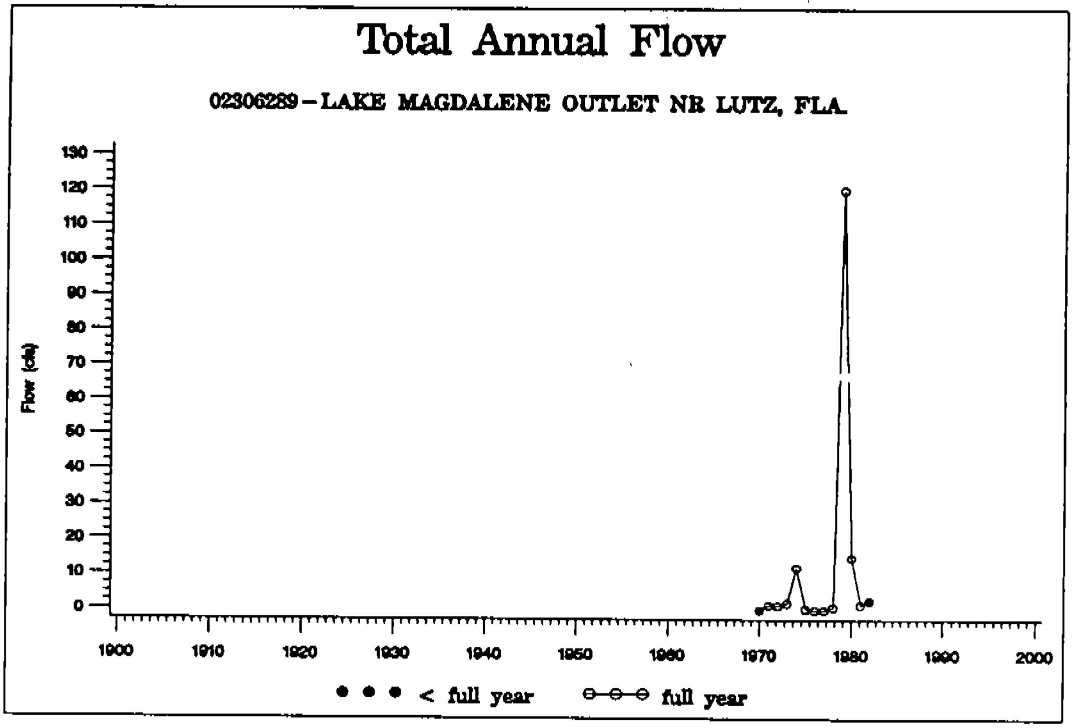

Average Monthly Flow
02305500 - DR DITCH AT BEARS AVE NR SULPHUR SPRINGS, FLA.
Flow (cfs)
0
10
20
30
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

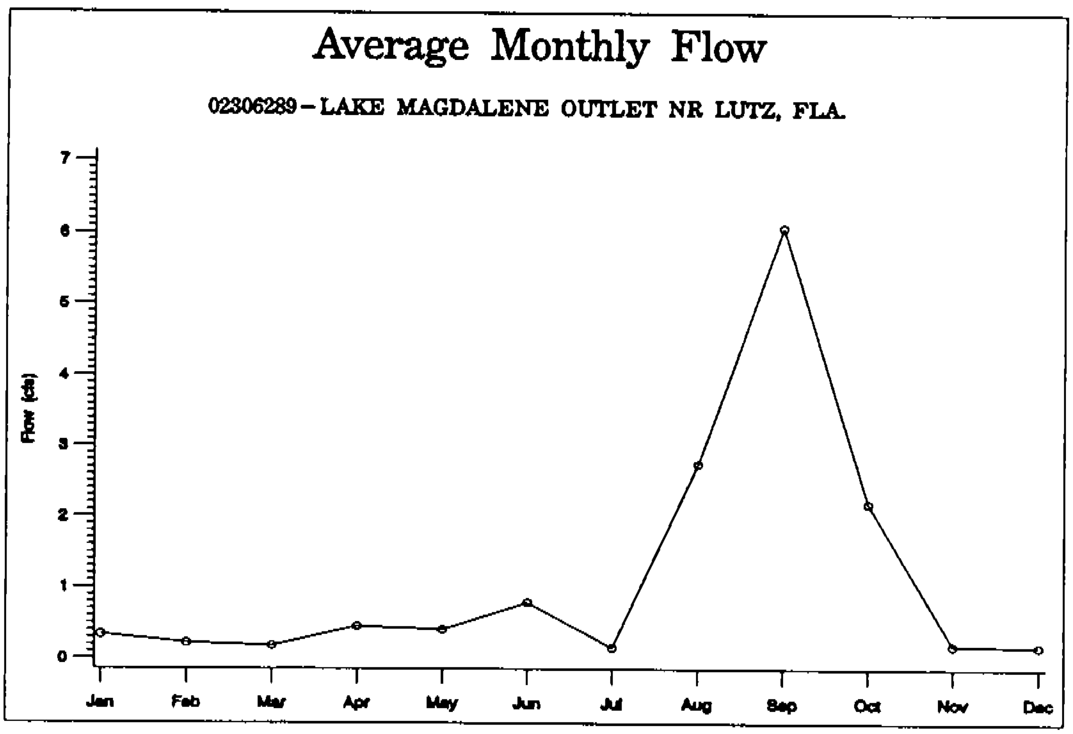


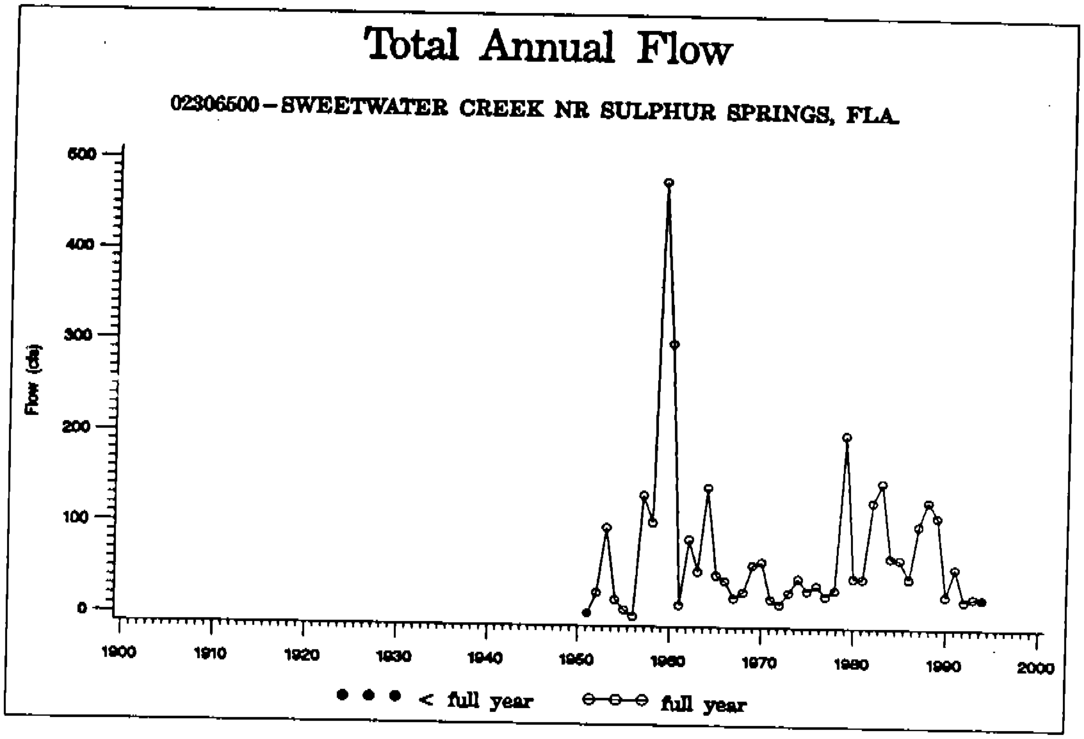
Total Annual Flow
02306000 – SULPHUR SPRINGS AT SULPHUR SPRINGS,FLA.
Flow (cfs)
800
700
600
500
400
300
200
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

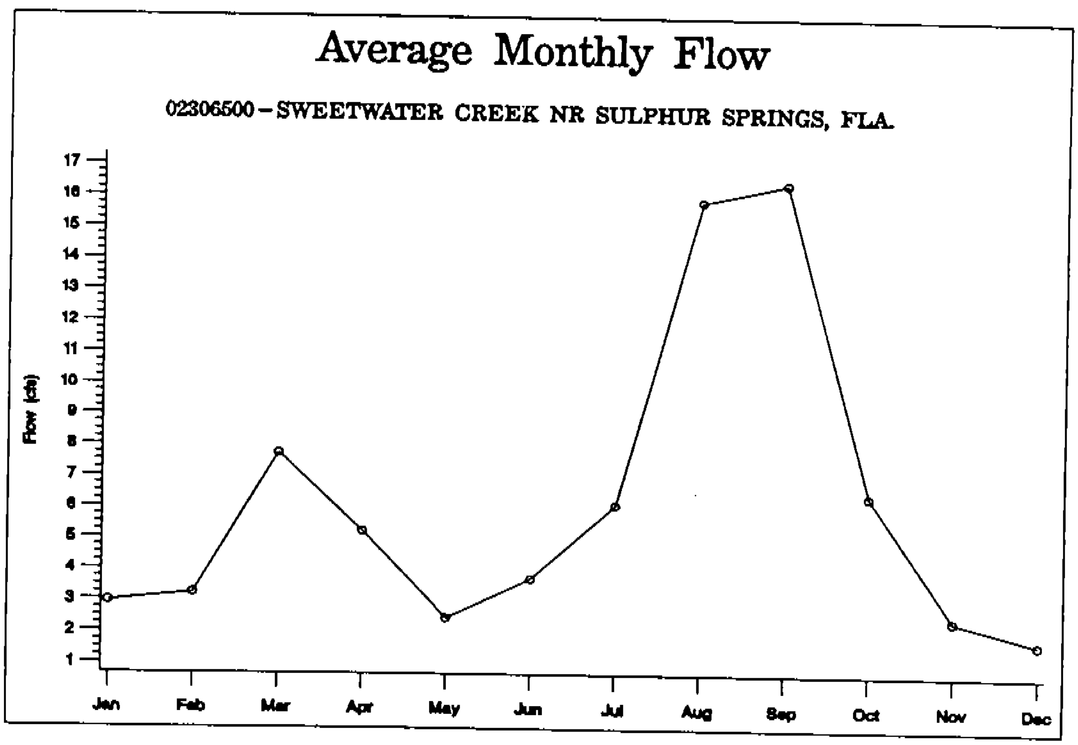


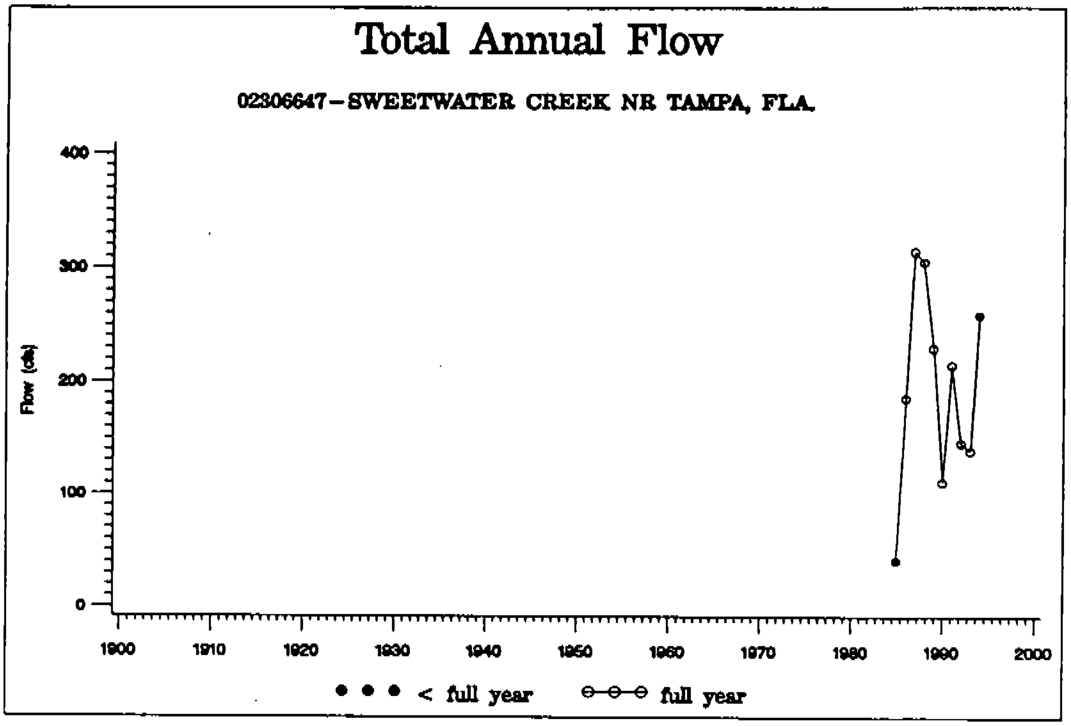
Average Monthly Flow
02306000 – SULPHUR SPRINGS AT SULPHUR SPRINGS,FLA.
Flow (cfs)
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

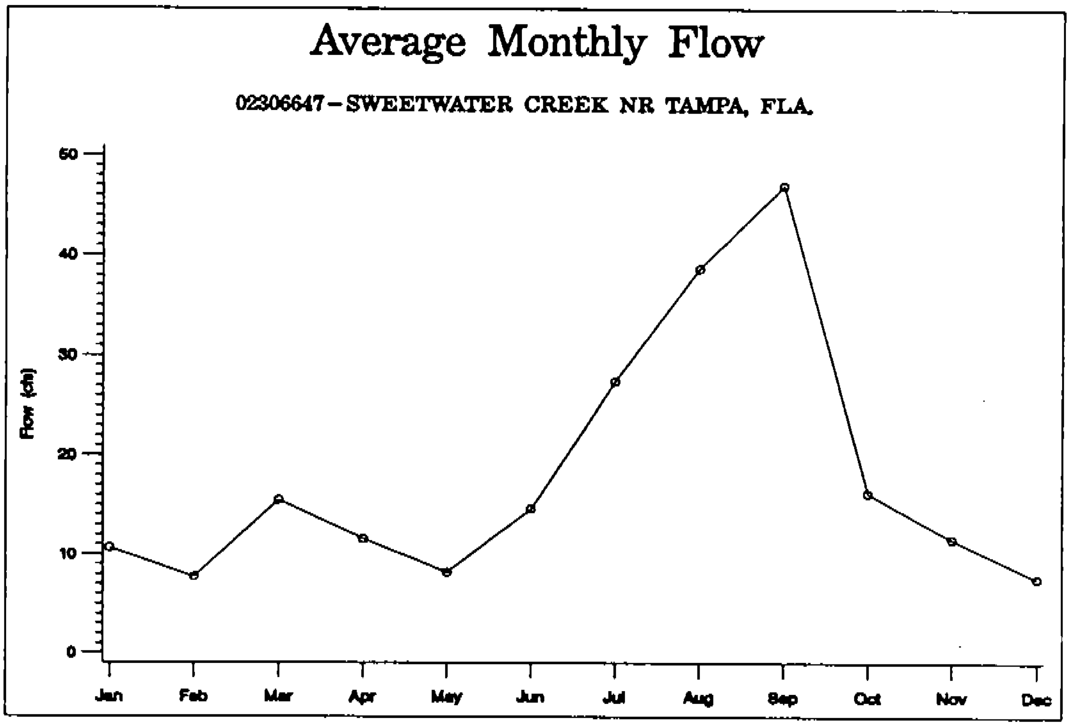

Total Annual Flow
02306289 – LAKE MAGDALENE OUTLET NR LUTZ, FLA.
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

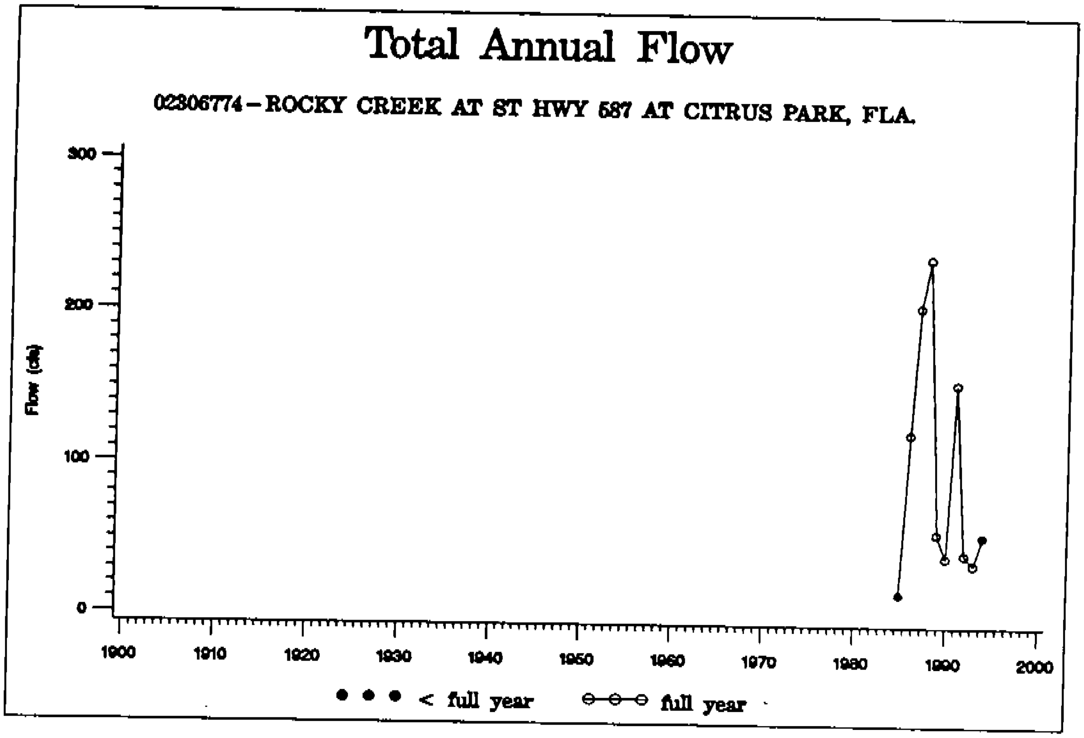

Average Monthly Flow
02306289 – LAKE MAGDALENE OUTLET NR LUTZ, FLA.
Flow (cfs)
0
1
2
3
4
5
6
7
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

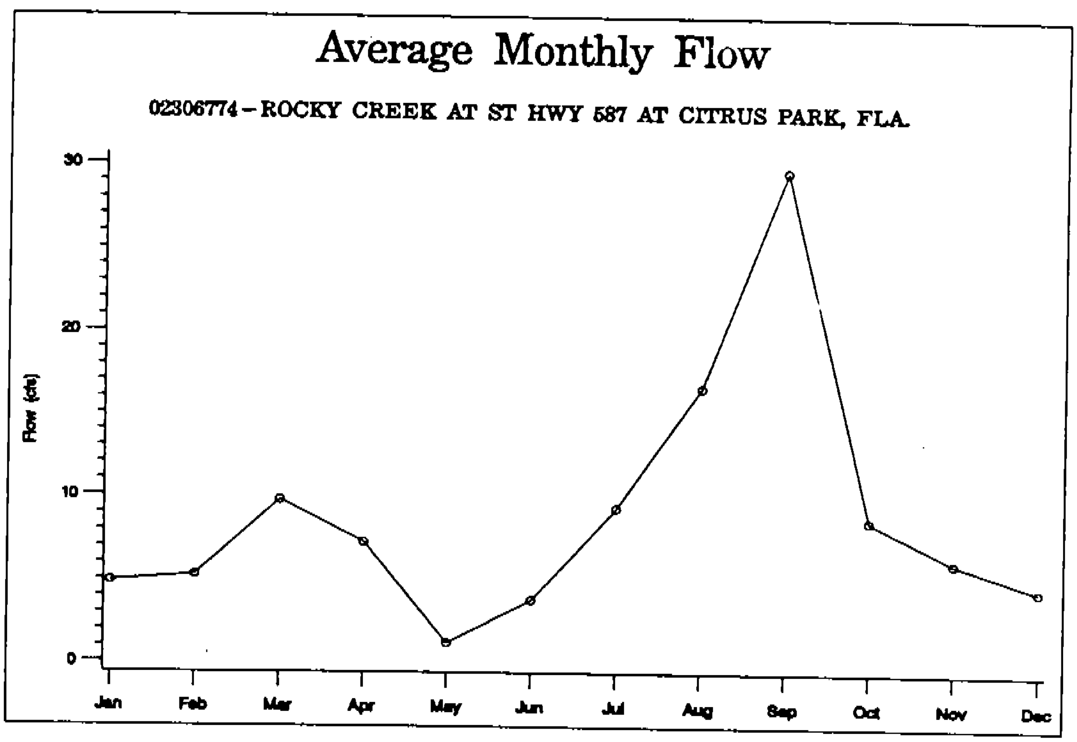

Total Annual Flow
02306500 – SWEETWATER CREEK NR SULPHUR SPRINGS, FLA.
Flow (cfs)
0
100
200
300
400
500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
• • • < full year
full year


Average Monthly Flow
02306500 – SWEETWATER CREEK NR SULPHUR SPRINGS, FLA.
Flow (cfs)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

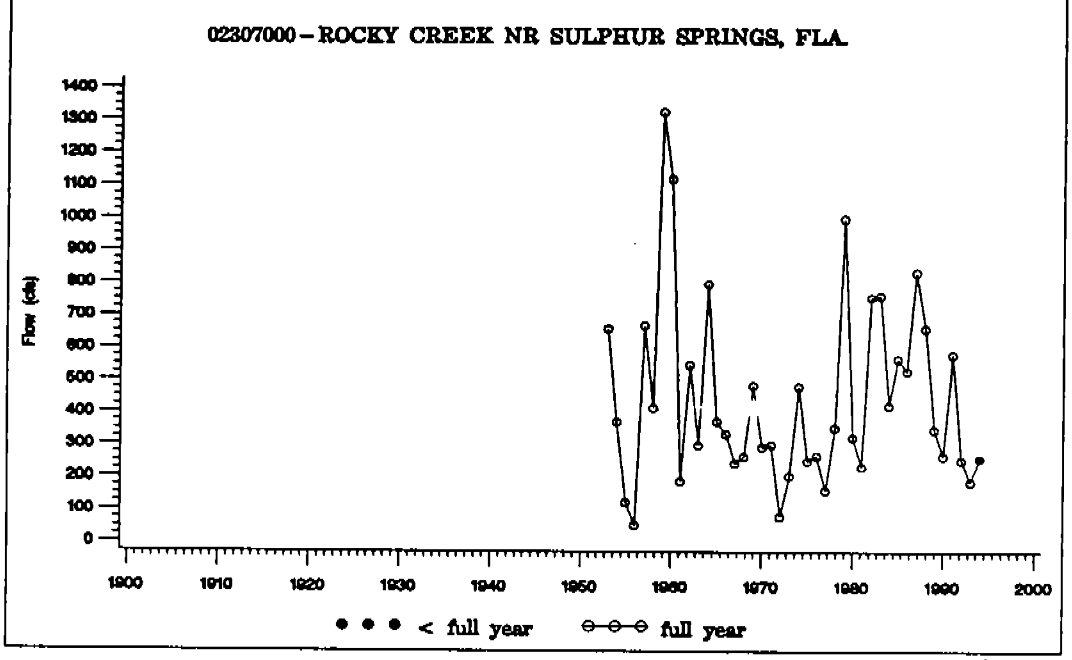

Total Annual Flow
02306647 - SWEETWATER CREEK NR TAMPA, FLA.
Flow (cfs)
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Flow
02306647 - SWEETWATER CREEK NR TAMPA, FLA.
Flow (cfs)
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

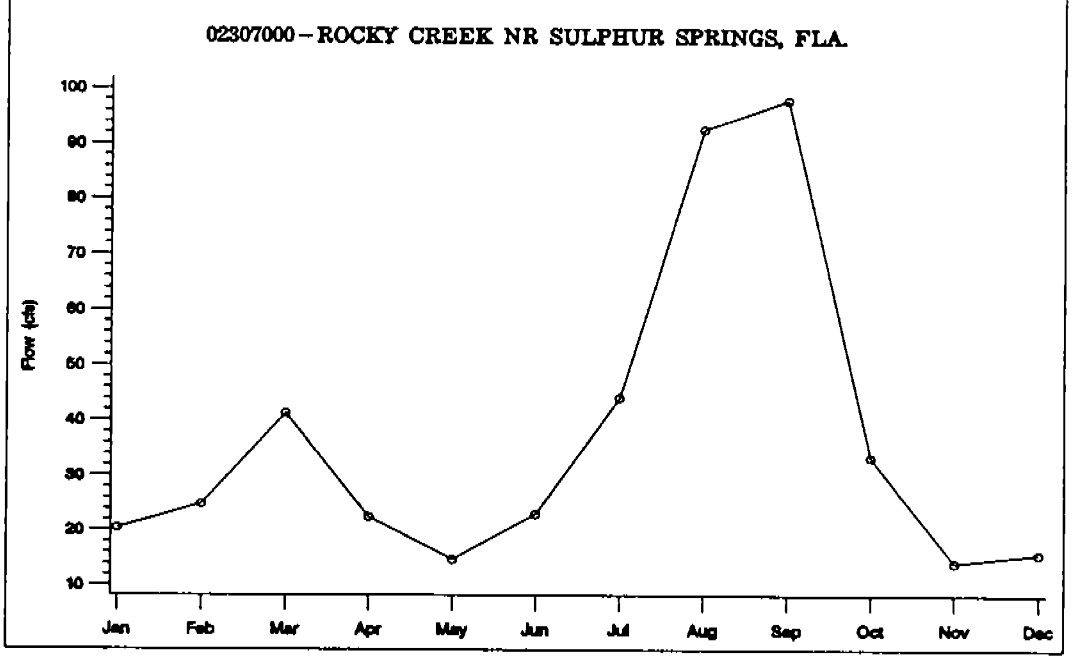

Total Annual Flow
02306774 - ROCKY CREEK AT ST HWY 587 AT CITRUS PARK, FLA.
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

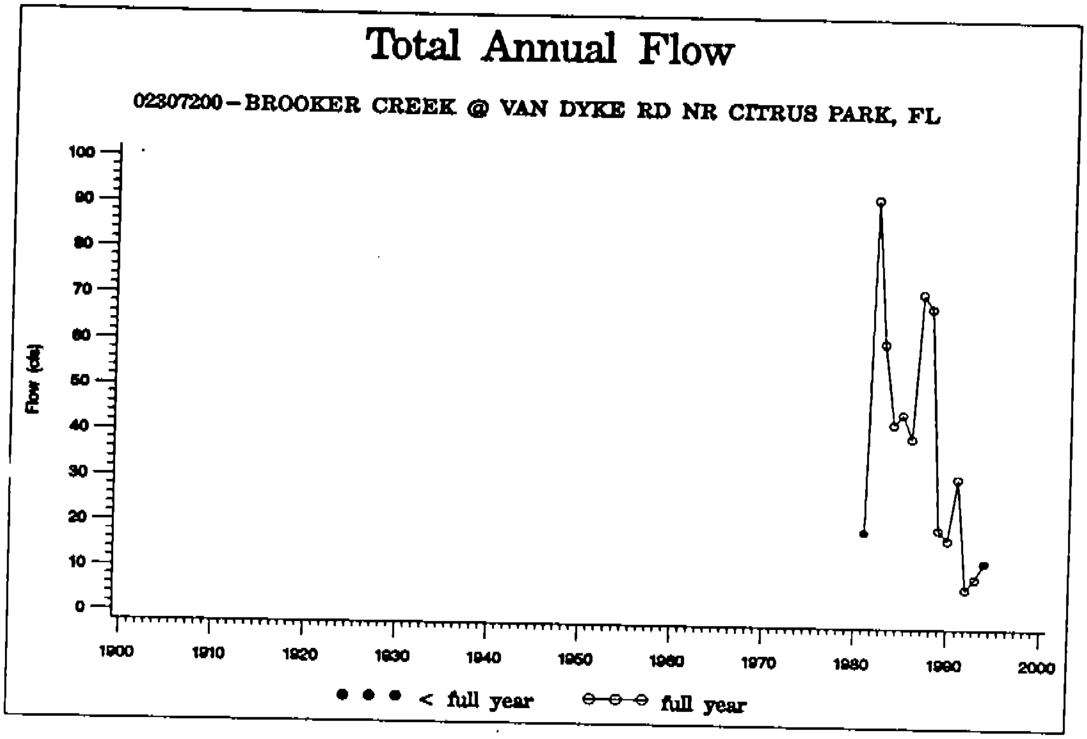

Average Monthly Flow
02306774 - ROCKY CREEK AT ST HWY 587 AT CITRUS PARK, FLA.
Flow (cfs)
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

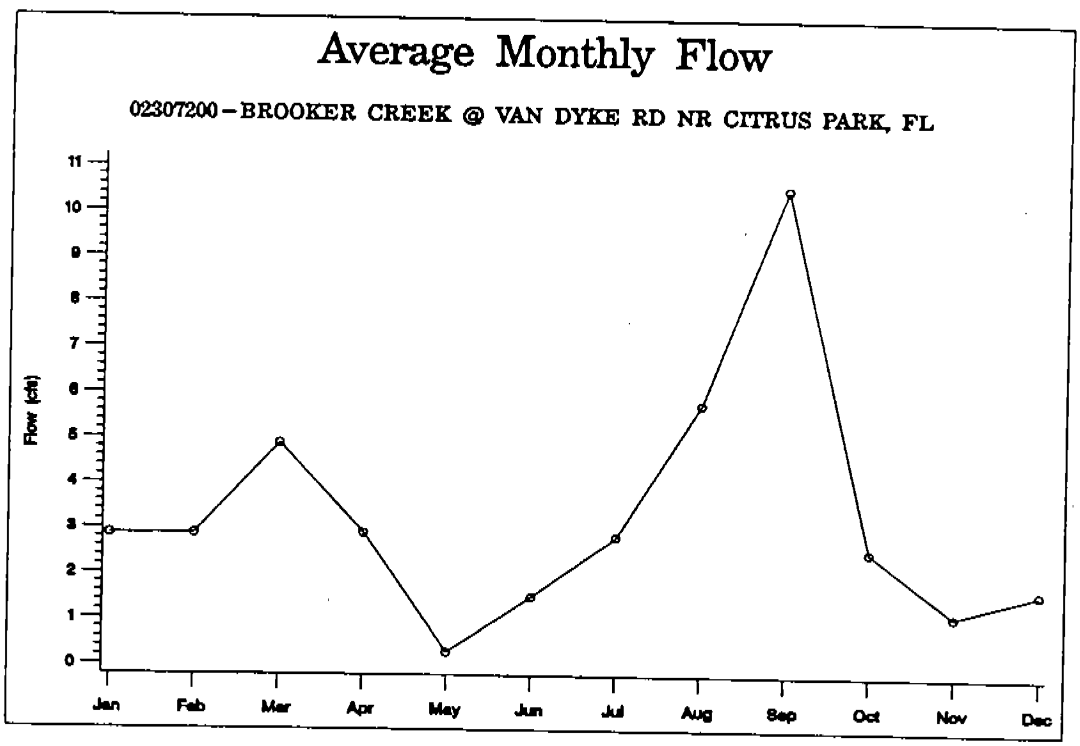
Total Annual Flow

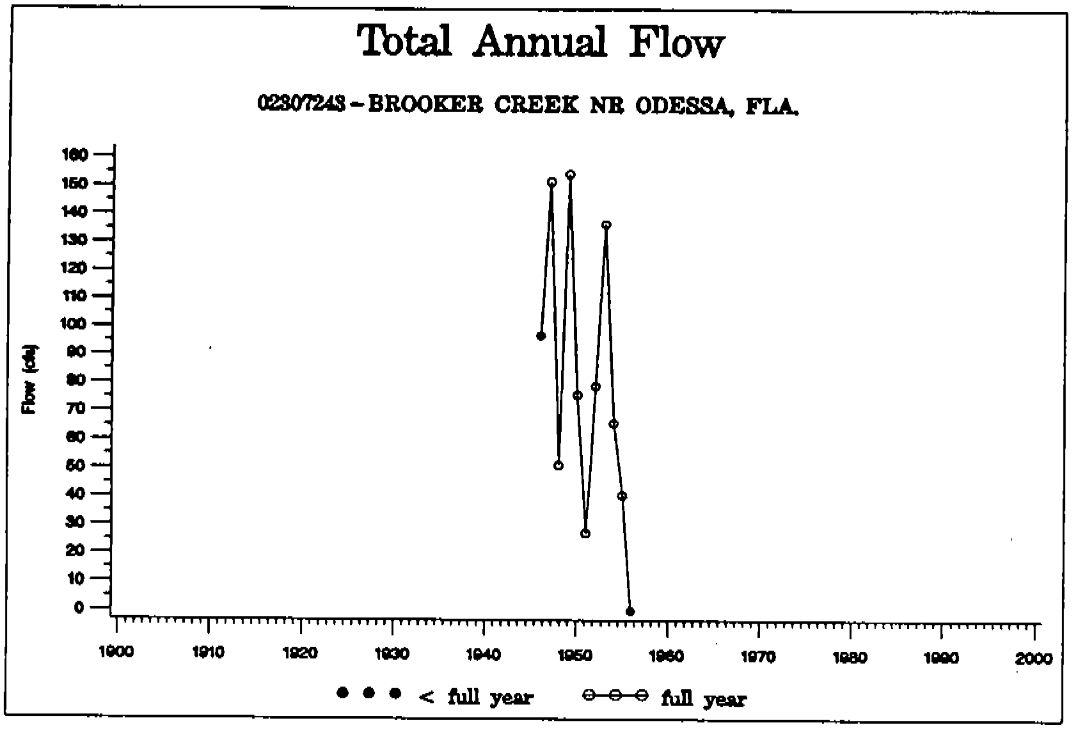


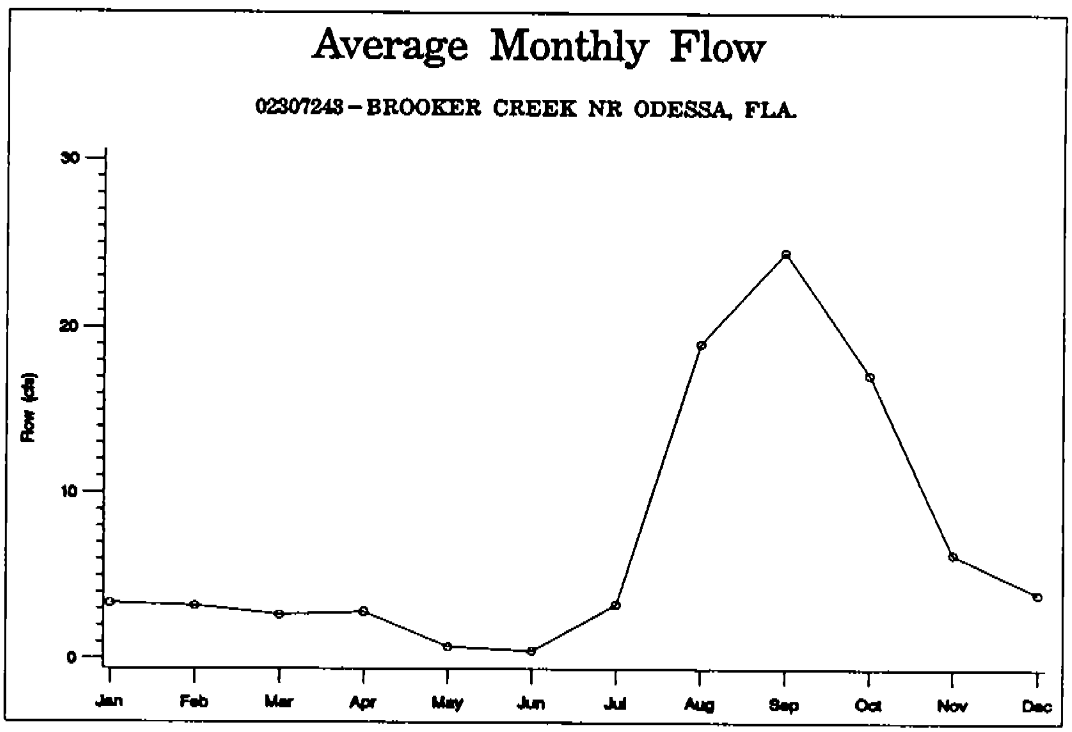
Average Monthly Flow

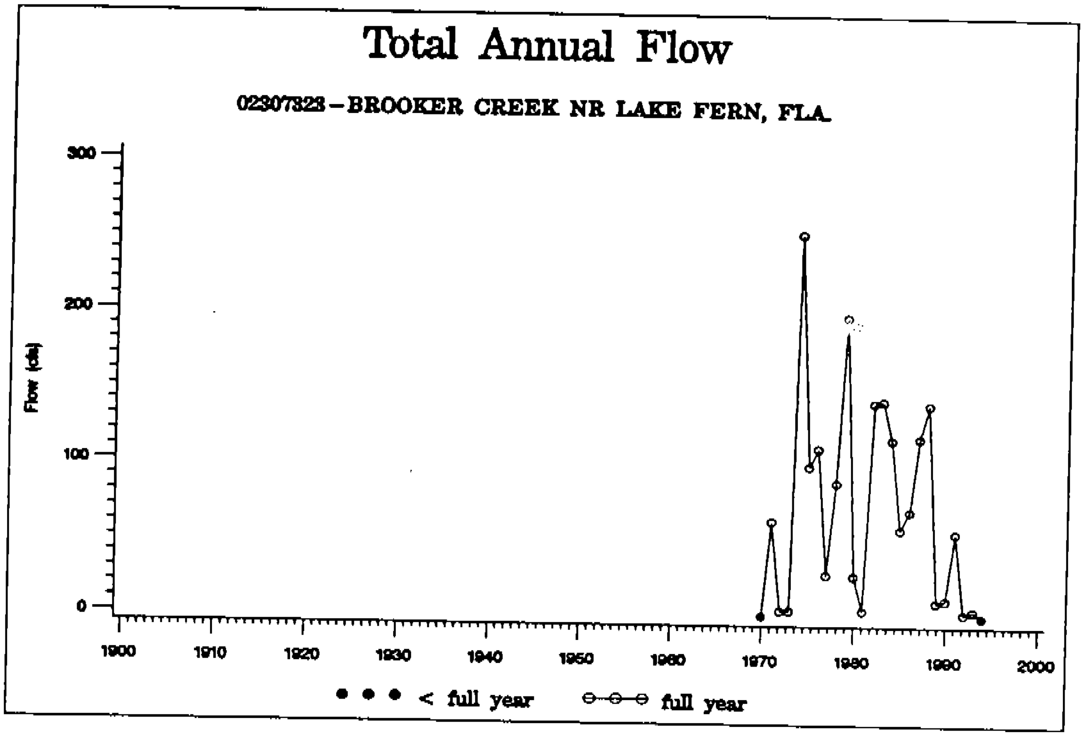


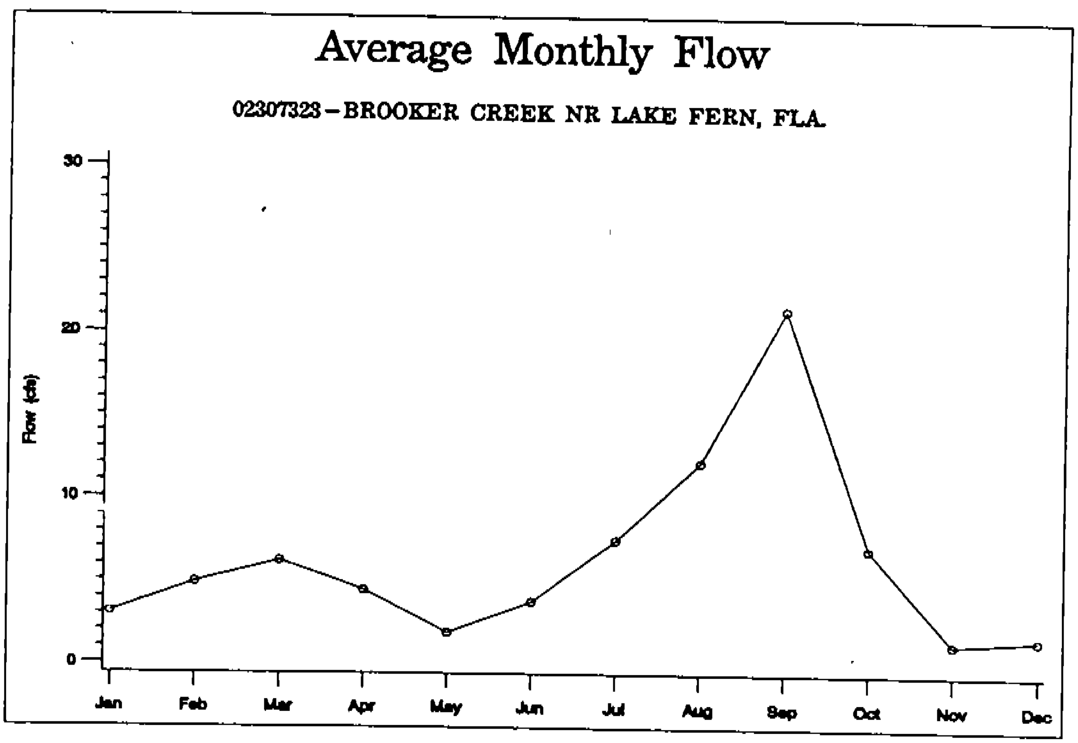

Total Annual Flow
02307200 – BROOKER CREEK @ VAN DYKE RD NR CITRUS PARK, FL
Flow (cfs)
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

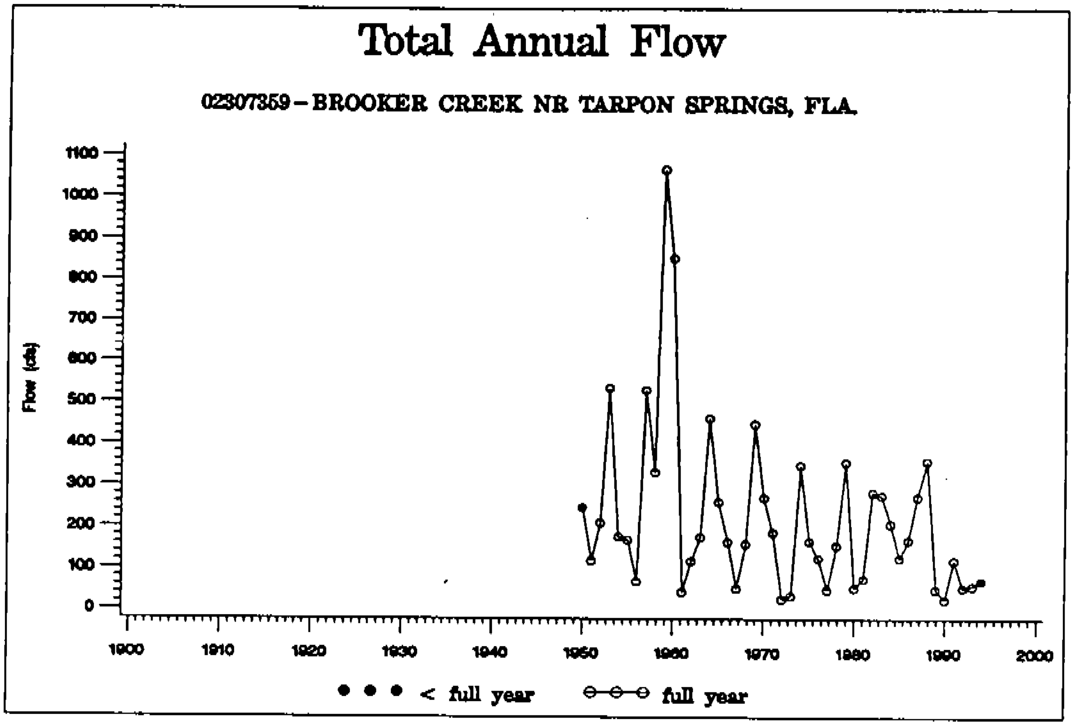

Average Monthly Flow
02307200 – BROOKER CREEK @ VAN DYKE RD NR CITRUS PARK, FL
Flow (cfs)
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

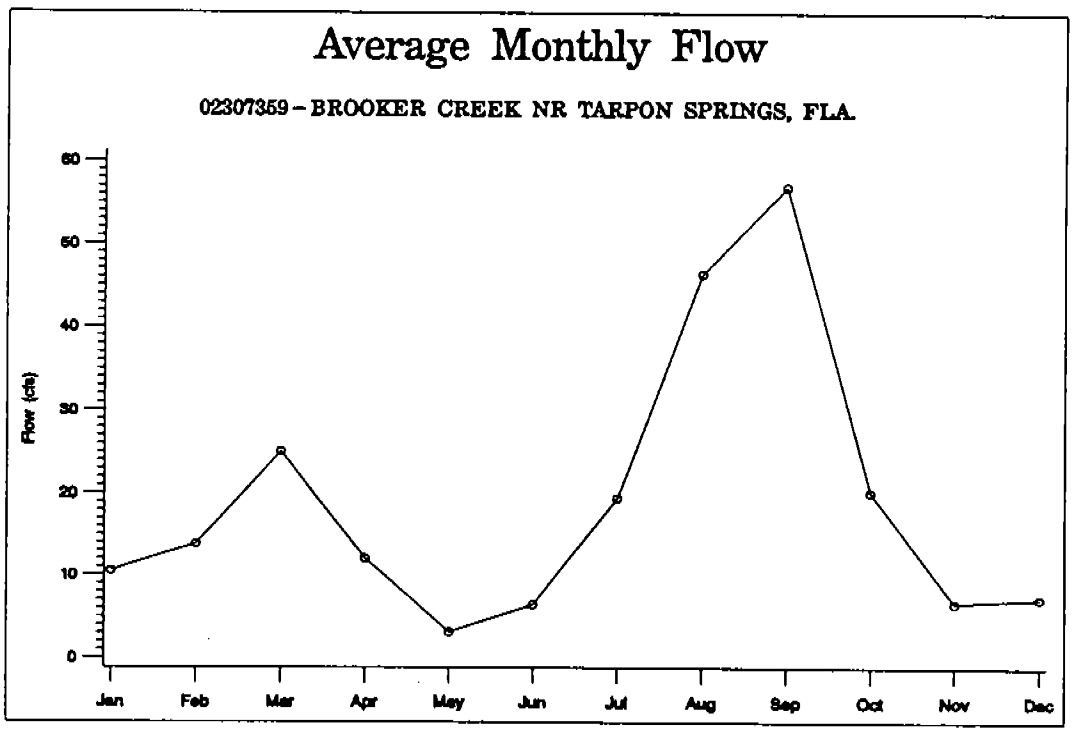

Total Annual Flow
02307243 - BROOKER CREEK NR ODESSA, FLA.
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

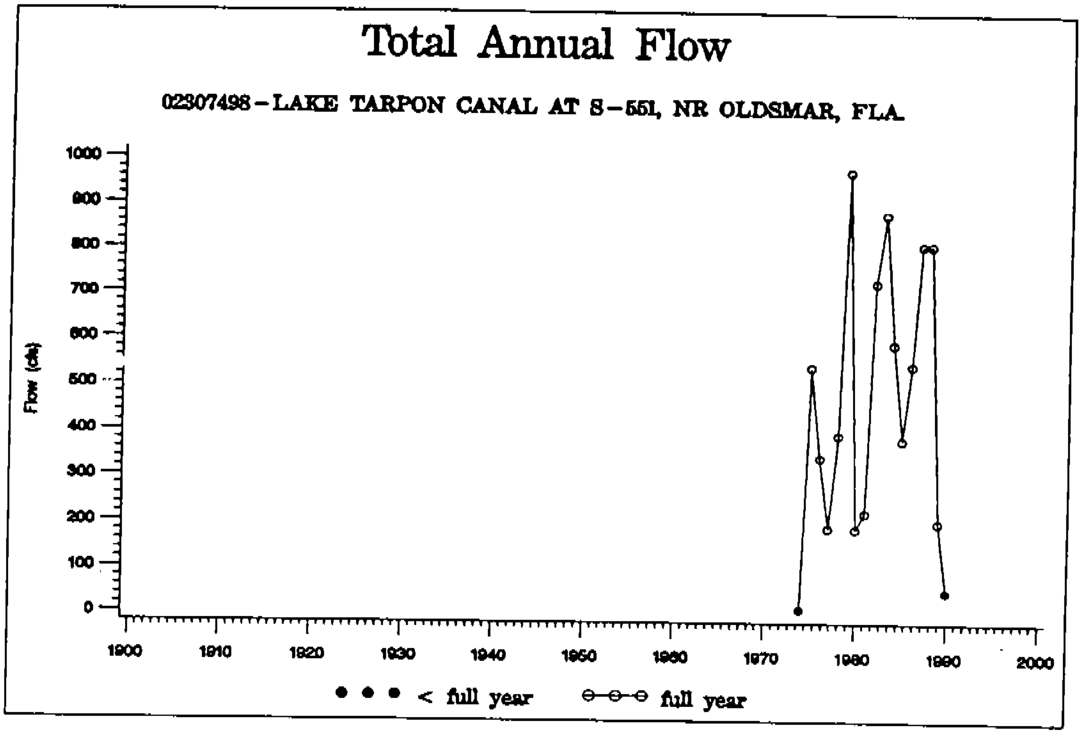

Average Monthly Flow
02307243 - BROOKER CREEK NR ODESSA, FLA.
Flow (cfs)
0
10
20
30
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02307323–BROOKER CREEK NR LAKE FERN, FLA.
Flow (cfs)
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

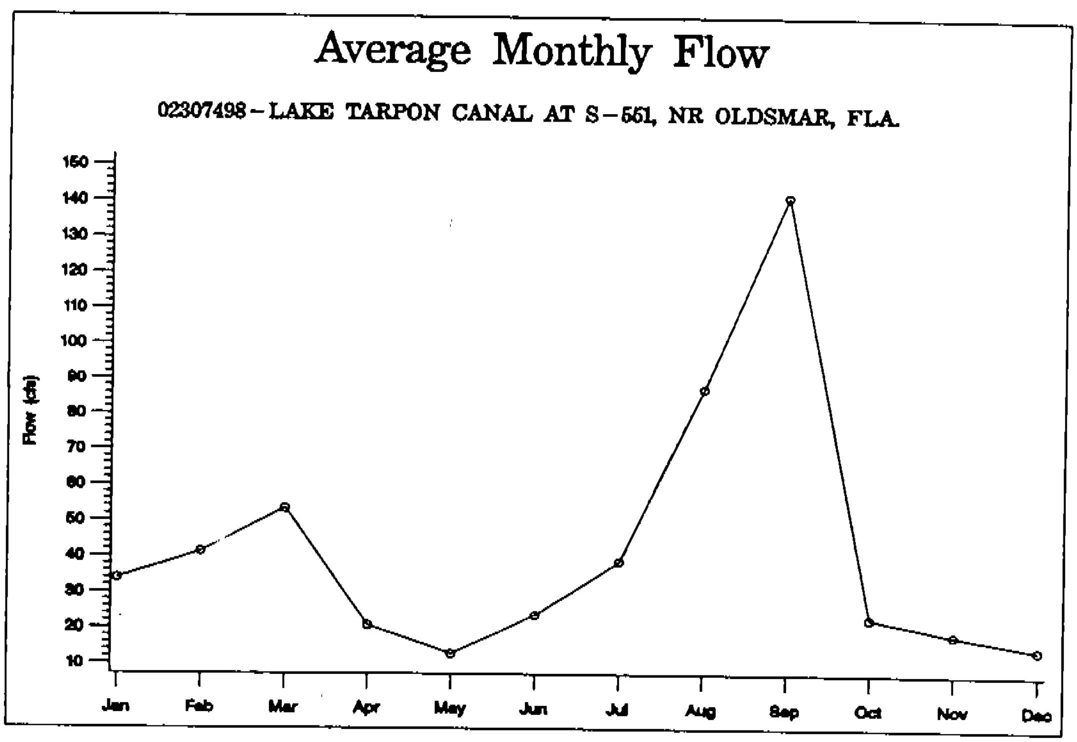

Average Monthly Flow
02307323–BROOKER CREEK NR LAKE FERN, FLA.
Flow (cfs)
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02307359 - BROOKER CREEK NR TARPON SPRINGS, FLA.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

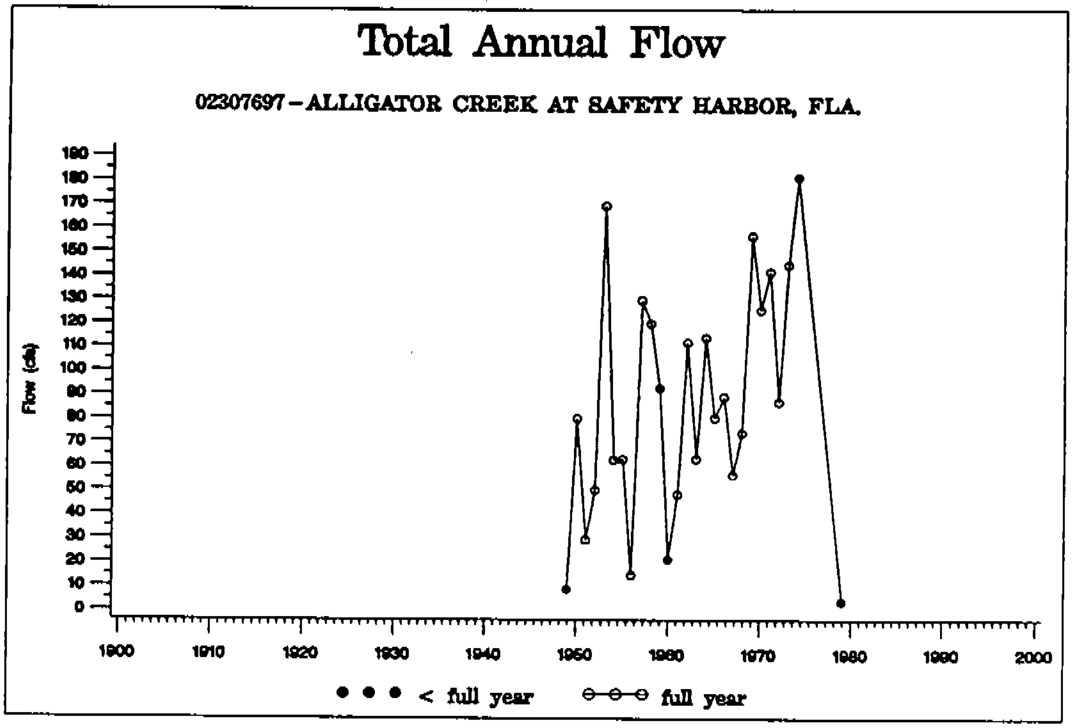

Average Monthly Flow
02307359 - BROOKER CREEK NR TARPON SPRINGS, FLA.
Flow (cfs)
0
10
20
30
40
50
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

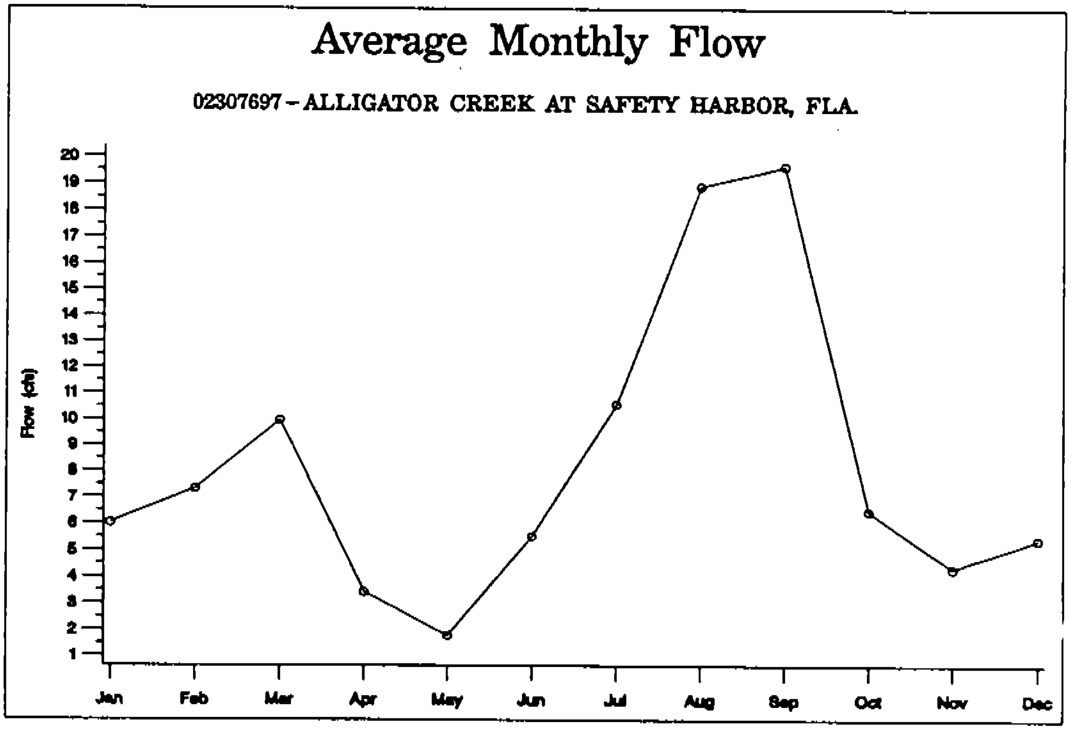


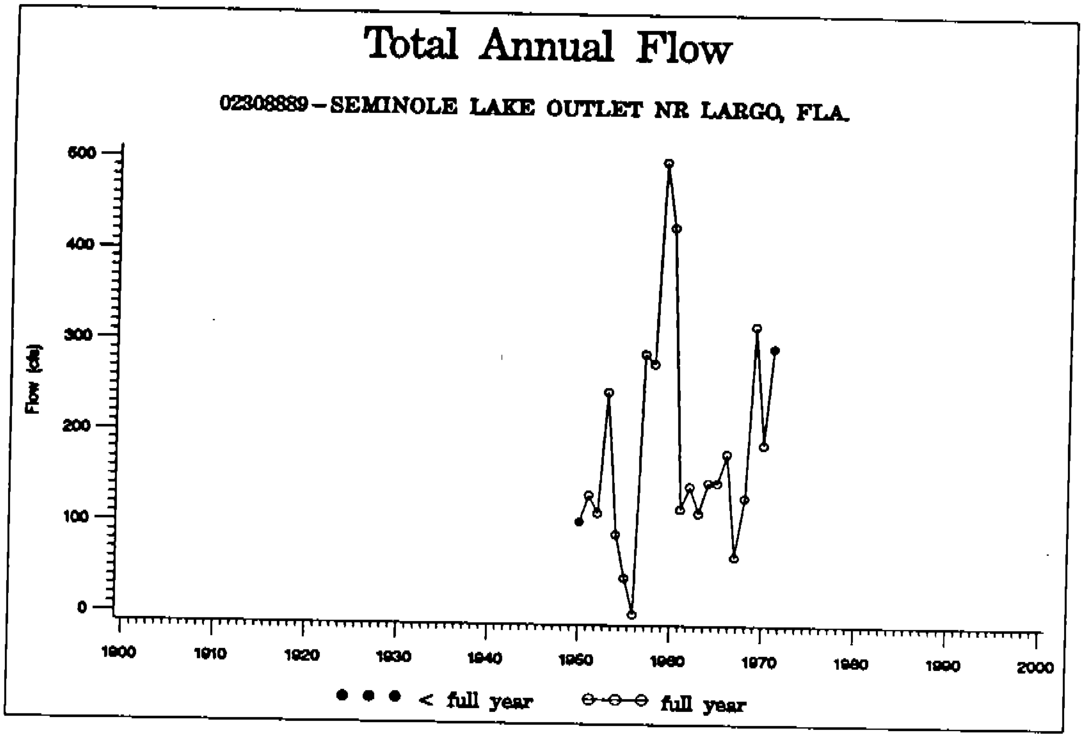
Total Annual Flow
02307498 - LAKE TARPON CANAL AT S-551, NR OLDSMAR, FLA.
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

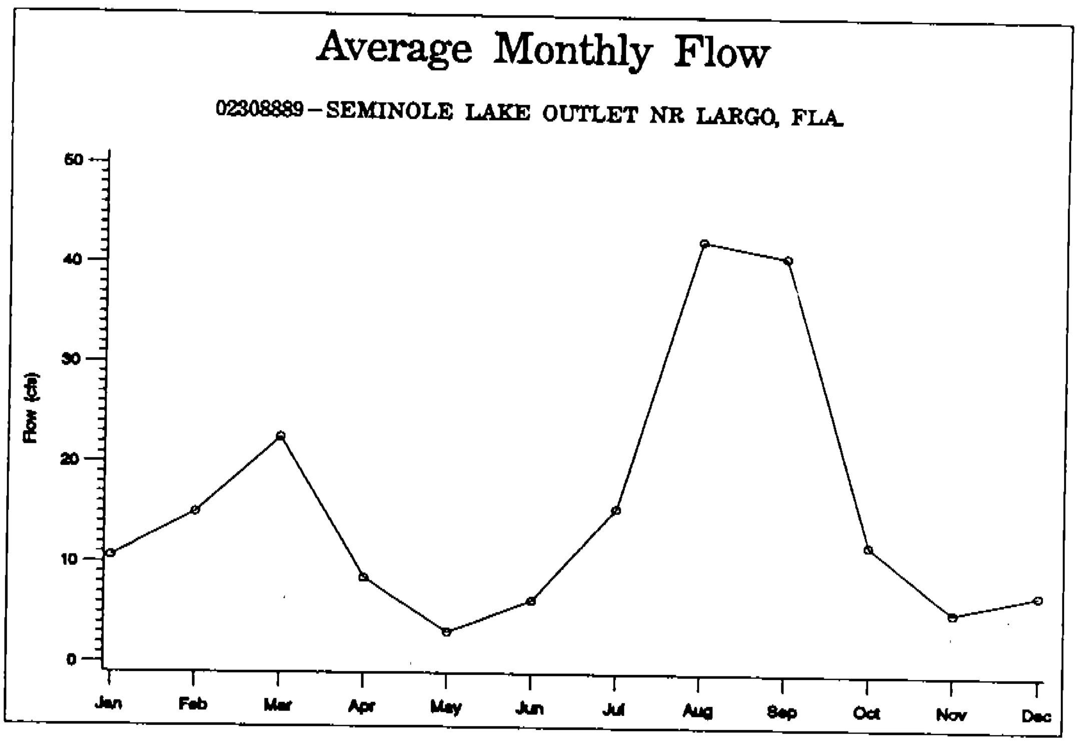


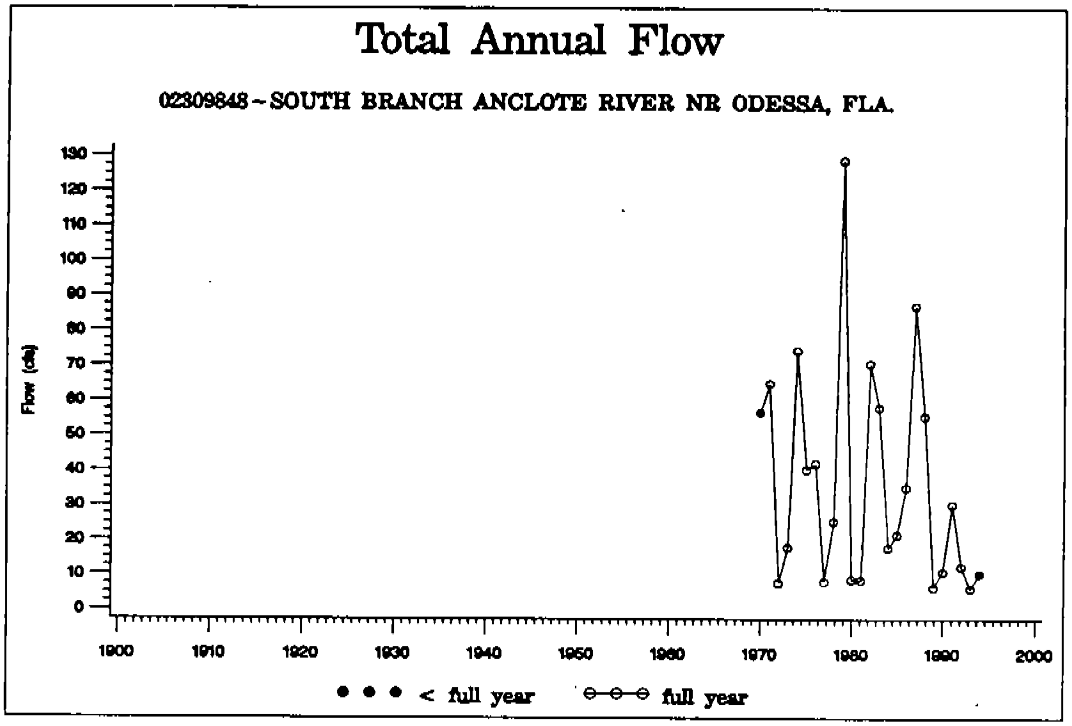
Average Monthly Flow
02307498 - LAKE TARPON CANAL AT S-551, NR OLDSMAR, FLA.
Flow (cfs)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

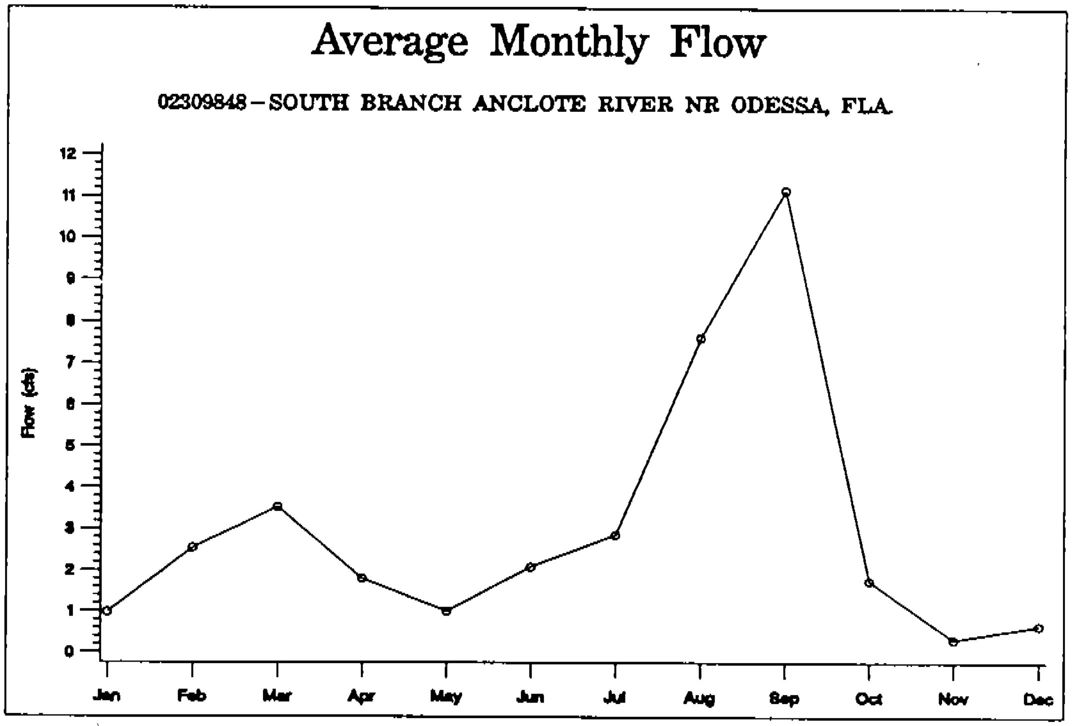

Total Annual Flow
02307697 - ALLIGATOR CREEK AT SAFETY HARBOR, FLA.
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

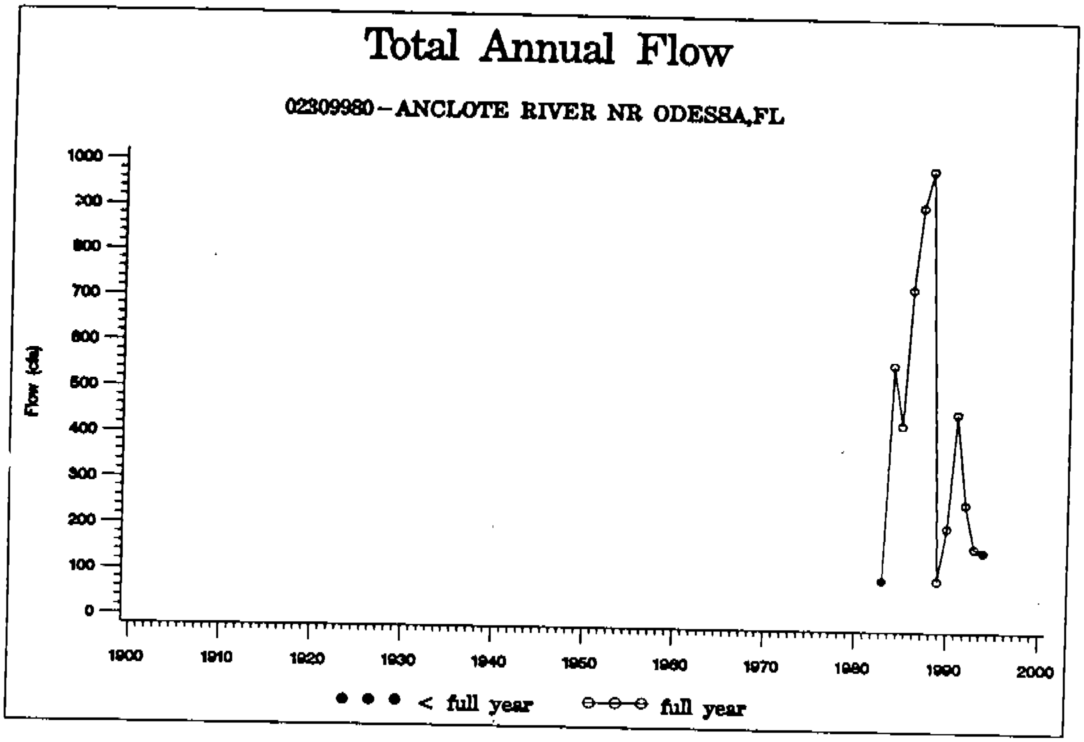

Average Monthly Flow
02307697 - ALLIGATOR CREEK AT SAFETY HARBOR, FLA.
Flow (cfs)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02308889 – SEMINOLE LAKE OUTLET NR LARGO, FLA.
Flow (cfs)
0
100
200
300
400
500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

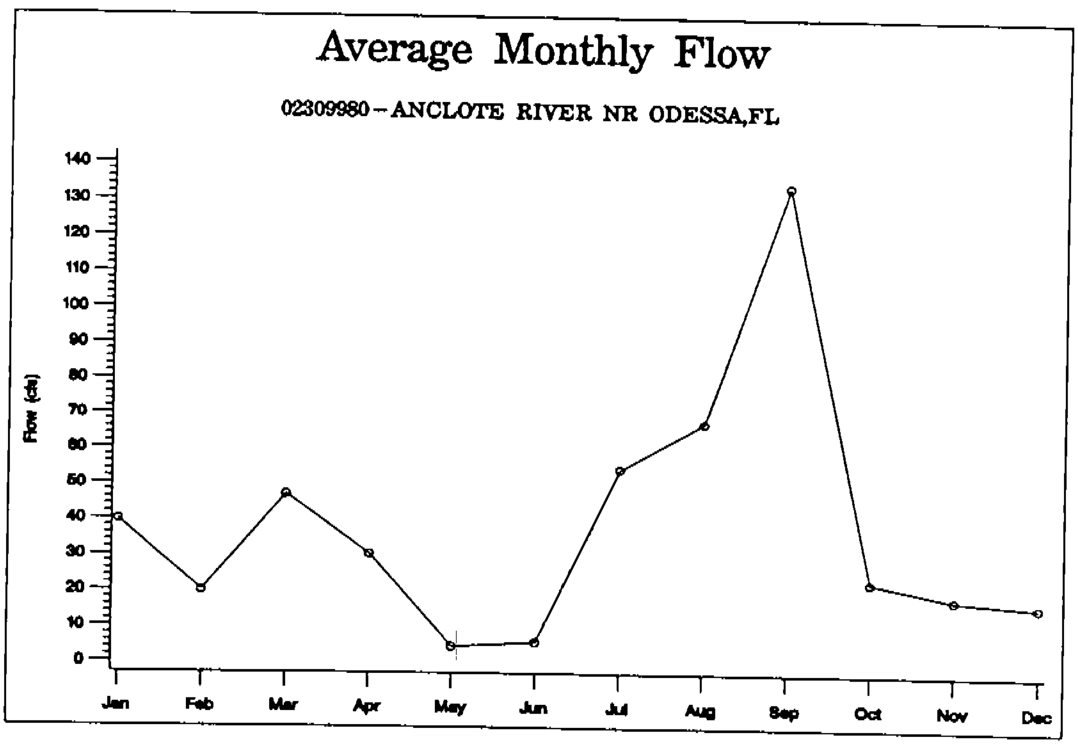

Average Monthly Flow
02308889 – SEMINOLE LAKE OUTLET NR LARGO, FLA.
Flow (cfs)
0
10
20
30
40
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02309848 - SOUTH BRANCH ANCLOTE RIVER NR ODESSA, FLA.
Flow (cfs)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

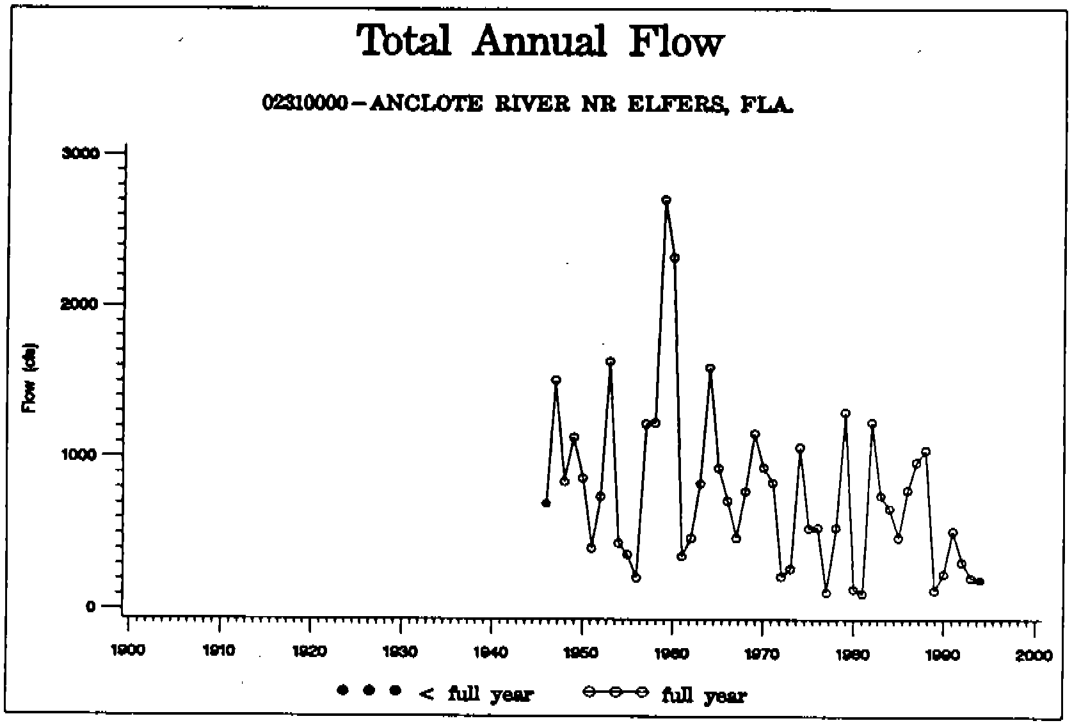

Average Monthly Flow
02309848 - SOUTH BRANCH ANCLOTE RIVER NR ODESSA, FLA.
Flow (cfs)
12
11
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

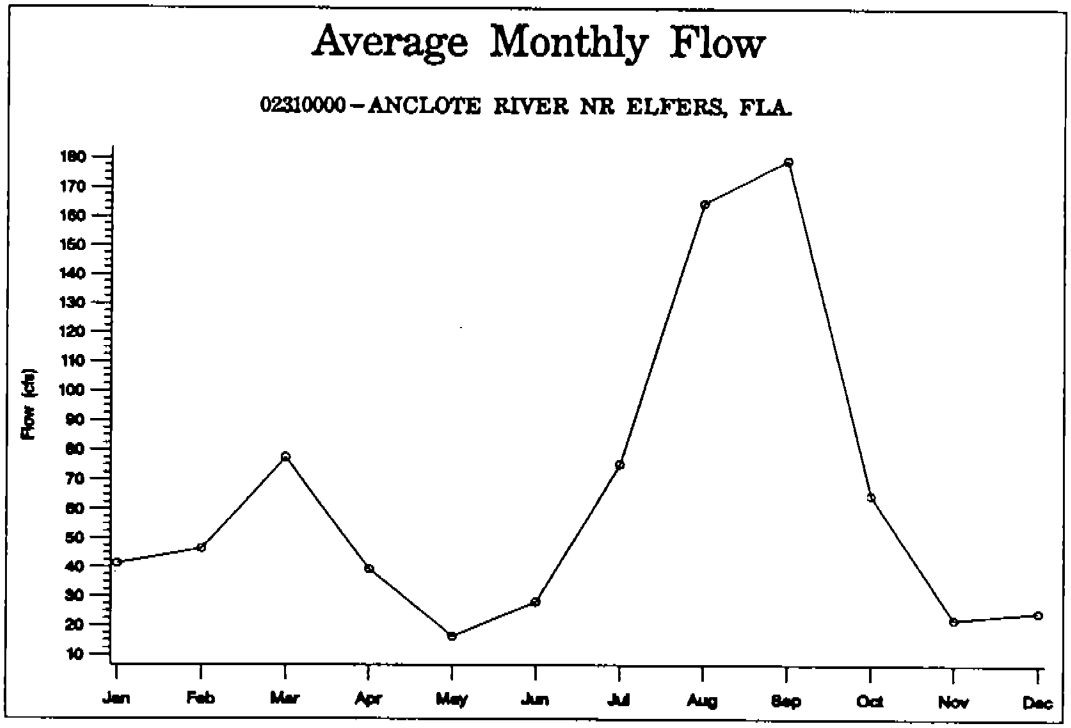


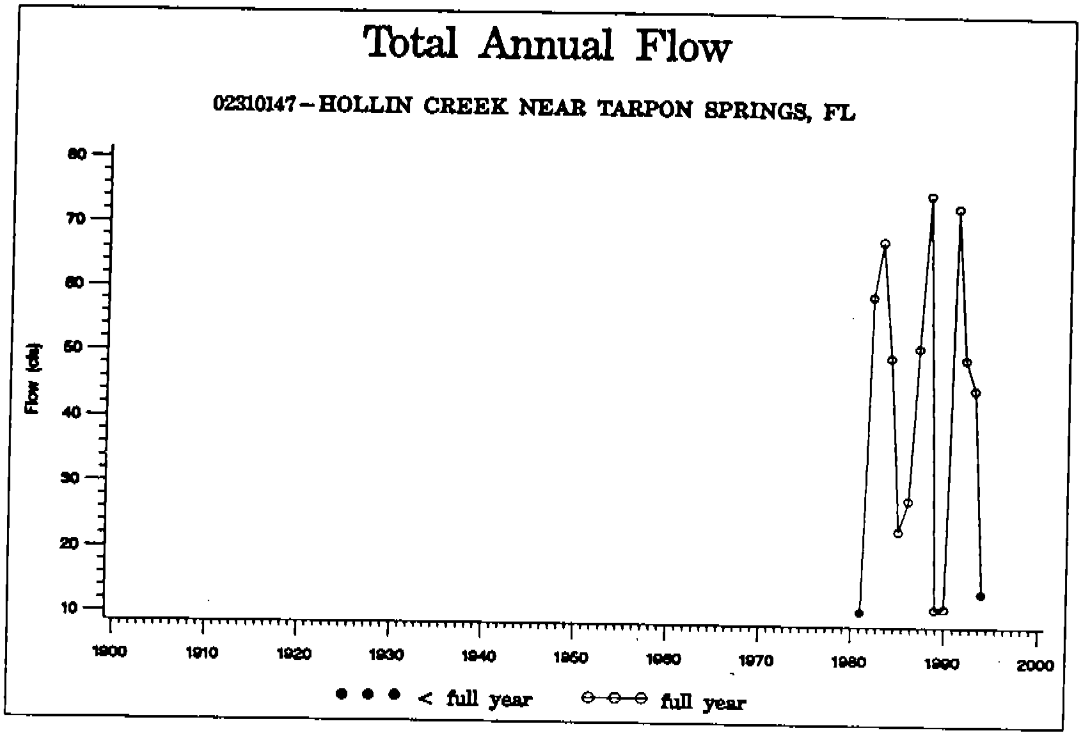
Total Annual Flow
02309980—ANCLOTE RIVER NR ODESSA,FL
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

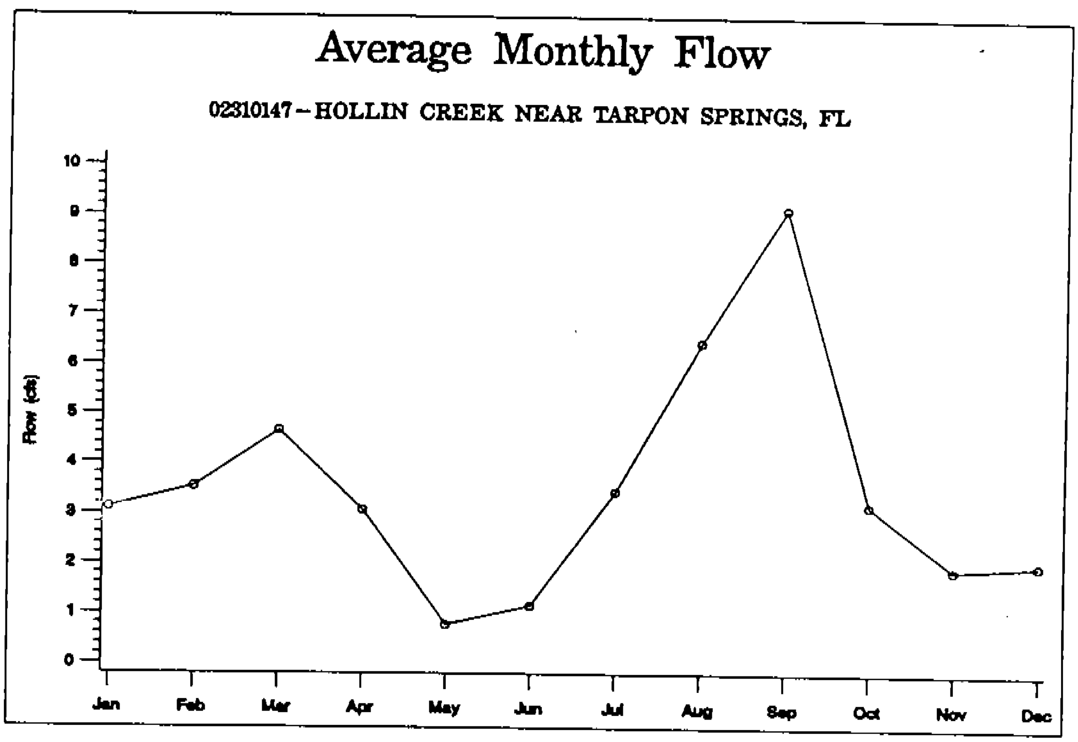


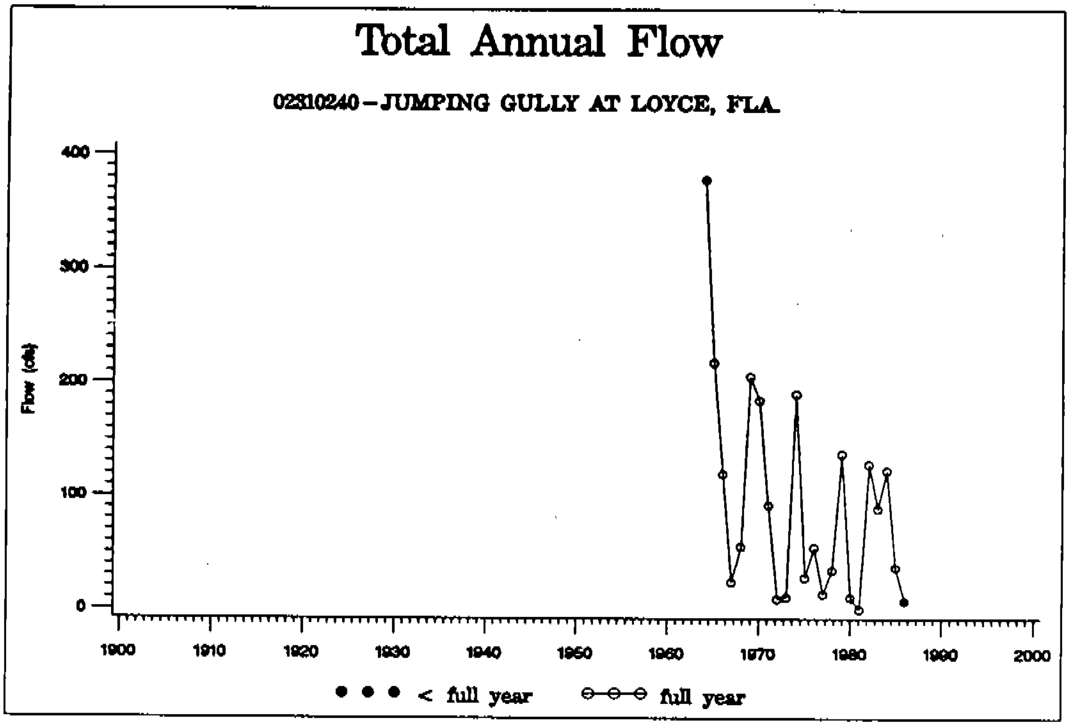
Average Monthly Flow
02309980—ANCLOTE RIVER NR ODESSA,FL
Flow (cfs)
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

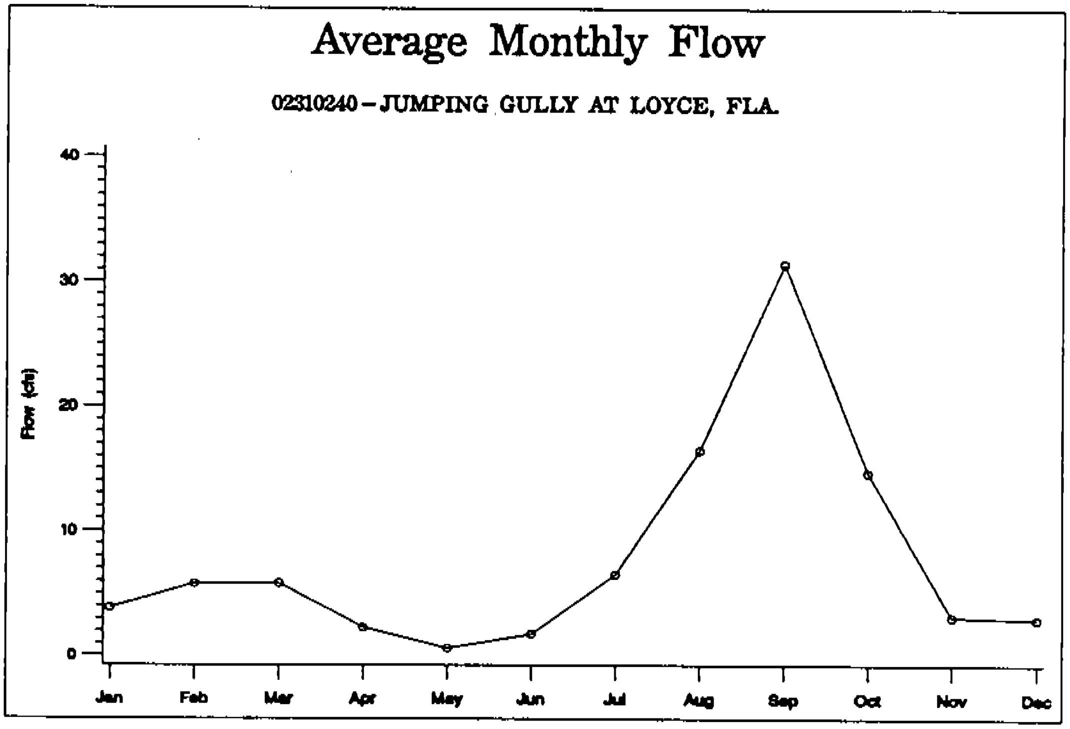

Total Annual Flow
02310000-ANCLOTE RIVER NR ELFERS, FLA.
Flow (cfs)
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

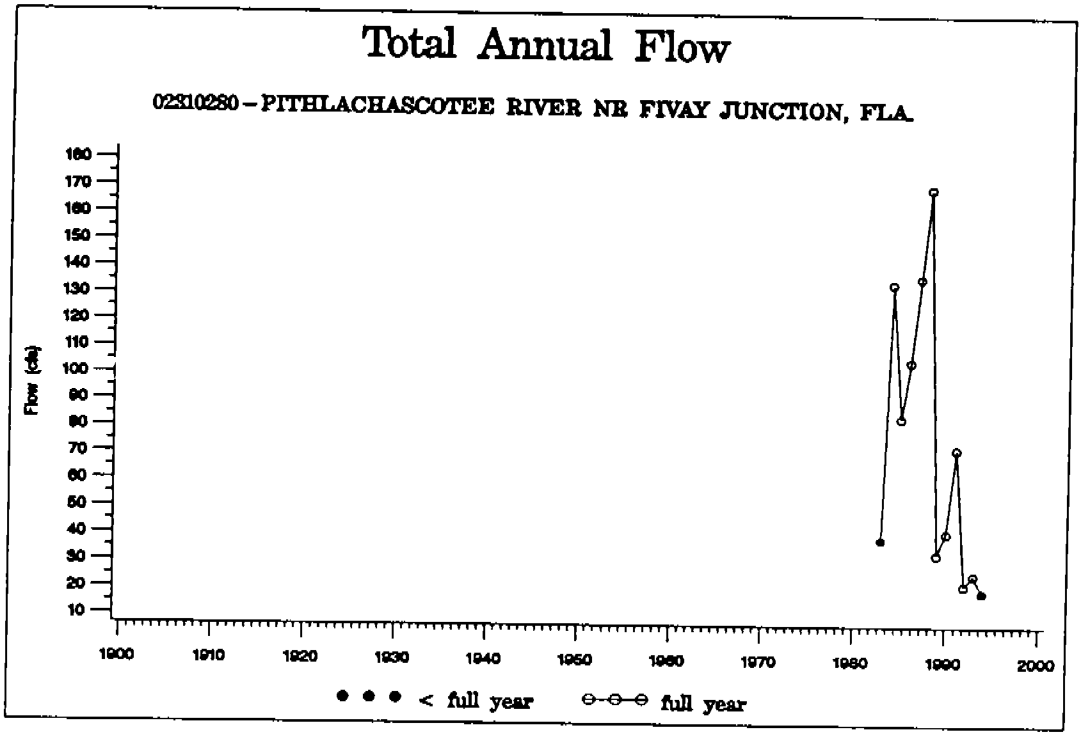

Average Monthly Flow
02310000-ANCLOTE RIVER NR ELFERS, FLA.
Flow (cfs)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

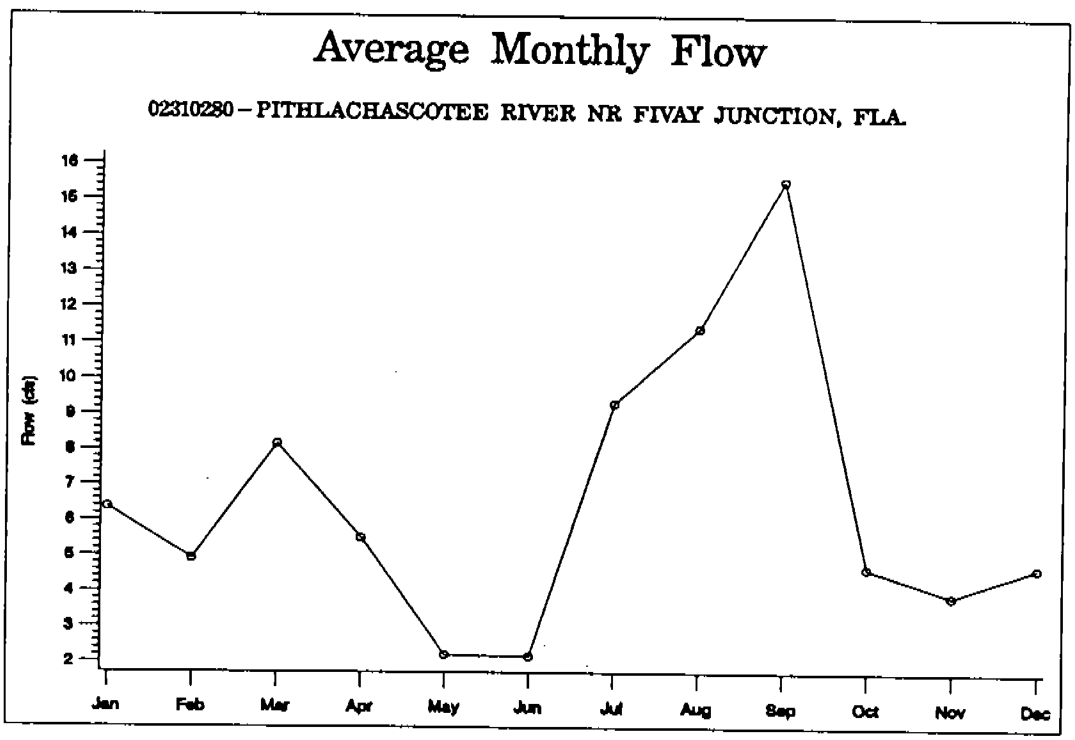

Total Annual Flow
02310147—HOLLIN CREEK NEAR TARPON SPRINGS, FL
Flow (cfs)
80
70
60
50
40
30
20
10
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

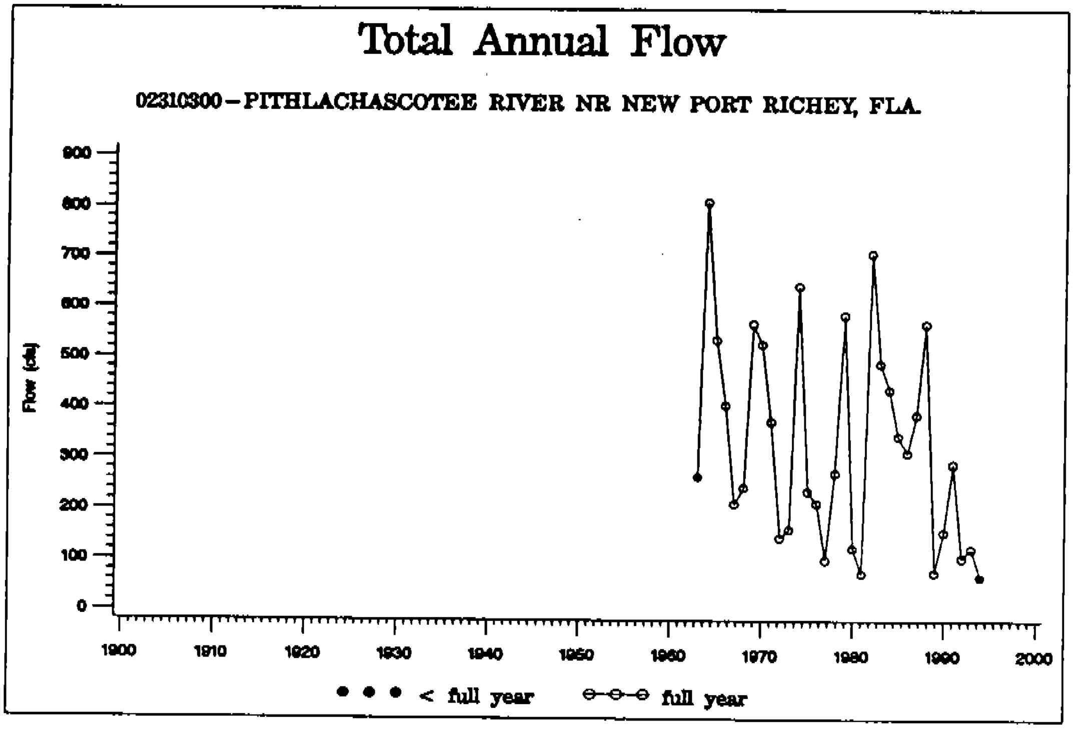

Average Monthly Flow
02310147—HOLLIN CREEK NEAR TARPON SPRINGS, FL
Flow (cfs)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

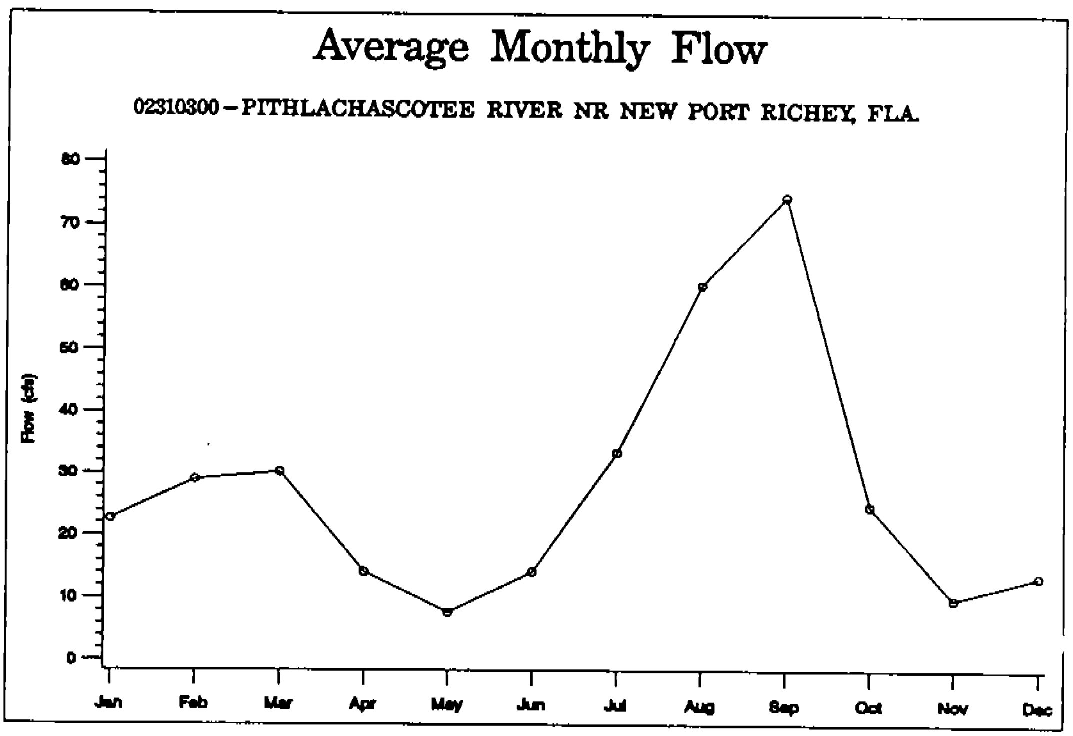

Total Annual Flow
02310240 - JUMPING GULLY AT LOYCE, FLA.
Flow (cfs)
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

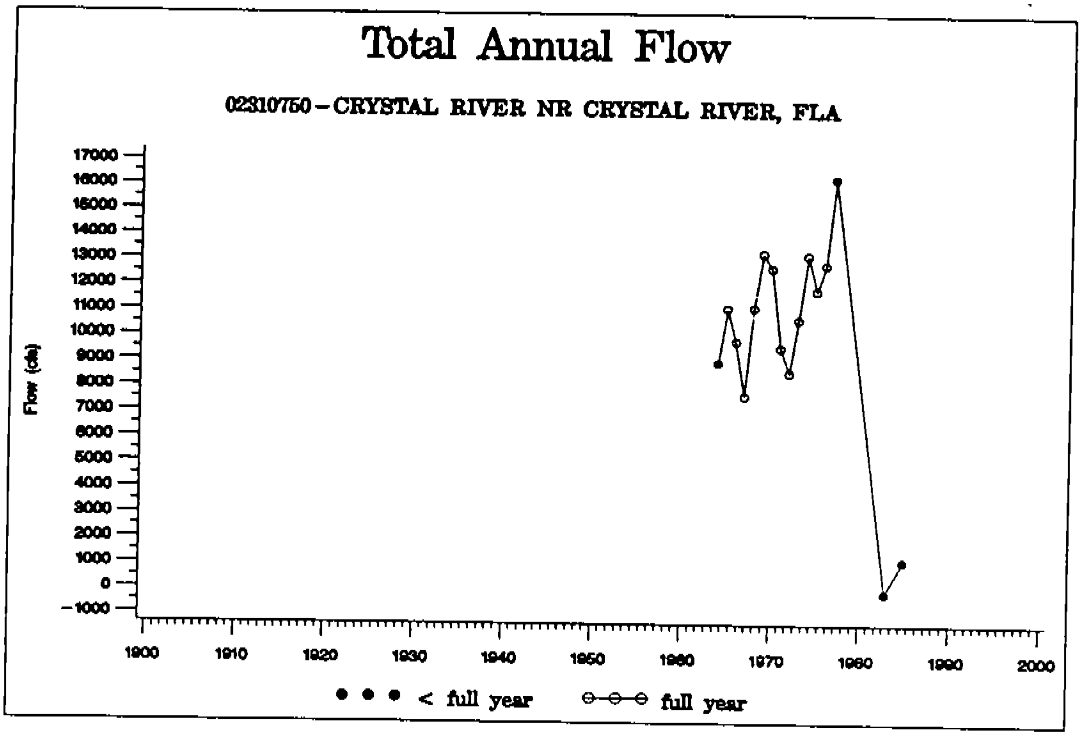

Average Monthly Flow
02310240 - JUMPING GULLY AT LOYCE, FLA.
Flow (cfs)
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

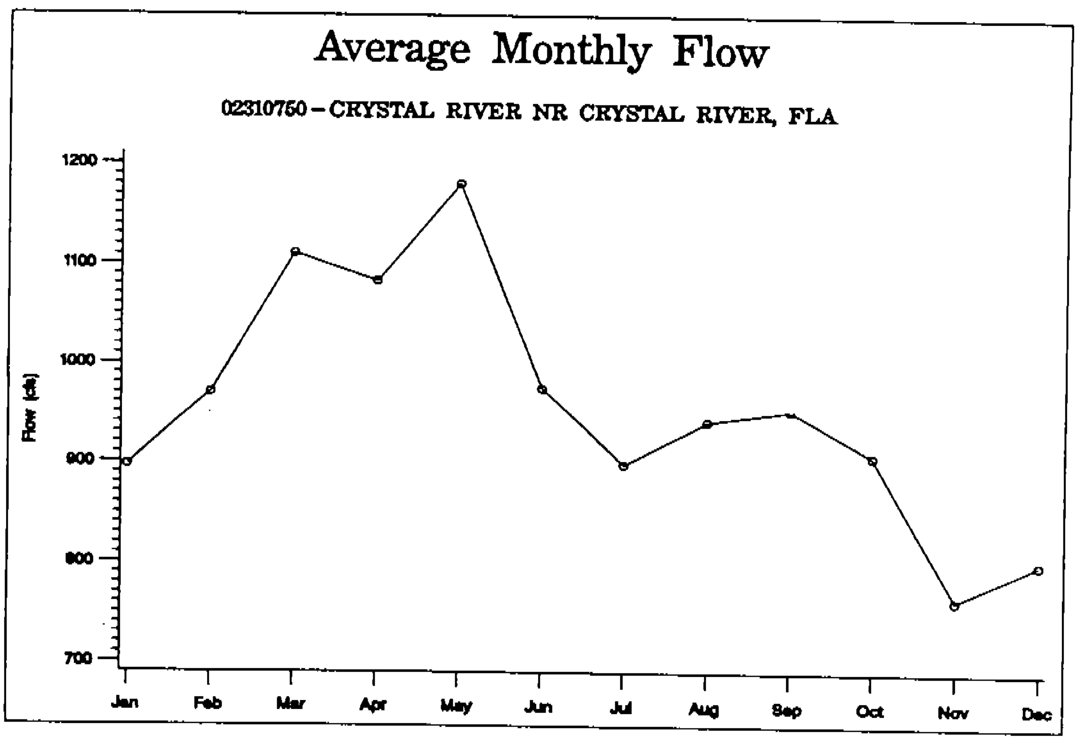

Total Annual Flow
02310280 – PITHLACHASCOTEE RIVER NR FIVAY JUNCTION, FLA.
Flow (cfs)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

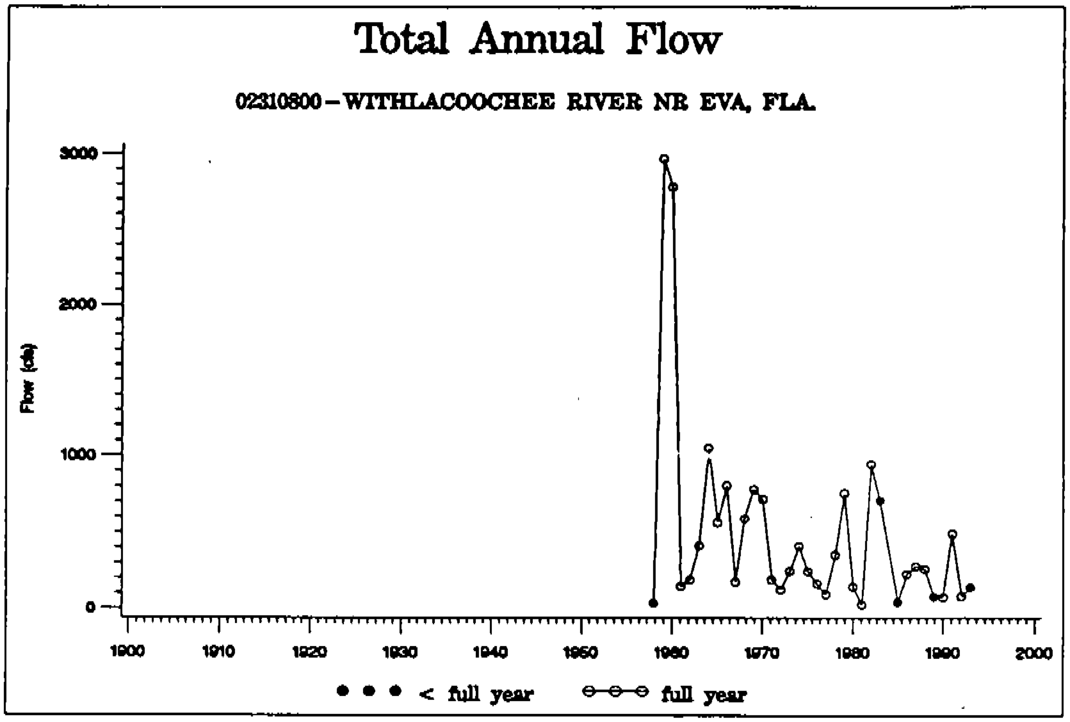

Average Monthly Flow
02310280 – PITHLACHASCOTEE RIVER NR FIVAY JUNCTION, FLA.
Flow (cfs)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

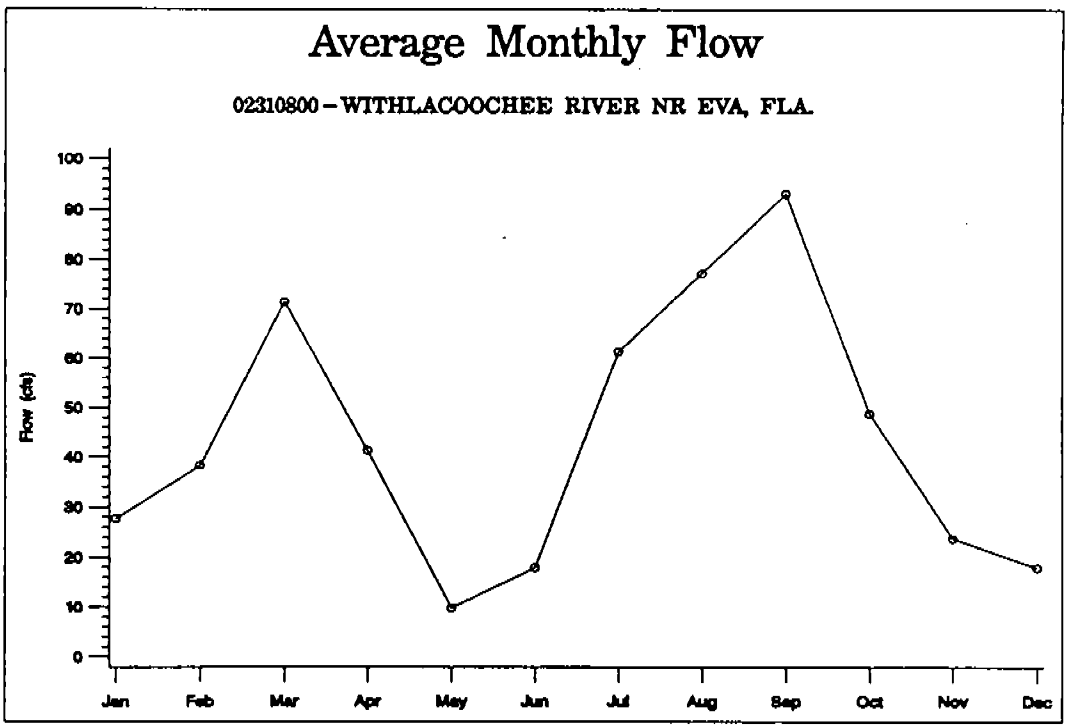

Total Annual Flow
02310300 – PITHLACHASCOTEE RIVER NR NEW PORT RICHEY, FLA.
Flow (cfs)
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

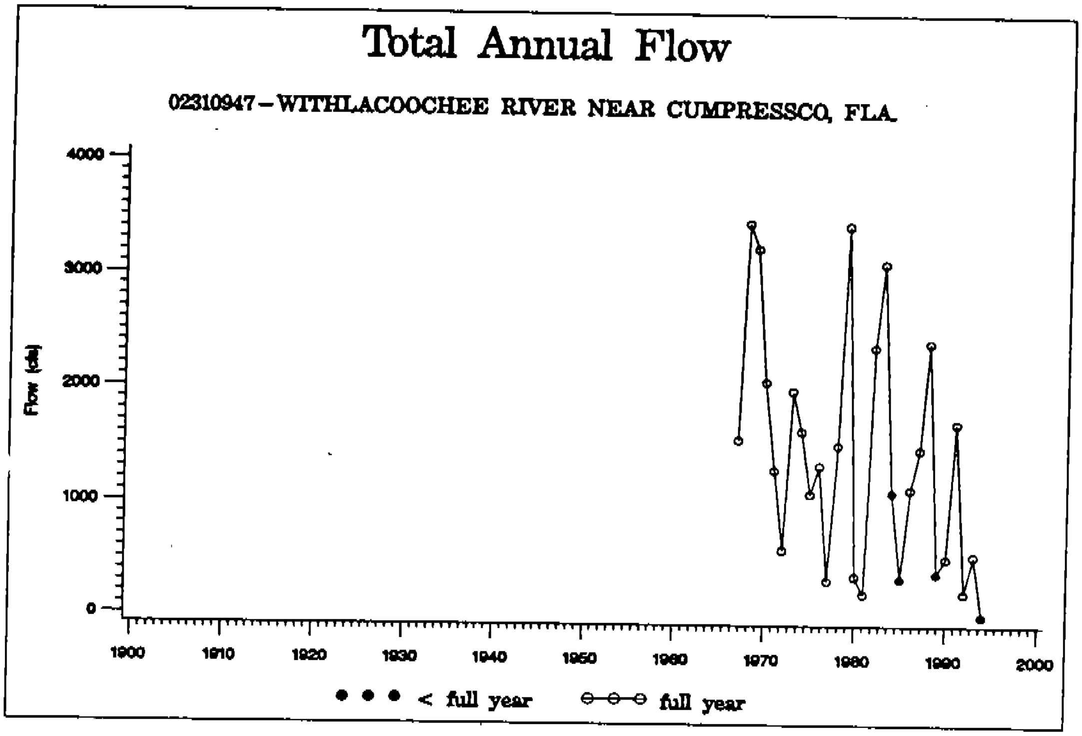

Average Monthly Flow
02310300 – PITHLACHASCOTEE RIVER NR NEW PORT RICHEY, FLA.
Flow (cfs)
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

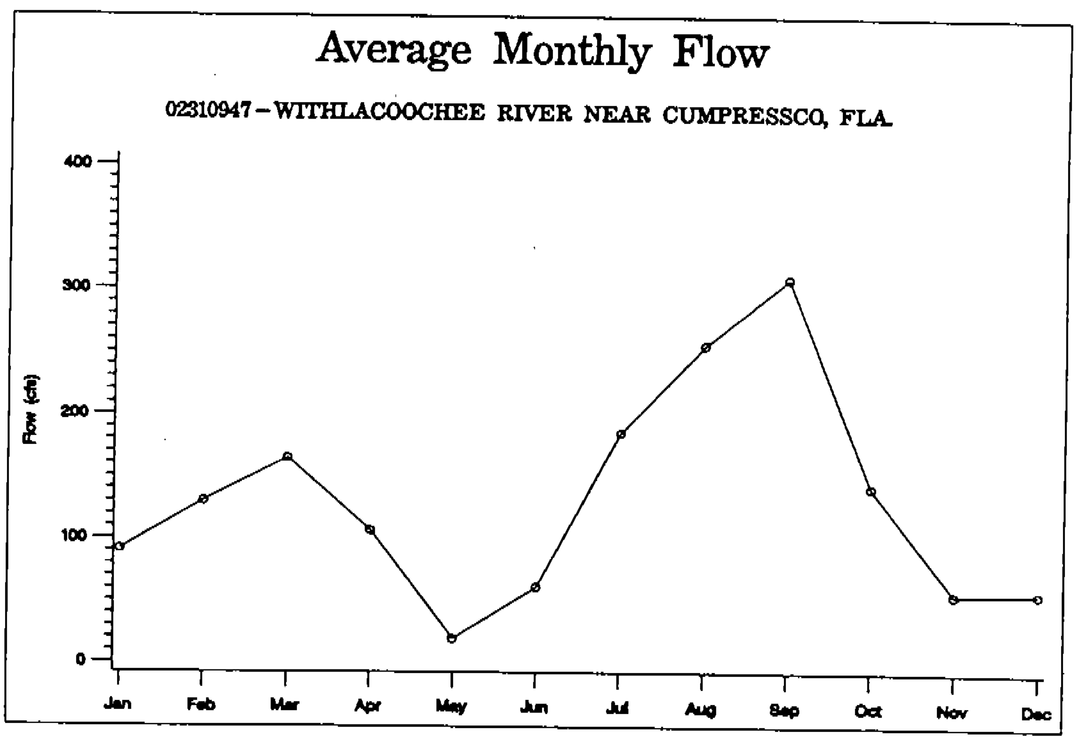

Total Annual Flow
02310750 - CRYSTAL RIVER NR CRYSTAL RIVER, FLA
Flow (cfs)
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

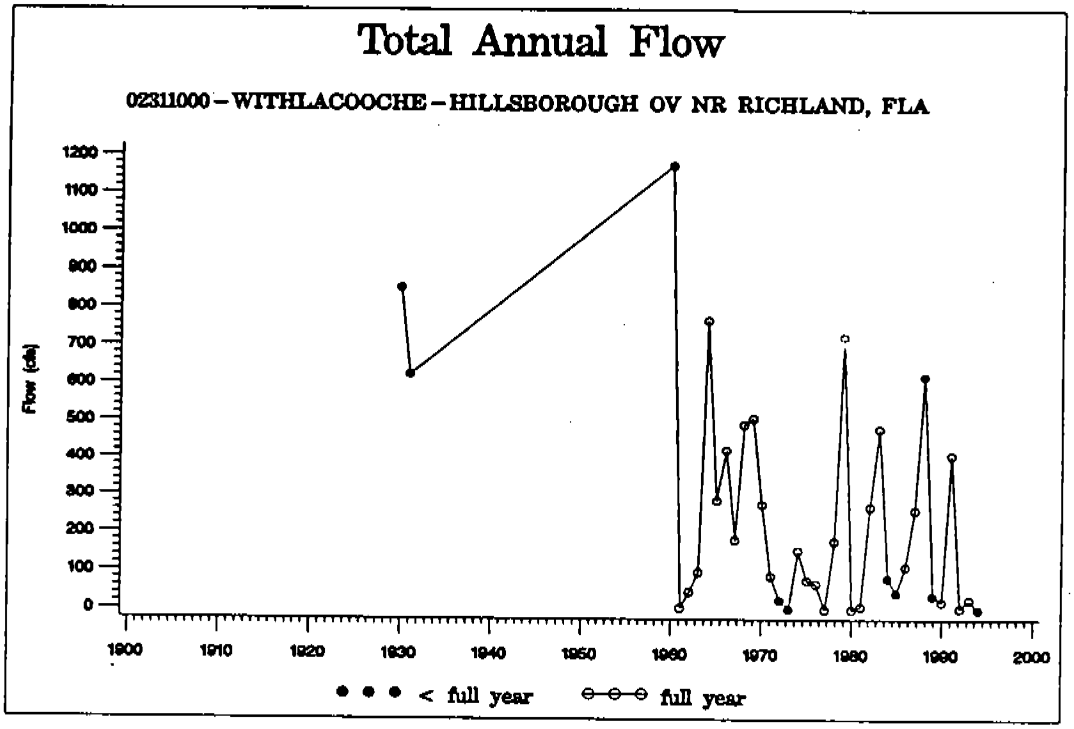

Average Monthly Flow
02310750 - CRYSTAL RIVER NR CRYSTAL RIVER, FLA
Flow (cfs)
1200
1100
1000
900
800
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

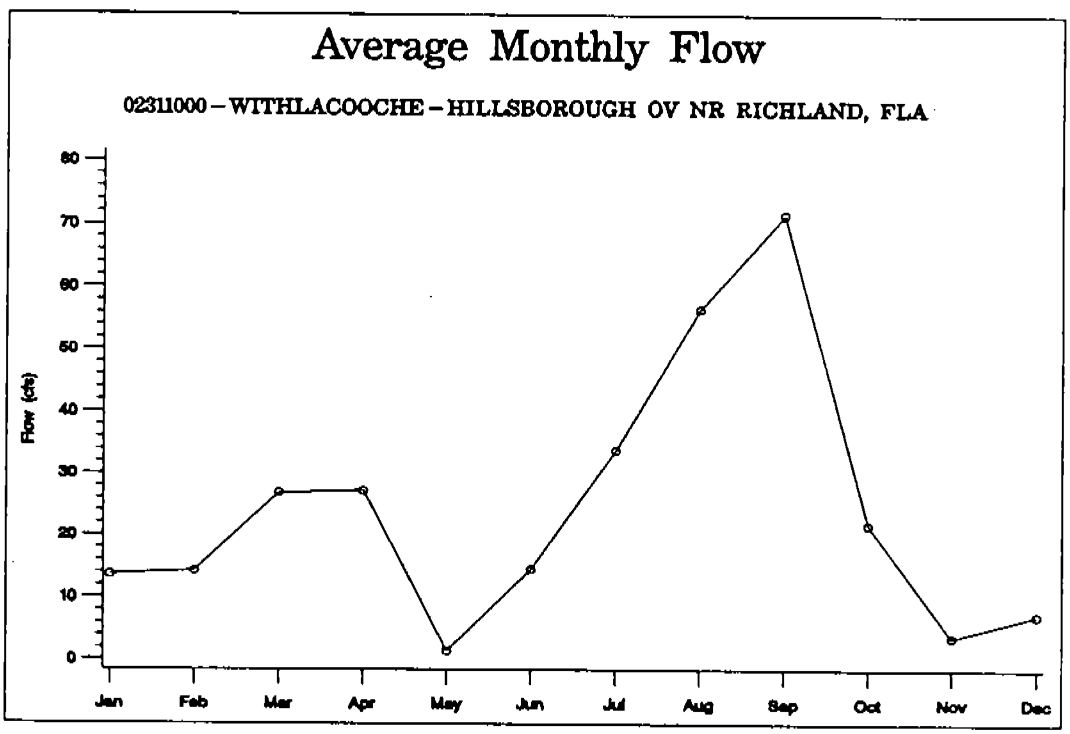

Total Annual Flow
02310800 - WITHLACOOCHEE RIVER NR EVA, FLA.
Flow (cfs)
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

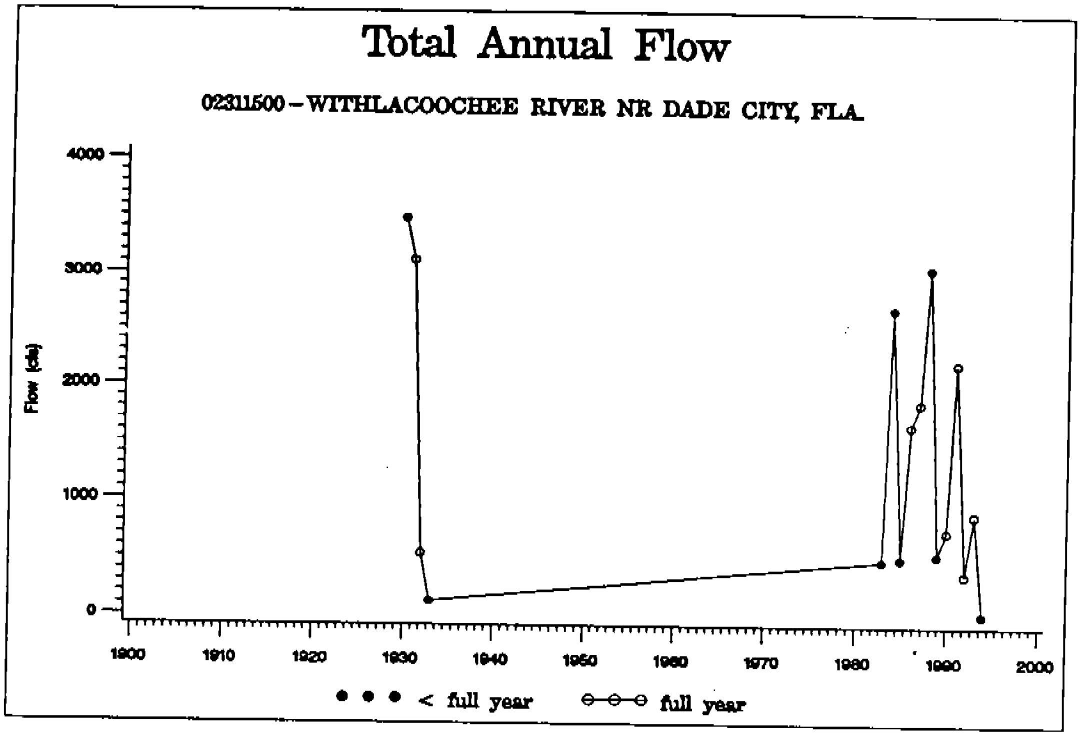

Average Monthly Flow
02310800 - WITHLACOOCHEE RIVER NR EVA, FLA.
Flow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

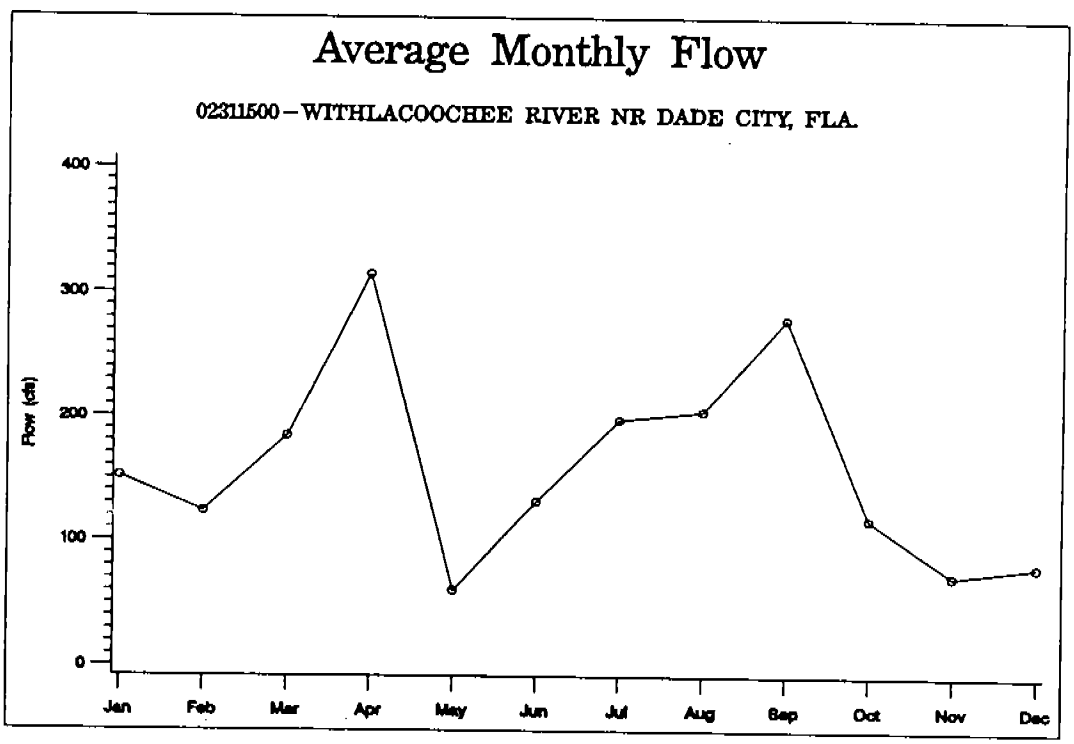

Total Annual Flow
02310947 – WITHLACOOCHEE RIVER NEAR CUMPRESSCO, FLA.
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

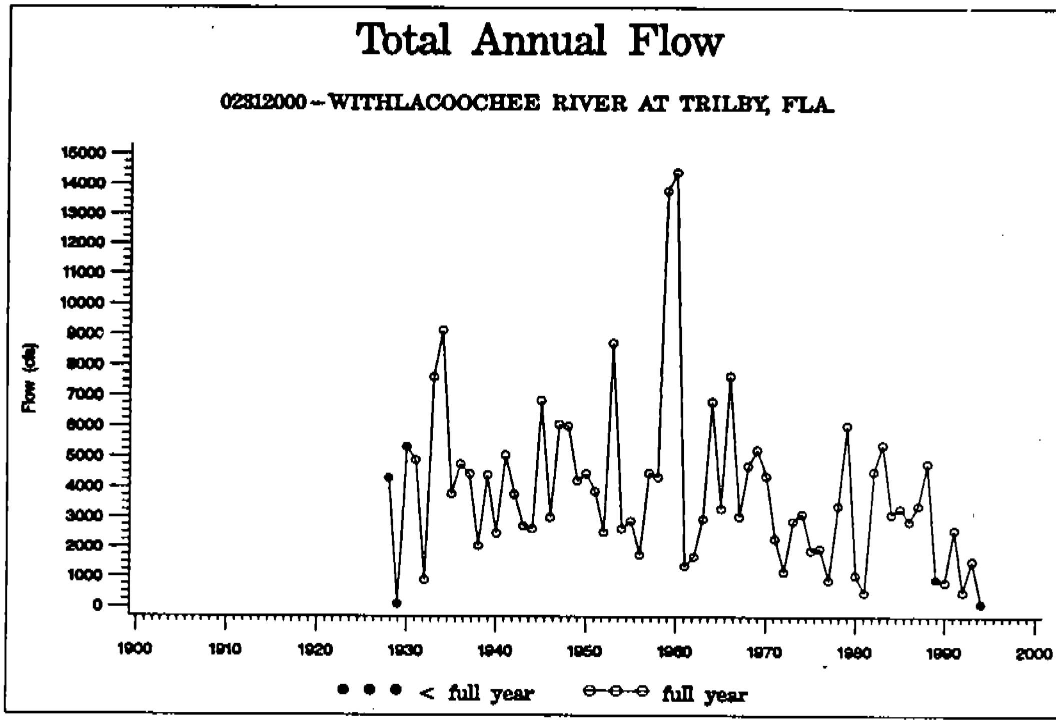

Average Monthly Flow
02310947 – WITHLACOOCHEE RIVER NEAR CUMPRESSCO, FLA.
Flow (cfs)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

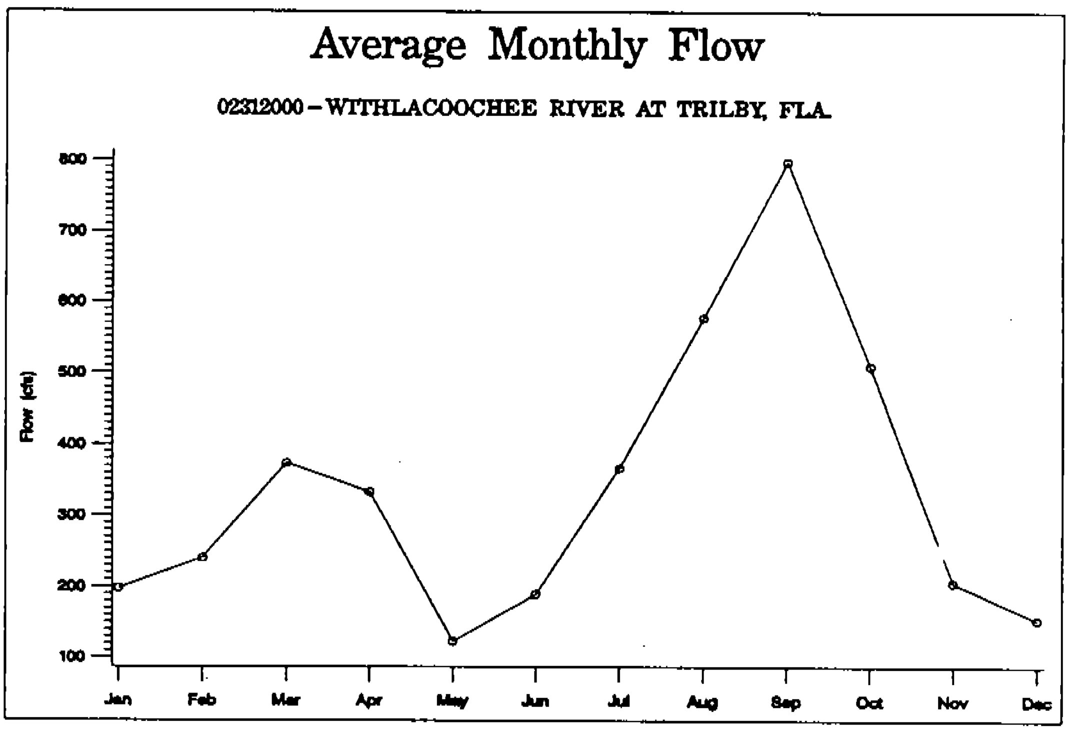

Total Annual Flow
02311000 – WITHLACOOCHE – HILLSBOROUGH OV NR RICHLAND, FLA
Flow (cfs)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

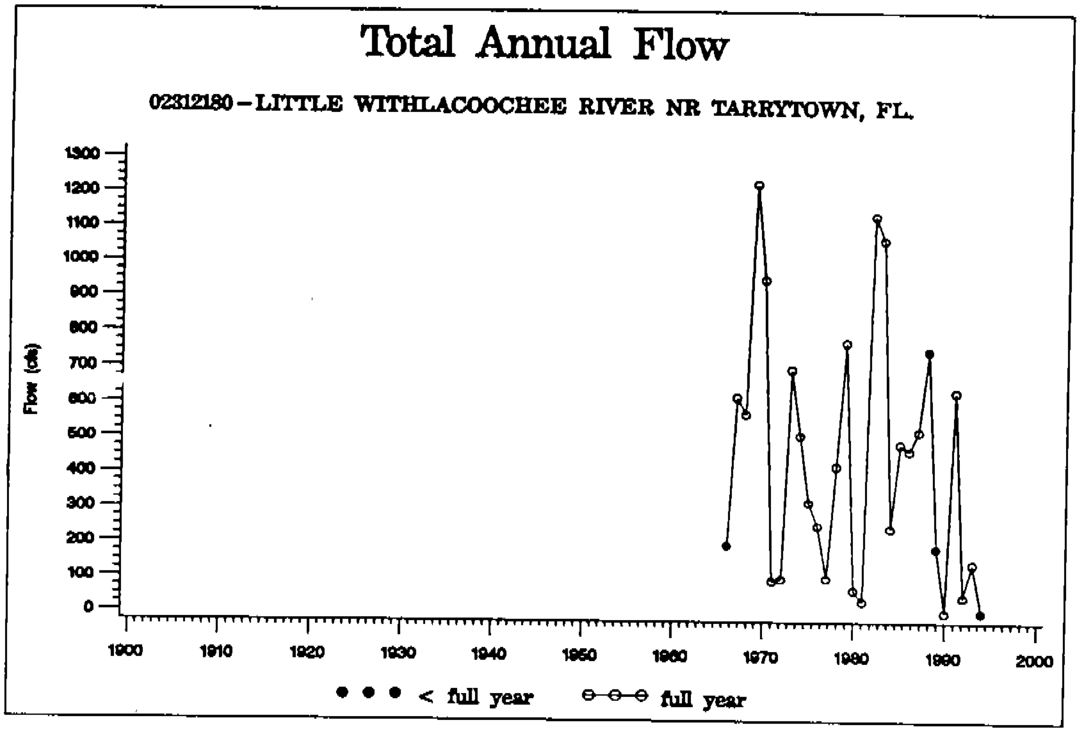

Average Monthly Flow
02311000 – WITHLACOOCHE – HILLSBOROUGH OV NR RICHLAND, FLA
Flow (cfs)
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

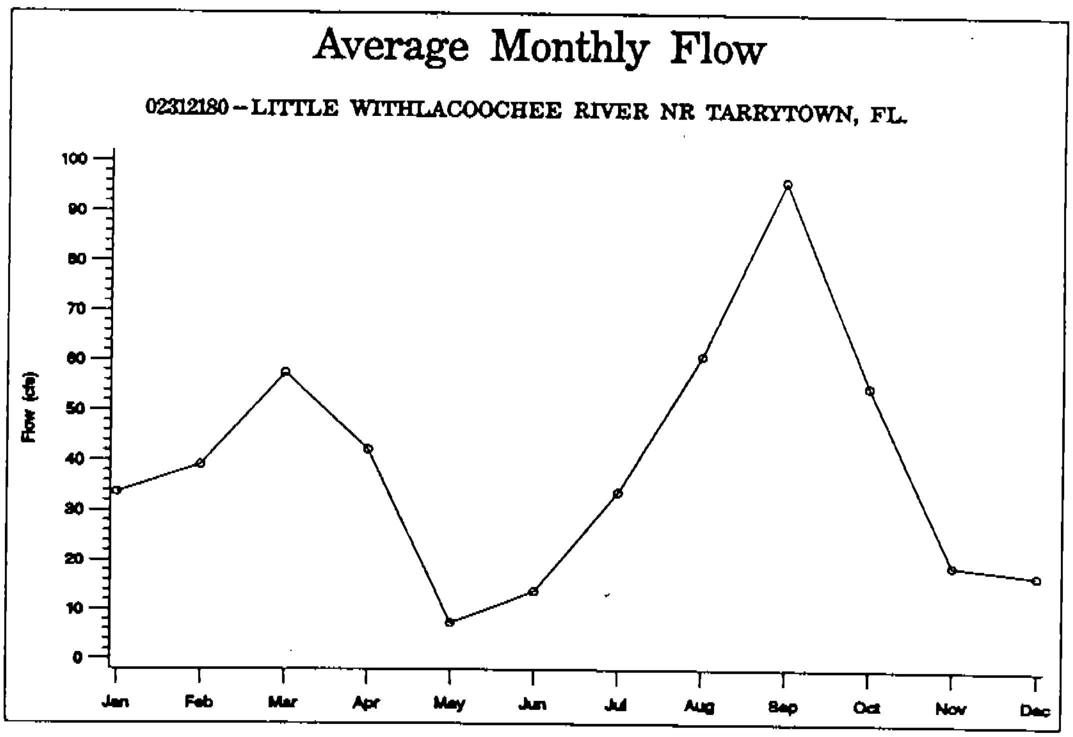

Total Annual Flow
02311500 – WITHLACOOCHEE RIVER NR DADE CITY, FLA.
Flow (cfs)
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

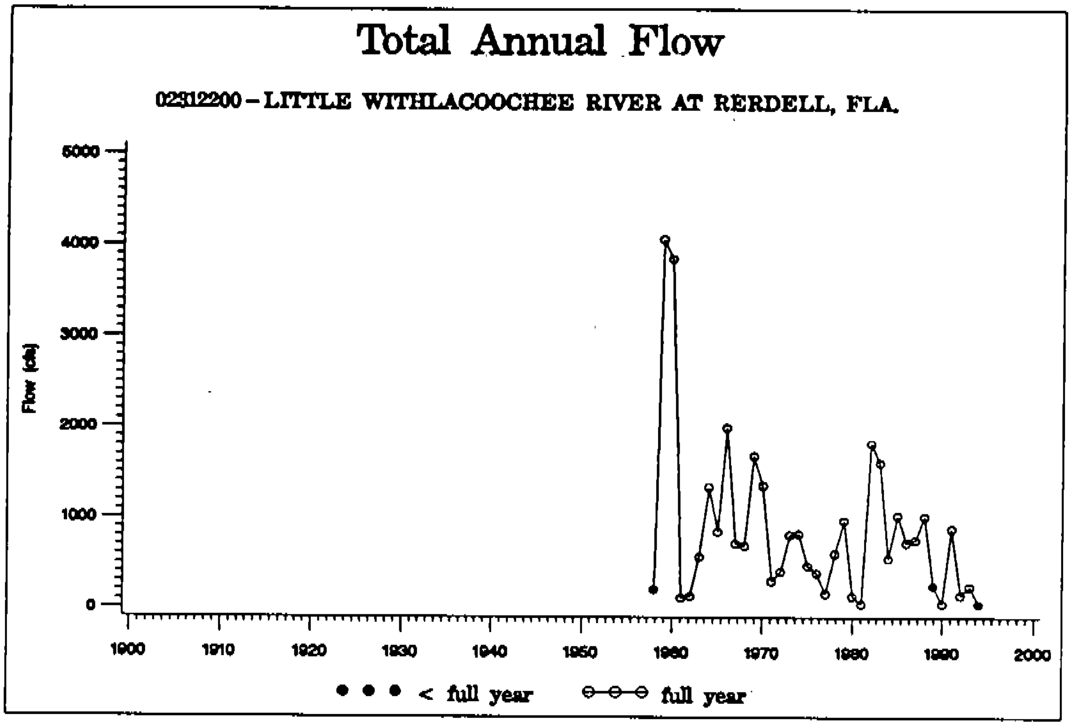

Average Monthly Flow
02311500 – WITHLACOOCHEE RIVER NR DADE CITY, FLA.
Flow (cfs)
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

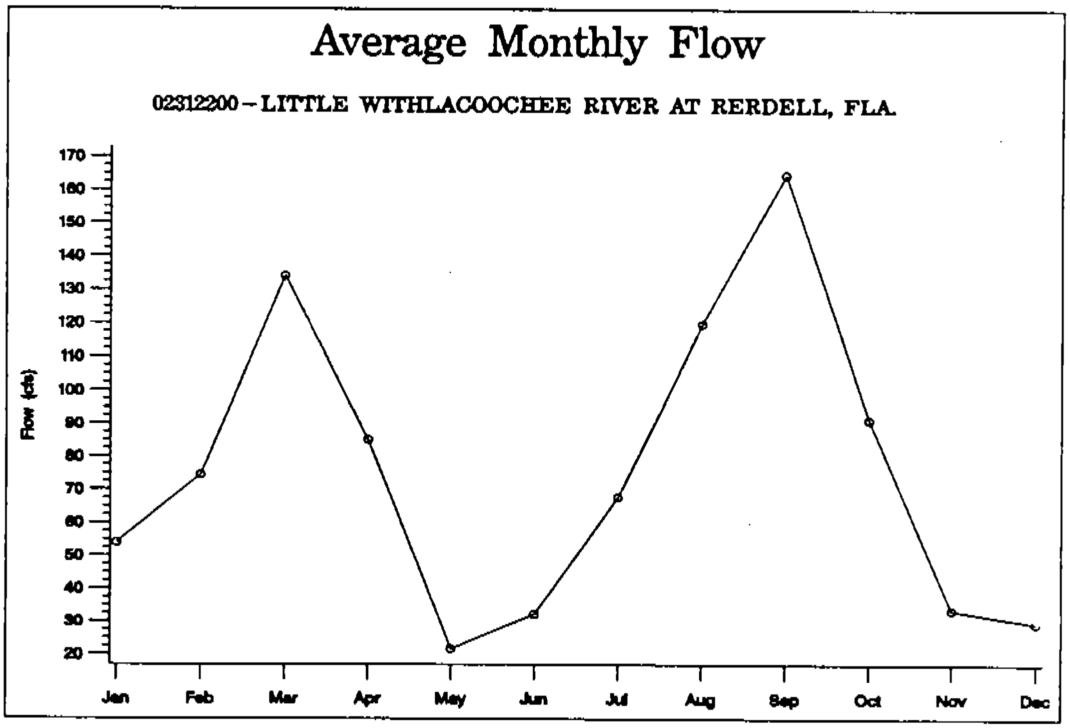

Total Annual Flow
02312000 - WITHLACOOCHEE RIVER AT TRILBY, FLA.
Flow (cfs)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

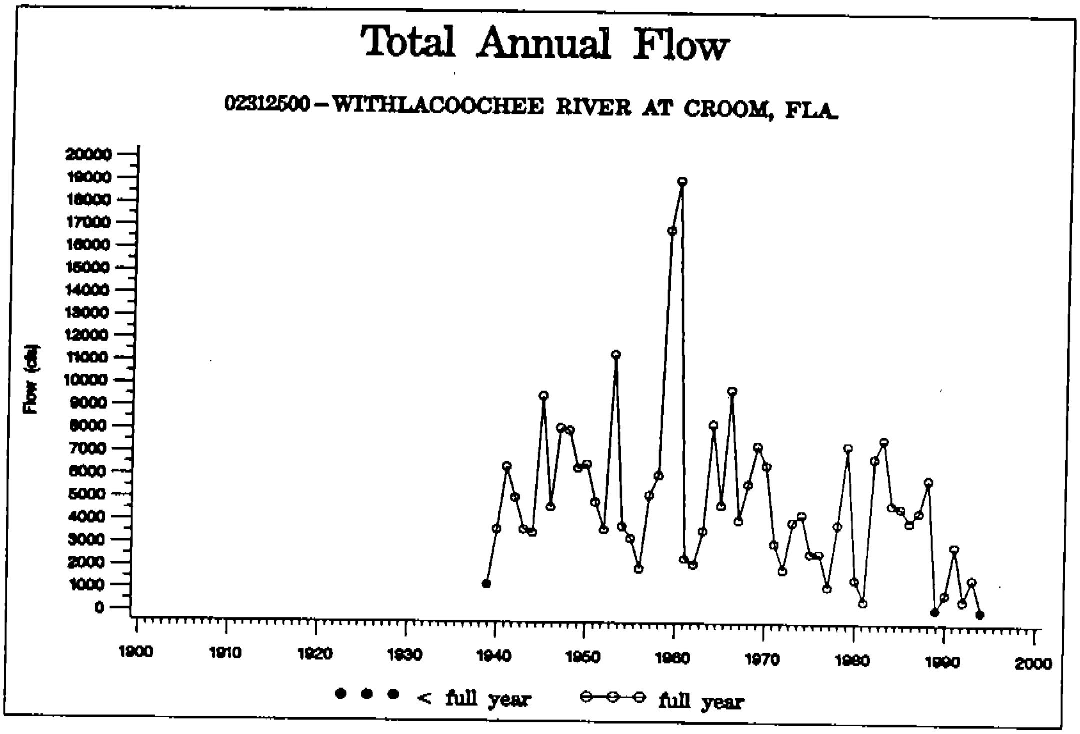

Average Monthly Flow
02312000 - WITHLACOOCHEE RIVER AT TRILBY, FLA.
Flow (cfs)
100
200
300
400
500
600
700
800
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

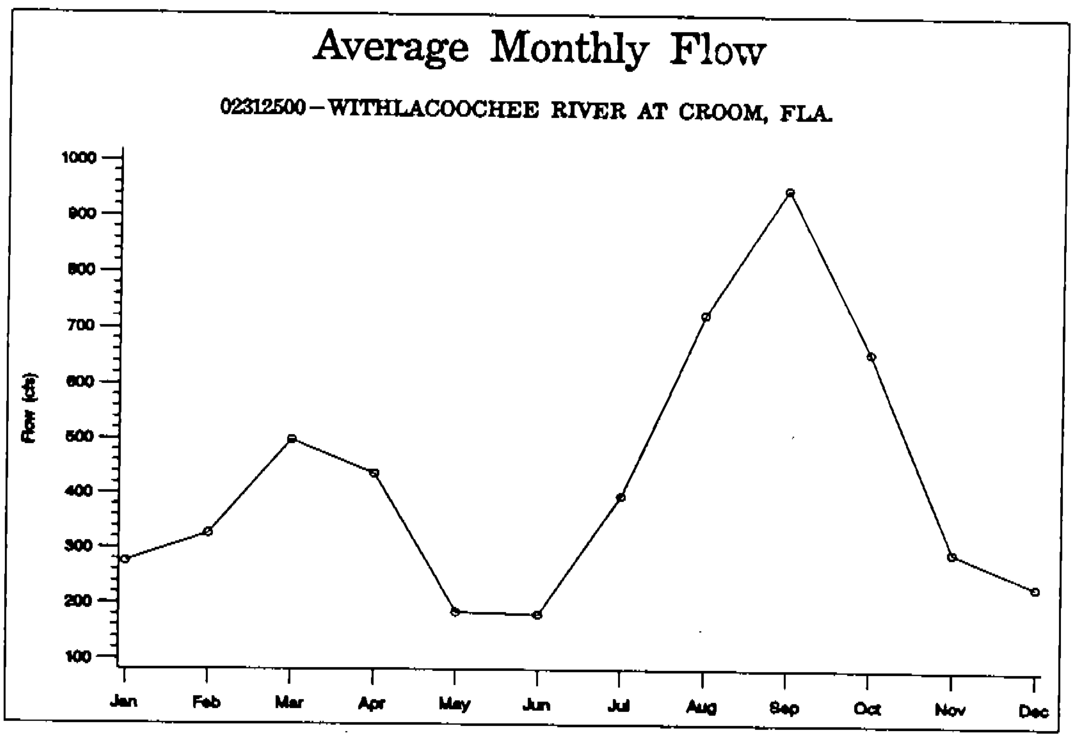

Total Annual Flow
02312180 – LITTLE WITHLACOOCHEE RIVER NR TARRYTOWN, FL.
Flow (cfs)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

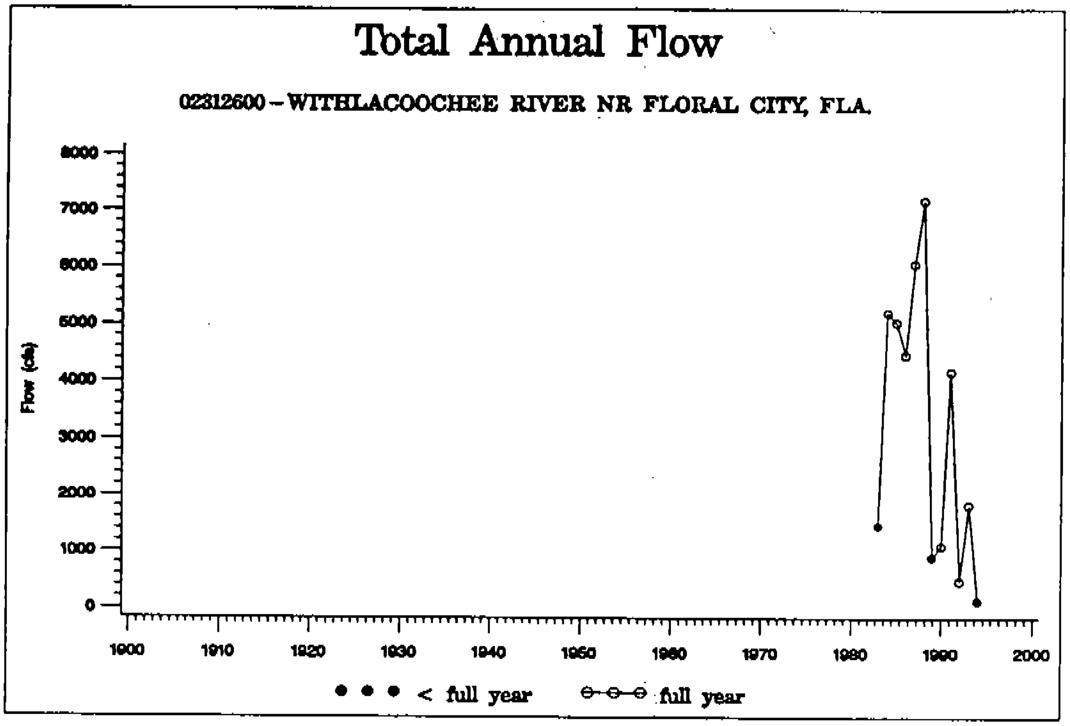

Average Monthly Flow
02312180 – LITTLE WITHLACOOCHEE RIVER NR TARRYTOWN, FL.
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02312200 – LITTLE WITHLACOOCHEE RIVER AT RERDELL, FLA.
Flow (cfs)
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

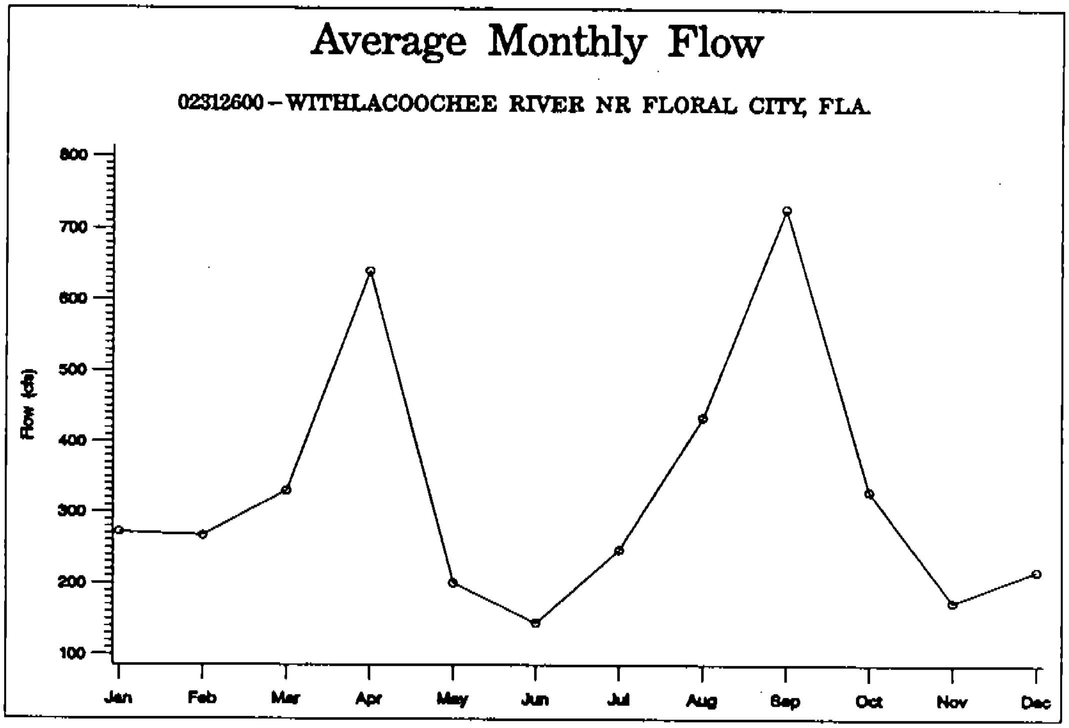

Average Monthly Flow
02312200 – LITTLE WITHLACOOCHEE RIVER AT RERDELL, FLA.
Flow (cfs)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02312500 – WITHLACOOCHEE RIVER AT CROOM, FLA.
Flow (cfs)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
18000
19000
20000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

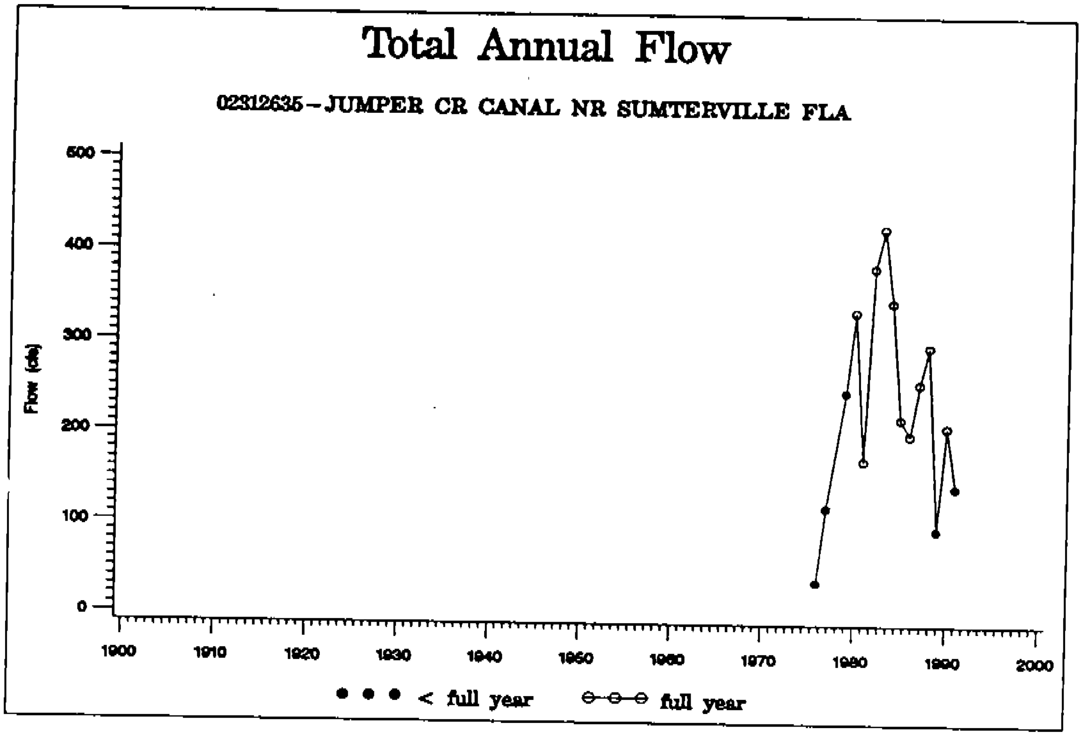

Average Monthly Flow
02312500 – WITHLACOOCHEE RIVER AT CROOM, FLA.
Flow (cfs)
100
200
300
400
500
600
700
800
900
1000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

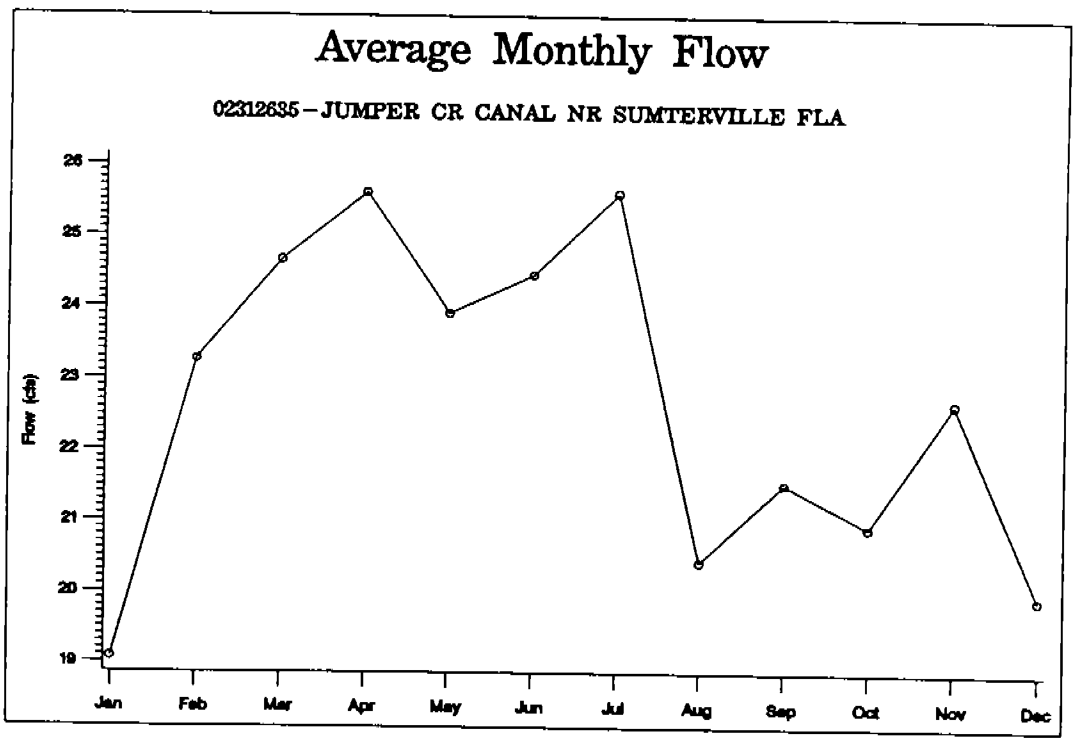


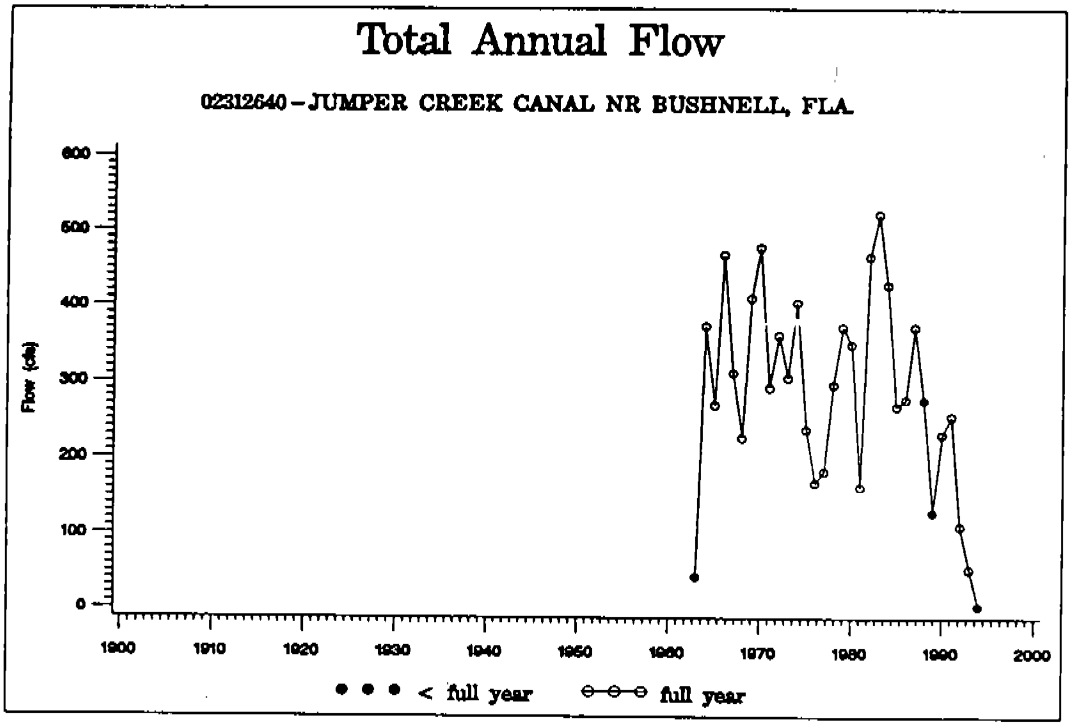
Total Annual Flow
02312600 – WITHLACOOCHEE RIVER NR FLORAL CITY, FLA.
Flow (cfs)
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

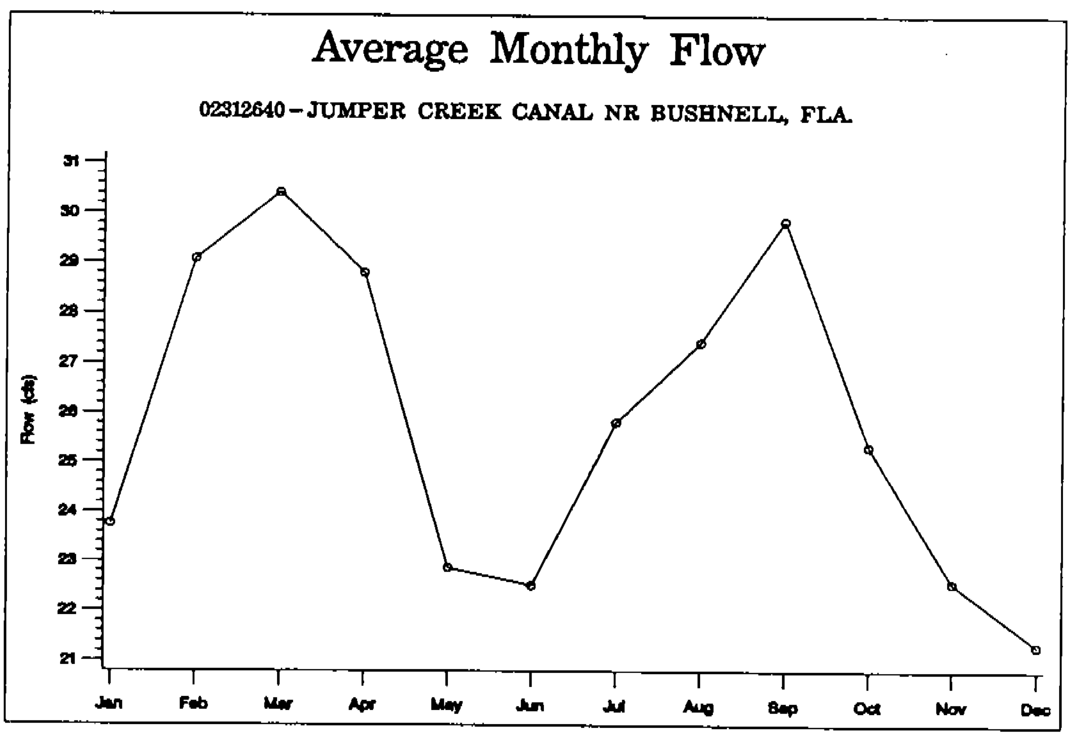


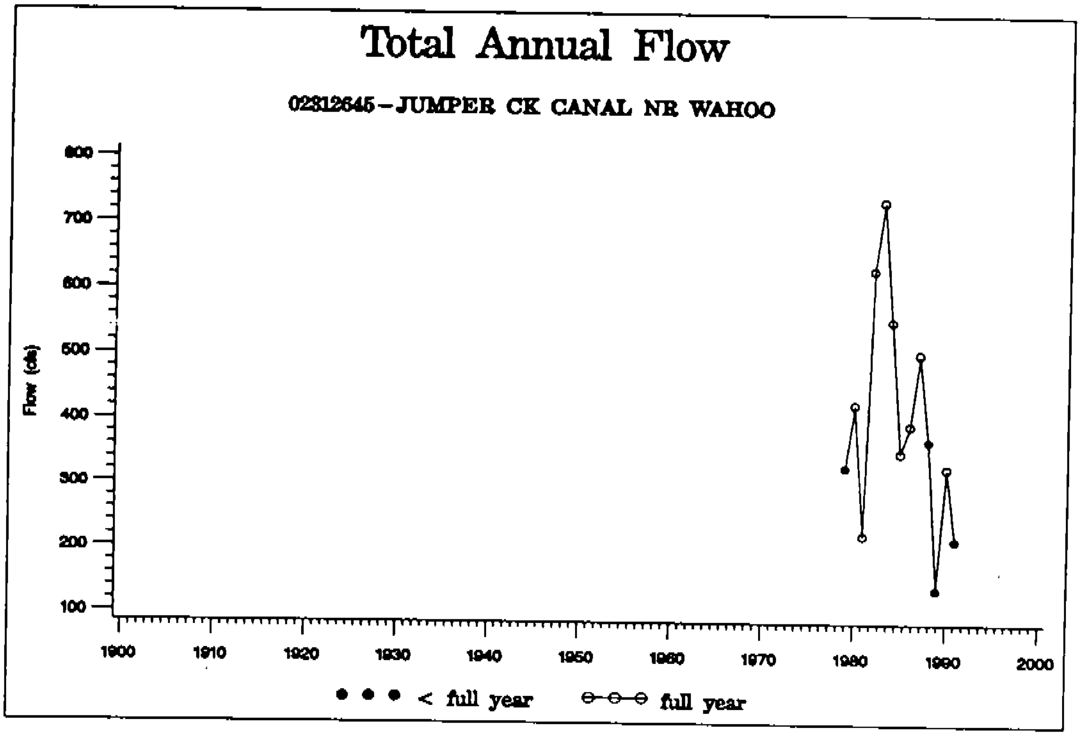
Average Monthly Flow
02312600 – WITHLACOOCHEE RIVER NR FLORAL CITY, FLA.
Flow (cfs)
800
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

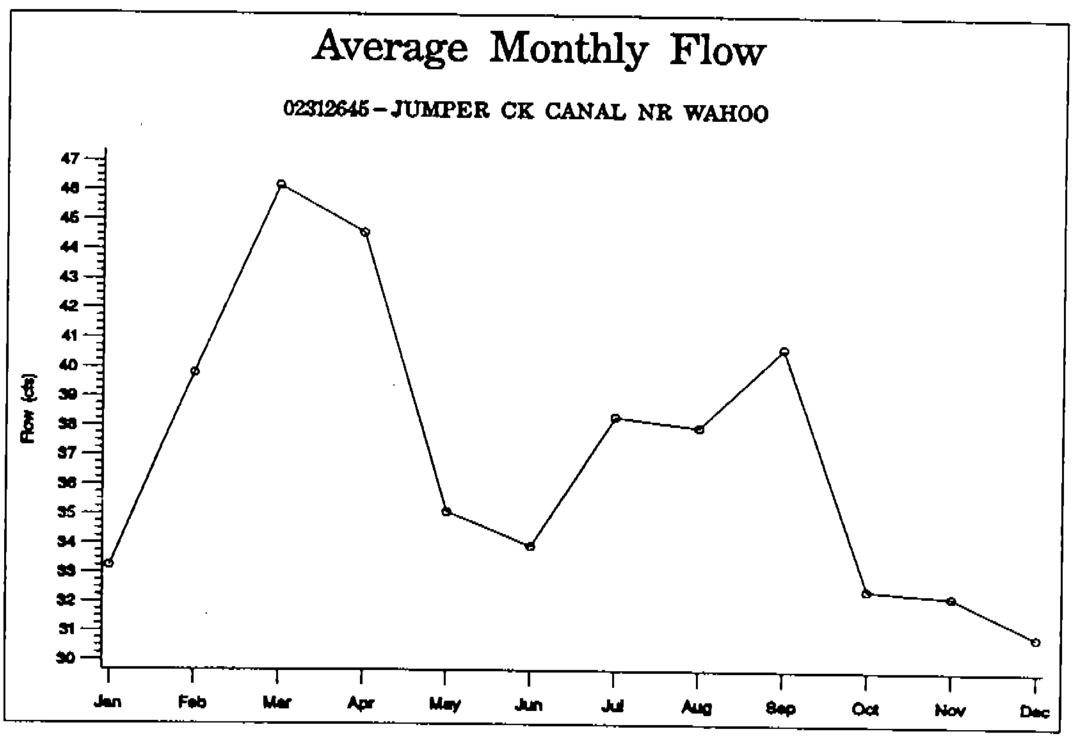

Total Annual Flow
02312635 - JUMPER CR CANAL NR SUMTERVILLE FLA
Flow (cfs)
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

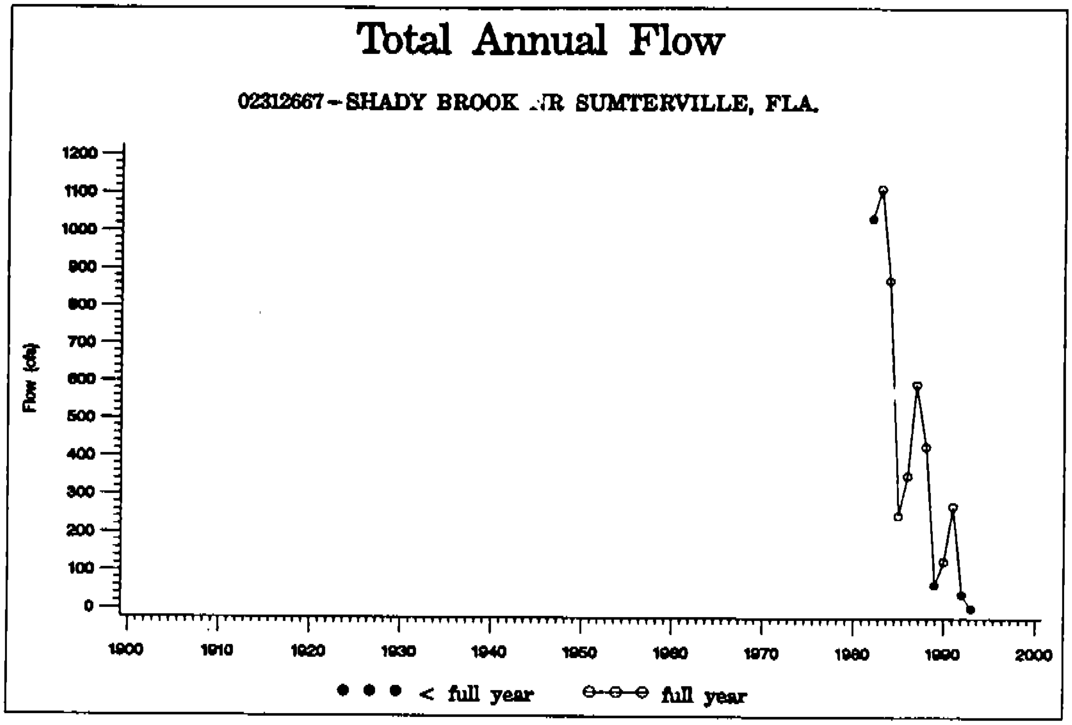

Average Monthly Flow
02312635 - JUMPER CR CANAL NR SUMTERVILLE FLA
Flow (cfs)
26
25
24
23
22
21
20
19
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02312640 – JUMPER CREEK CANAL NR BUSHNELL, FLA.
Flow (cfs)
0
100
200
300
400
500
600
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

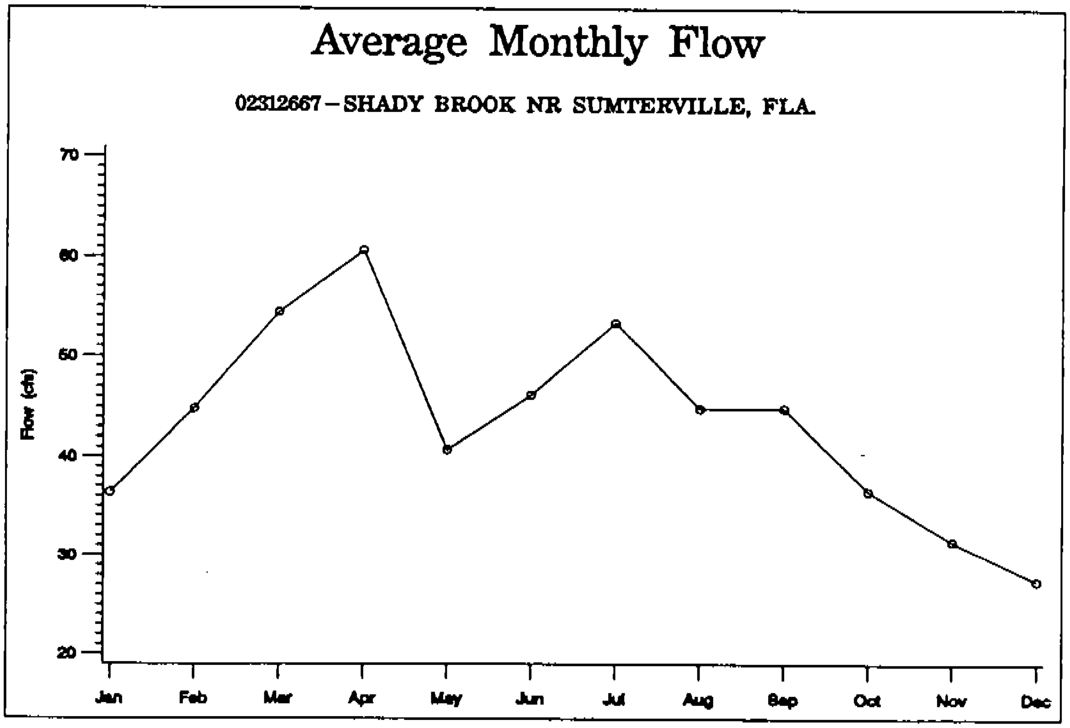

Average Monthly Flow
02312640 – JUMPER CREEK CANAL NR BUSHNELL, FLA.
Flow (cfs)
21
22
23
24
25
26
27
28
29
30
31
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02312645 - JUMPER CK CANAL NR WAHOO
Flow (cfs)
800
700
600
500
400
300
200
100
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Flow
02312645 - JUMPER CK CANAL NR WAHOO
Flow (cfs)
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



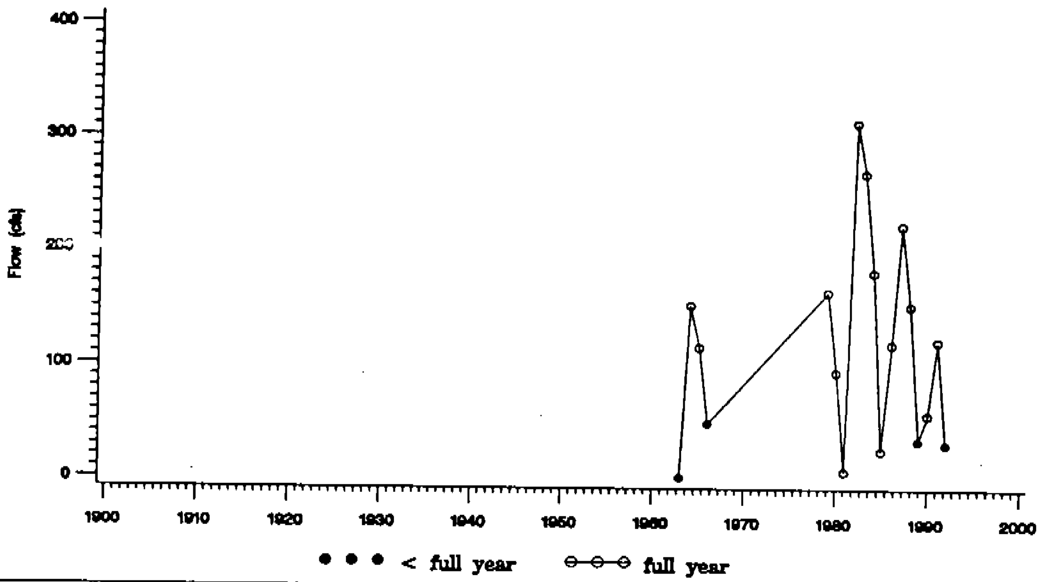
Total Annual Flow
02312667—SHADY BROOK NR SUMTERVILLE, FLA.
Flow (cfs)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Flow
02312667—SHADY BROOK NR SUMTERVILLE, FLA.
Flow (cfs)
70
60
50
40
30
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

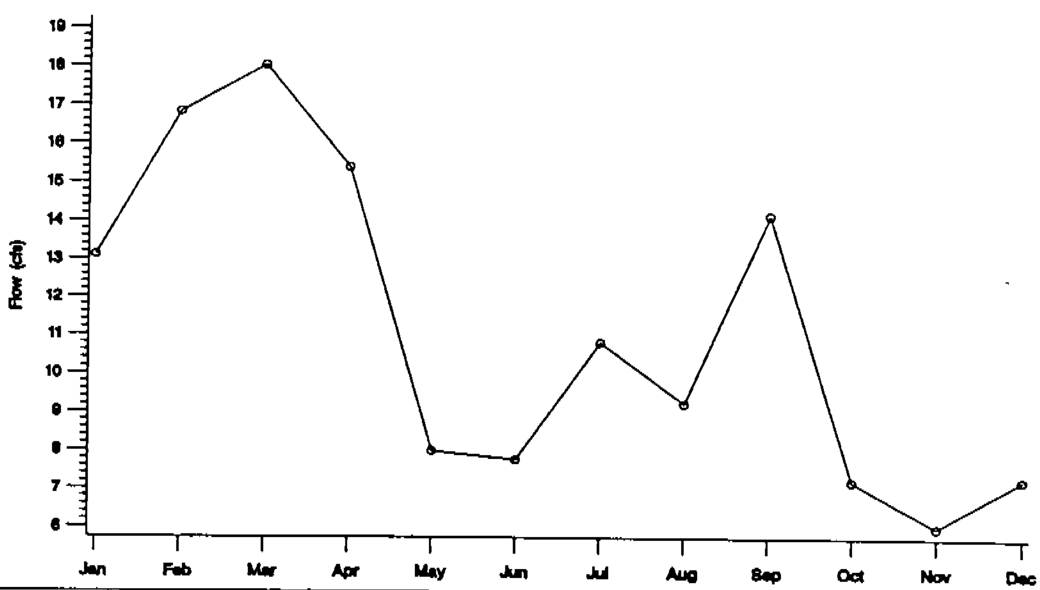
Total Annual Flow

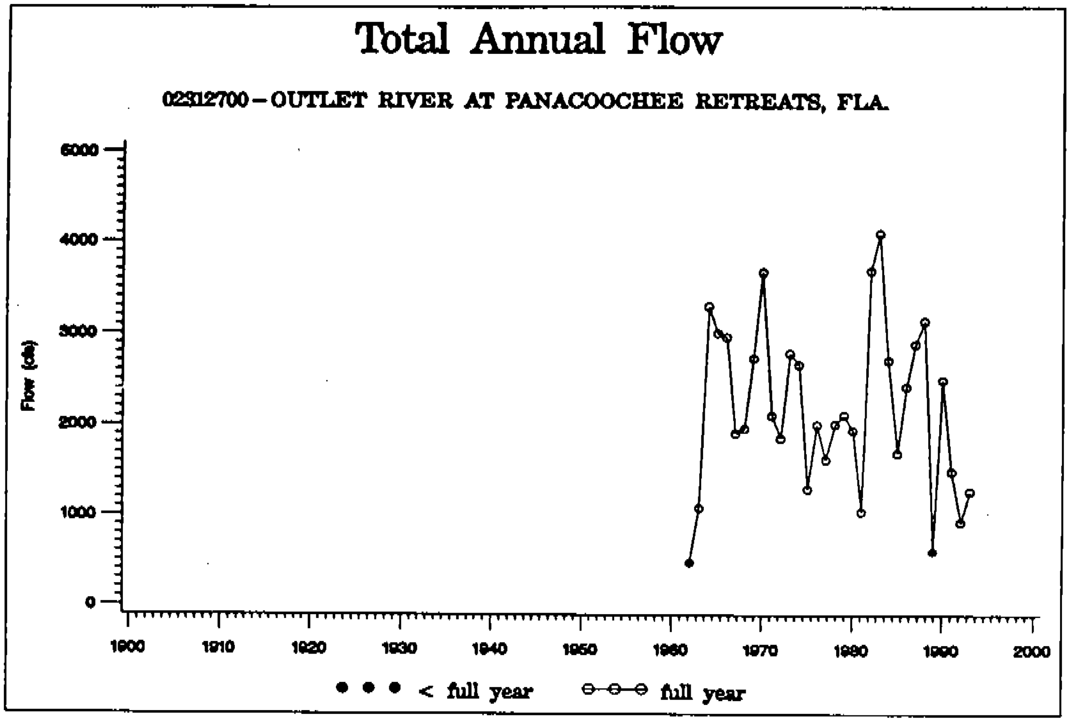
02312690 - CHITTY CHATTY CREEK NR WILDWOOD, FLA.

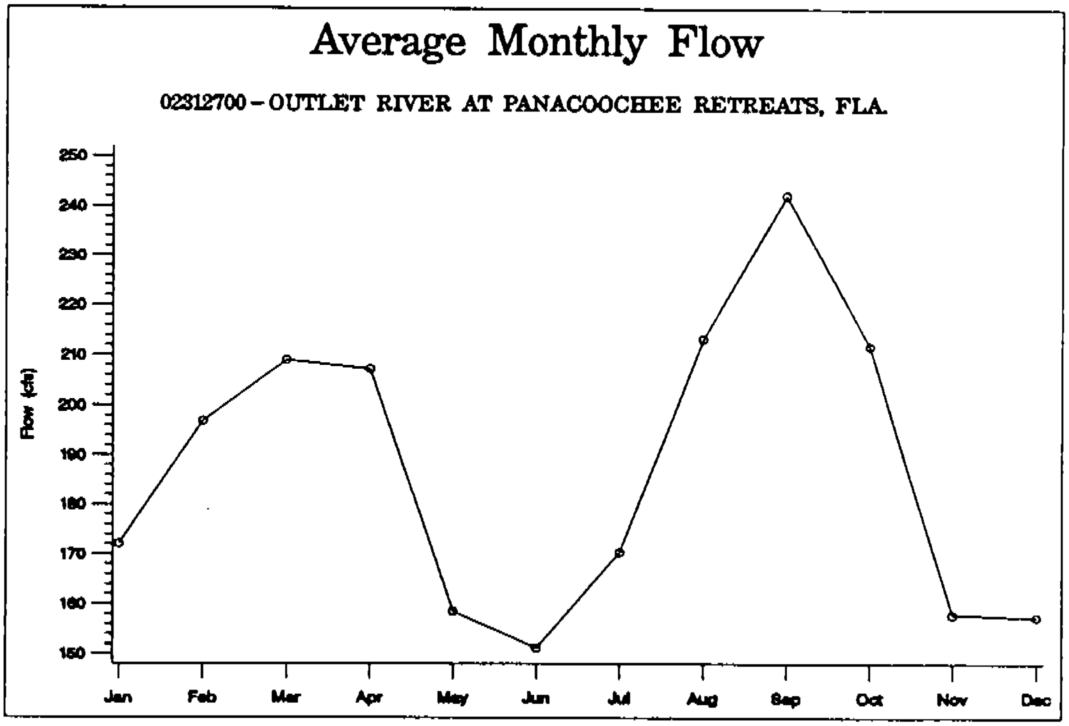


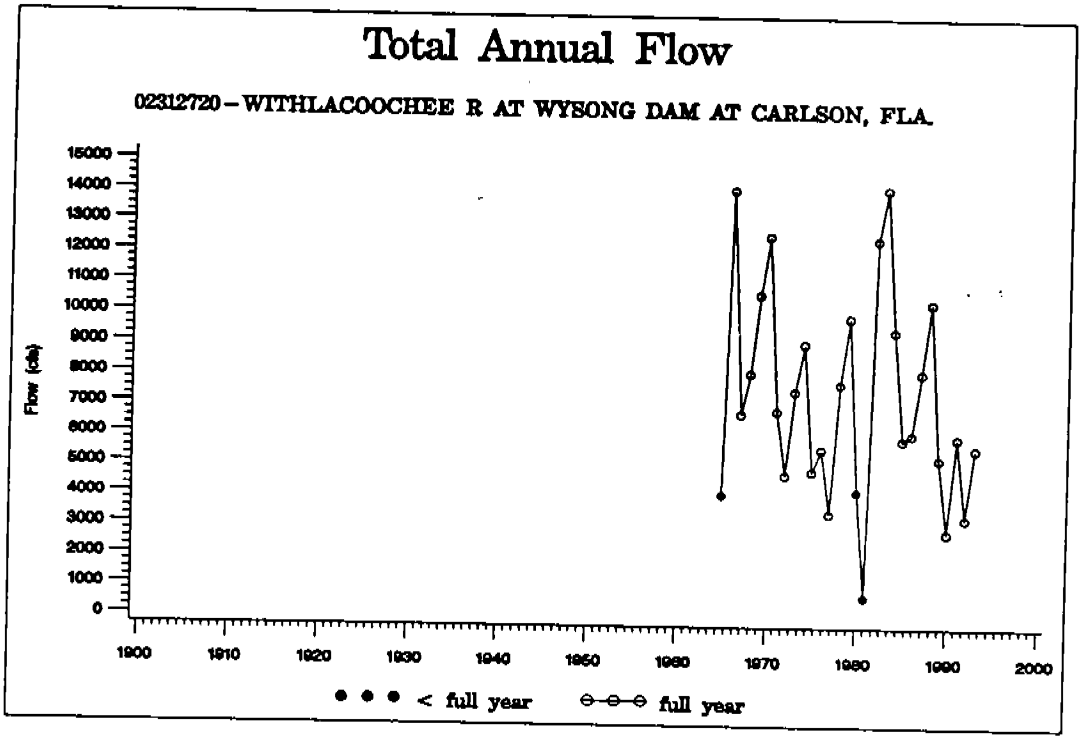
Average Monthly Flow

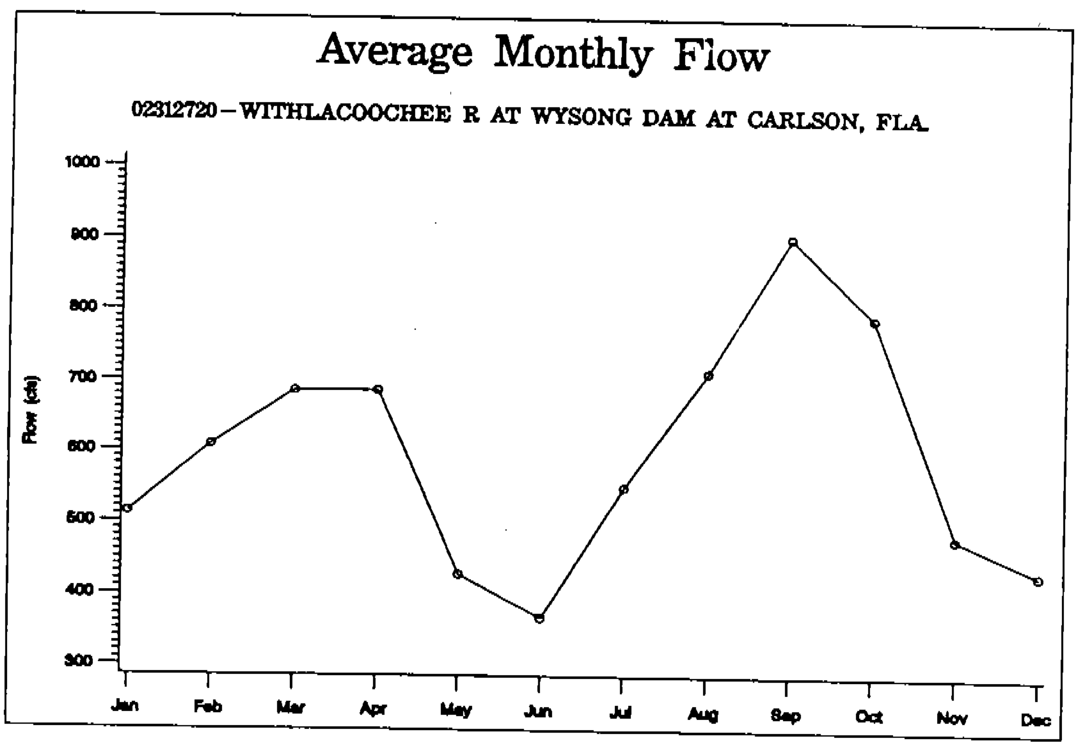
02312690 - CHITTY CHATTY CREEK NR WILDWOOD, FLA.

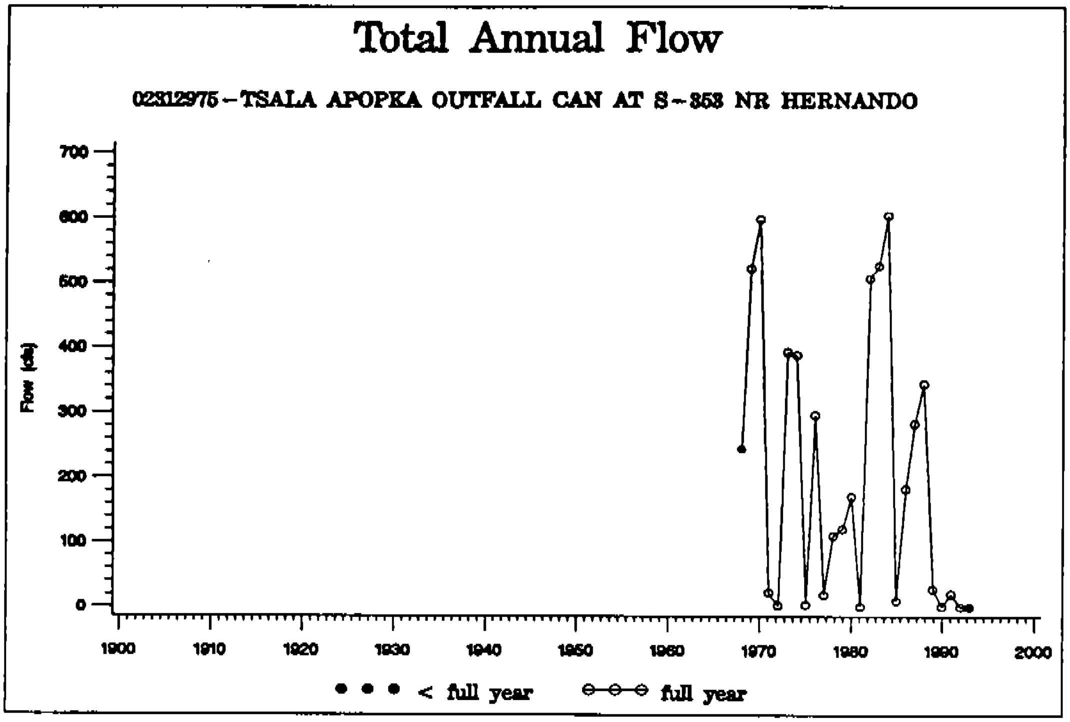


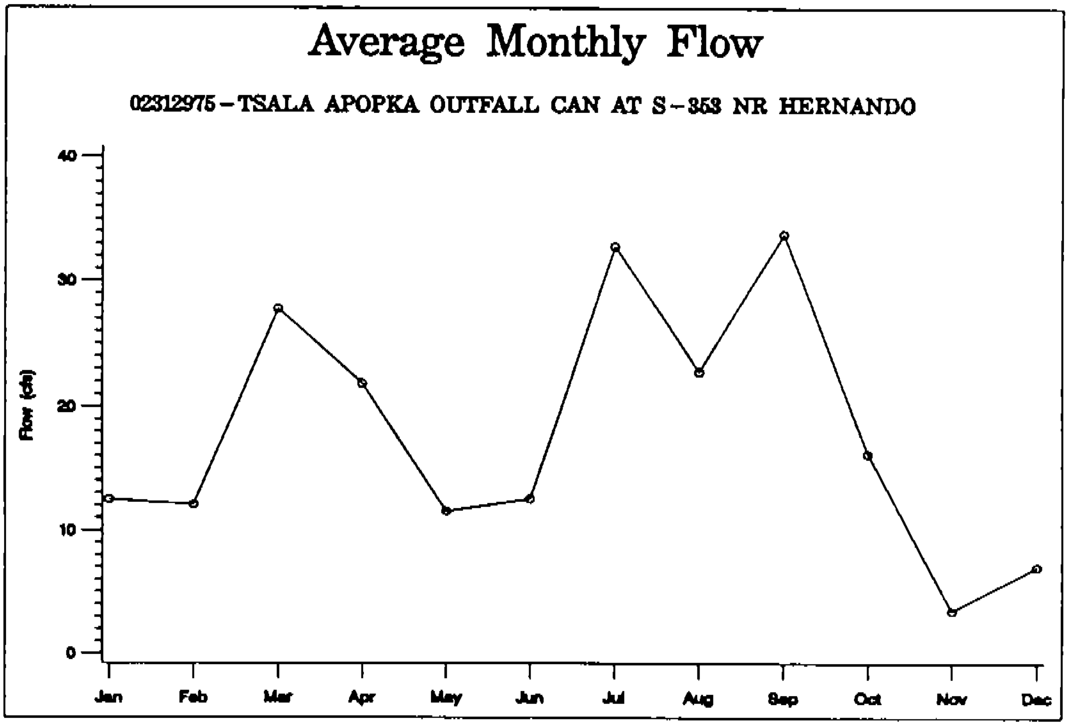

Total Annual Flow
02312700 - OUTLET RIVER AT PANACOOCHEE RETREATS, FLA.
Flow (cfs)
0
1000
2000
3000
4000
5000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

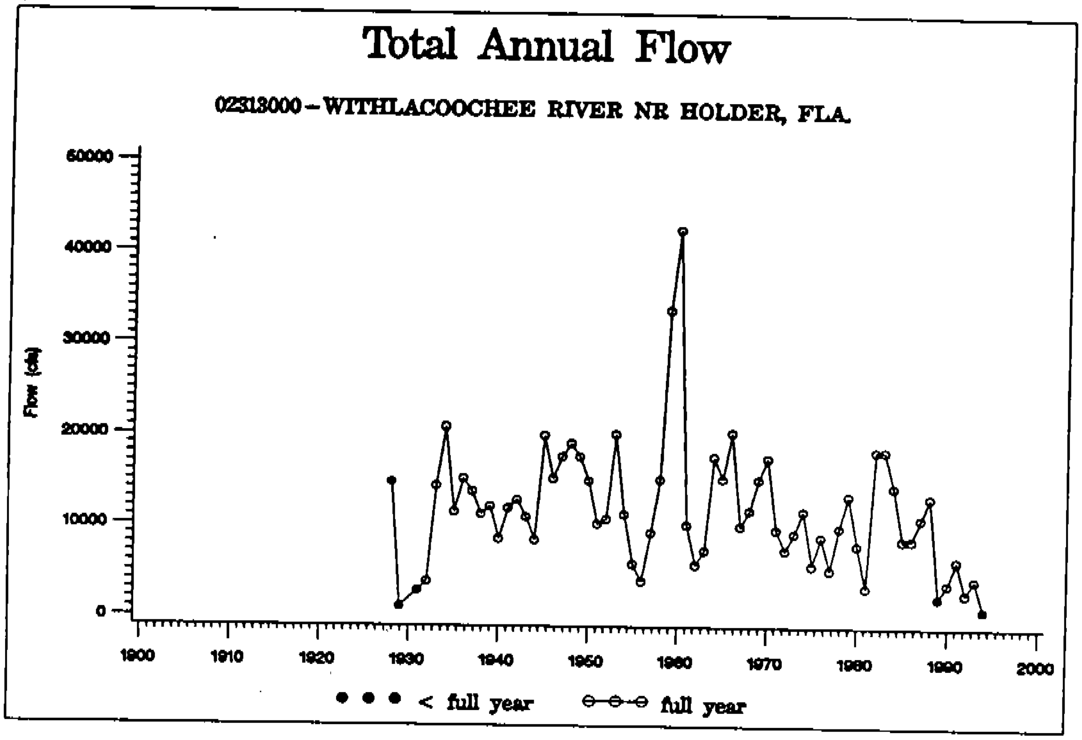

Average Monthly Flow
02312700 - OUTLET RIVER AT PANACOOCHEE RETREATS, FLA.
Flow (cfs)
150
160
170
180
190
200
210
220
230
240
250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02312720 – WITHLACOOCHEE R AT WYSONG DAM AT CARLSON, FLA.
Flow (cfs)
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year

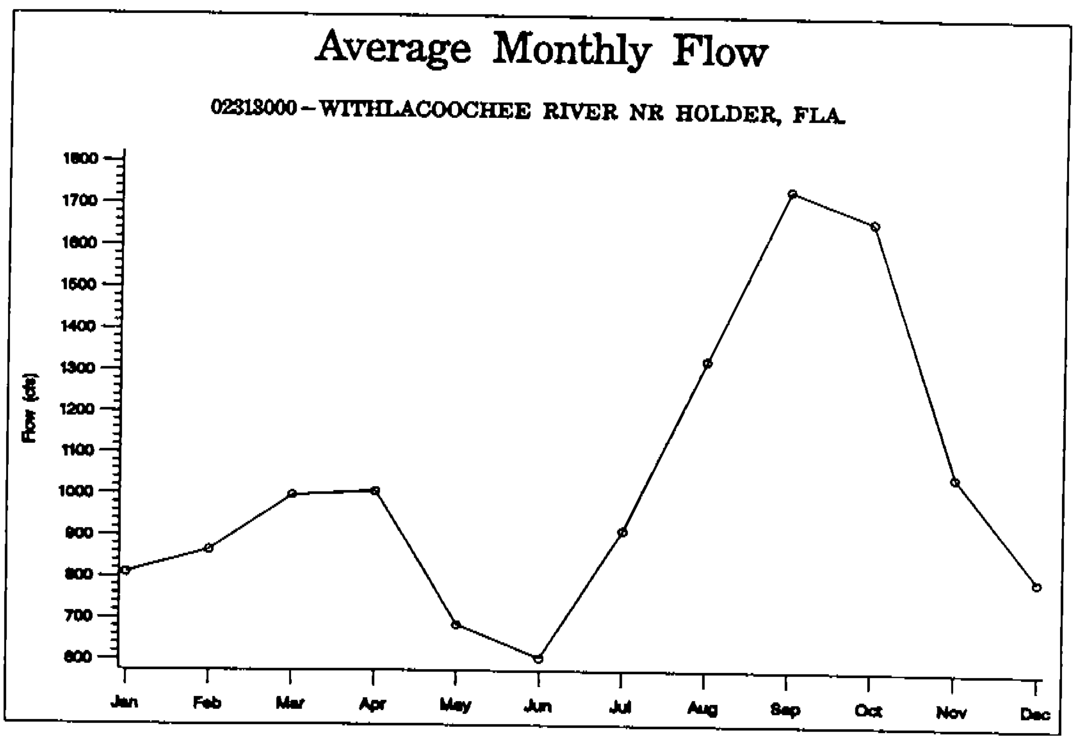

Average Monthly Flow
02312720 – WITHLACOOCHEE R AT WYSONG DAM AT CARLSON, FLA.
Flow (cfs)
1000
900
800
700
600
500
400
300
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Total Annual Flow
02312975 - TSALA APOPKA OUTFALL CAN AT S-353 NR HERNANDO
Flow (cfs)
700
600
500
400
300
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year


Average Monthly Flow
02312975 - TSALA APOPKA OUTFALL CAN AT S-353 NR HERNANDO
Flow (cfs)
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Total Annual Flow
02313000 – WITHLACOOCHEE RIVER NR HOLDER, FLA.
Flow (cfs)
60000
40000
30000
20000
10000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
< full year
full year



Average Monthly Flow
02313000 – WITHLACOOCHEE RIVER NR HOLDER, FLA.
Flow (cfs)
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Appendix C

Surface water quality summaries for basins within the Charlotte Harbor Study Area

Myakka River Basin
Peace River Basin
Charlotte Harbor Basin
Pine Island/ Matlacha Pass Basin
Caloosahatchee River Basin
Estero Bay Basin
Coastal Venice Basin

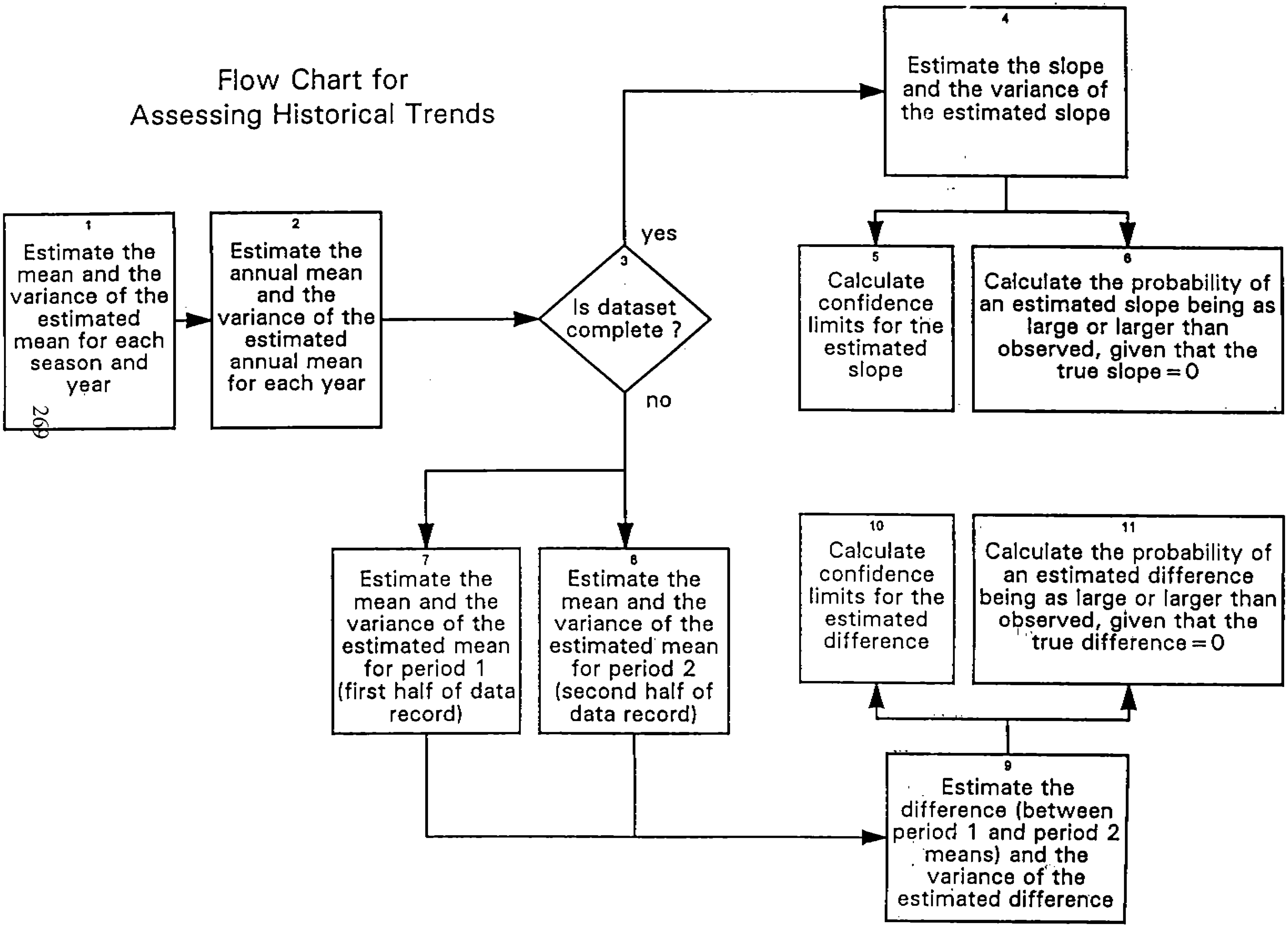
Trend Analysis Procedures

The procedures used to statistically test for the presence of trends were developed for the Florida Department of Environmental Protection's Surface Water Ambient Monitoring Program (Coastal Environmental, 1996). Depending on the observed distribution of the sampling frequency, the software tests for the presence of seasonally adjusted trends either: 1) over the entire sampling record, or; 2) by dividing and statistically comparing estimated slopes between two different periods within the data. The following series of figures outline the series of procedures and statistical protocols used by the Trend Analysis Procedure.

Trend Analysis

The procedures used to statistically test for the presence of trends were developed for the Florida Department of Environmental Protection's Surface Water Ambient Monitoring Program (Coastal Environmental, 1996). Depending on the observed distribution of the sampling frequency, the software tests for the presence of seasonally adjusted trends either: 1) over the entire sampling record, or; 2) by dividing and statistically comparing estimated slopes between two different periods within the data. The following series of figures outline the series of procedures and statistical protocols used by the Trend Analysis Procedure.

Flow Chart for Assessing Historical Trends



Formulae for Assessing Historical Trends	
1. Estimate the mean (for response variable, y_{ist}) and variance of the estimated mean for each season (s) and year (t) [the subscript, i, denotes sample number within season and year]	$\bar{y}_{st} = \frac{1}{n_{st}} \sum_{i=1}^{n_{st}} y_{ist}$ $\hat{var}(\bar{y}_{st}) = \frac{1}{n_{st}} \sum_{i=1}^{n_{st}} \frac{(y_{ist} - \bar{y}_{st})^2}{n_{st} - 1}$ n_{st} = number of samples collected in season s in year t
2. Estimate the annual mean and the variance of the estimated annual mean for each year [for this example, 3 seasons per year are assumed]	$\bar{y}_t = \frac{\sum_{s=1}^{3} w_s \times \bar{y}_{st}}{\sum_{s=1}^{3} w_s}$ $\hat{var}(\bar{y}_t) = \frac{\sum_{s=1}^{3} w_s^2 \times \hat{var}(\bar{y}_{st})}{\left[\sum_{s=1}^{3} w_s\right]^2}$ w_s = duration of season s
3. Is the dataset complete?	If there are no missing estimated means and no missing estimated variances for all M years within the range of years of study, then the dataset is complete. If any estimates are missing within the range of years of study, then the dataset is incomplete.

Formulae for Assessing Historical Trends	
4. Estimate the slope and the variance for the estimated slope	$\beta = \sum_{t=1}^{M} c_t \times \bar{y}_t$ $\hat{var}(\beta) = \sum_{t=1}^{M} c_t^2 \times \hat{var}(\bar{y}_t)$ $c_t = \frac{t - \bar{t}}{\sum_{t=1}^{M} \left(t - \bar{t}\right)^2}$ $\bar{t} = \frac{1}{M} \sum_{t=1}^{M} t$
5. Calculate confidence limits for the estimated slope	$lower\ limit = \beta - \left[1.96 \times \sqrt{\hat{var}(\beta)}\right]$ $upper\ limit = \beta + \left[1.96 \times \sqrt{\hat{var}(\beta)}\right]$
6. Calculate the probability of an estimated slope being as large or larger than observed, given that the true slope=0	$2 \times Pr\left(Z > \left| \frac{\beta}{\sqrt{\hat{var}(\beta)}} \right| \right)$ where Z is a standard Normal random variable

Formulae for
Assessing Historical Trends

7. Estimate the mean and the variance of the estimated mean for period 1 (first half of data record)	$$\bar{y}_1 = \frac{\sum_{t=1}^{M} d_{1t} \times g_t \times \bar{y}_t}{\sum_{t=1}^{M} d_{1t} \times g_t}$$ $$v\hat{a}r(\bar{y}_1) = \left[\frac{1-f_1}{m_1} \times S_1^2\right] + \left[f_1 \times v\hat{a}r_1\right]$$ $$v\hat{a}r_1 = \frac{\sum_{t=1}^{M} (d_{1t} \times g_t)^2 \times v\hat{a}r(\bar{y}_t)}{\left[\sum_{t=1}^{M} d_{1t} \times g_t\right]^2}$$ $$S_1^2 = \frac{\sum_{t=1}^{M} d_{1t} \times g_t \times (\bar{y}_t - \bar{y}_1)^2}{m_1 - 1}$$ $$m_1 = \sum_{t=1}^{M} (d_{1t} \times g_t)$$ $$f_1 = \frac{m_1}{\sum_{t=1}^{M} d_{1t}}$$ d_{1t} = 1 if t < M/2, and d_{1t} = 0 otherwise g_t = 1 if mean and variance estimates are available for year t, and g_t = 1 otherwise

Formulae for Assessing Historical Trends	
8. Estimate the mean and the variance of the estimated mean for period 2 (second half of data record)	$$\bar{y}_2 = \frac{\sum_{t=1}^{M} d_{2t} \times g_t \times \bar{y}_t}{\sum_{t=1}^{M} d_{2t} \times g_t}$$ $$v\hat{a}r\,(\bar{y}_2) = \left[\frac{1-f_2}{m_2} \times S_2^2\right] + \left[f_2 \times v\hat{a}r_2\right]$$ $$v\hat{a}r_2 = \frac{\sum_{t=1}^{M} \left(d_{2t} \times g_t\right)^2 \times v\hat{a}r\,(\bar{y}_t)}{\left[\sum_{t=1}^{M} d_{2t} \times g_t\right]^2}$$ $$S_2^2 = \frac{\sum_{t=1}^{M} d_{2t} \times g_t \times \left(\bar{y}_t - \bar{y}_2\right)^2}{m_2 - 1}$$ $$m_2 = \sum_{t=1}^{M} (d_{2t} \times g_t)$$ $$f_2 = \frac{m_2}{\sum_{t=1}^{M} d_{2t}}$$ d_{2t} = 1 if t > M/2, and d_{2t} = 0 otherwise g_t = 1 if mean and variance estimates are available for year t, and g_t = 1 otherwise

Formulae for Assessing Historical Trends	
9. Estimate the difference (between period1 and period 2 means) and the variance of the estimated difference	$\hat{\Delta} = \bar{y}_1 - \bar{y}_2$ $v\hat{a}r(\hat{\Delta}) = v\hat{a}r(\bar{y}_1) + v\hat{a}r(\bar{y}_2)$
10. Calculate confidence limits for the estimated difference	$lower\ limit = \hat{\Delta} - \left[1.96 \times \sqrt{v\hat{a}r(\hat{\Delta})}\right]$ $upper\ limit = \hat{\Delta} + \left[1.96 \times \sqrt{v\hat{a}r(\hat{\Delta})}\right]$
11. Calculate the probability of an estimated difference being as large or larger than observed, given that the true difference=0	$2 \times Pr\left(Z > \left\| \frac{\hat{\Delta}}{\sqrt{v\hat{a}r(\hat{\Delta})}} \right\|\right)$ where Z is a standard Normal random variable

Myakka River Basin

Trend Analysis of EQL Data from the Lower Myakka River

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Myakka River Basin
EQL DATA

Conductivity (mmhos/cm)

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Lower Myakka River	17	76	94	404	0.78424	3.02965	-1.46116	0.49362

Color (CPU)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	14	5.76253	4.76145	6.76361	0	0.060836	326

Nitrite/Nitrate (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	14	.0031294	.00061497	.0056437	0.014712	0.096188	326

Ortho-Phosphate (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	14	.0040848	.0024474	.0057221	.0000010094	0.016502	326

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Myakka River Basin
EQL DATA

Total Phosphorus (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	14	-.0018006	-.0043726	.00077146	0.17003	-.0060862	321

Turbidity (NTU)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	14	-.0068668	-0.045754	0.032020	0.72926	-.0021008	326

Total Kjeldahl Nitrogen (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	10	0.039975	0.025714	0.054236	.000000039253	0.041351	235

Chlorophyll a (ug/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Myakka River	14	0.63694	0.32279	0.95109	.000070716	0.10835	326

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Myakka River Basin

USGS DATA

Chloride (mg/L)

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Myakka River near Sarasota	8	63	80	83	-0.18139	3.35086	-3.71364	0.91983

Ortho-Phosphate (mg/L)

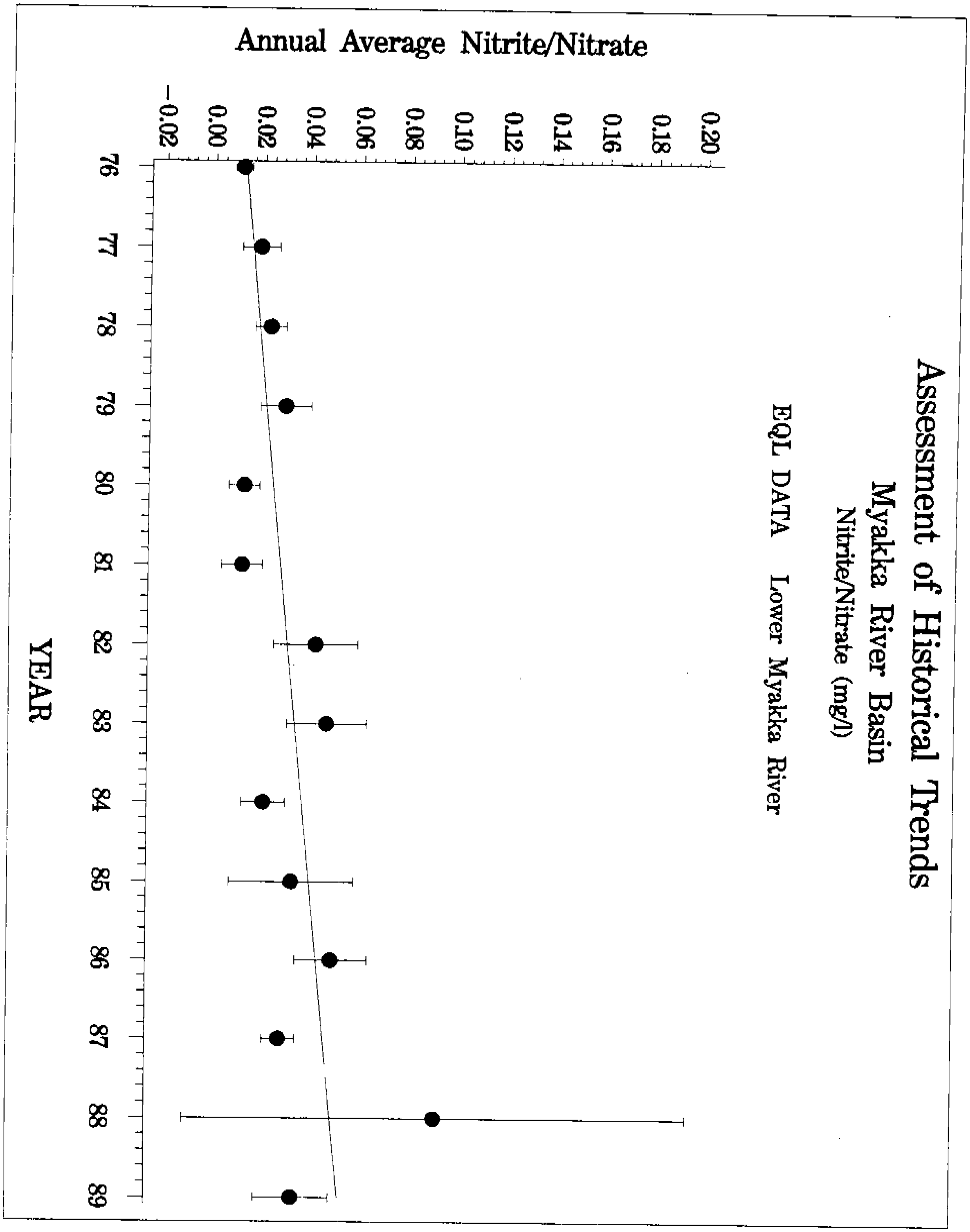
Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Myakka River near Sarasota	7	63	80	75	-0.29503	-0.19034	-0.39973	.000000033284

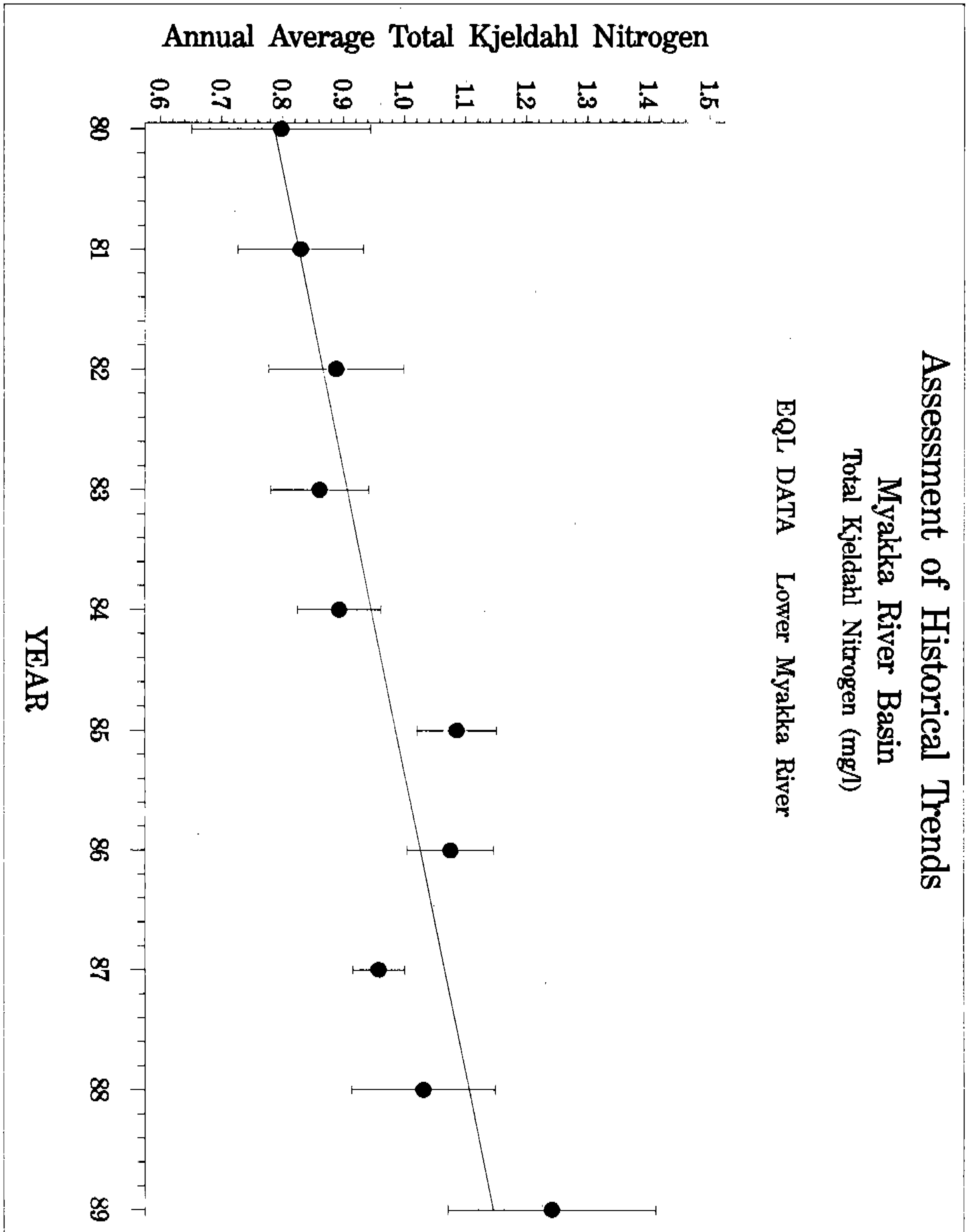
Conductivity (us/cm)

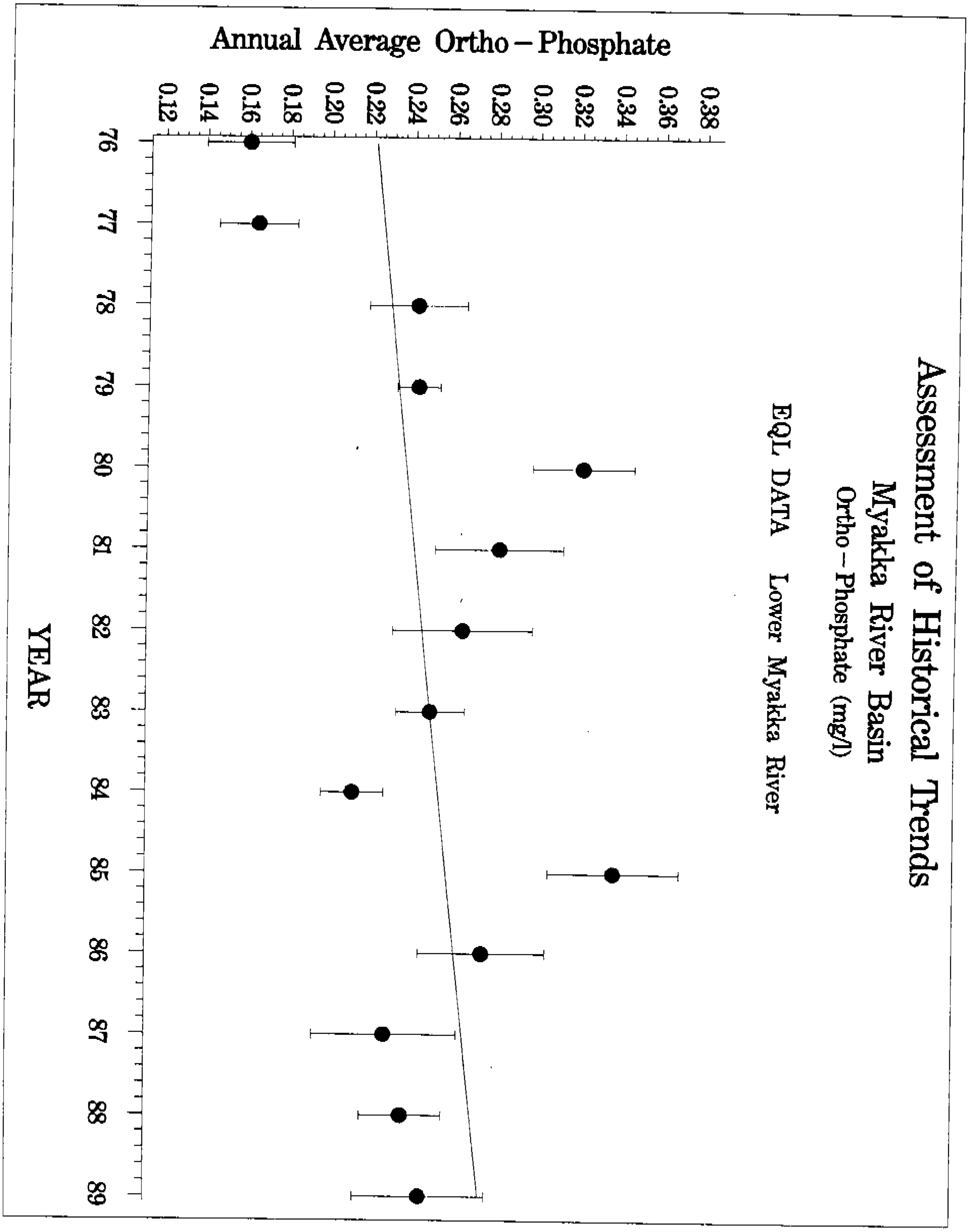
Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Myakka River near Sarasota	10	63	80	96	89.9405	116.876	63.0053	5.9606E-11

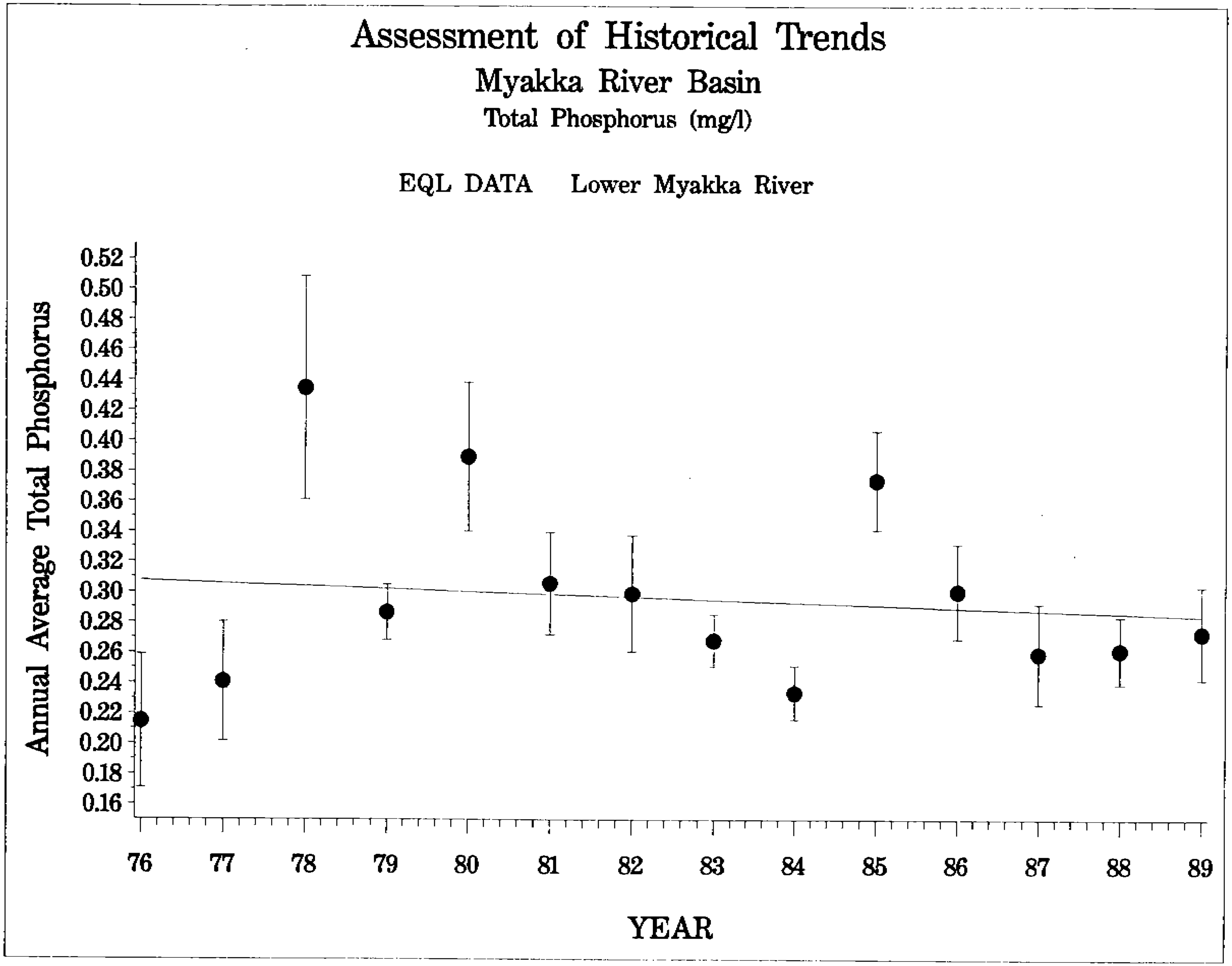


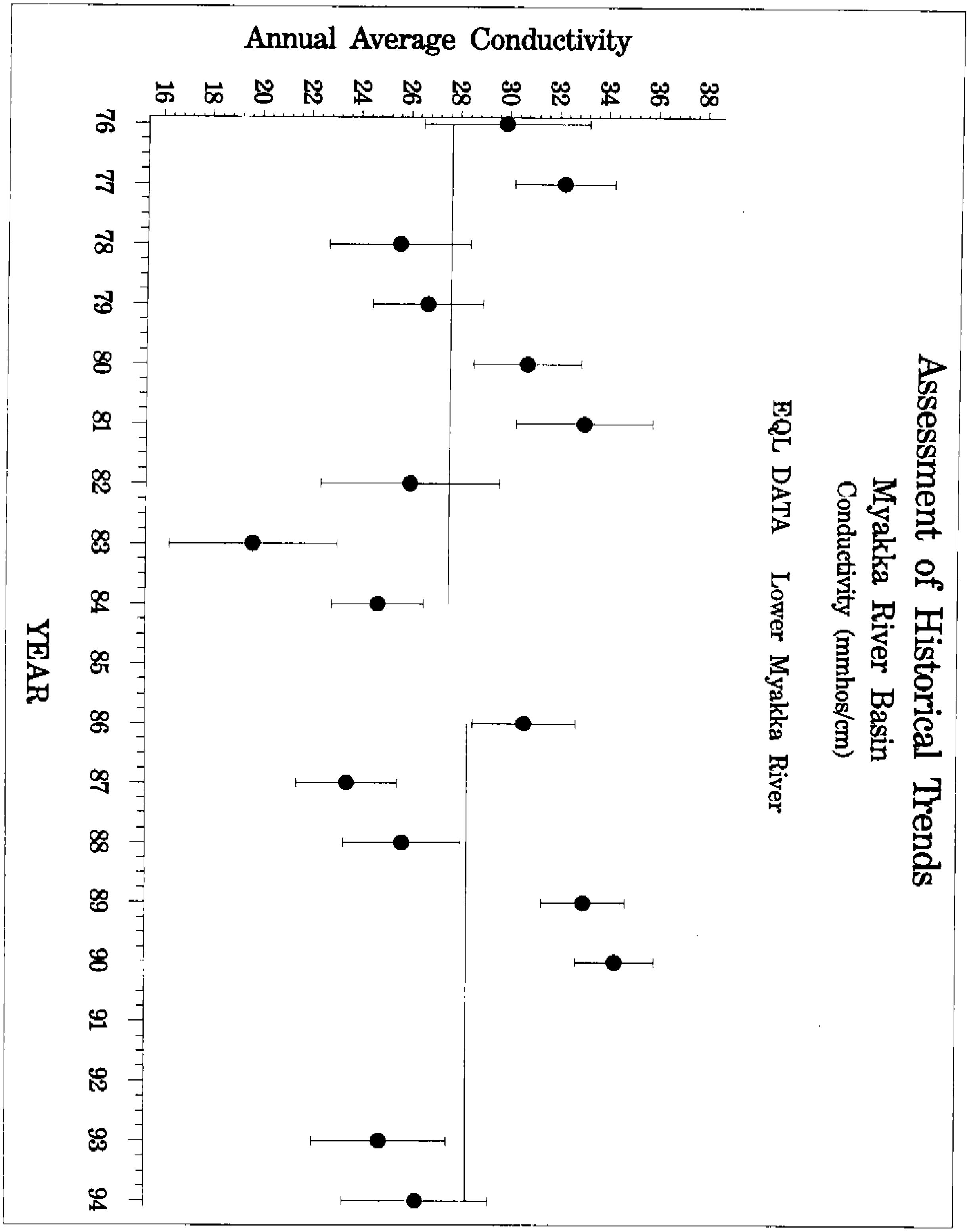
Assessment of Historical Trends
Myakka River Basin
Nitrite/Nitrate (mg/l)
EQL DATA Lower Myakka River
Annual Average Nitrite/Nitrate
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

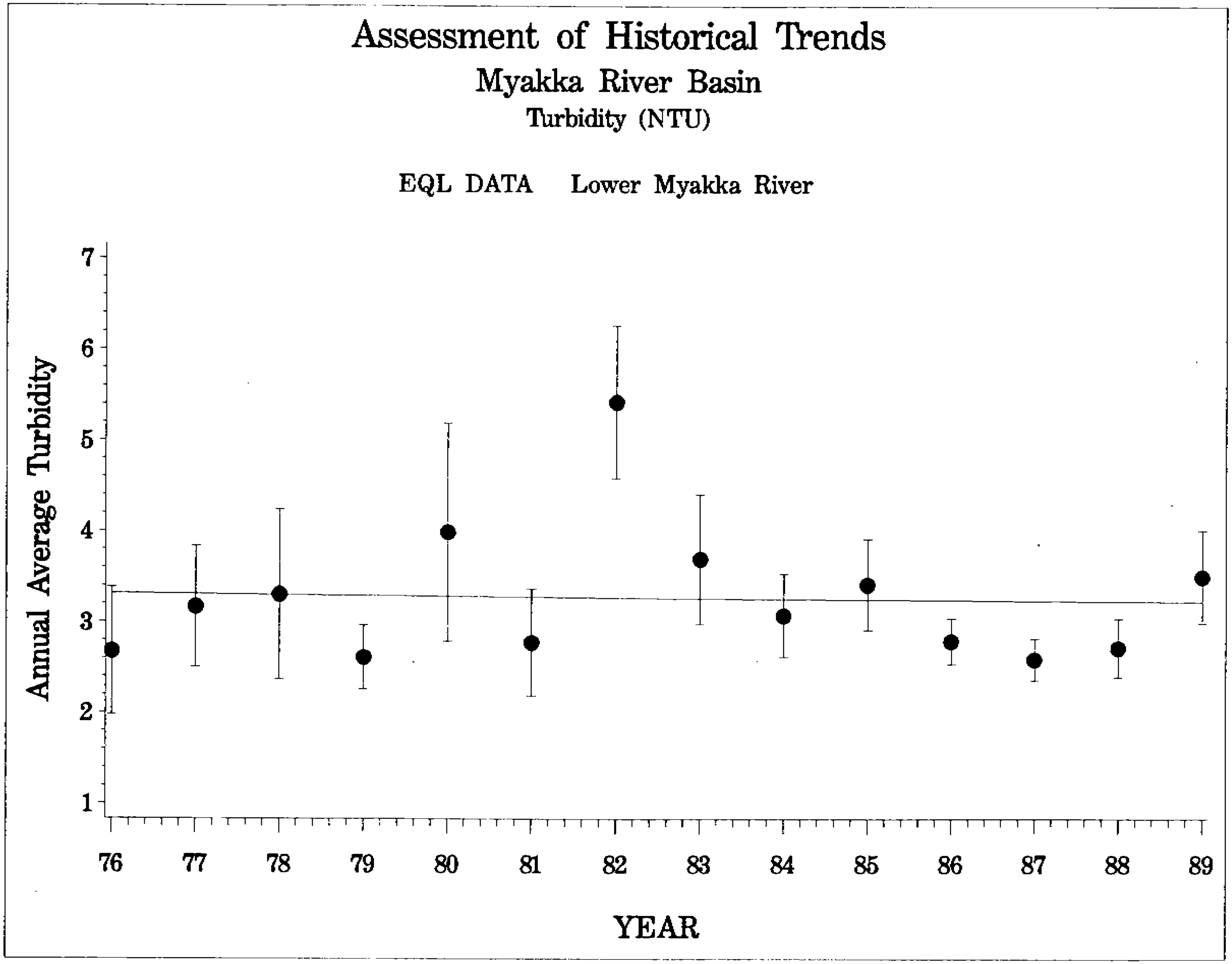

Assessment of Historical Trends
Myakka River Basin
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Lower Myakka River
Annual Average Total Kjeldahl Nitrogen
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
80
81
82
83
84
85
86
87
88
89
YEAR

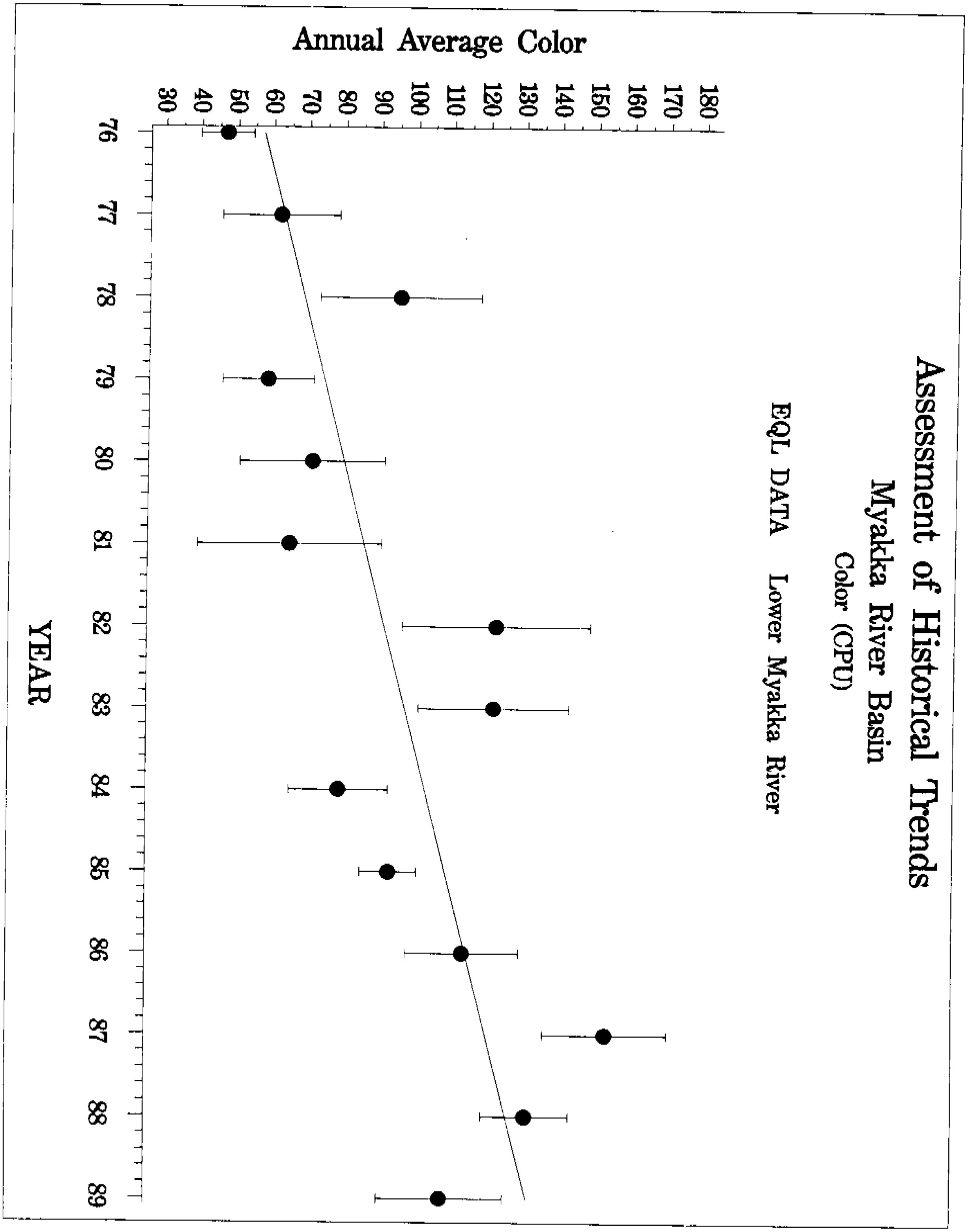


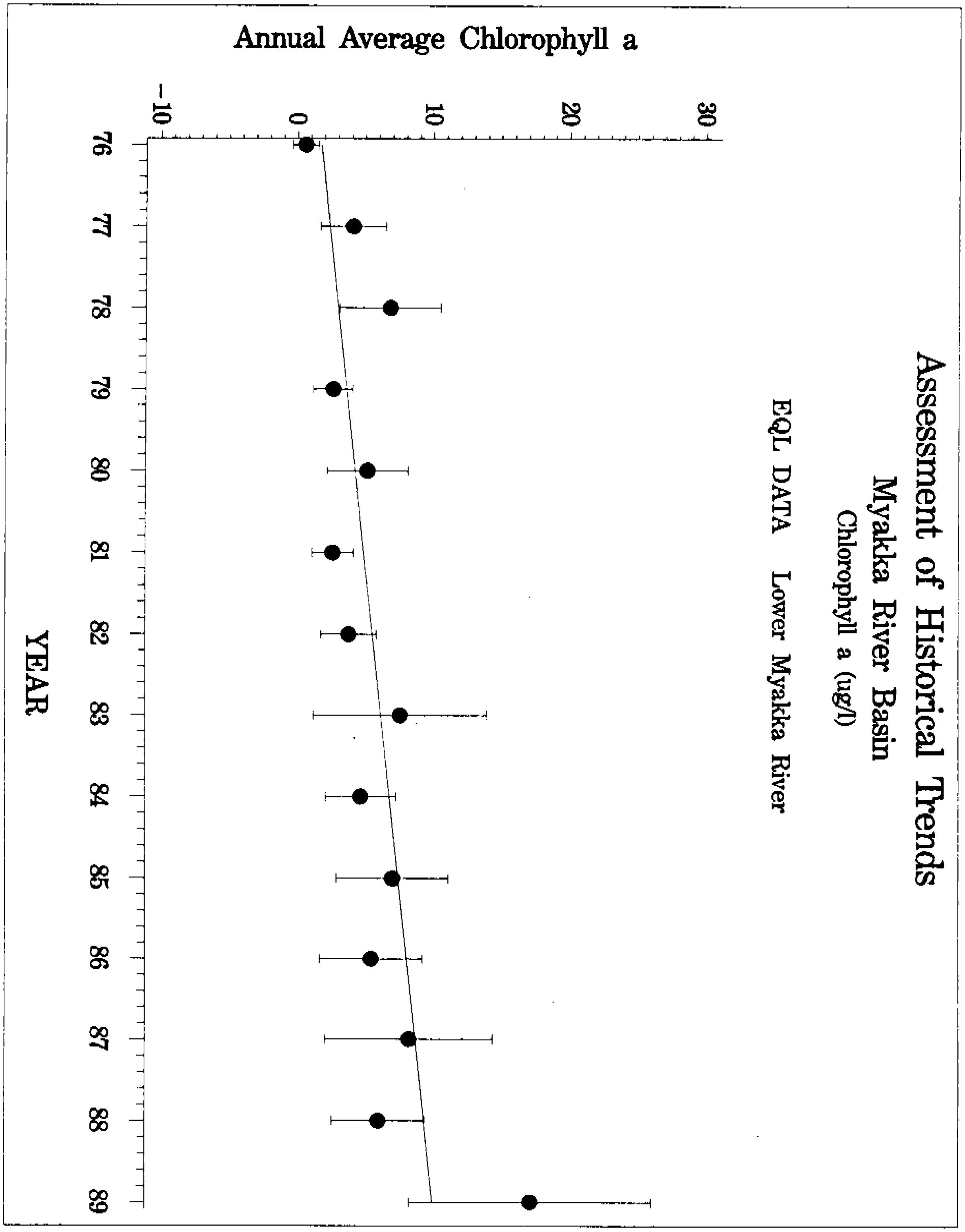
Assessment of Historical Trends
Myakka River Basin
Ortho – Phosphate (mg/l)
EQL DATA Lower Myakka River
Annual Average Ortho – Phosphate
0.12
0.14
0.16
0.18
0.20
0.22
0.24
0.26
0.28
0.30
0.32
0.34
0.36
0.38
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Myakka River Basin
Total Phosphorus (mg/l)
EQL DATA Lower Myakka River
Annual Average Total Phosphorus
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Myakka River Basin
Conductivity (mmhos/cm)
EQL DATA Lower Myakka River
Annual Average Conductivity
16
18
20
22
24
26
28
30
32
34
36
38
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
YEAR


Assessment of Historical Trends
Myakka River Basin
Turbidity (NTU)
EQL DATA Lower Myakka River
Annual Average Turbidity
1
2
3
4
5
6
7
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Myakka River Basin
Color (CPU)
EQL DATA Lower Myakka River
Annual Average Color
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Myakka River Basin
Chlorophyll a (ug/l)
EQL DATA Lower Myakka River
Annual Average Chlorophyll a
-10
0
10
20
30
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

Peace River Basin

Trend Analysis of EQL Data from the Peace River Basin

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Peace River Basin - South
EQL DATA

Conductivity (mmhos/cm)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Peace Estuary	21	-0.08691	-0.18755	0.01372	0.09050	-0.00502	490
Shell Creek Below Dam	6	-0.61081	-0.84803	-0.37359	0.00000	-0.24435	138
Shell Creek Above Dam	6	-0.02121	-0.04174	-0.00068	0.04290	-0.02583	138
Lower Peace River	14	0.09122	-0.07018	0.25263	0.26797	0.10653	324

Clorides (mg/L)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Peace Estuary	14	-91.2452	-143.400	-39.0907	0.000606	-0.018010	326
Lower Peace River	14	2.0594	-0.322	4.4409	0.090089	0.045977	321
Horse Creek	11	0.3758	0.059	0.6926	0.020090	0.019179	129

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Peace Arcadia	13	76	89	150	0.89969	2.15833	-0.35894	0.16120

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Peace River Basin - South
EQL DATA

Color (CPU)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Shell Creek Below Dam	6	-0.16607	-6.95830	6.62615	0.96178	-0.001477	69
Shell Creek Above Dam	6	-2.59722	-9.29994	4.10550	0.44757	-0.023181	69
Lower Peace River	14	-0.19832	-1.80198	1.40533	0.80848	-0.001453	324
Horse Creek	13	-3.93480	-8.08741	0.21782	0.06328	-0.019579	153
Peace Arcadia	13	0.34208	-2.86584	3.55000	0.83444	0.002539	153

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Lower Peace Estuary	20	76	96	395	9.49160	21.4563	-2.47307	0.11998

Nitrite/Nitrate (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Peace Estuary	21	-0.003719	-0.005584	-0.001854	0.00009	-0.01919	454
Shell Creek Below Dam	6	0.010767	-0.002982	0.024516	0.12480	0.11472	69
Shell Creek Above Dam	6	-0.008782	-0.032629	0.015064	0.47039	-0.04428	69
Lower Peace River	14	0.009163	0.000882	0.017444	0.03010	0.01565	324
Horse Creek	13	0.032219	0.020859	0.043580	0.00000	0.14830	153
Peace Arcadia	14	0.002477	-0.012790	0.017744	0.75049	0.00326	165

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Peace River Basin - South
EQL DATA

Ortho-Phosphate (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Shell Creek Below Dam	6	-0.01719	-0.02773	-0.00666	0.001374	-0.10933	69
Shell Creek Above Dam	6	-0.00954	-0.01762	-0.00145	0.020764	-0.08998	69
Lower Peace River	14	-0.11947	-0.13117	-0.10777	0.000000	-0.08043	324
Horse Creek	13	-0.00812	-0.01406	-0.00218	0.007361	-0.01542	153
Peace Arcadia	14	-0.13455	-0.15578	-0.11332	0.000000	-0.07772	164

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Lower Peace Estuary	20	76	96	395	-0.59833	-0.52930	-0.66735	0

Total Phosphorus (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Peace Estuary	21	-0.06108	-0.06566	-0.05650	0.000000	-0.07820	454
Shell Creek Below Dam	6	-0.02285	-0.04172	-0.00397	0.017672	-0.10725	69
Shell Creek Above Dam	6	-0.01522	-0.03153	0.00109	0.067481	-0.09799	69
Lower Peace River	14	-0.15333	-0.16747	-0.13920	0.000000	-0.09184	324
Horse Creek	13	-0.02639	-0.04291	-0.00987	0.001741	-0.04366	152
Peace Arcadia	14	-0.18243	-0.20933	-0.15553	0.000000	-0.09143	164

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Peace River Basin - South
EQL DATA

Turbidity (NTU)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Shell Creek Below Dam	6	0.00760	-0.08932	0.10451	0.87792	0.002718	69
Shell Creek Above Dam	6	-0.08103	-0.24798	0.08593	0.34148	-0.021007	69
Lower Peace River	14	0.09175	0.01737	0.16614	0.01562	0.018633	323
Horse Creek	13	0.11778	0.03017	0.20539	0.00841	0.051688	150
Peace Arcadia	14	0.12859	0.00774	0.24945	0.03702	0.021967	163

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Lower Peace Estuary	20	76	96	395	-0.34259	0.33544	-1.02062	0.32201

Total Kjeldahl Nitrogen (mg/l)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Peace Estuary	17	0.011610	0.006724	0.016496	0.00000	0.011260	362
Shell Creek Below Dam	6	-0.012109	-0.040569	0.016351	0.40433	-0.009949	69
Shell Creek Above Dam	6	0.001438	-0.027399	0.030274	0.92215	0.001223	69
Lower Peace River	10	-0.023157	-0.040641	-0.005672	0.00944	-0.020970	232
Horse Creek	10	0.003399	-0.018099	0.024897	0.75665	0.003697	115
Peace Arcadia	10	-0.047506	-0.089275	-0.005737	0.02580	-0.039668	116

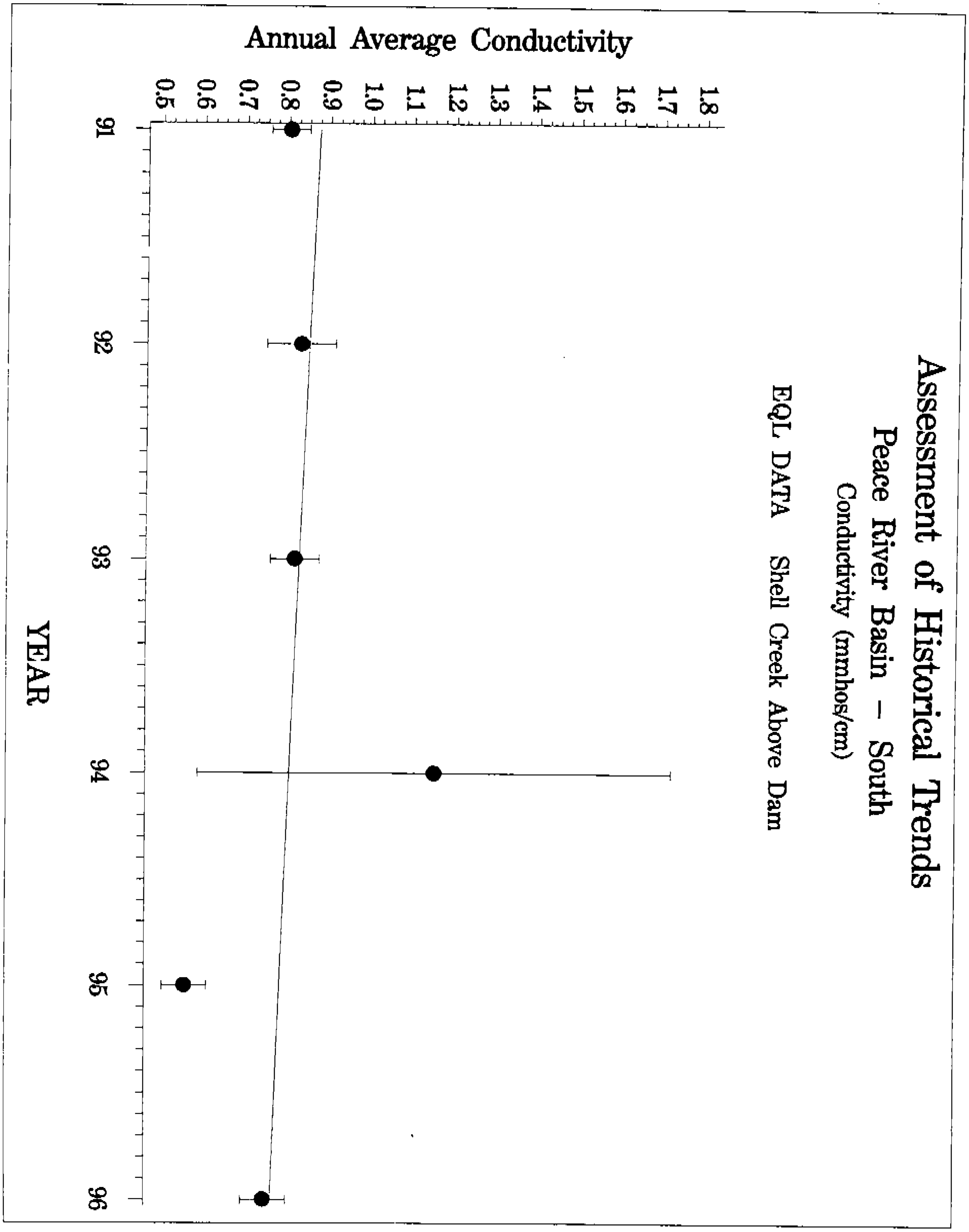
Chlorophyll a (ug/l)

Slope Analyzed Over Entire Record

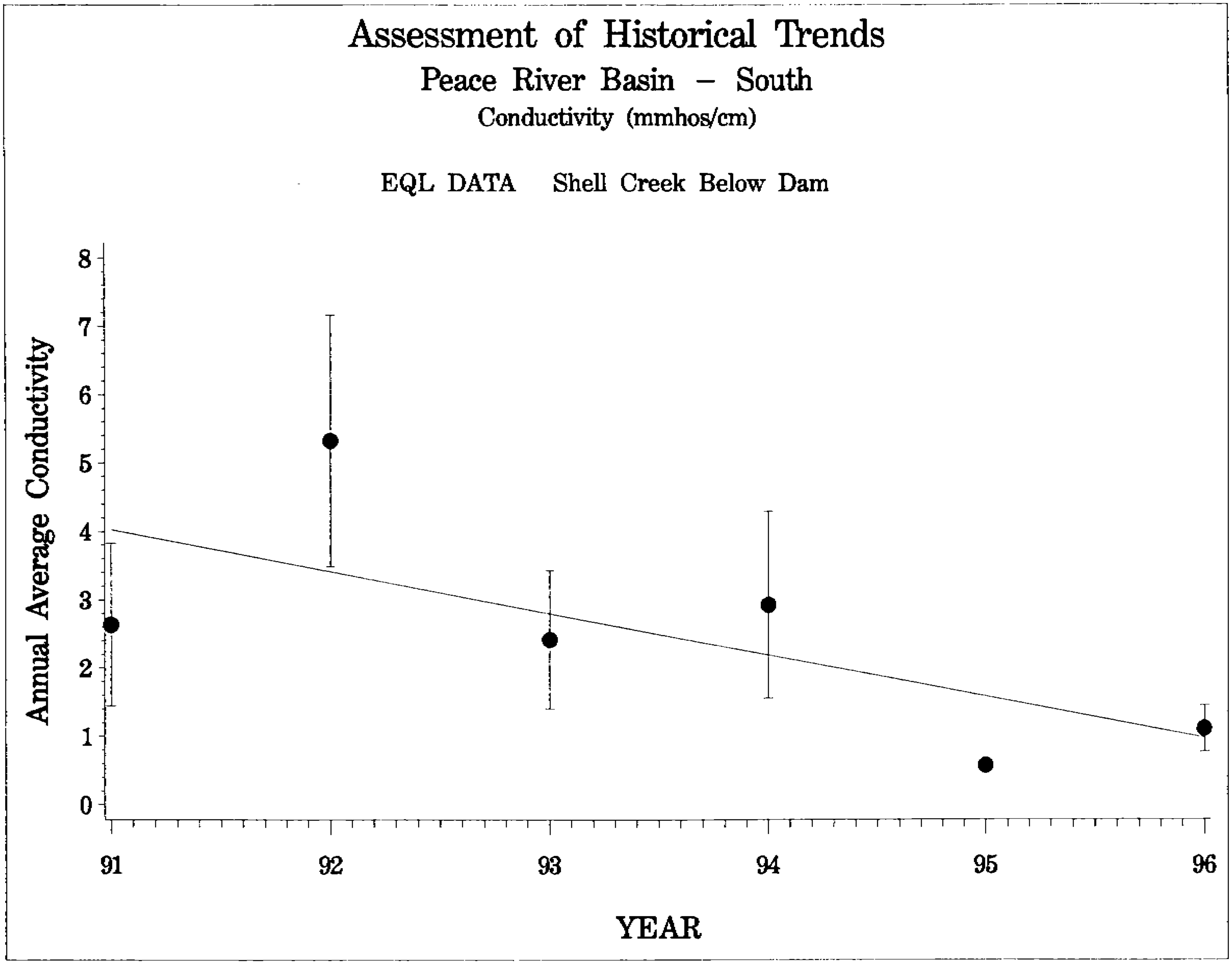
Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Shell Creek Below Dam	6	0.16518	-0.73259	1.06294	0.71839	0.01652	69
Shell Creek Above Dam	6	-0.08610	-0.69461	0.52241	0.78153	-0.01419	69
Lower Peace River	14	0.19160	-0.08086	0.46406	0.16810	0.03330	324
Horse Creek	13	0.23013	0.10001	0.36025	0.00053	0.12686	153
Peace Arcadia	14	0.64388	-0.03492	1.32268	0.06300	0.04418	165

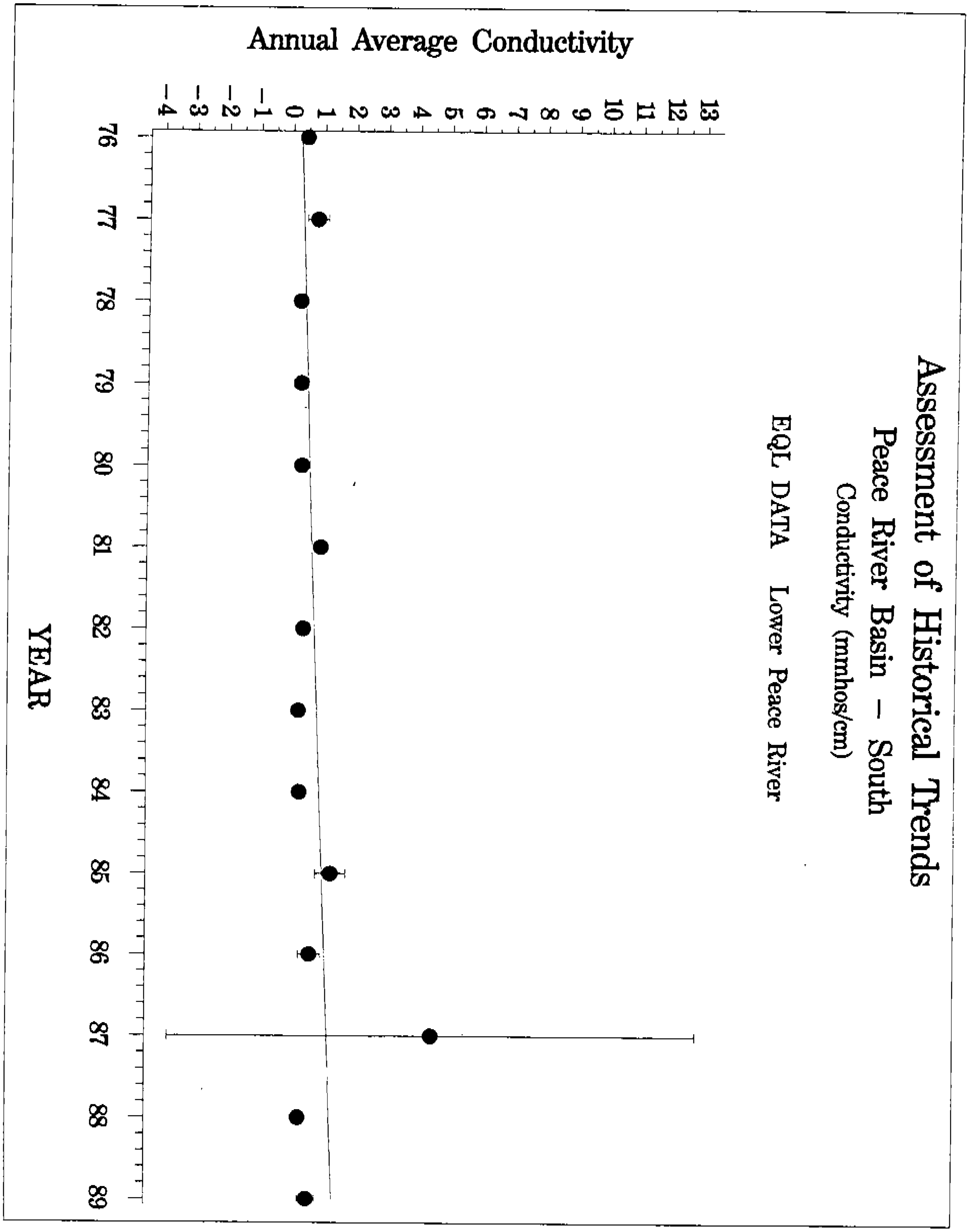
Comparison by Division of Period of Record

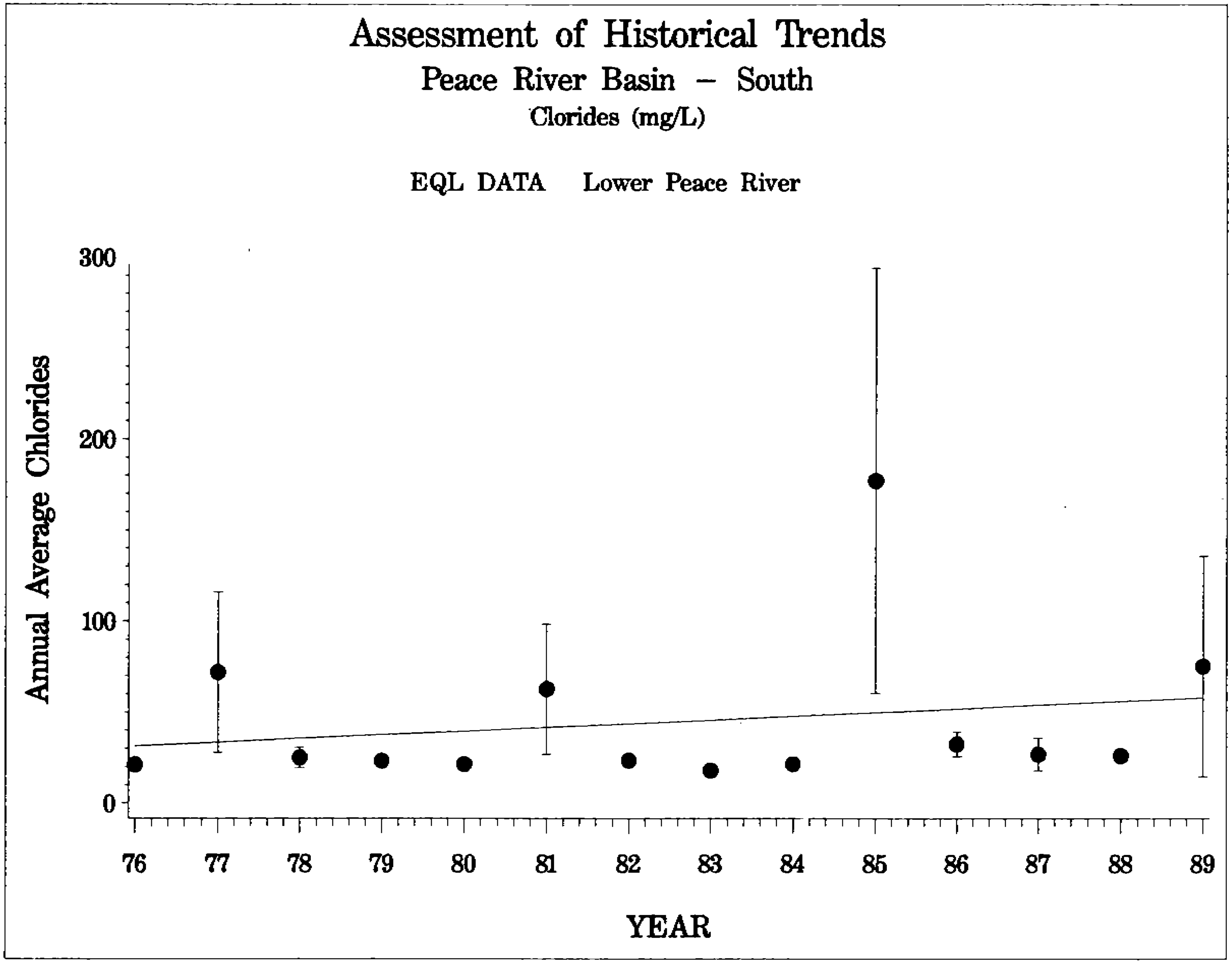
Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Lower Peace Estuary	20	76	96	395	3.85048	7.91167	-0.21071	0.063126

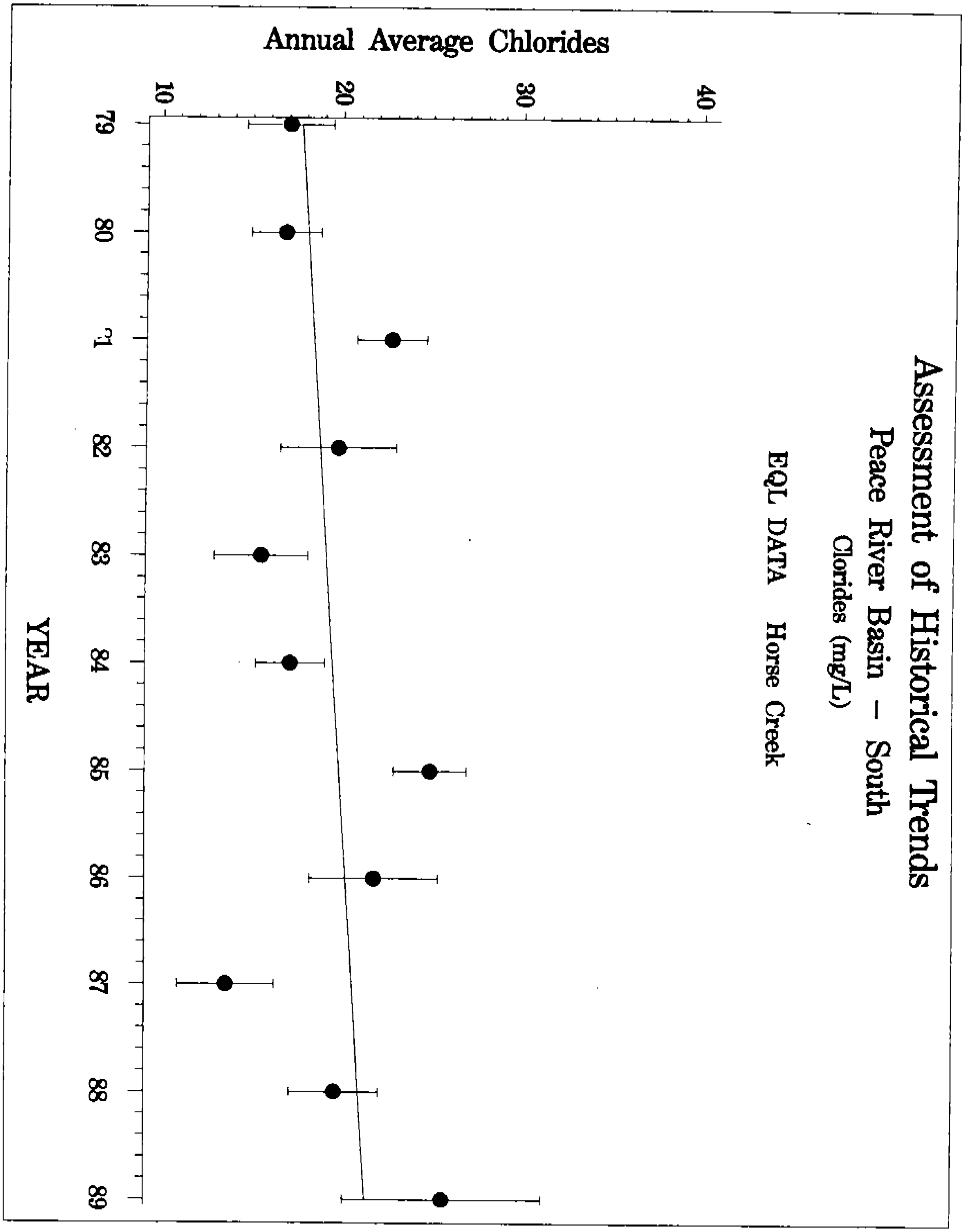


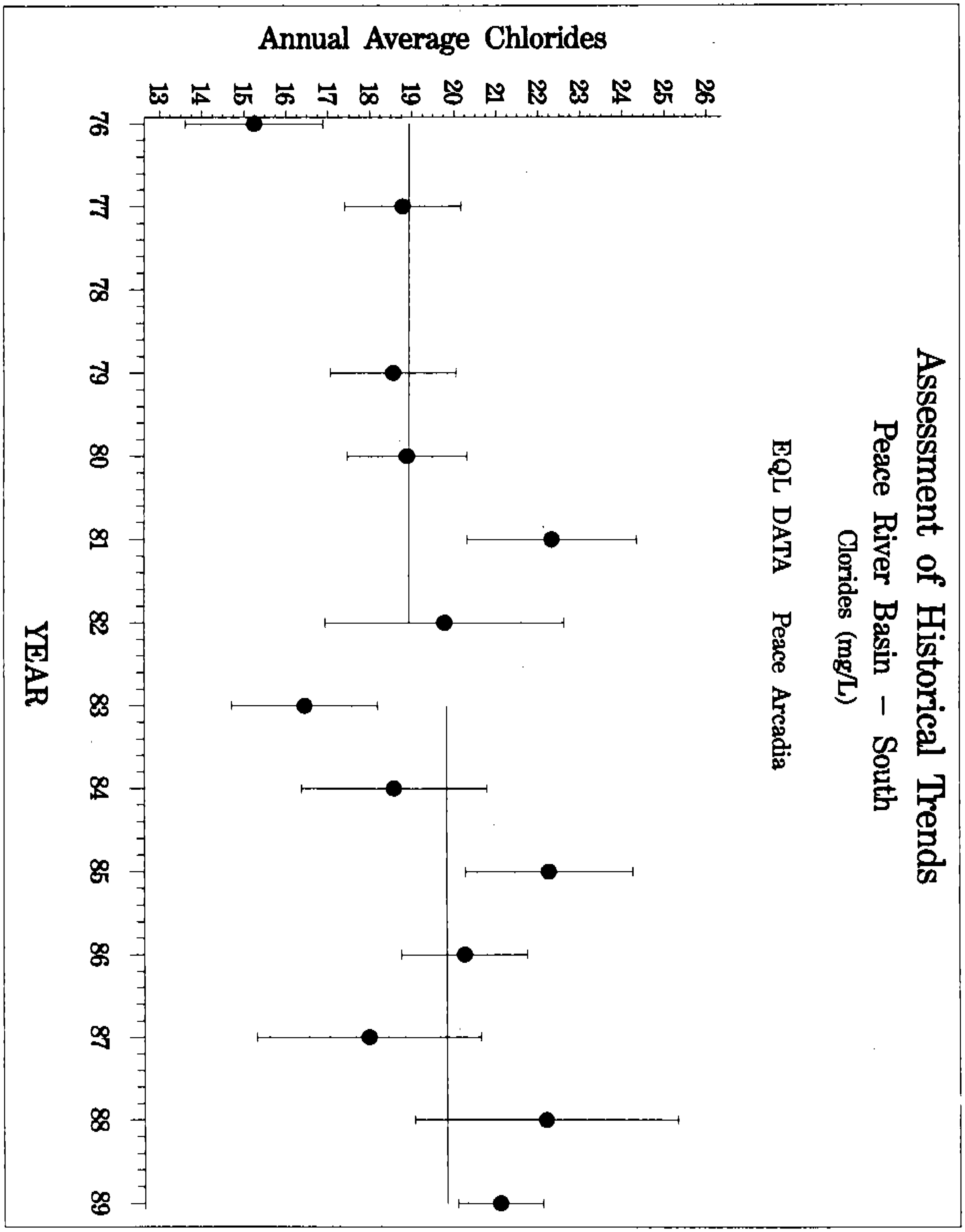
Assessment of Historical Trends
Peace River Basin – South
Conductivity (mmhos/cm)
EQL DATA Shell Creek Above Dam
Annual Average Conductivity
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Conductivity (mmhos/cm)
EQL DATA Shell Creek Below Dam
Annual Average Conductivity
0
1
2
3
4
5
6
7
8
91
92
93
94
95
96
YEAR

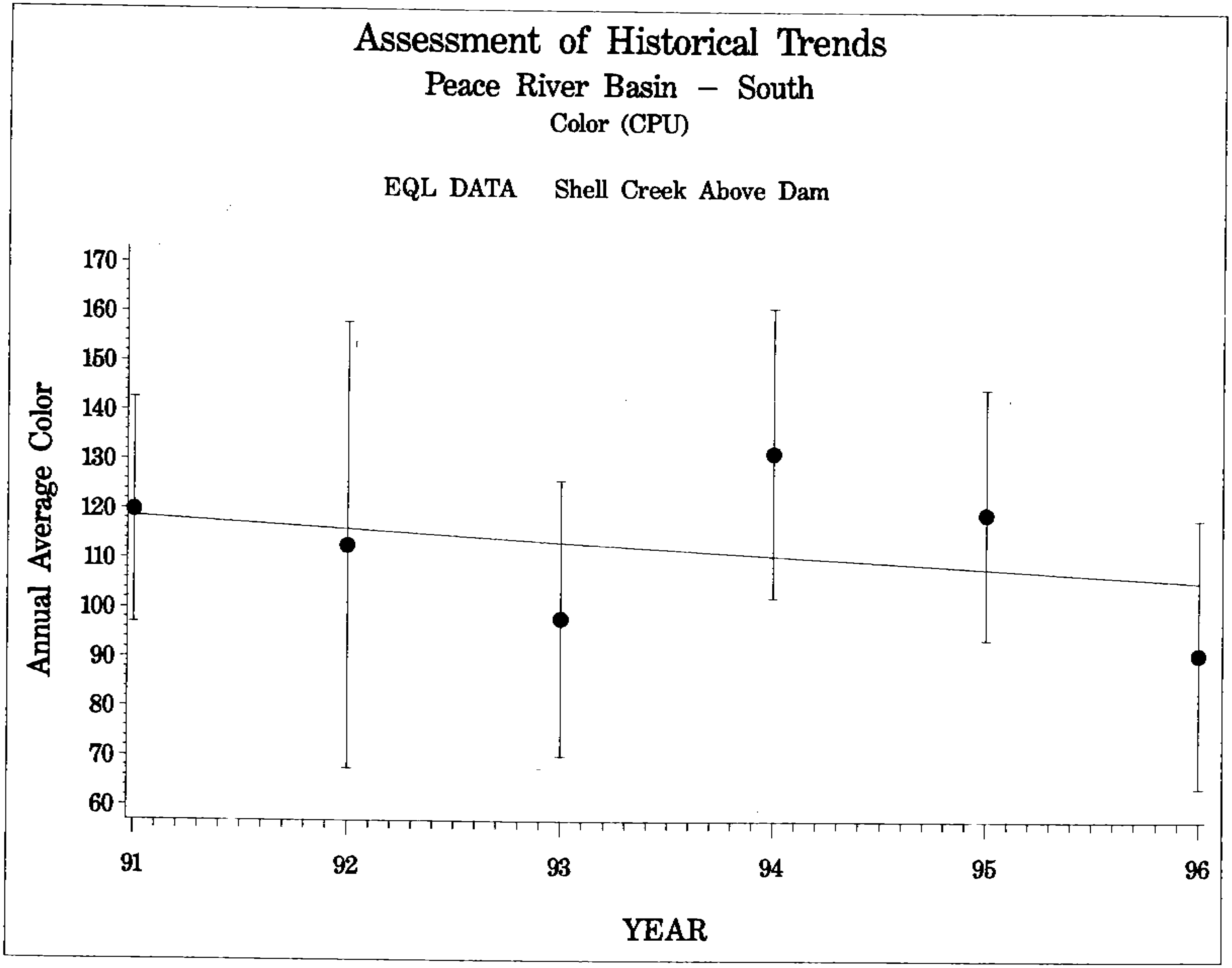

Assessment of Historical Trends
Peace River Basin – South
Conductivity (mmhos/cm)
EQL DATA Lower Peace River
Annual Average Conductivity
YEAR
−4 −3 −2 −1 0 1 2 3 4 5 6 7 8 9 10 11 12 13
76 77 78 79 80 81 82 83 84 85 86 87 88 89

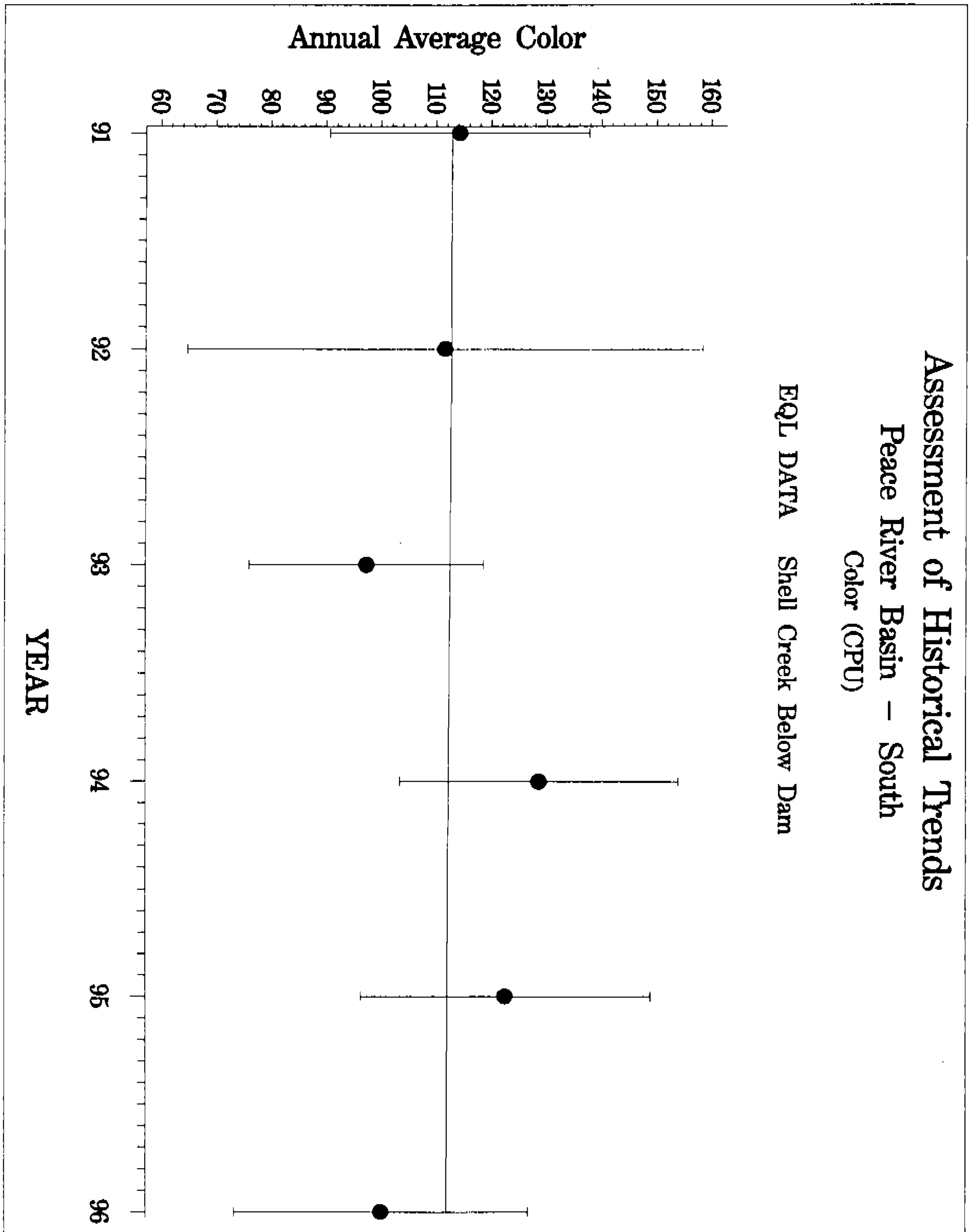

Assessment of Historical Trends
Peace River Basin – South
Clorides (mg/L)
EQL DATA Lower Peace River
Annual Average Chlorides
0
100
200
300
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

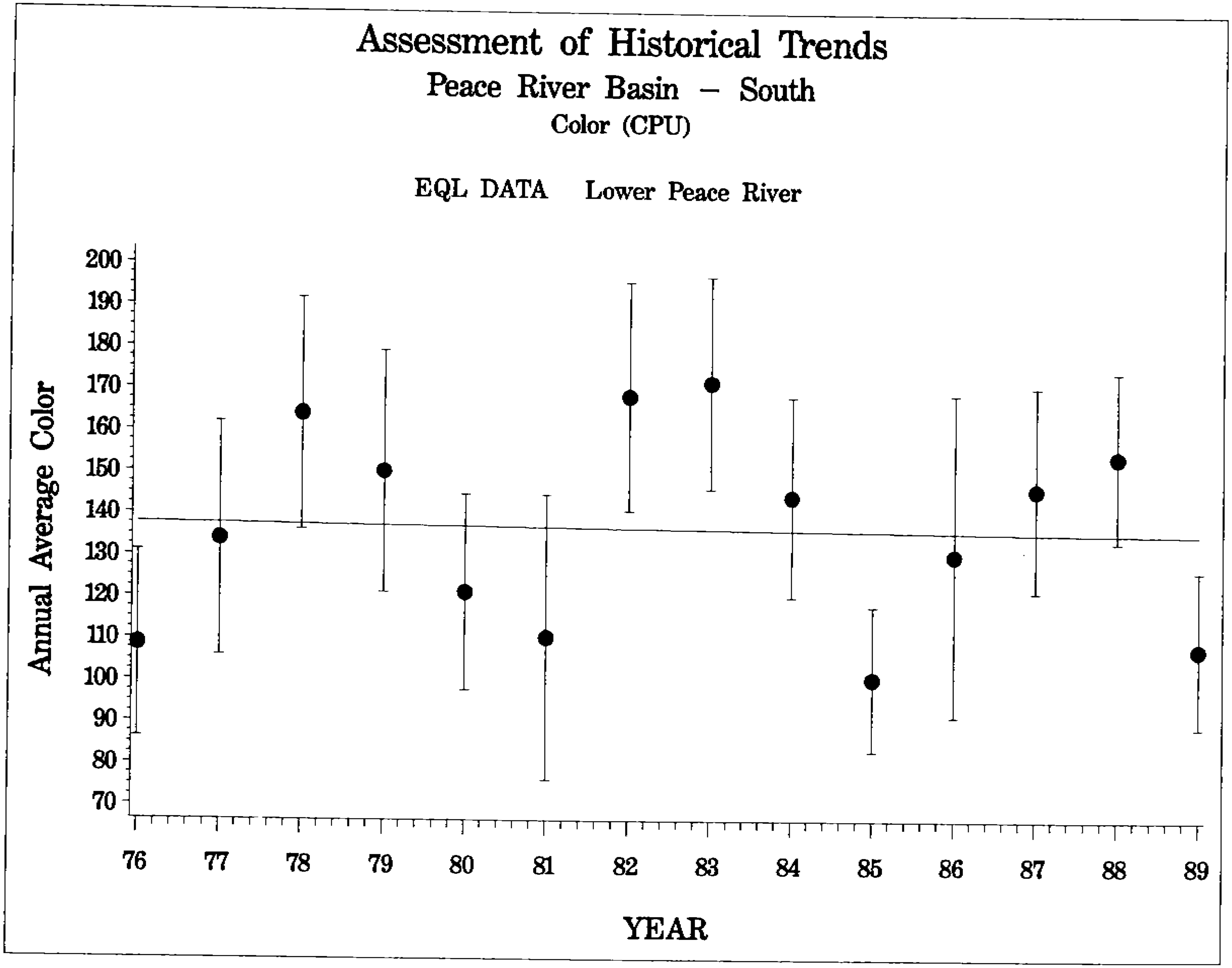

Assessment of Historical Trends
Peace River Basin – South
Clorides (mg/L)
EQL DATA Horse Creek
Annual Average Chlorides
10
20
30
40
79
80
82
83
84
85
86
87
88
89
YEAR

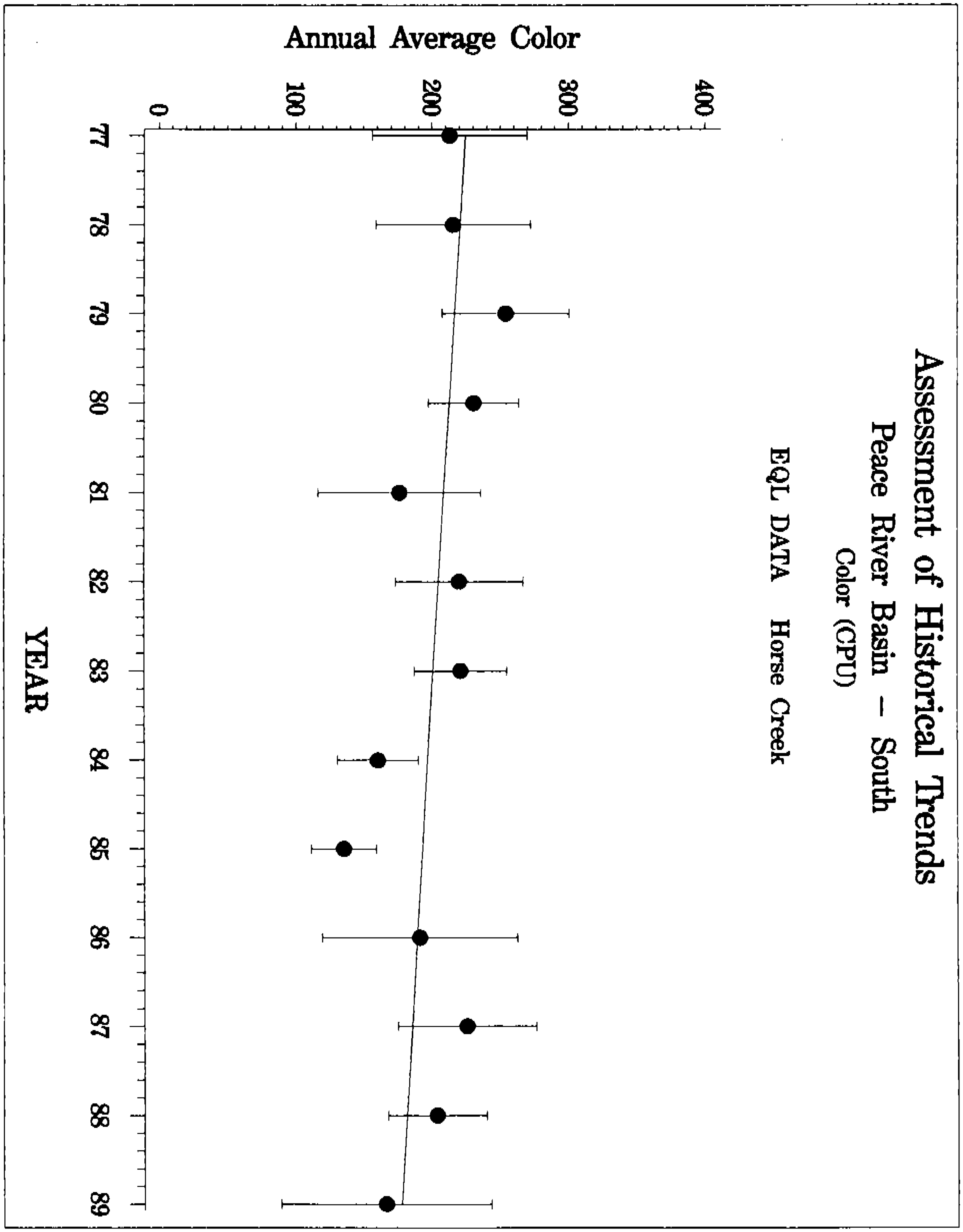


Assessment of Historical Trends
Peace River Basin – South
Clorides (mg/L)
EQL DATA Peace Arcadia
Annual Average Chlorides
13
14
15
16
17
18
19
20
21
22
23
24
25
26
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

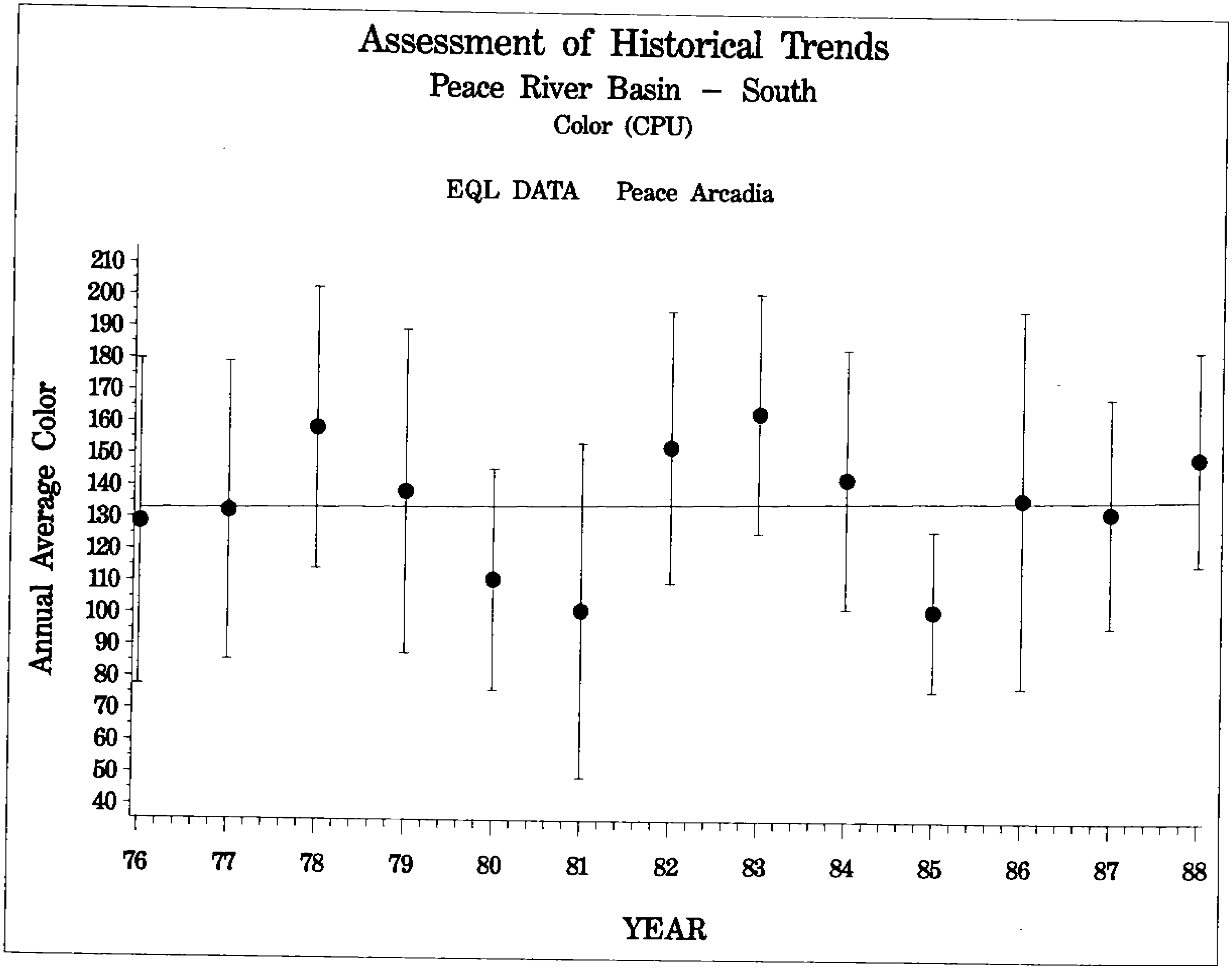

Assessment of Historical Trends
Peace River Basin – South
Color (CPU)
EQL DATA Shell Creek Above Dam
Annual Average Color
170
160
150
140
130
120
110
100
90
80
70
60
91
92
93
94
95
96
YEAR

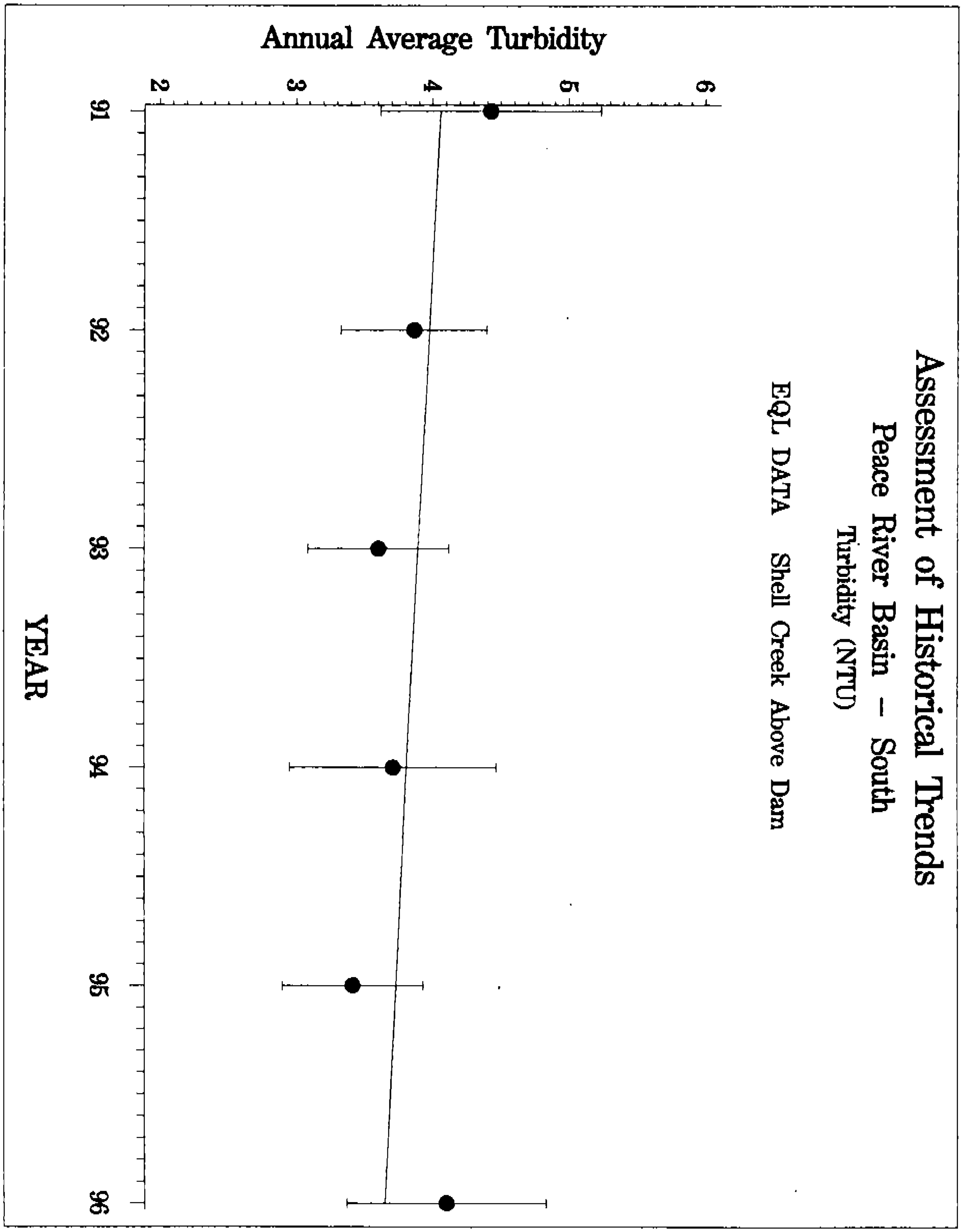

Assessment of Historical Trends
Peace River Basin – South
Color (CPU)
EQL DATA Shell Creek Below Dam
Annual Average Color
60
70
80
90
100
110
120
130
140
150
160
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Color (CPU)
EQL DATA Lower Peace River
Annual Average Color
200
190
180
170
160
150
140
130
120
110
100
90
80
70
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

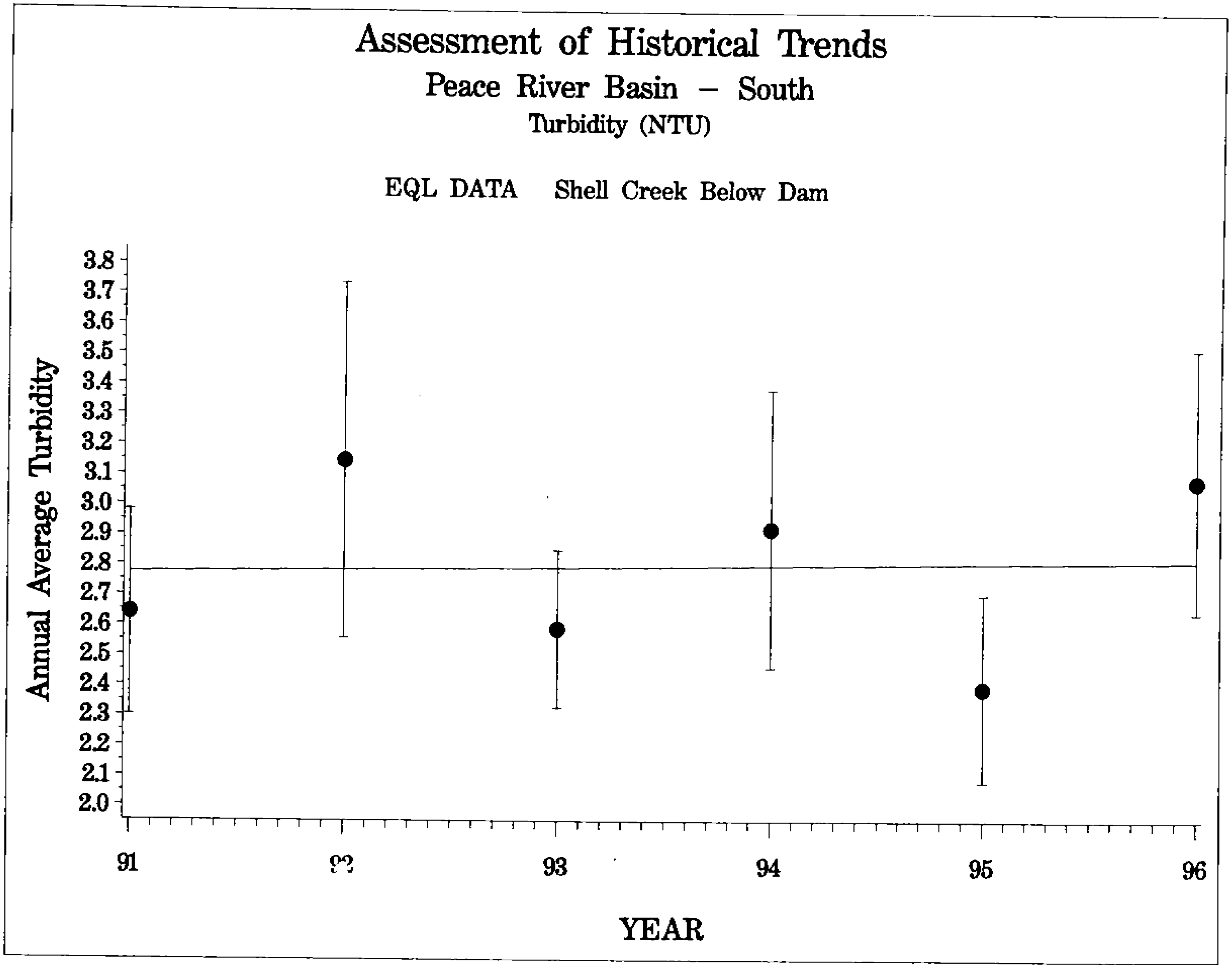


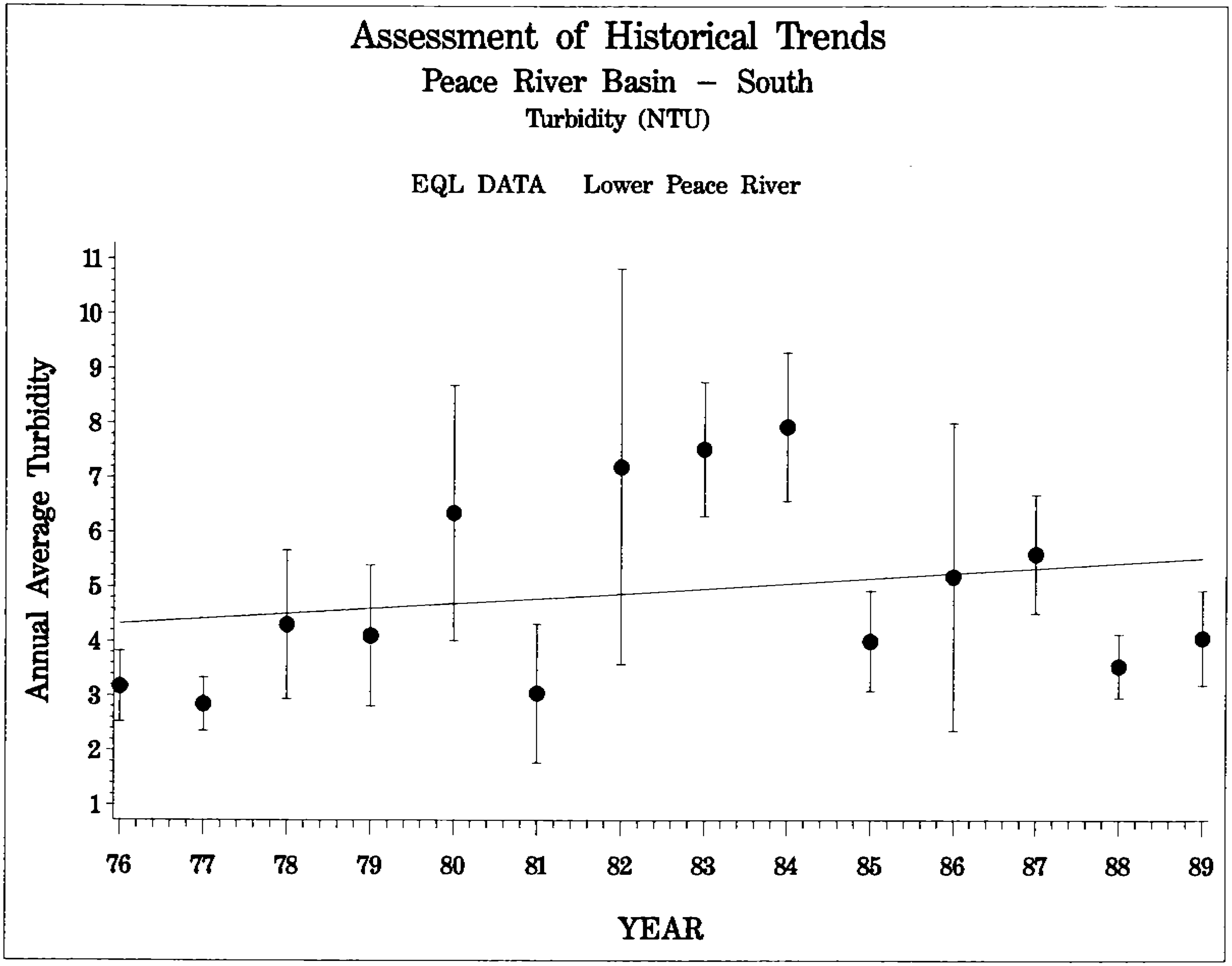
Assessment of Historical Trends
Peace River Basin - South
Color (CPU)
EQL DATA Horse Creek
Annual Average Color
0
100
200
300
400
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Color (CPU)
EQL DATA Peace Arcadia
Annual Average Color
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
76
77
78
79
80
81
82
83
84
85
86
87
88
YEAR



Assessment of Historical Trends
Peace River Basin – South
Turbidity (NTU)
EQL DATA Shell Creek Above Dam
Annual Average Turbidity
2
3
4
5
6
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Turbidity (NTU)
EQL DATA Shell Creek Below Dam
Annual Average Turbidity
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
91
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Turbidity (NTU)
EQL DATA Lower Peace River
Annual Average Turbidity
1
2
3
4
5
6
7
8
9
10
11
76
77
78
79
80
81
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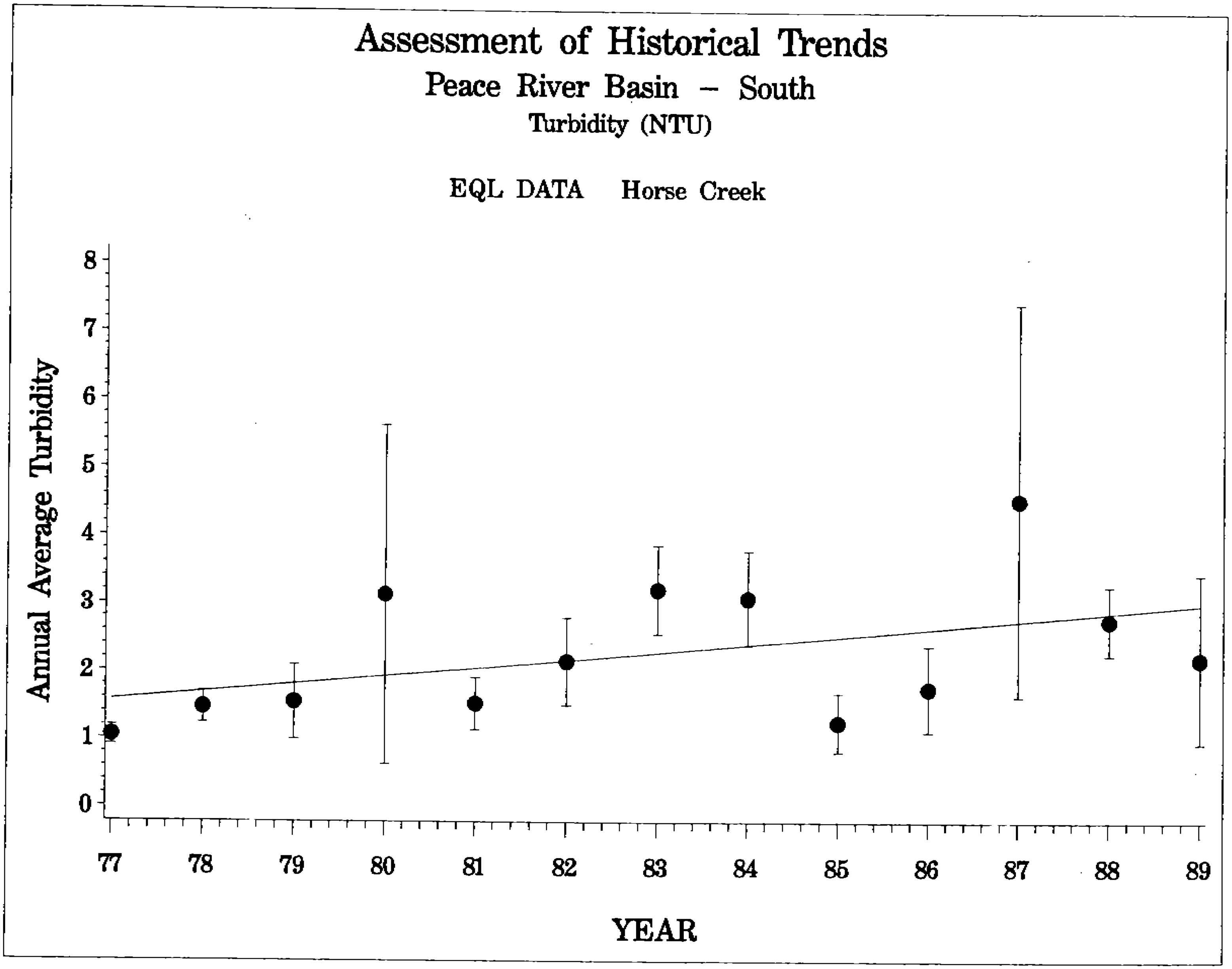
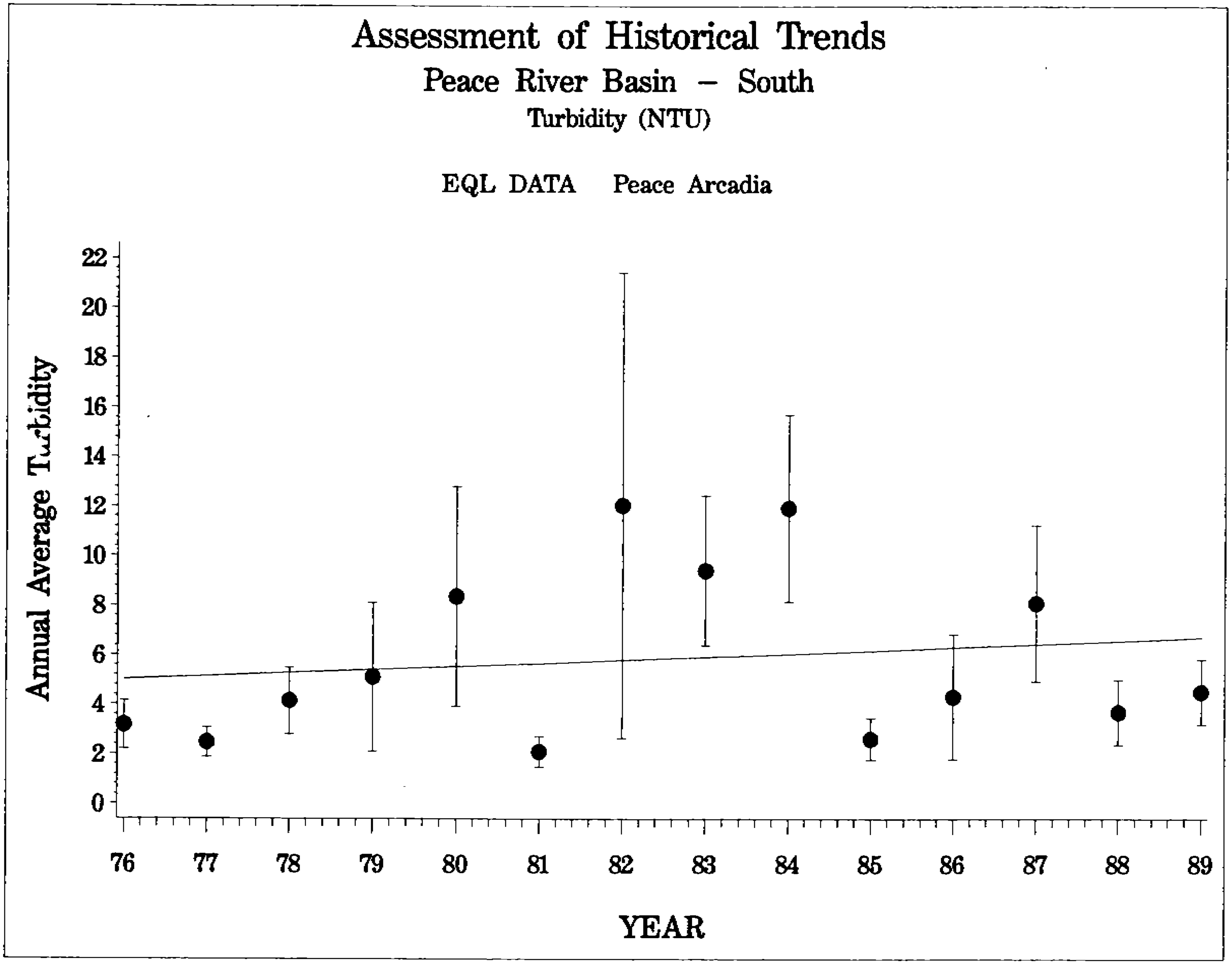
YEAR


Assessment of Historical Trends
Peace River Basin – South
Turbidity (NTU)
EQL DATA Horse Creek
Annual Average Turbidity
0
1
2
3
4
5
6
7
8
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Turbidity (NTU)
EQL DATA Peace Arcadia
Annual Average Turbidity
0
2
4
6
8
10
12
14
16
18
20
22
76
77
78
79
80
81
82
83
84
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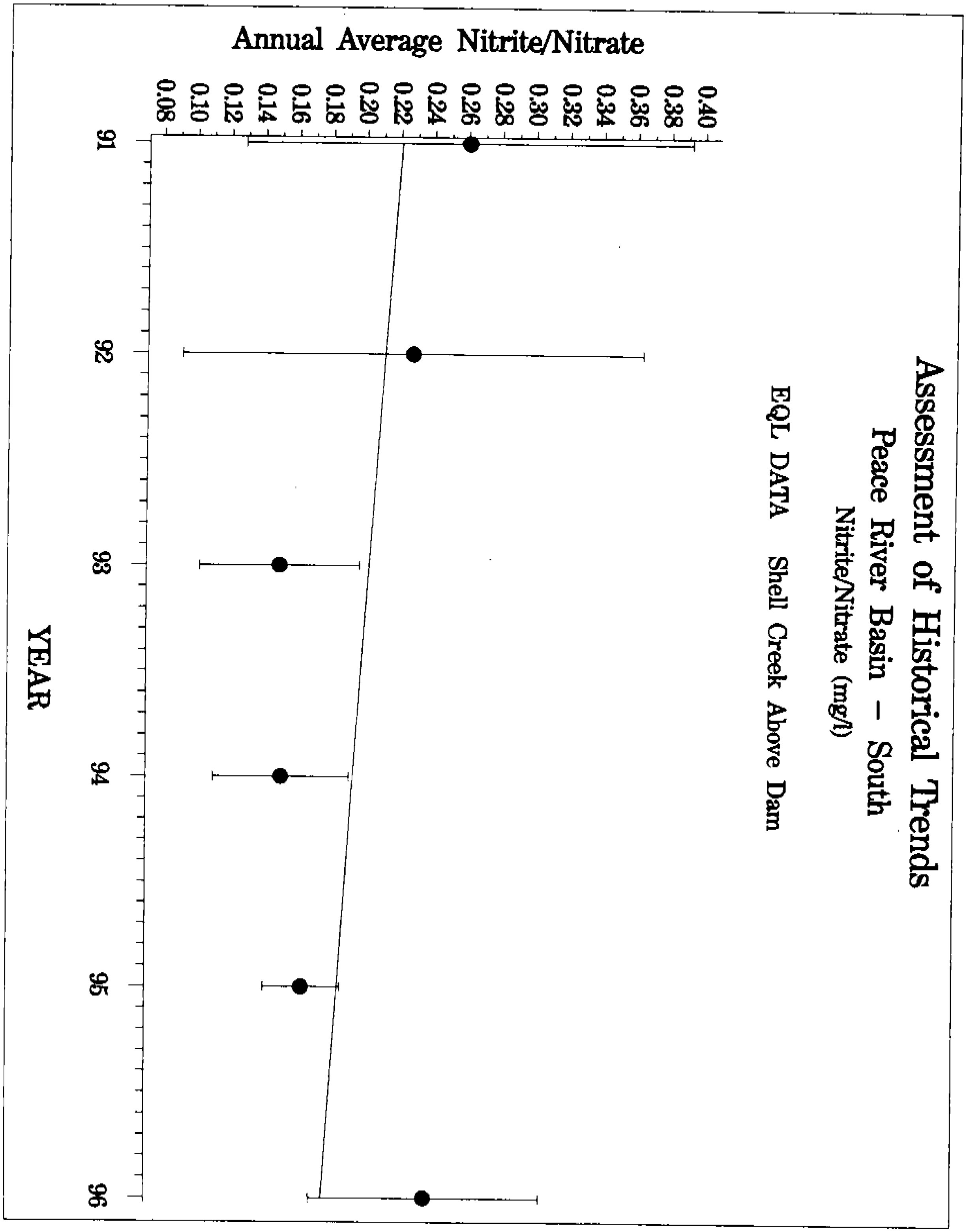
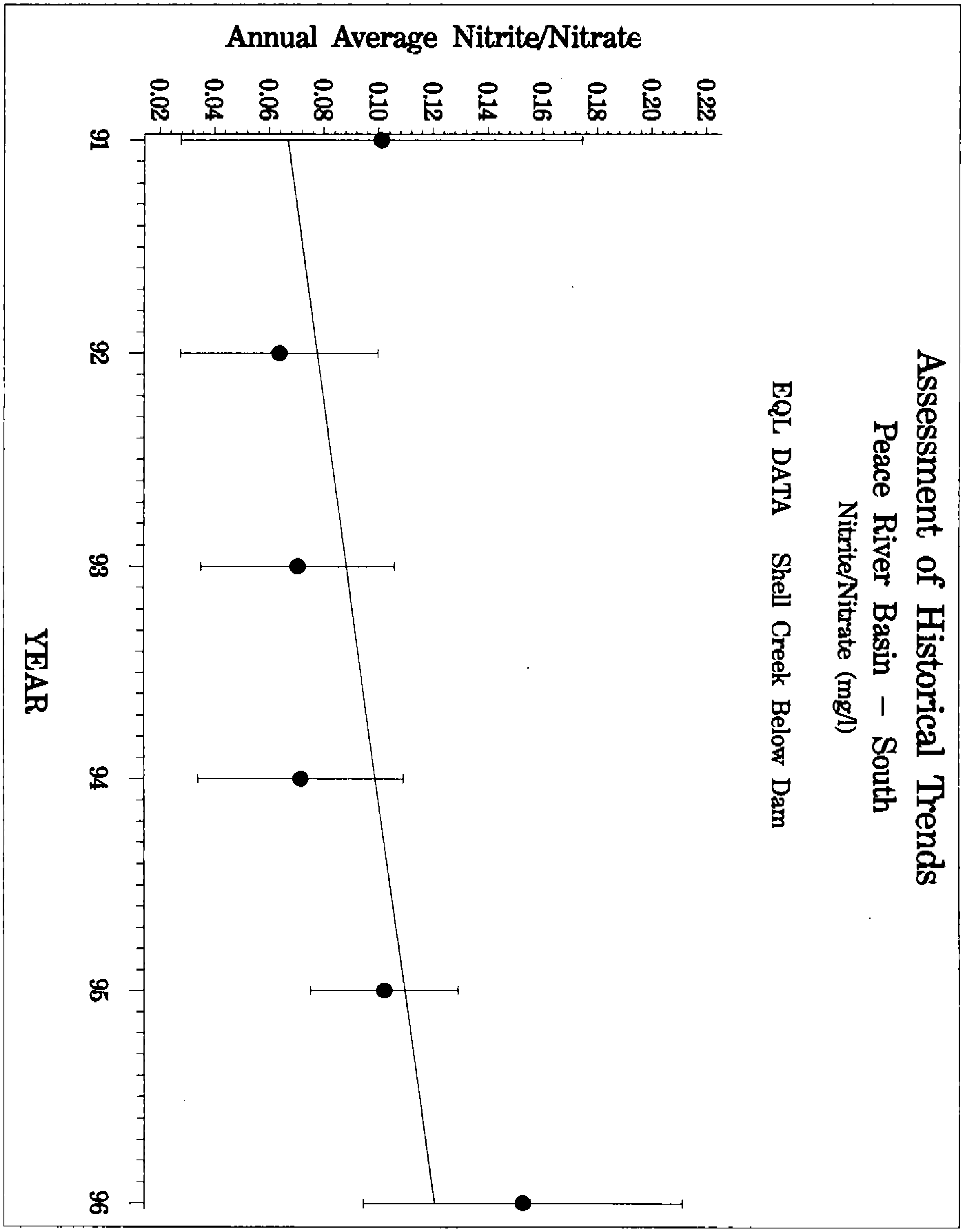
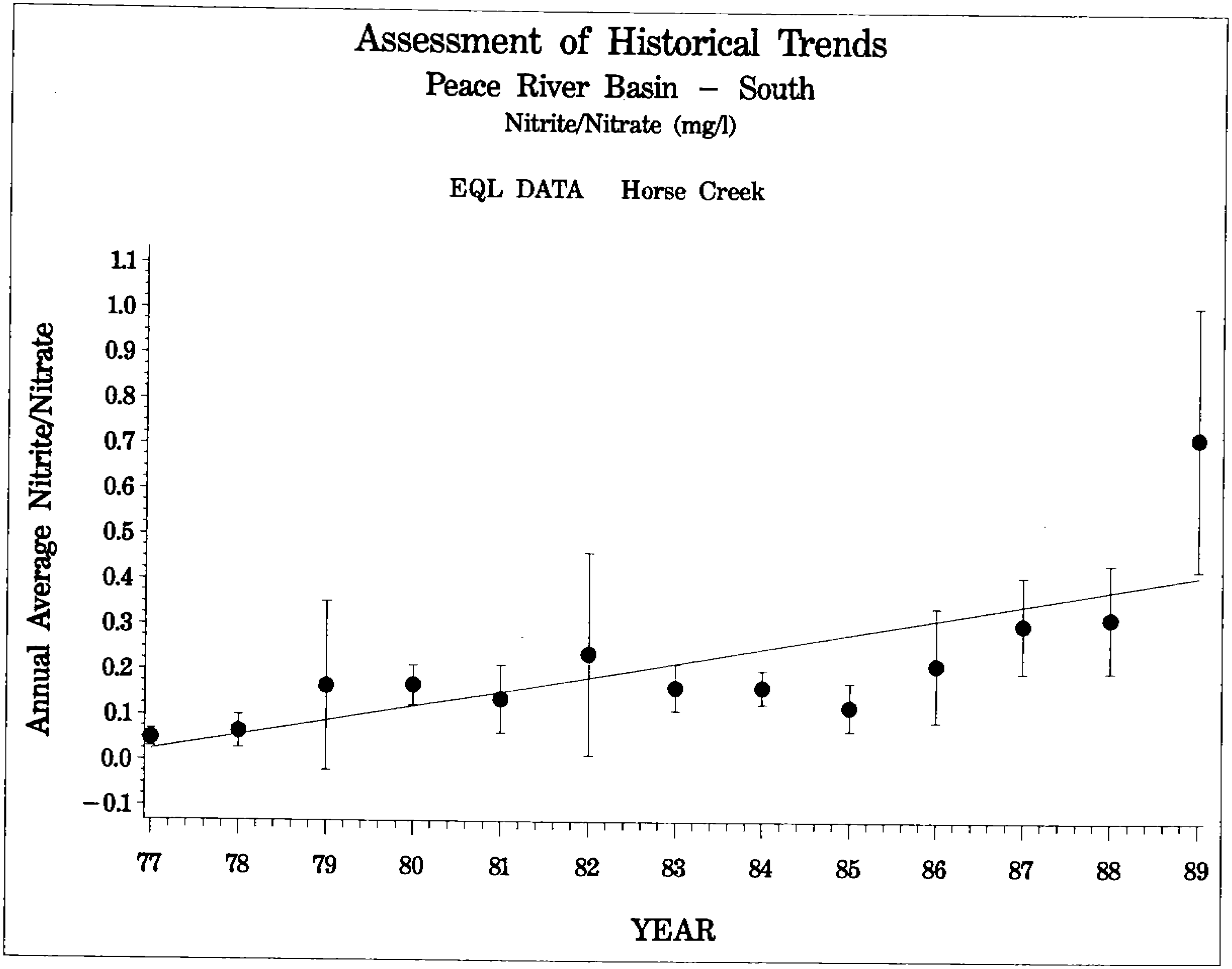
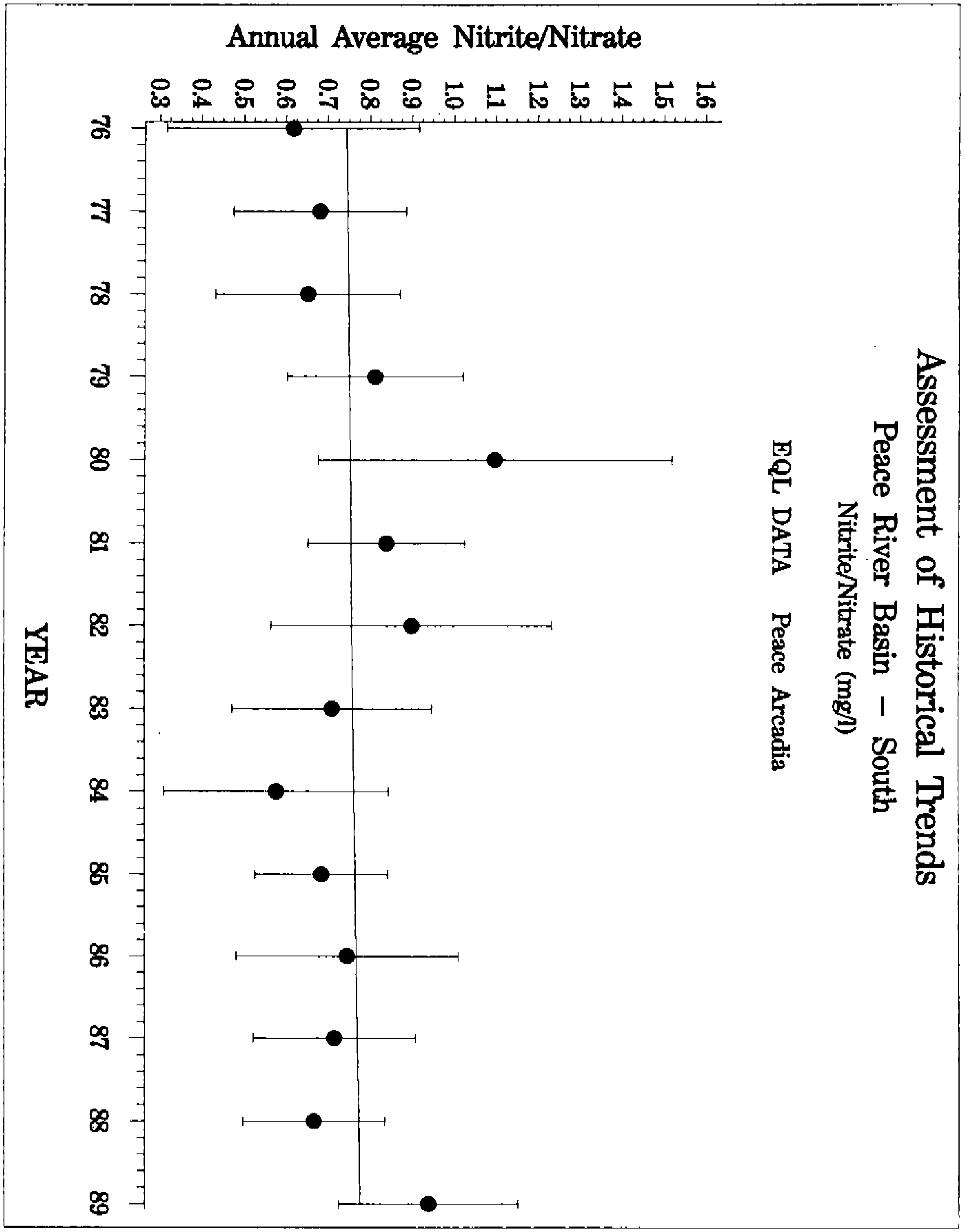
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Nitrite/Nitrate (mg/l)
EQL DATA Shell Creek Above Dam
Annual Average Nitrite/Nitrate
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
0.24
0.26
0.28
0.30
0.32
0.34
0.36
0.38
0.40
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Nitrite/Nitrate (mg/l)
EQL DATA Shell Creek Below Dam
Annual Average Nitrite/Nitrate
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Nitrite/Nitrate (mg/l)
EQL DATA Horse Creek
Annual Average Nitrite/Nitrate
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Nitrite/Nitrate (mg/l)
EQL DATA Peace Arcadia
Annual Average Nitrite/Nitrate
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
76
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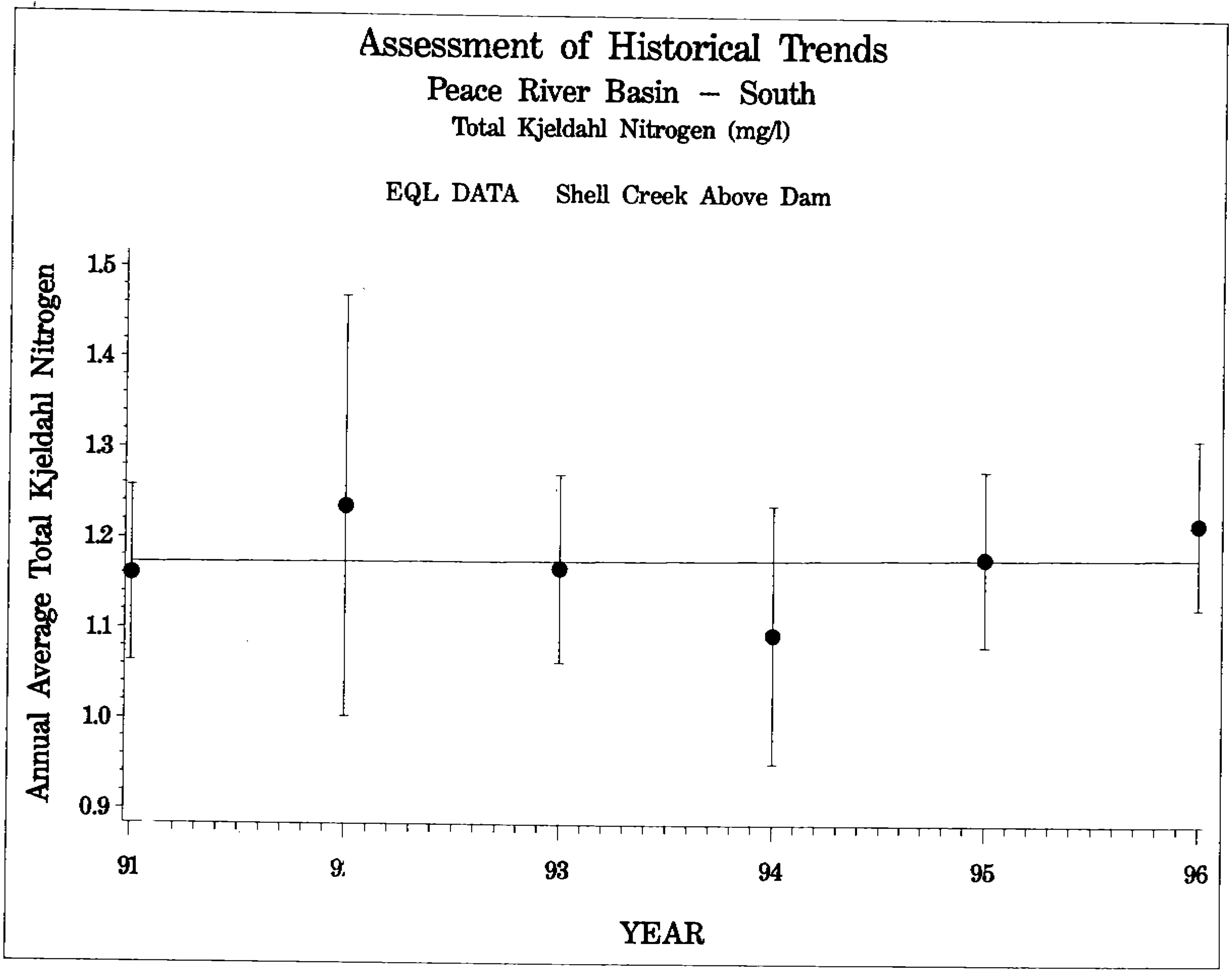
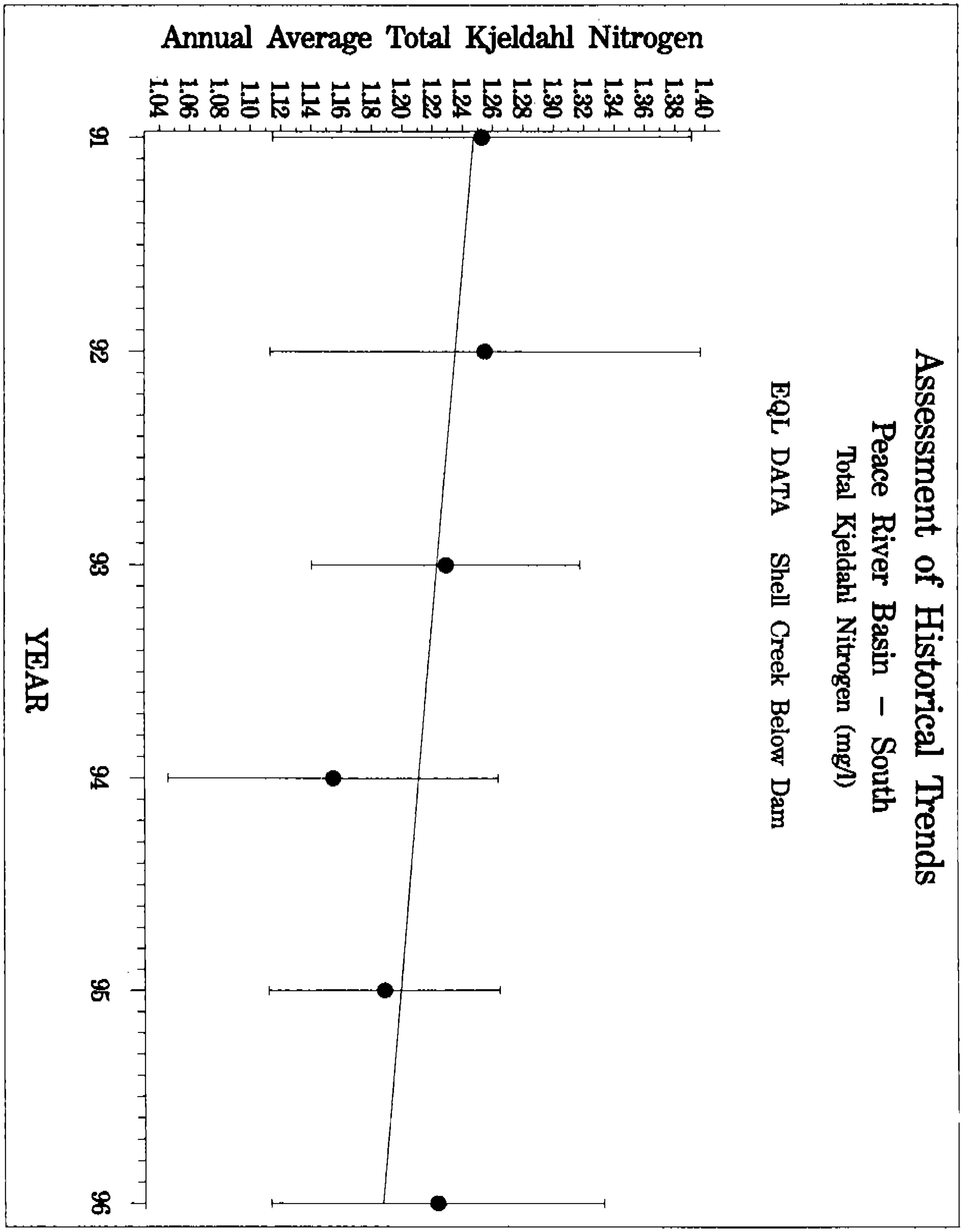
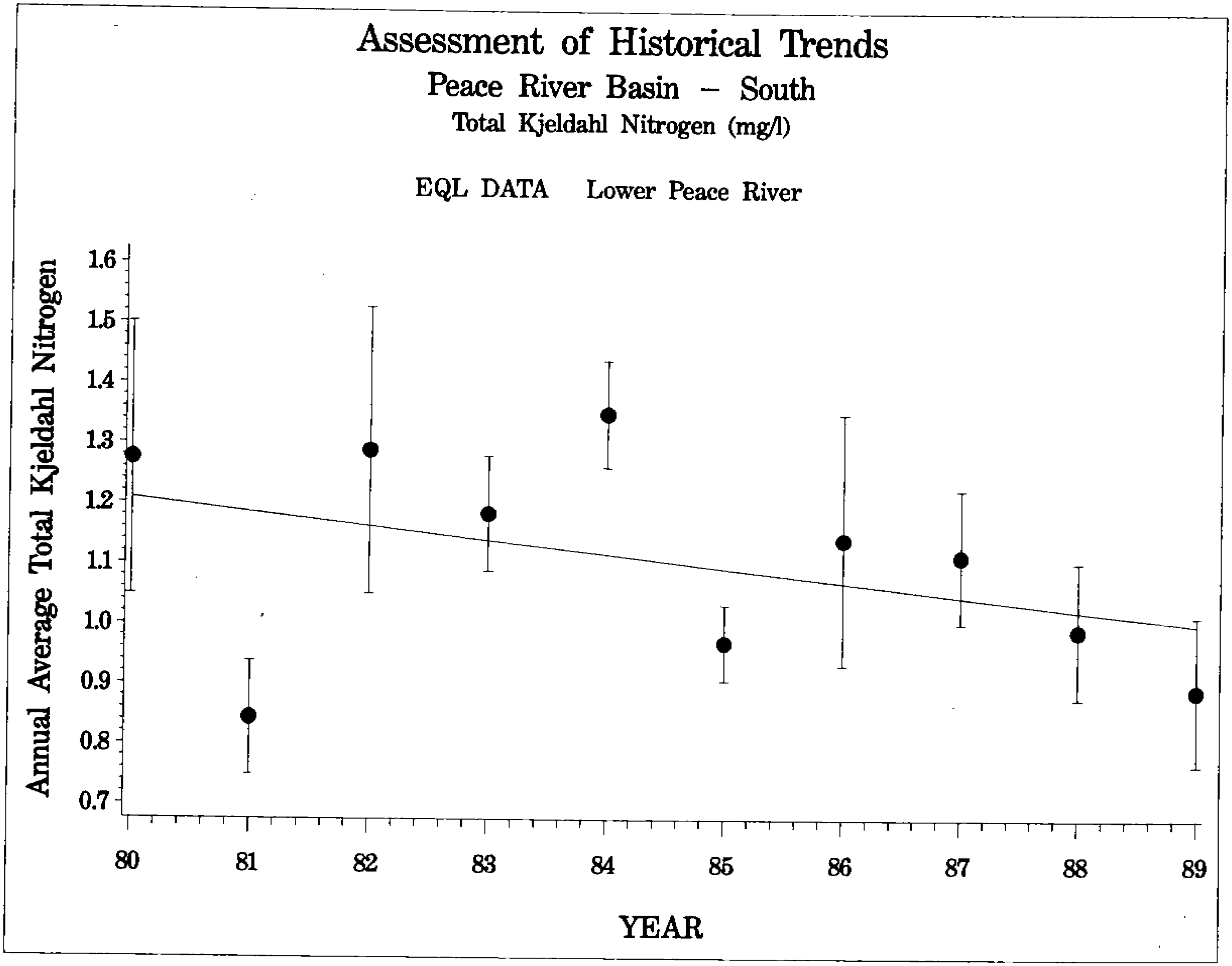
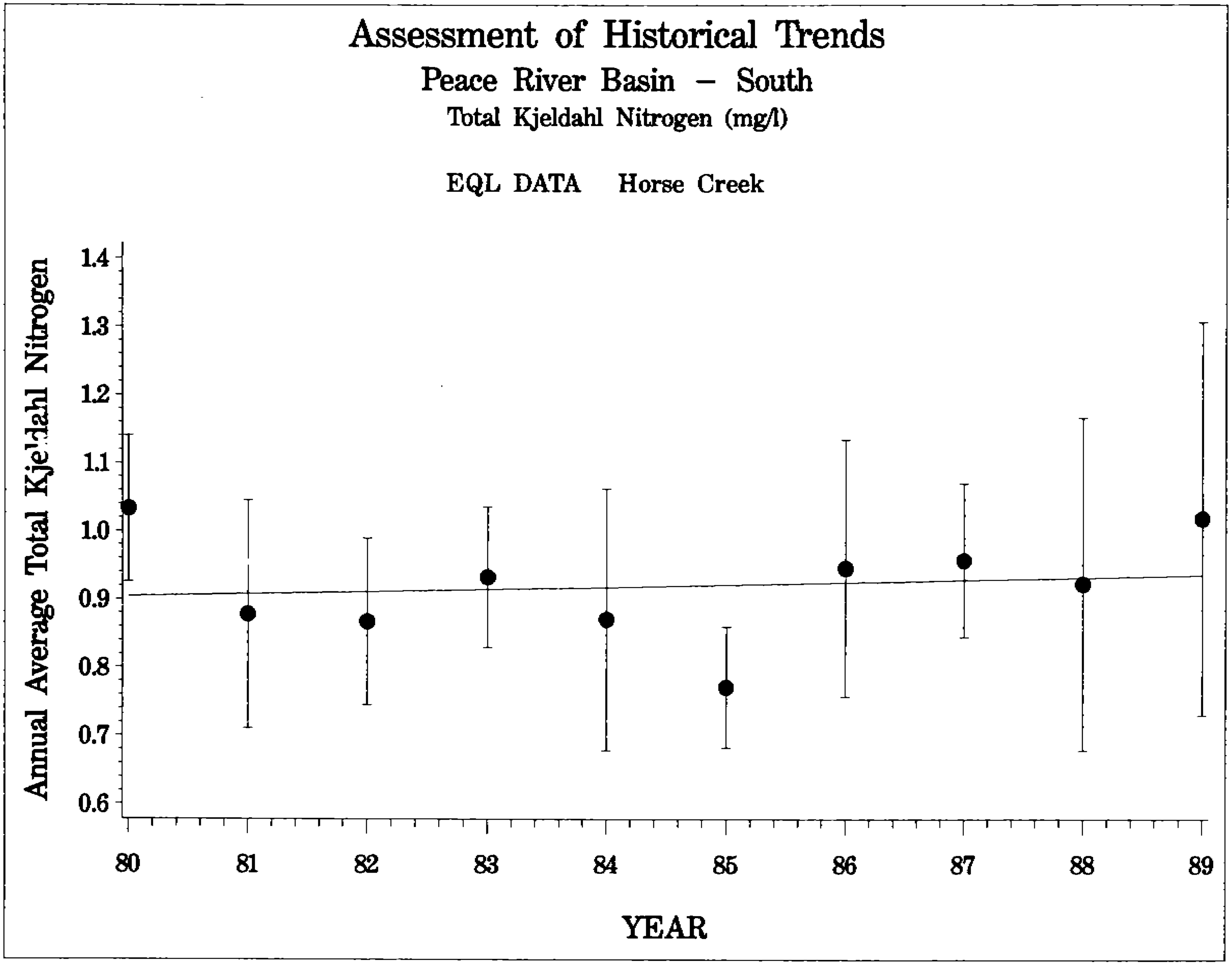
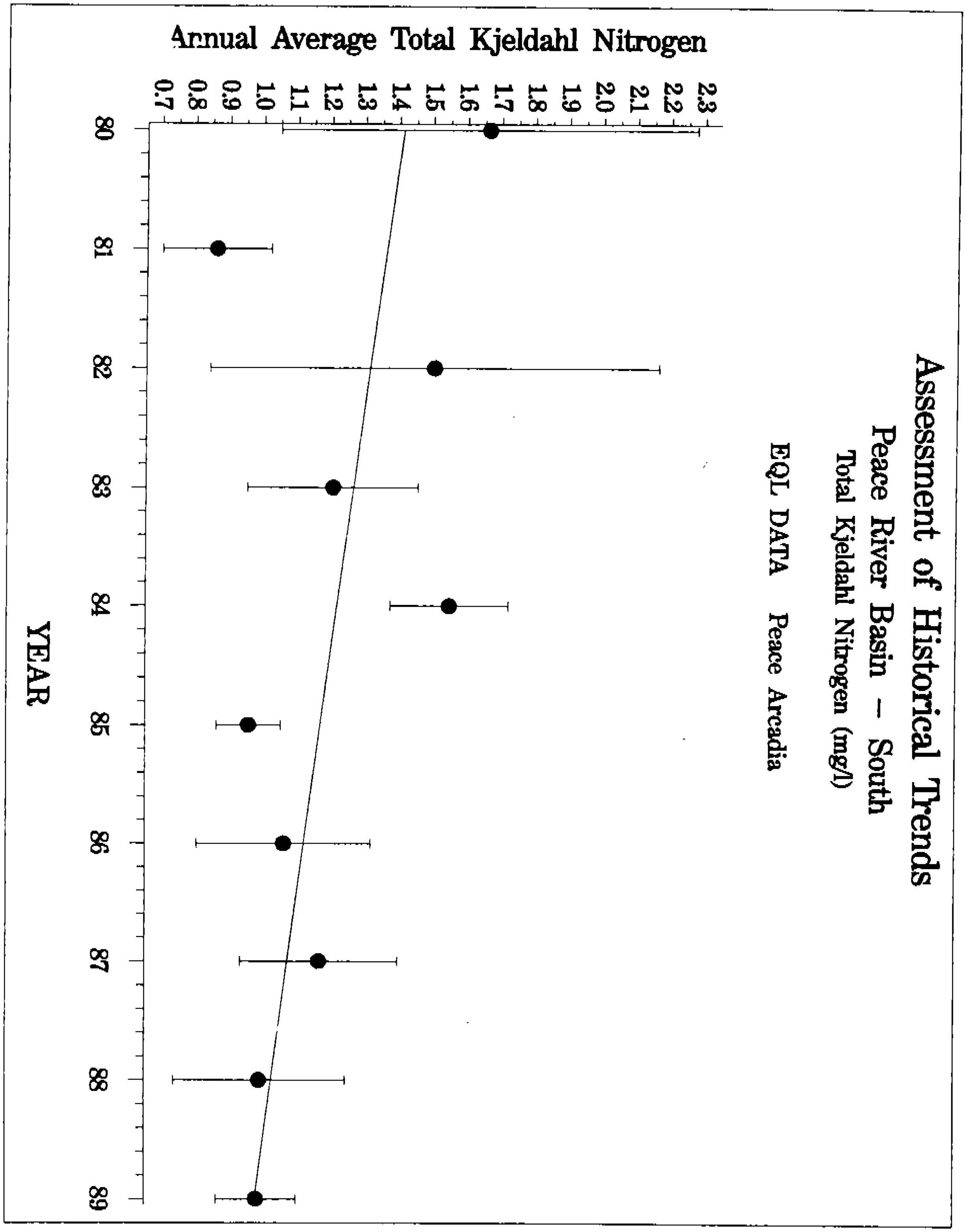
YEAR

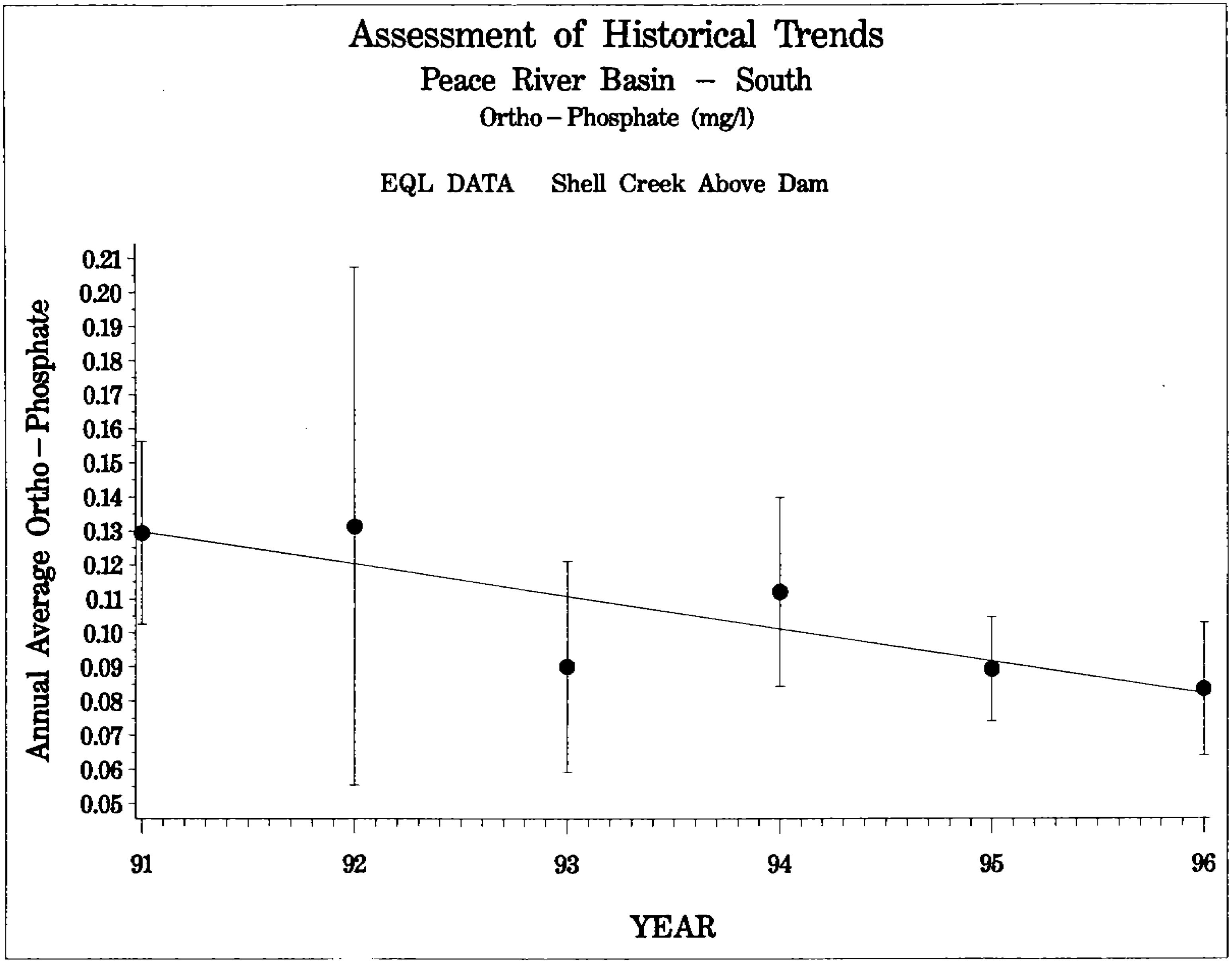

Assessment of Historical Trends
Peace River Basin – South
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Shell Creek Above Dam
Annual Average Total Kjeldahl Nitrogen
0.9
1.0
1.1
1.2
1.3
1.4
1.5
91
93
94
95
96
YEAR

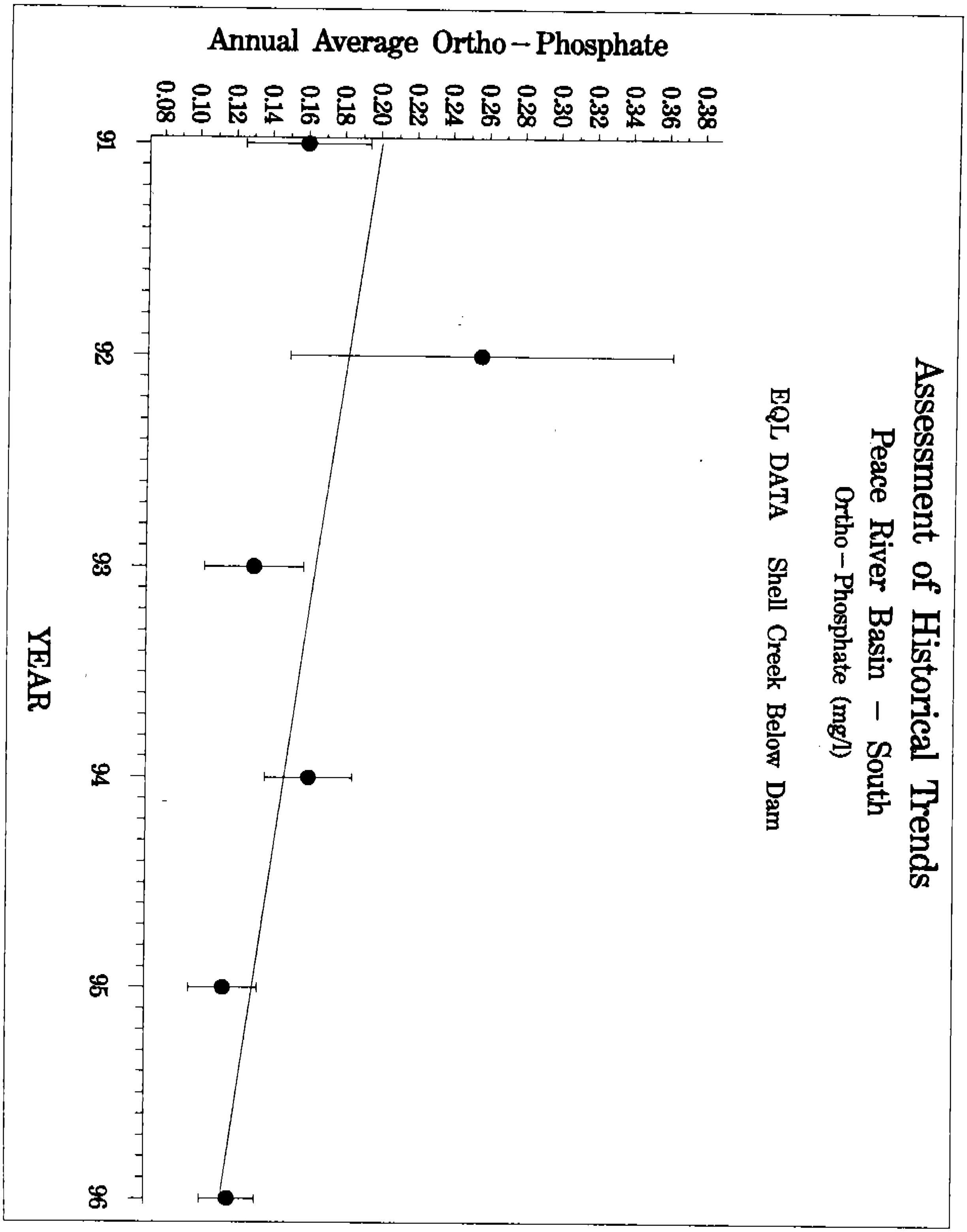

Assessment of Historical Trends
Peace River Basin – South
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Shell Creek Below Dam
Annual Average Total Kjeldahl Nitrogen
1.04
1.06
1.08
1.10
1.12
1.14
1.16
1.18
1.20
1.22
1.24
1.26
1.28
1.30
1.32
1.34
1.36
1.38
1.40
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Lower Peace River
Annual Average Total Kjeldahl Nitrogen
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
80
81
82
83
84
85
86
87
88
89
YEAR

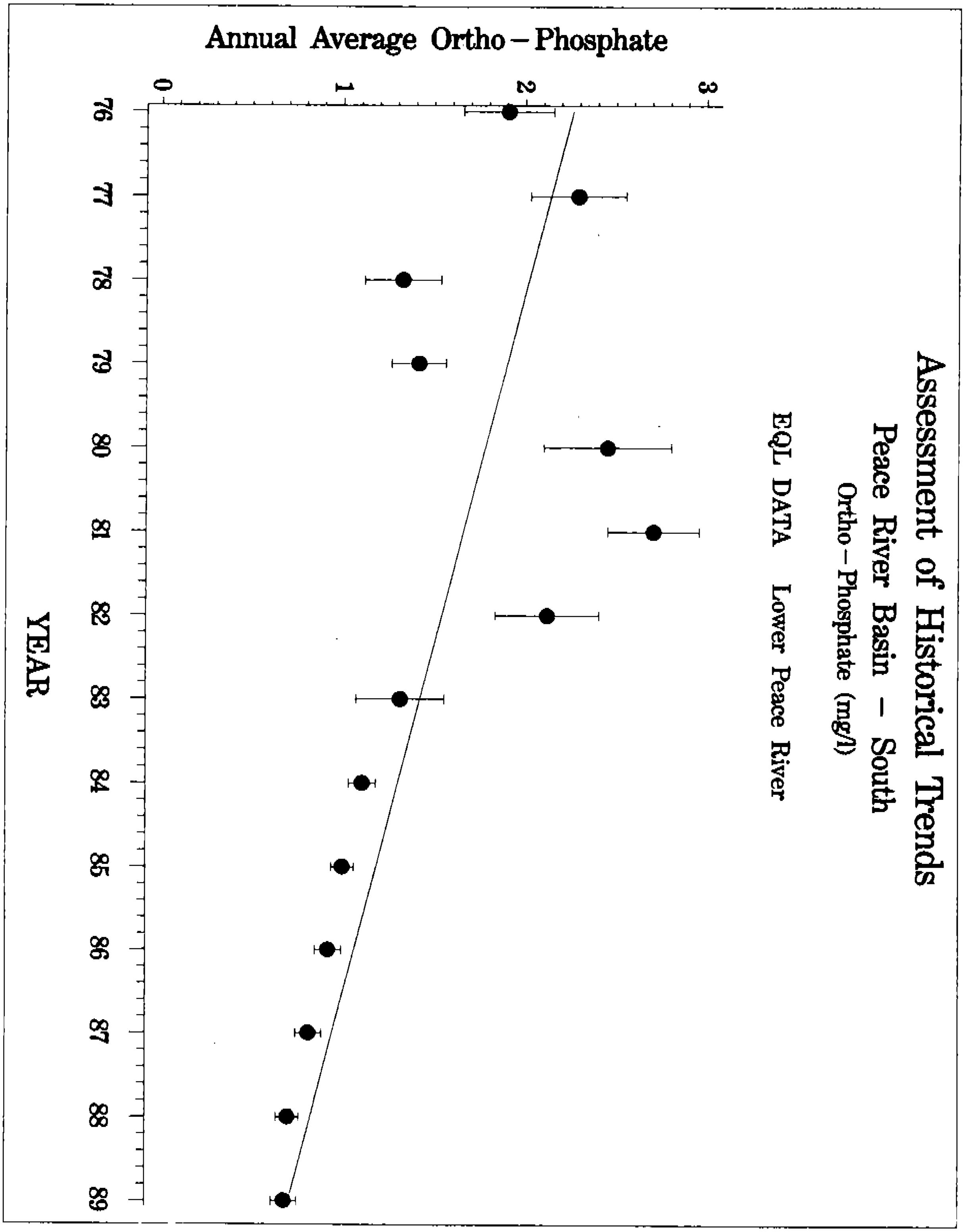

Assessment of Historical Trends
Peace River Basin – South
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Horse Creek
Annual Average Total Kje'dahl Nitrogen
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
80
81
82
83
84
85
86
87
88
89
YEAR

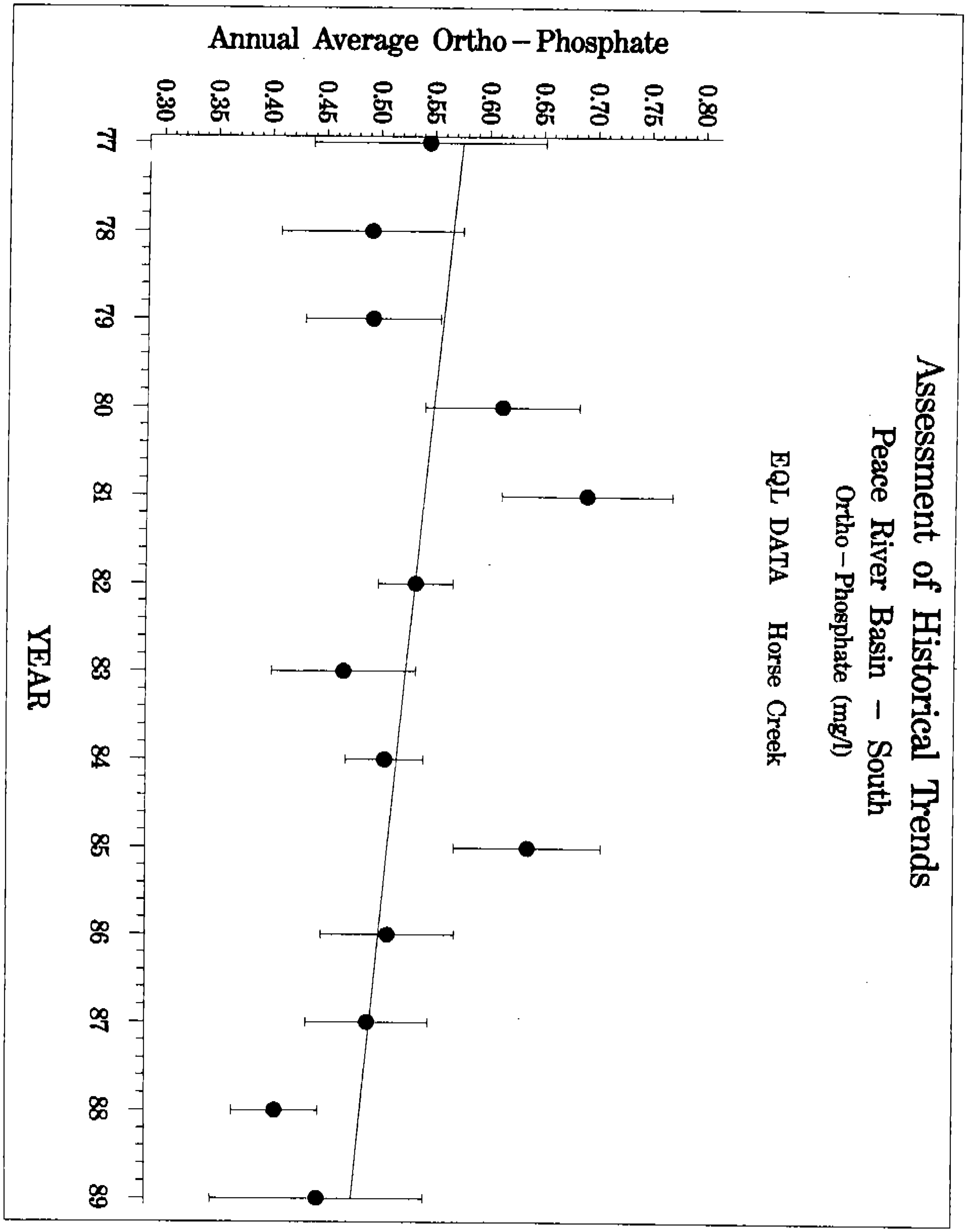

Assessment of Historical Trends
Peace River Basin - South
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Peace Arcadia
Annual Average Total Kjeldahl Nitrogen
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Ortho – Phosphate (mg/l)
EQL DATA Shell Creek Above Dam
Annual Average Ortho – Phosphate
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
91
92
93
94
95
96
YEAR

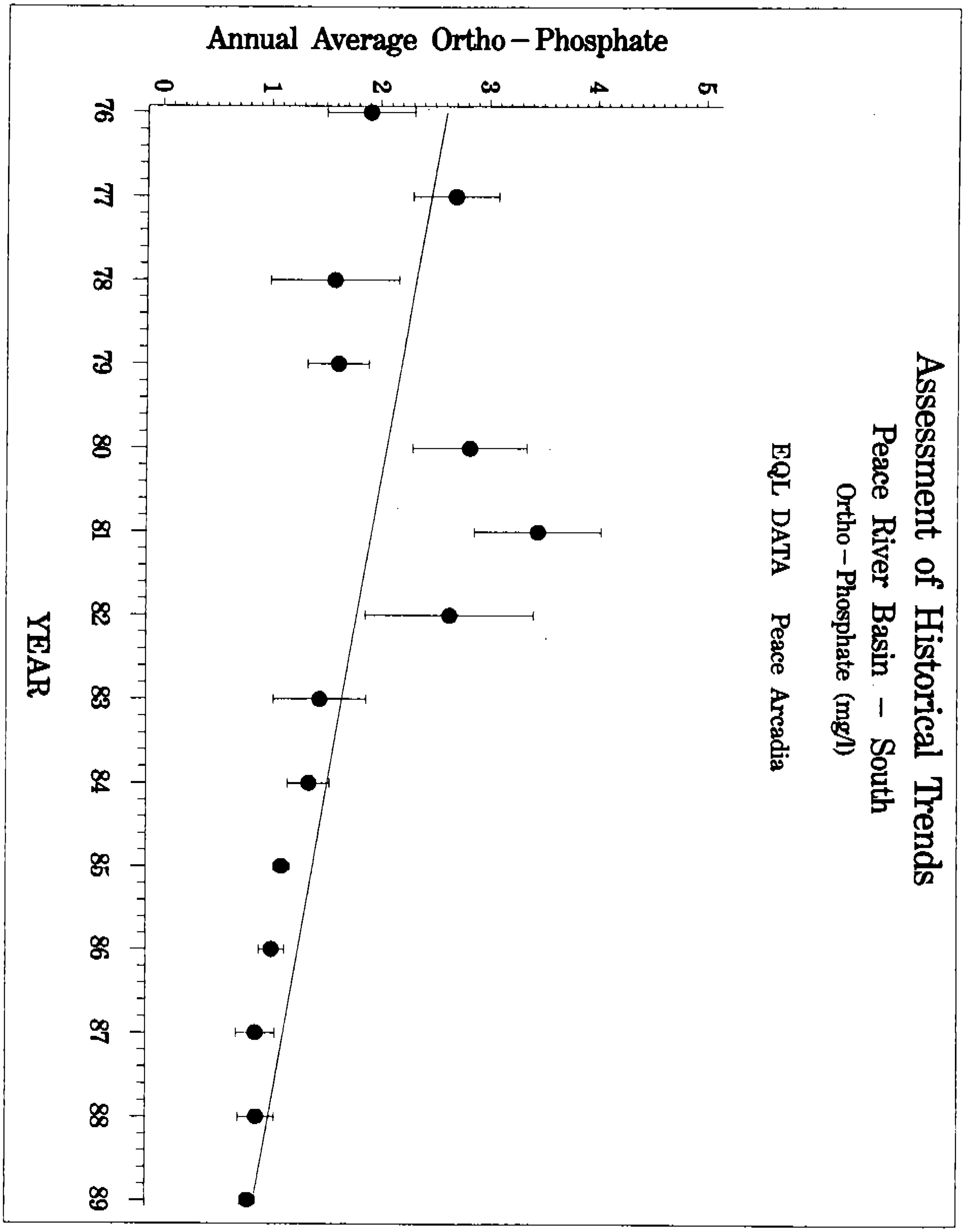


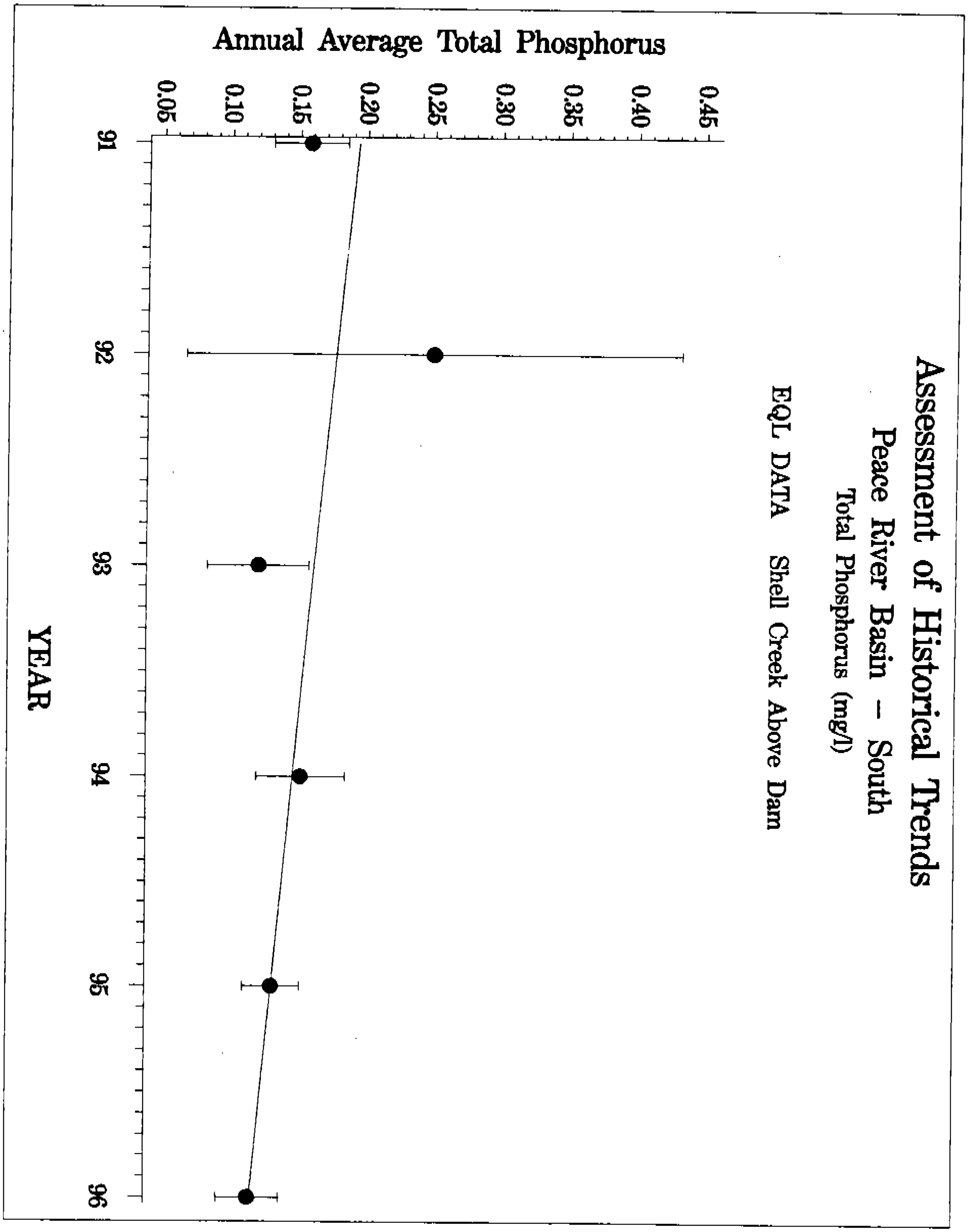
Assessment of Historical Trends
Peace River Basin – South
Ortho – Phosphate (mg/l)
EQL DATA Shell Creek Below Dam
Annual Average Ortho – Phosphate
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
0.24
0.26
0.28
0.30
0.32
0.34
0.36
0.38
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Ortho-Phosphate (mg/l)
EQL DATA Lower Peace River
Annual Average Ortho-Phosphate
0
1
2
3
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

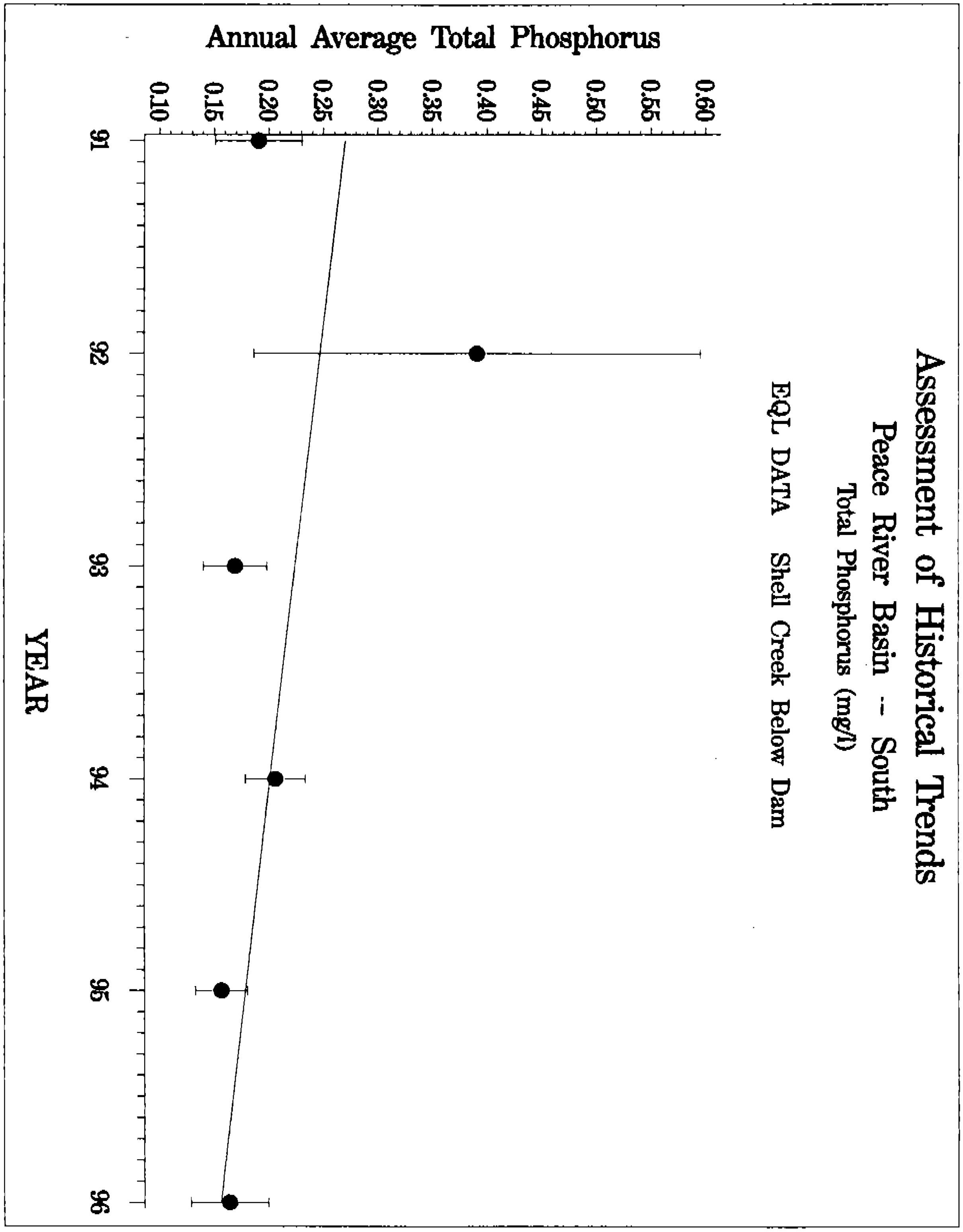


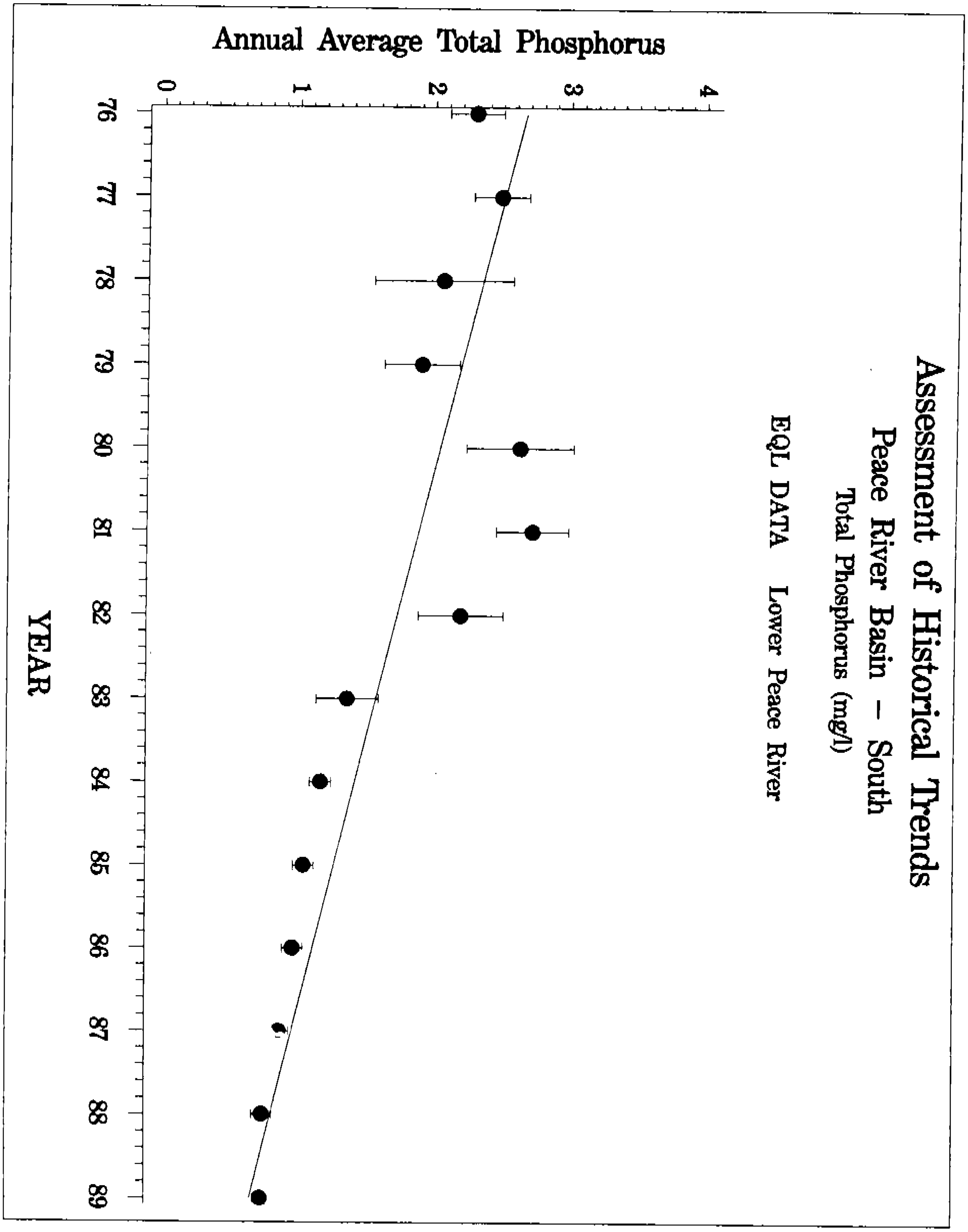
Assessment of Historical Trends
Peace River Basin - South
Ortho - Phosphate (mg/l)
EQL DATA Horse Creek
Annual Average Ortho - Phosphate
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

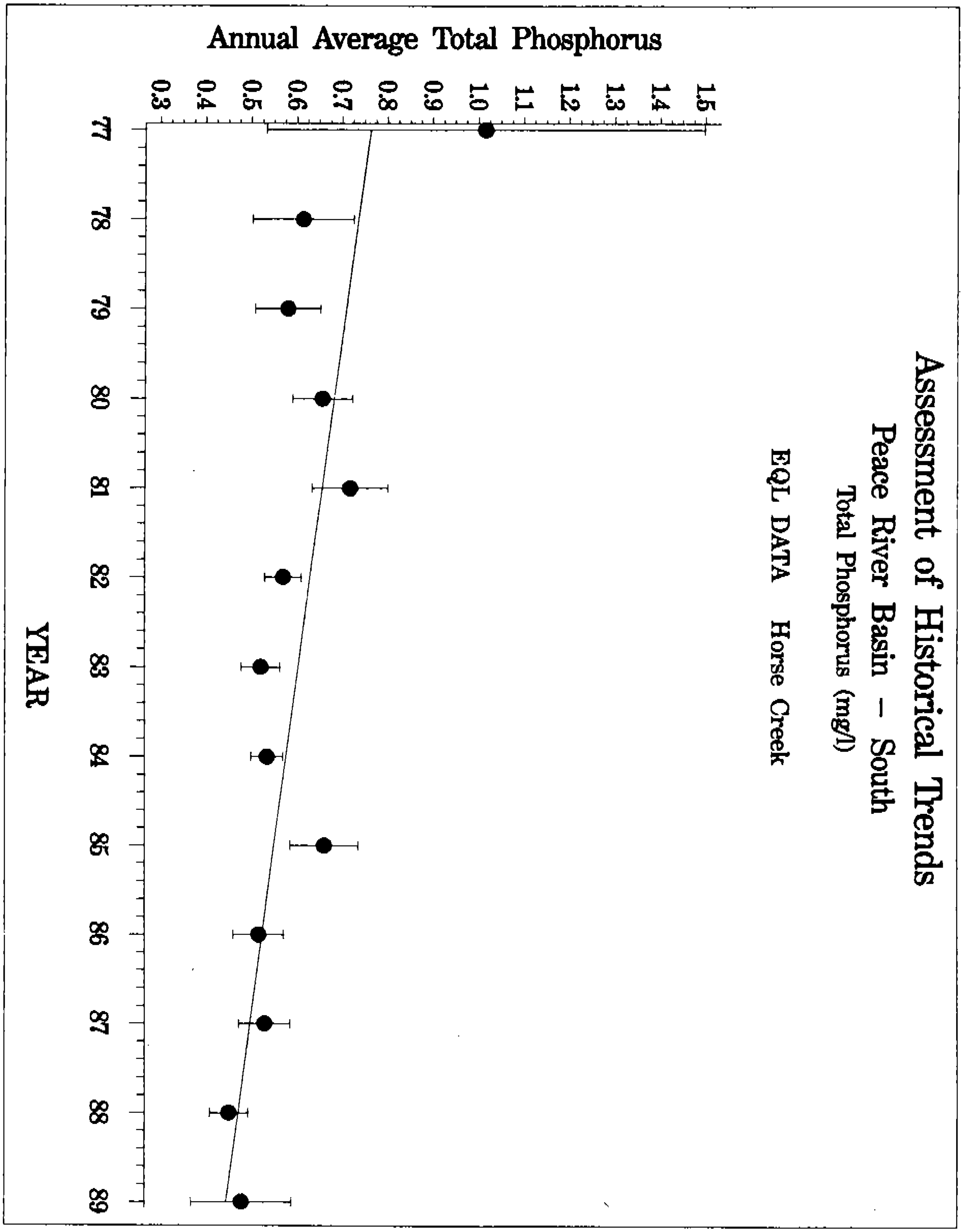

Assessment of Historical Trends
Peace River Basin – South
Ortho – Phosphate (mg/l)
EQL DATA Peace Arcadia
Annual Average Ortho – Phosphate
0
1
2
3
4
5
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR



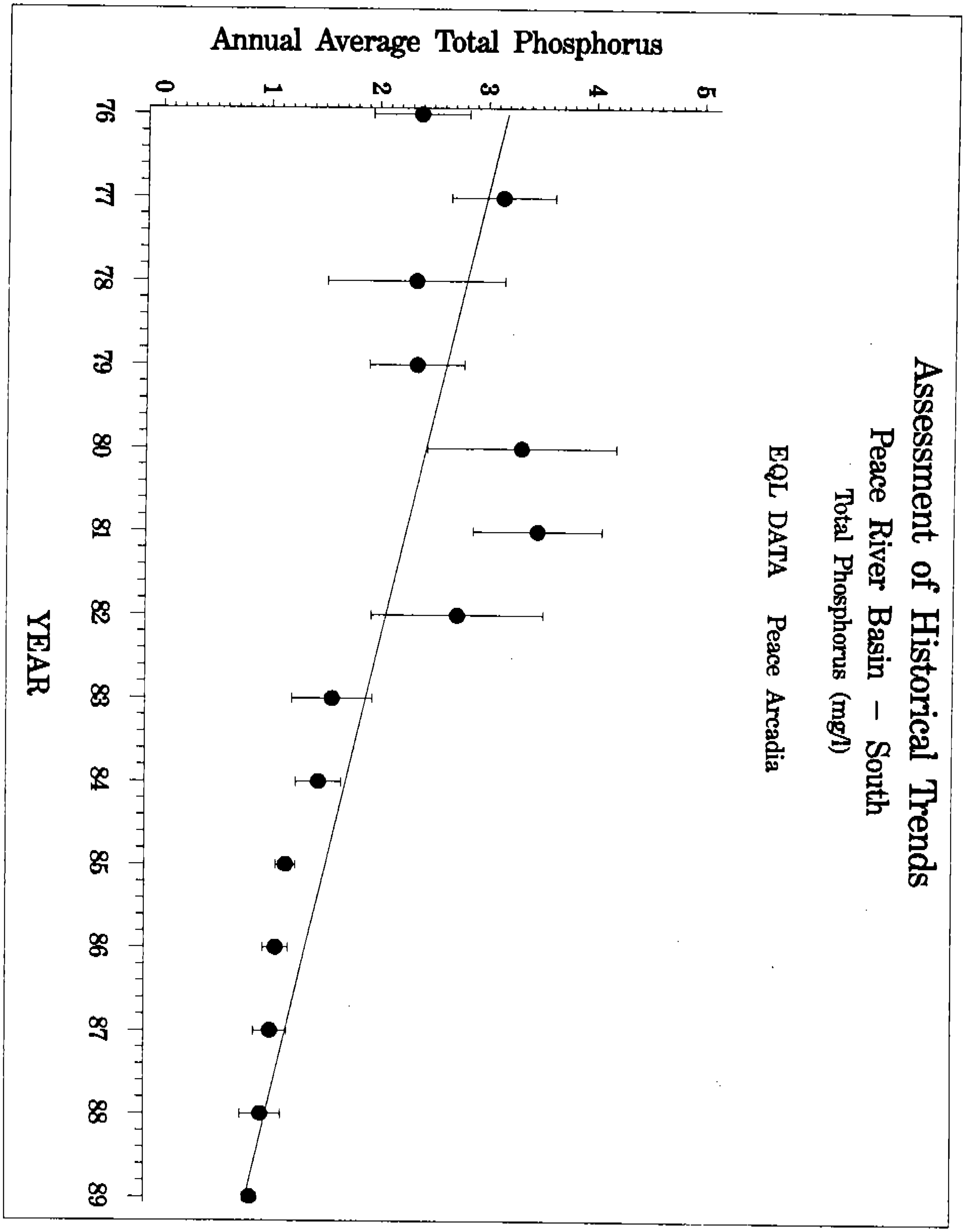
Assessment of Historical Trends
Peace River Basin – South
Total Phosphorus (mg/l)
EQL DATA Shell Creek Above Dam
Annual Average Total Phosphorus
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin - South
Total Phosphorus (mg/l)
EQL DATA Shell Creek Below Dam
Annual Average Total Phosphorus
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
91
92
93
94
95
96
YEAR

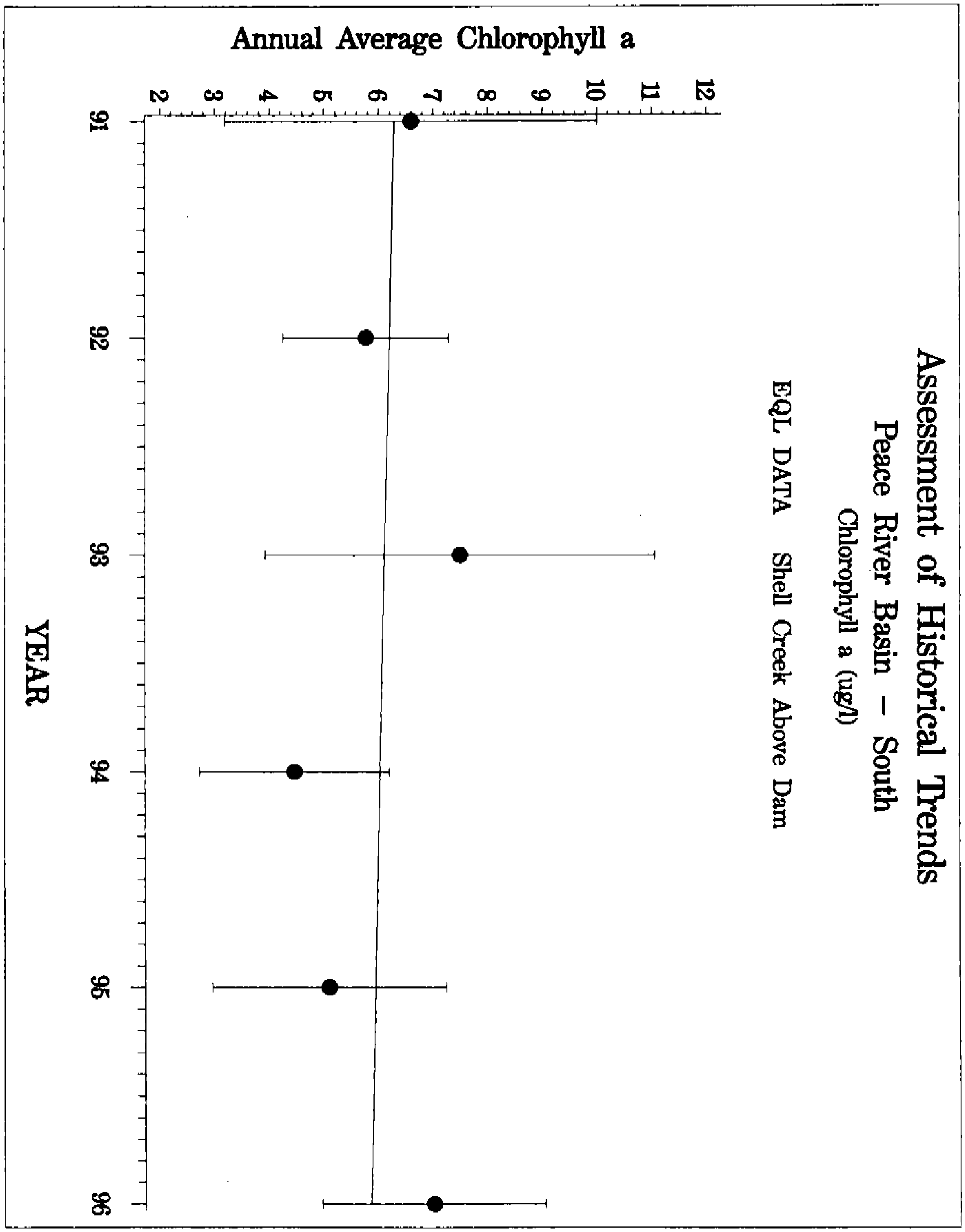

Assessment of Historical Trends
Peace River Basin – South
Total Phosphorus (mg/l)
EQL DATA Lower Peace River
Annual Average Total Phosphorus
0
1
2
3
4
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

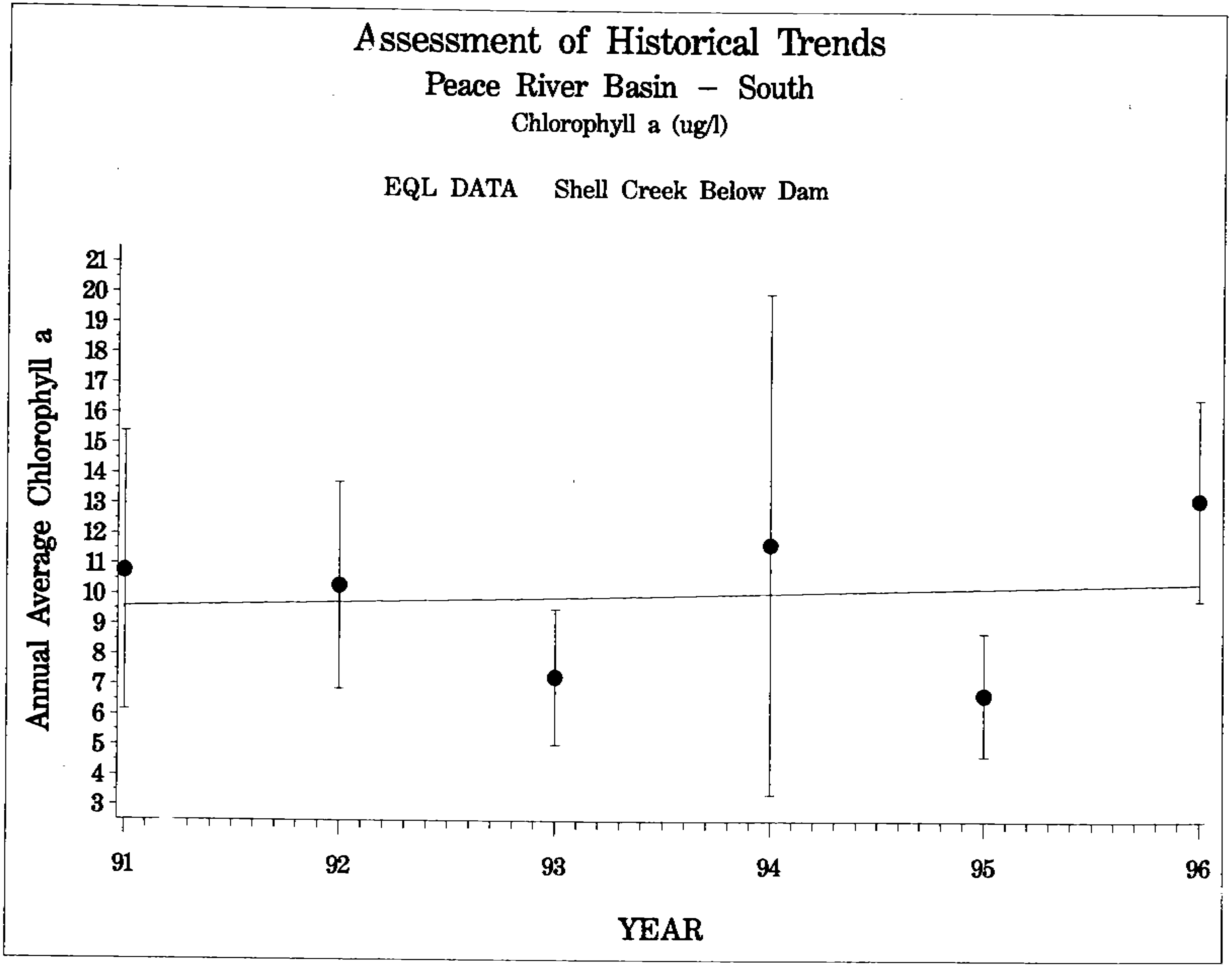


Assessment of Historical Trends
Peace River Basin – South
Total Phosphorus (mg/l)
EQL DATA Horse Creek
Annual Average Total Phosphorus
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

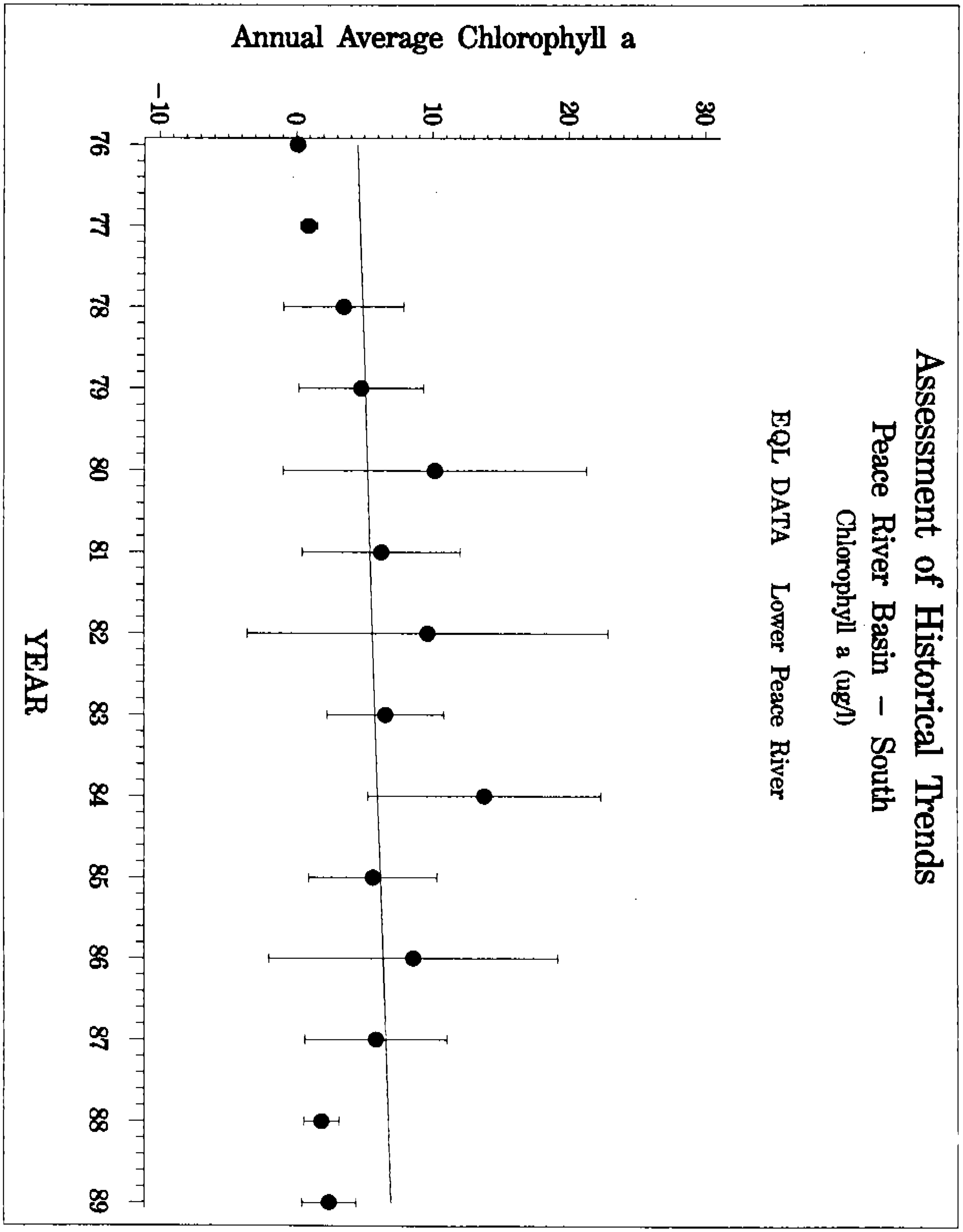


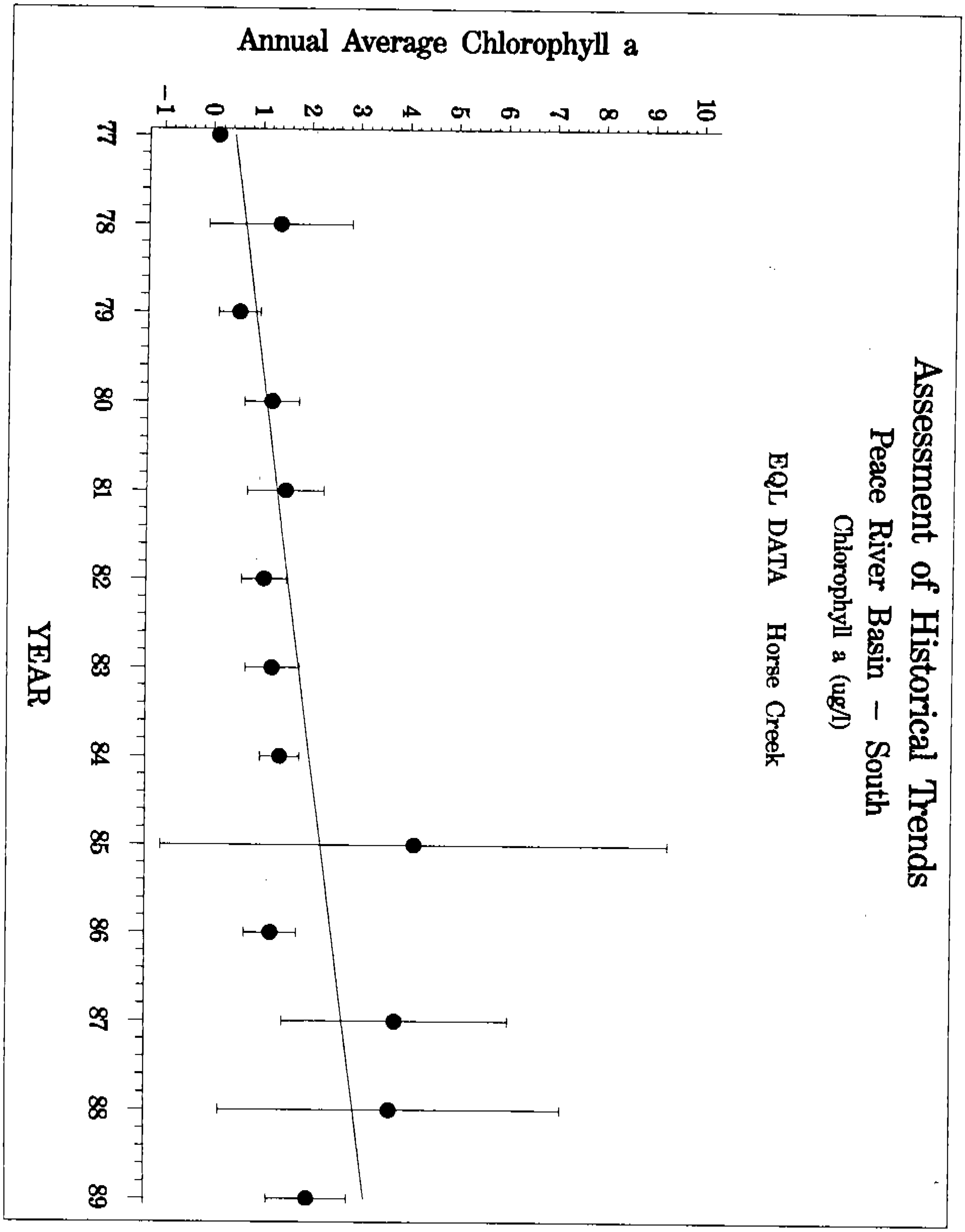
Assessment of Historical Trends
Peace River Basin – South
Total Phosphorus (mg/l)
EQL DATA Peace Arcadia
Annual Average Total Phosphorus
0
1
2
3
4
5
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

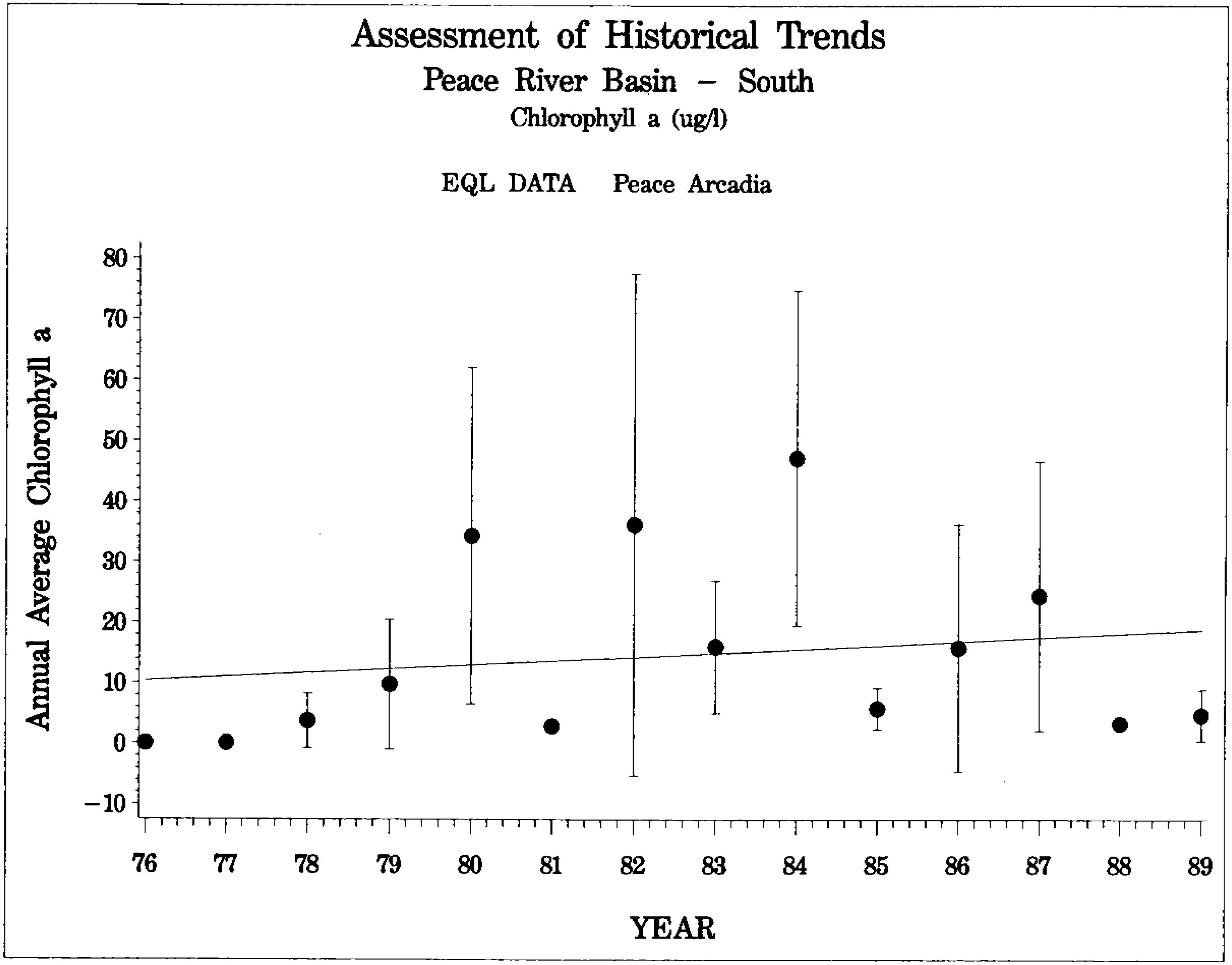

Assessment of Historical Trends
Peace River Basin – South
Chlorophyll a (ug/l)
EQL DATA Shell Creek Above Dam
Annual Average Chlorophyll a
2
3
4
5
6
7
8
9
10
11
12
91
92
93
94
95
96
YEAR



Assessment of Historical Trends
Peace River Basin – South
Chlorophyll a (ug/l)
EQL DATA Shell Creek Below Dam
Annual Average Chlorophyll a
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
91
92
93
94
95
96
YEAR


Assessment of Historical Trends
Peace River Basin – South
Chlorophyll a (ug/l)
EQL DATA Lower Peace River
Annual Average Chlorophyll a
-10
0
10
20
30
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Chlorophyll a (ug/l)
EQL DATA Horse Creek
Annual Average Chlorophyll a
YEAR
77
78
79
80
81
82
83
84
85
86
87
88
89
−1
0
1
2
3
4
5
6
7
8
9
10


Assessment of Historical Trends
Peace River Basin – South
Chlorophyll a (ug/l)
EQL DATA Peace Arcadia
Annual Average Chlorophyll a
80
70
60
50
40
30
20
10
0
–10
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

Charlotte Harbor Proper Basin

Trend Analysis of EQL Data from Charlotte Harbor

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Charlotte Harbor Proper

EQL DATA

Conductivity (mmhos/cm)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Lower Charlotte Harbor	7	0.55905	0.26963	0.84848	0.00015	0.011484	156
Middle Charlotte Harbor	7	0.10866	-0.25068	0.46800	0.55339	0.002604	156

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Upper Charlotte Harbor	17	76	94	404	-8.48153	-6.27730	-10.6858	4.6407E-14

Color (CPU)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Upper Charlotte Harbor	14	0.22743	-0.34493	0.79978	0.43609	.0061053	325

Turbidity (NTU)

Slope Analyzed Over Entire Record

Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Upper Charlotte Harbor	14	-0.071025	-0.13387	-.0081833	0.026744	-0.023893	325

Charlotte Harbor National Estuary Program
Synthesis of Existing Information
Water Quality Data Analysis - Charlotte Harbor Proper

EQL DATA

Nitrite/Nitrate (mg/l)

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Upper Charlotte Harbor	17	76	94	365	.0012602	.0090340	-.0065137	0.75069

Total Kjeldahl Nitrogen (mg/l)

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Upper Charlotte Harbor	13	80	94	265	0.042724	0.13466	-0.049213	0.36238

Ortho-Phosphate (mg/l)

Comparison by Division of Period of Record

Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Upper Charlotte Harbor	17	76	94	364	-0.11034	-0.088801	-0.13188	0

Total Phosphorus (mg/l)

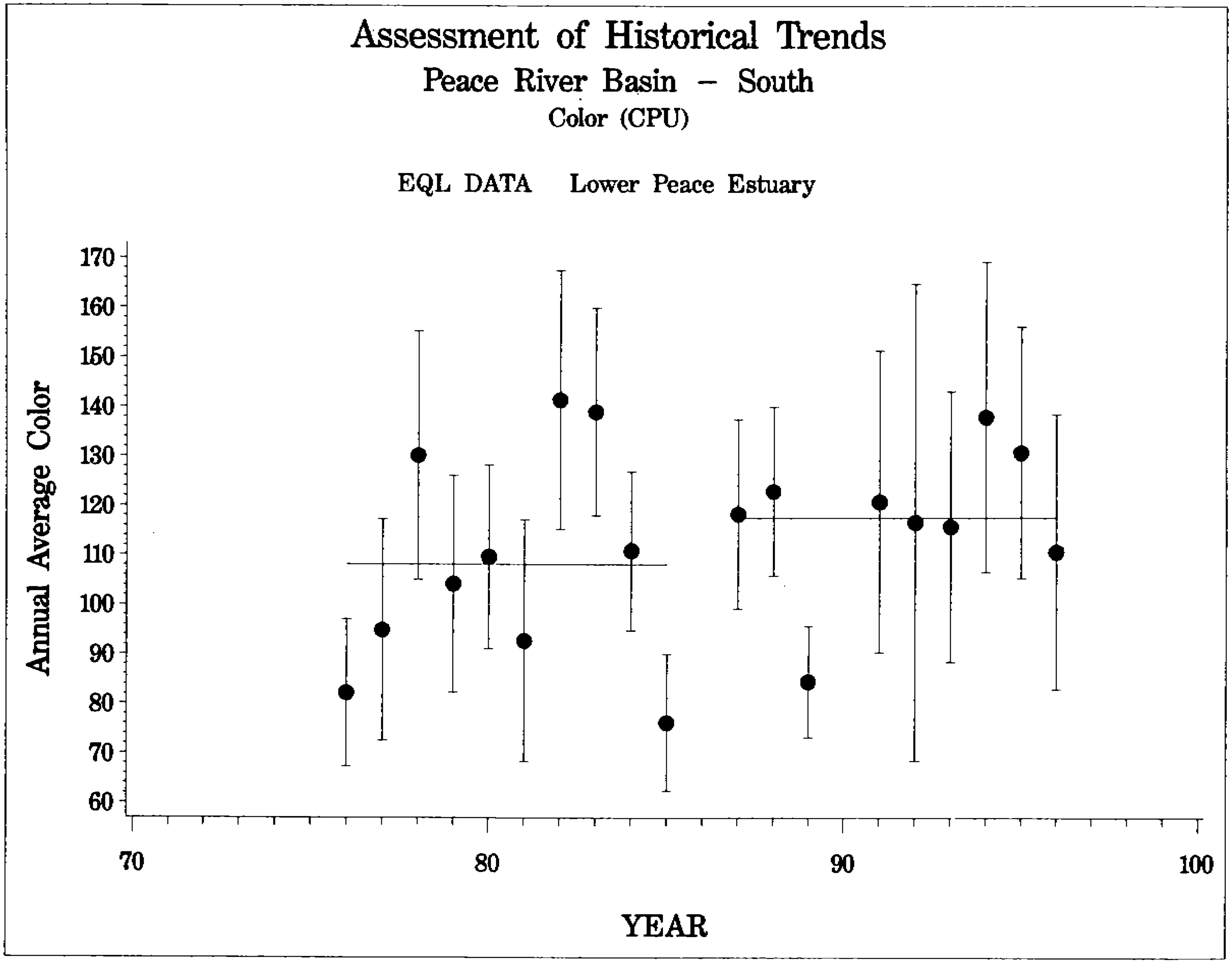
Comparison by Division of Period of Record

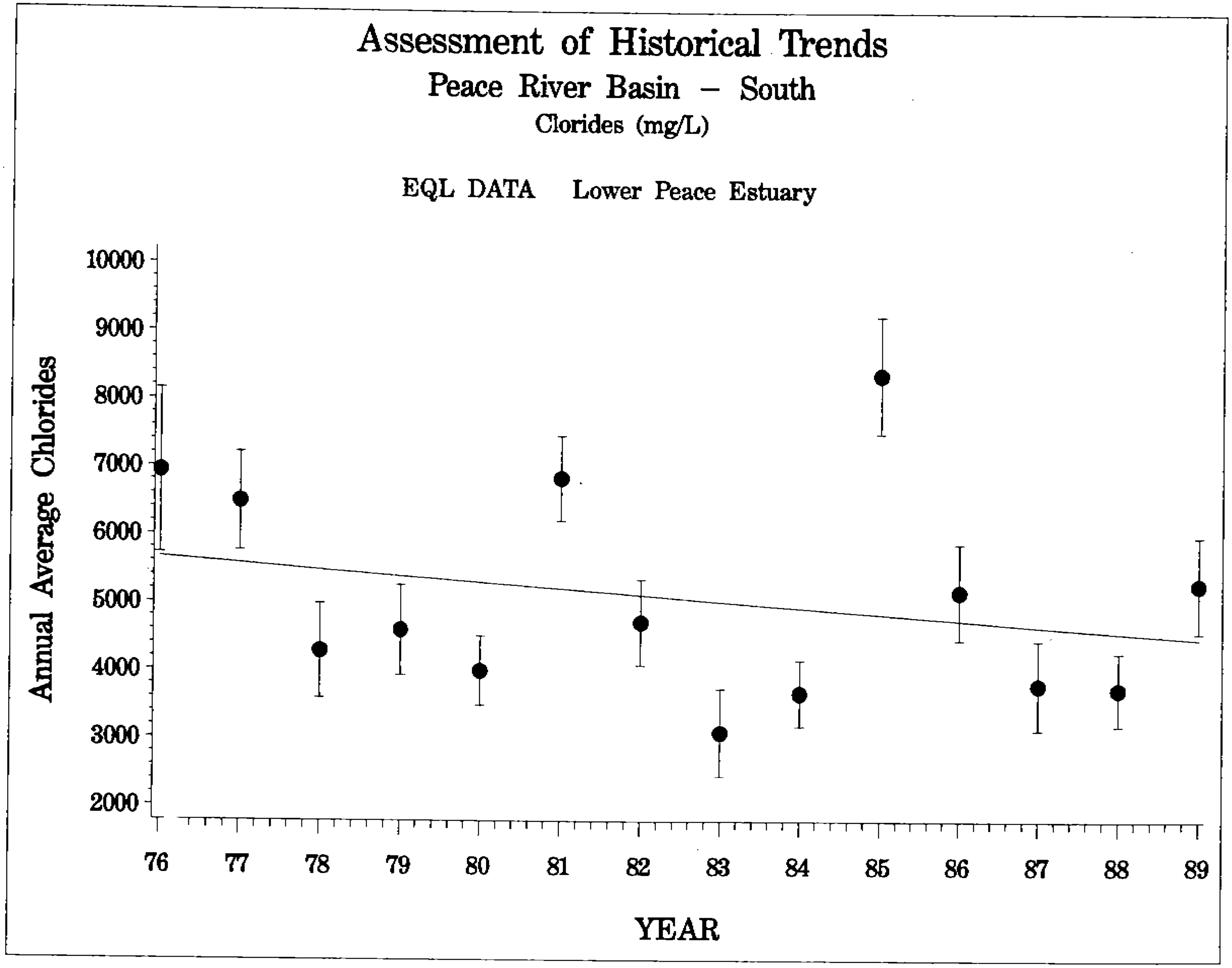
Station Name	# of Years of Sampling	First Year of Sampling	Last Year of Sampling	Number of Samples	Mean Difference Estimate	Upper 95% Limit	Lower 95% Limit	P Value for Diff. Test
Upper Charlotte Harbor	17	76	94	363	-0.11990	-0.083977	-0.15581	6.0538E-11

Chlorophyll a (ug/l)

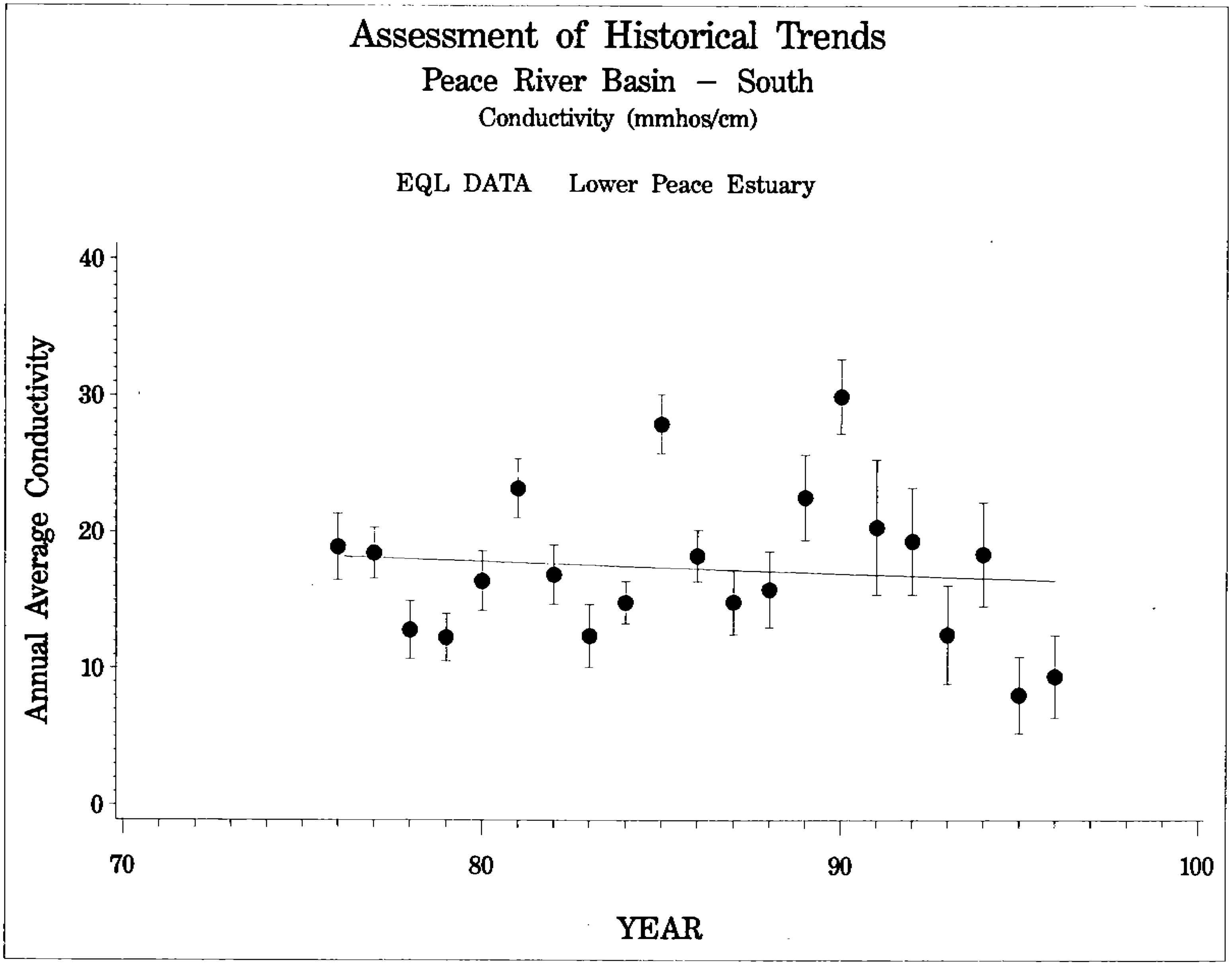
Slope Analyzed Over Entire Record

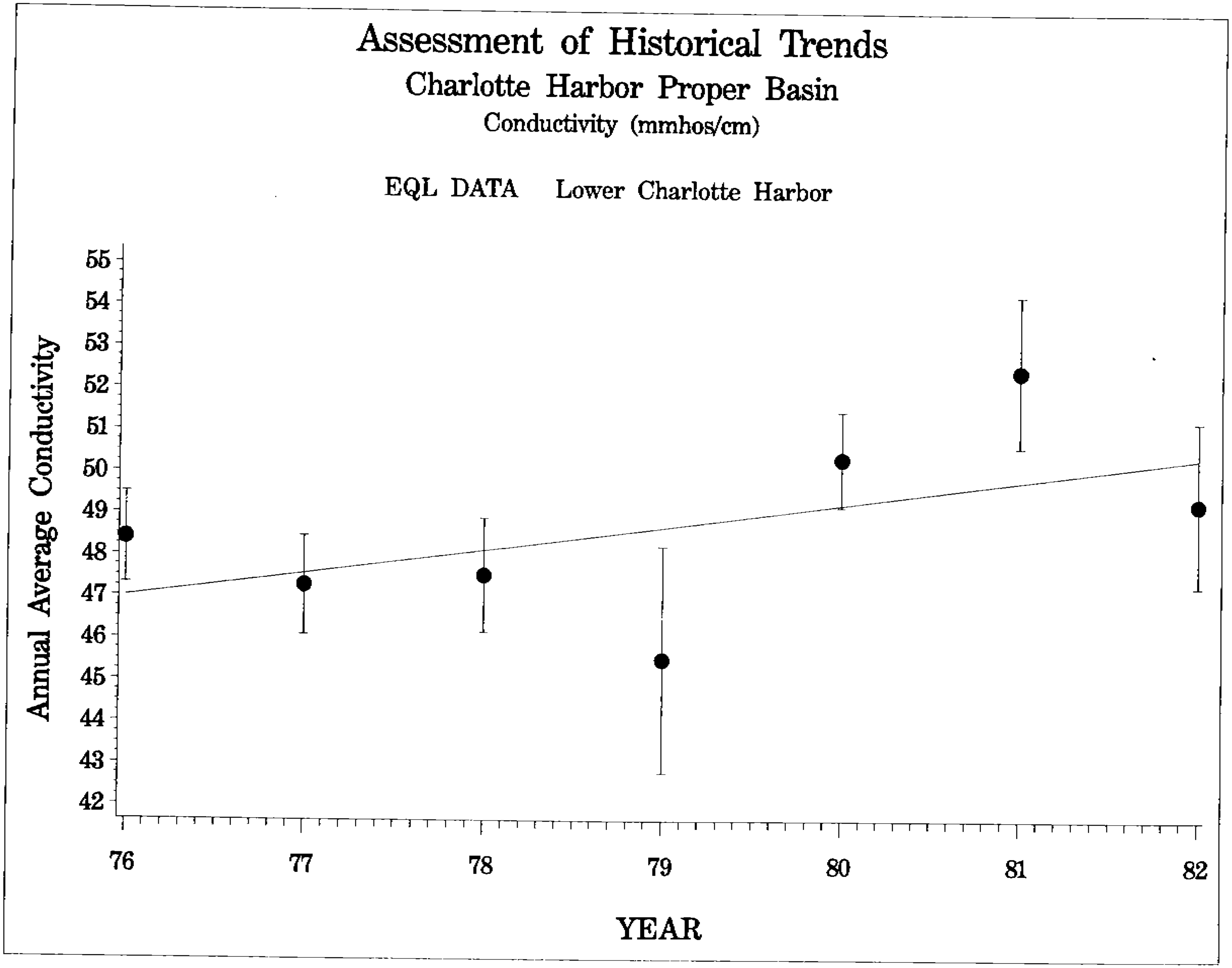
Station Name	# of Years of Sampling	Annual Slope Estimate	Lower 95% Limit	Upper 95% Limit	P Value for Trend Test	Percent Change per Year	Number of Samples
Upper Charlotte Harbor	12	0.22138	-0.22005	0.66280	.32563	0.029509	277

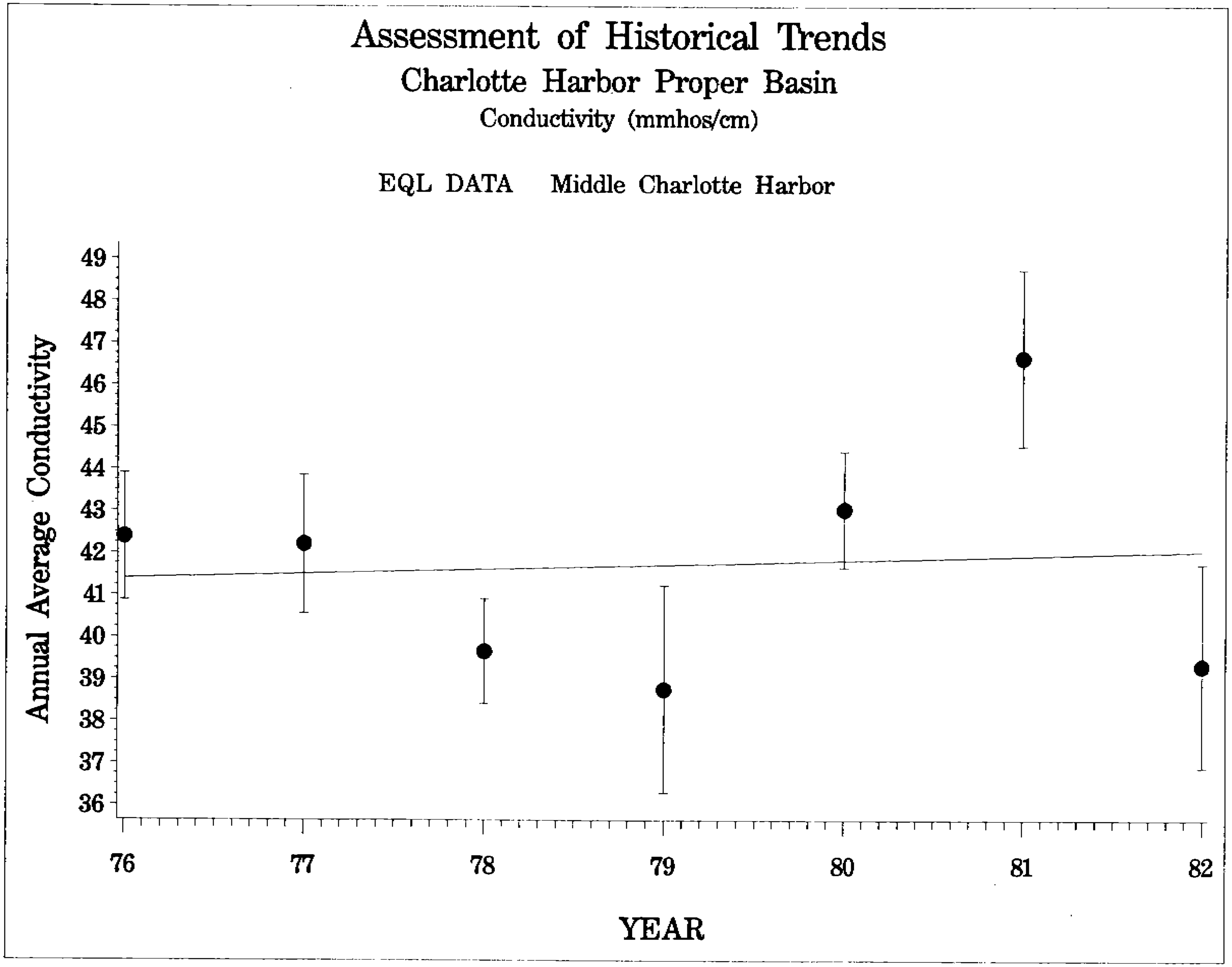

Assessment of Historical Trends
Peace River Basin – South
Color (CPU)
EQL DATA Lower Peace Estuary
Annual Average Color
170
160
150
140
130
120
110
100
90
80
70
60
70
80
90
100
YEAR



Assessment of Historical Trends
Peace River Basin – South
Clorides (mg/L)
EQL DATA Lower Peace Estuary
Annual Average Chlorides
10000
9000
8000
7000
6000
5000
4000
3000
2000
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Conductivity (mmhos/cm)
EQL DATA Lower Peace Estuary
Annual Average Conductivity
0
10
20
30
40
70
80
90
100
YEAR


Assessment of Historical Trends
Charlotte Harbor Proper Basin
Conductivity (mmhos/cm)
EQL DATA Lower Charlotte Harbor
Annual Average Conductivity
55
54
53
52
51
50
49
48
47
46
45
44
43
42
76
77
78
79
80
81
82
YEAR

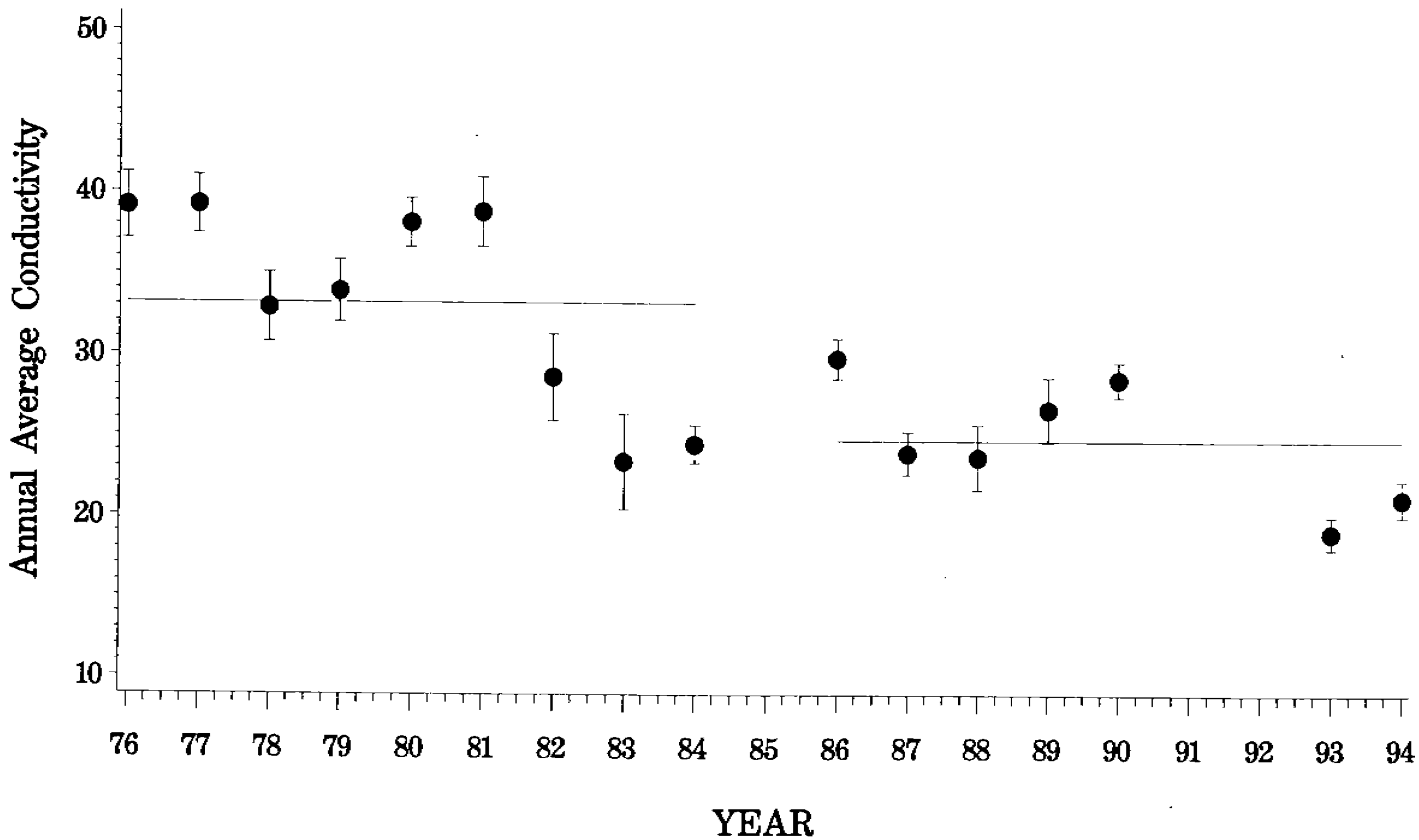

Assessment of Historical Trends
Charlotte Harbor Proper Basin
Conductivity (mmhos/cm)
EQL DATA Middle Charlotte Harbor
Annual Average Conductivity
49
48
47
46
45
44
43
42
41
40
39
38
37
36
76
77
78
79
80
81
82
YEAR

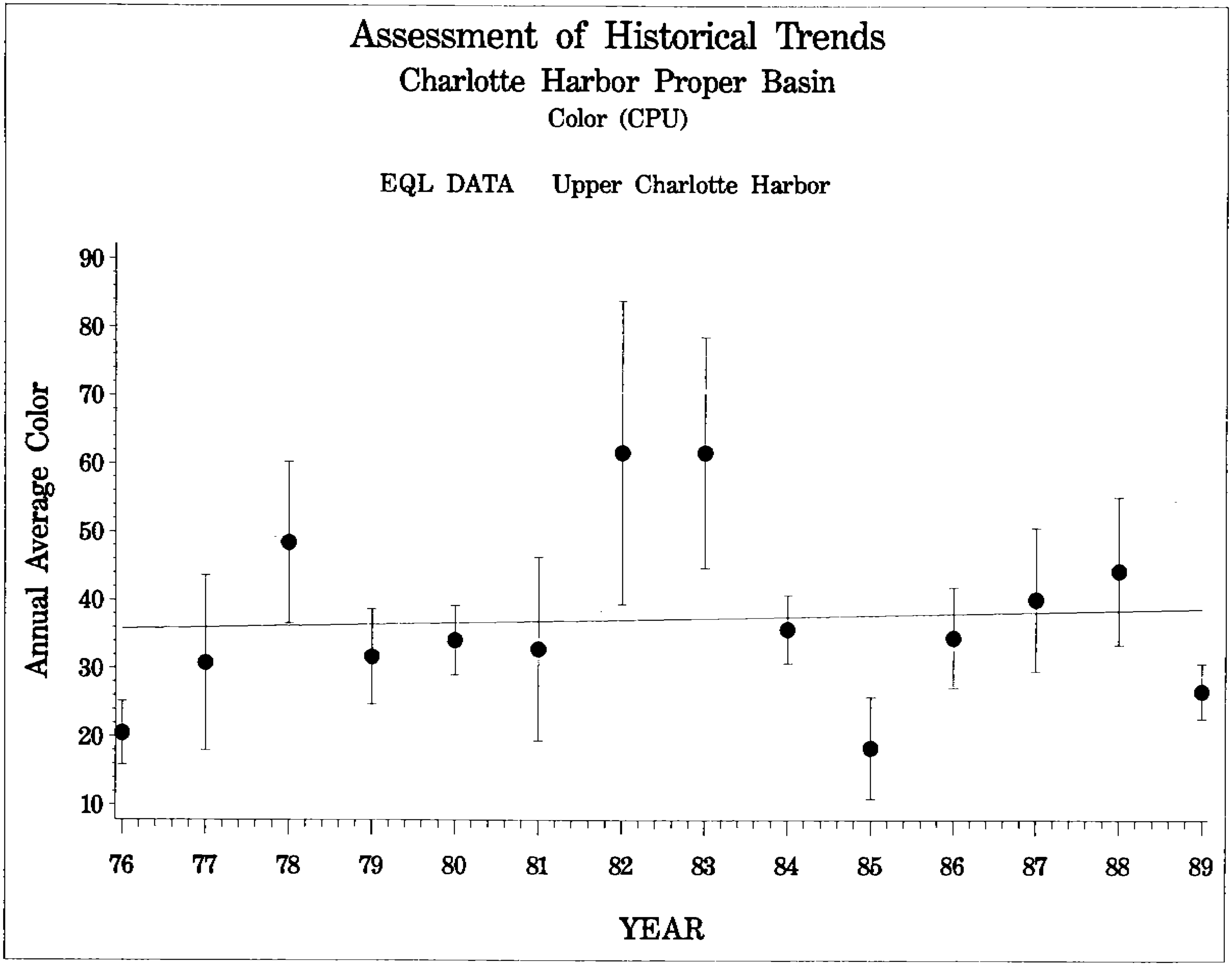
Assessment of Historical Trends

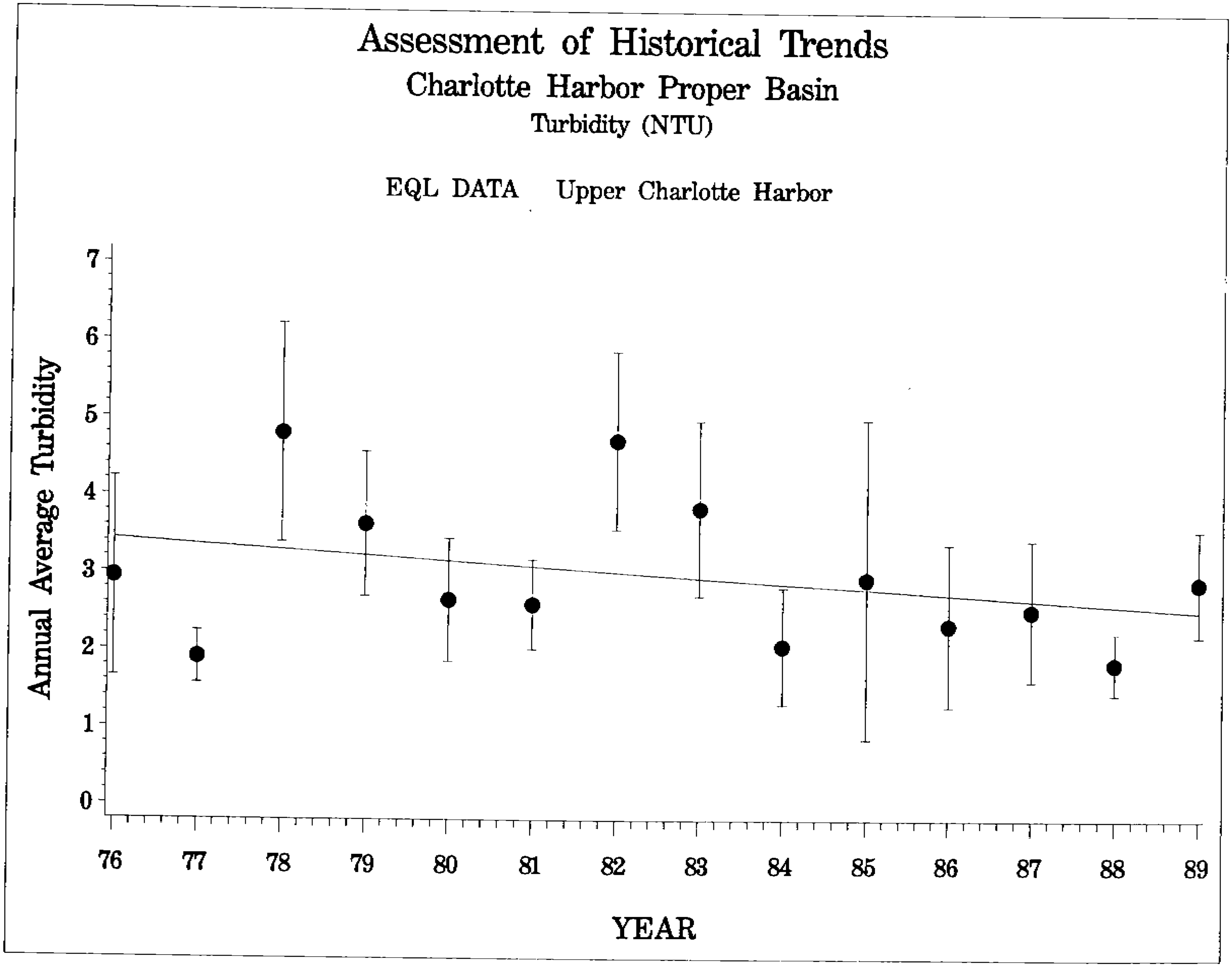
Charlotte Harbor Proper Basin

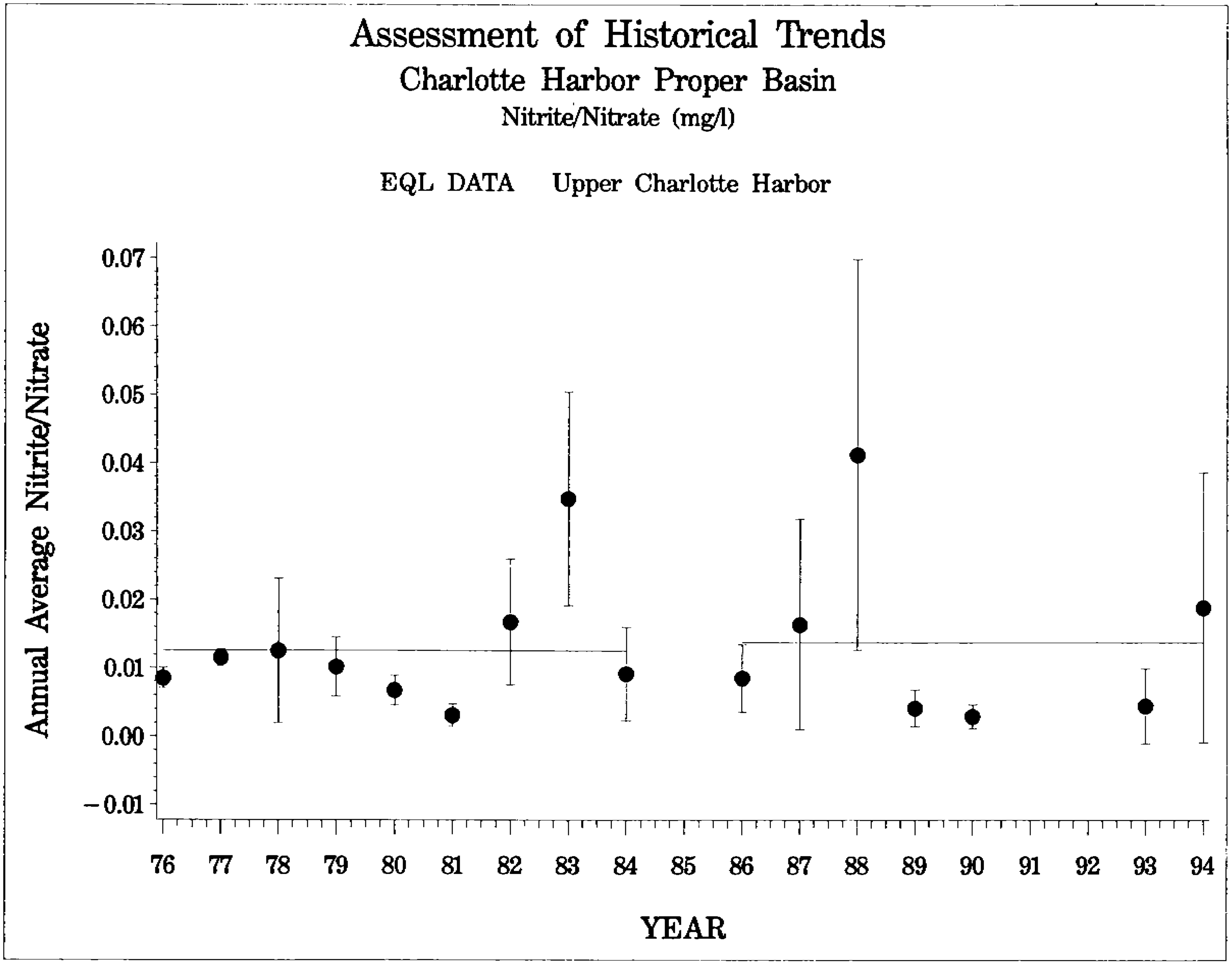
Conductivity (mmhos/cm)

EQL DATA Upper Charlotte Harbor

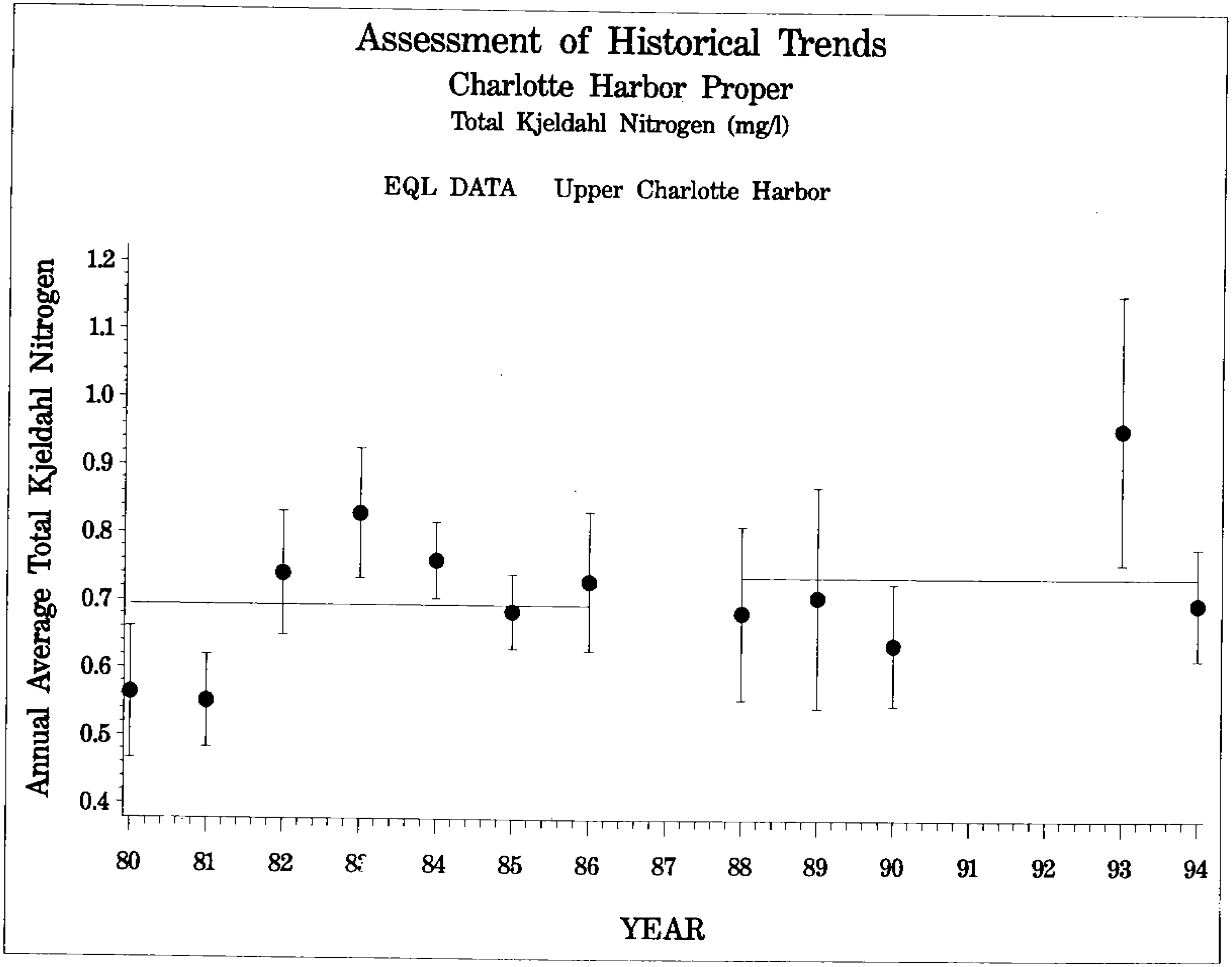


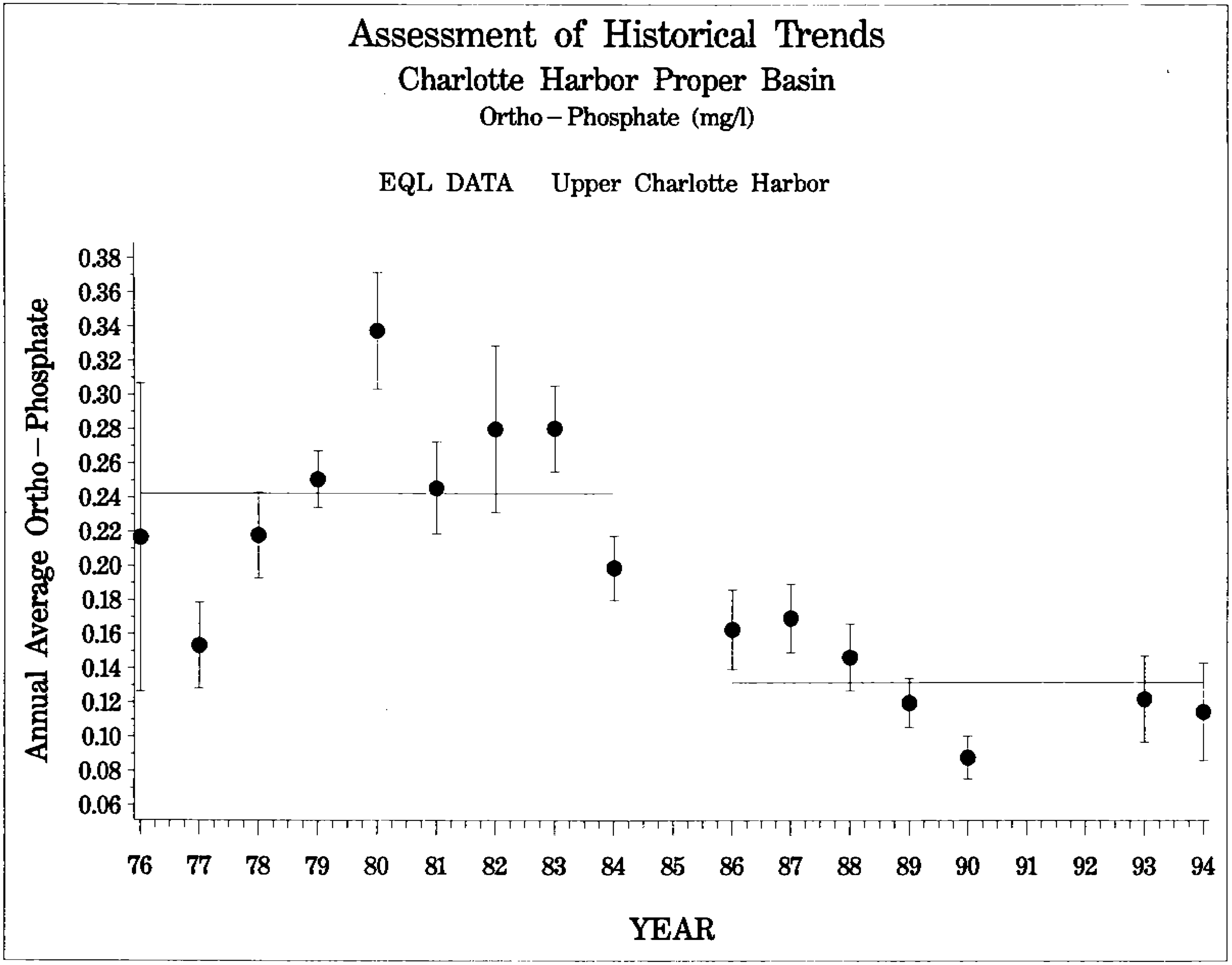

Assessment of Historical Trends
Charlotte Harbor Proper Basin
Color (CPU)
EQL DATA Upper Charlotte Harbor
Annual Average Color
10
20
30
40
50
60
70
80
90
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

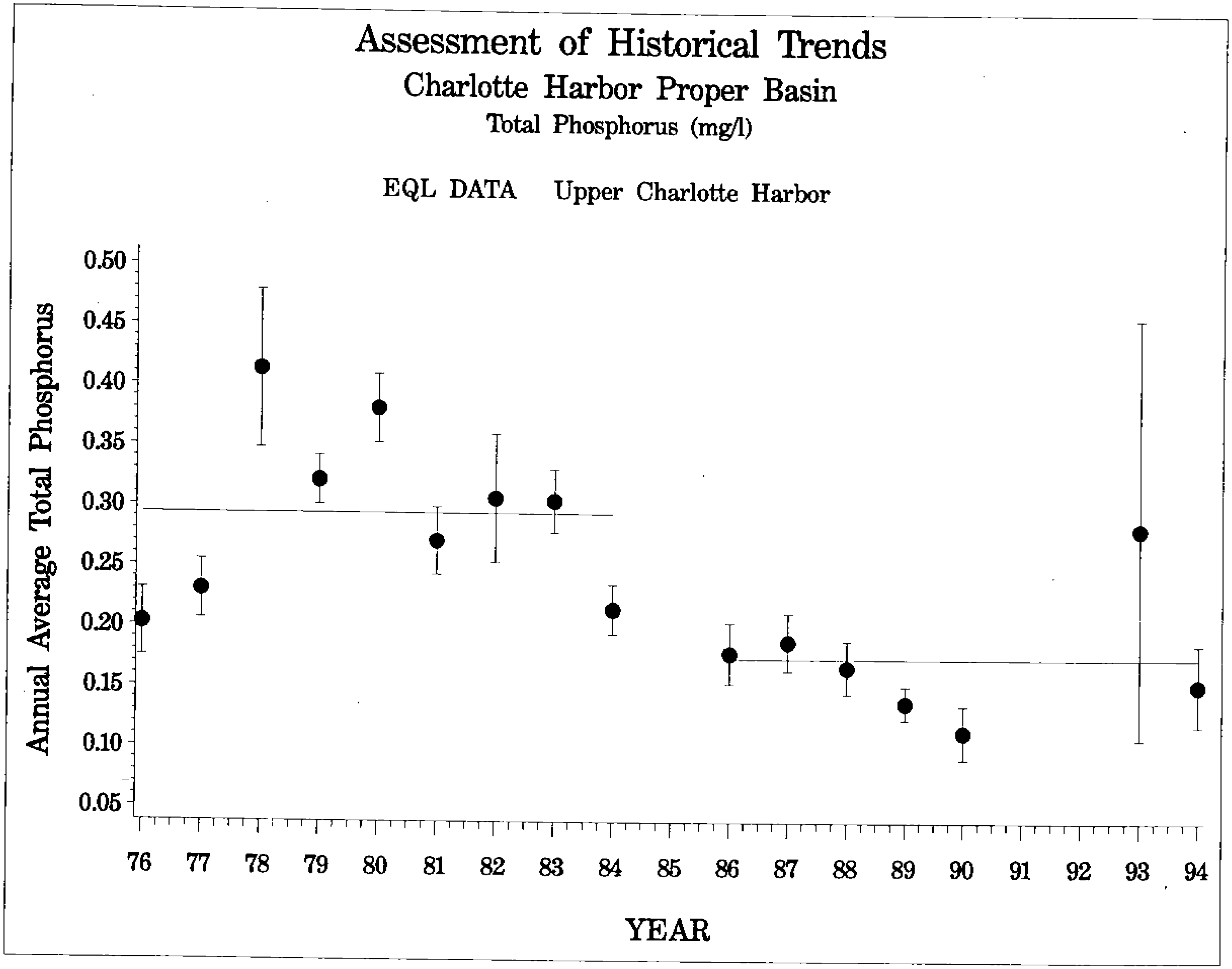

Assessment of Historical Trends
Charlotte Harbor Proper Basin
Turbidity (NTU)
EQL DATA Upper Charlotte Harbor
Annual Average Turbidity
0
1
2
3
4
5
6
7
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR

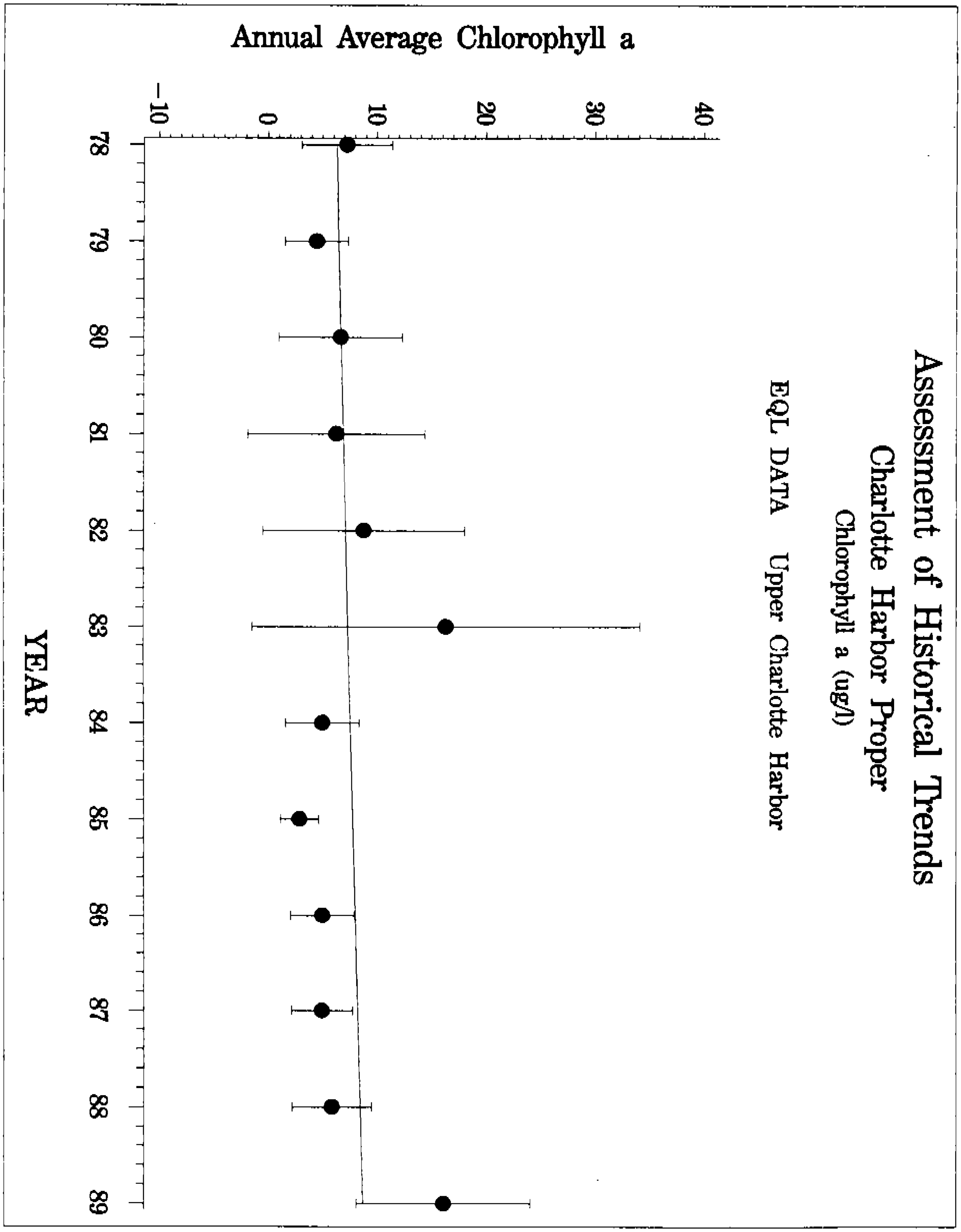


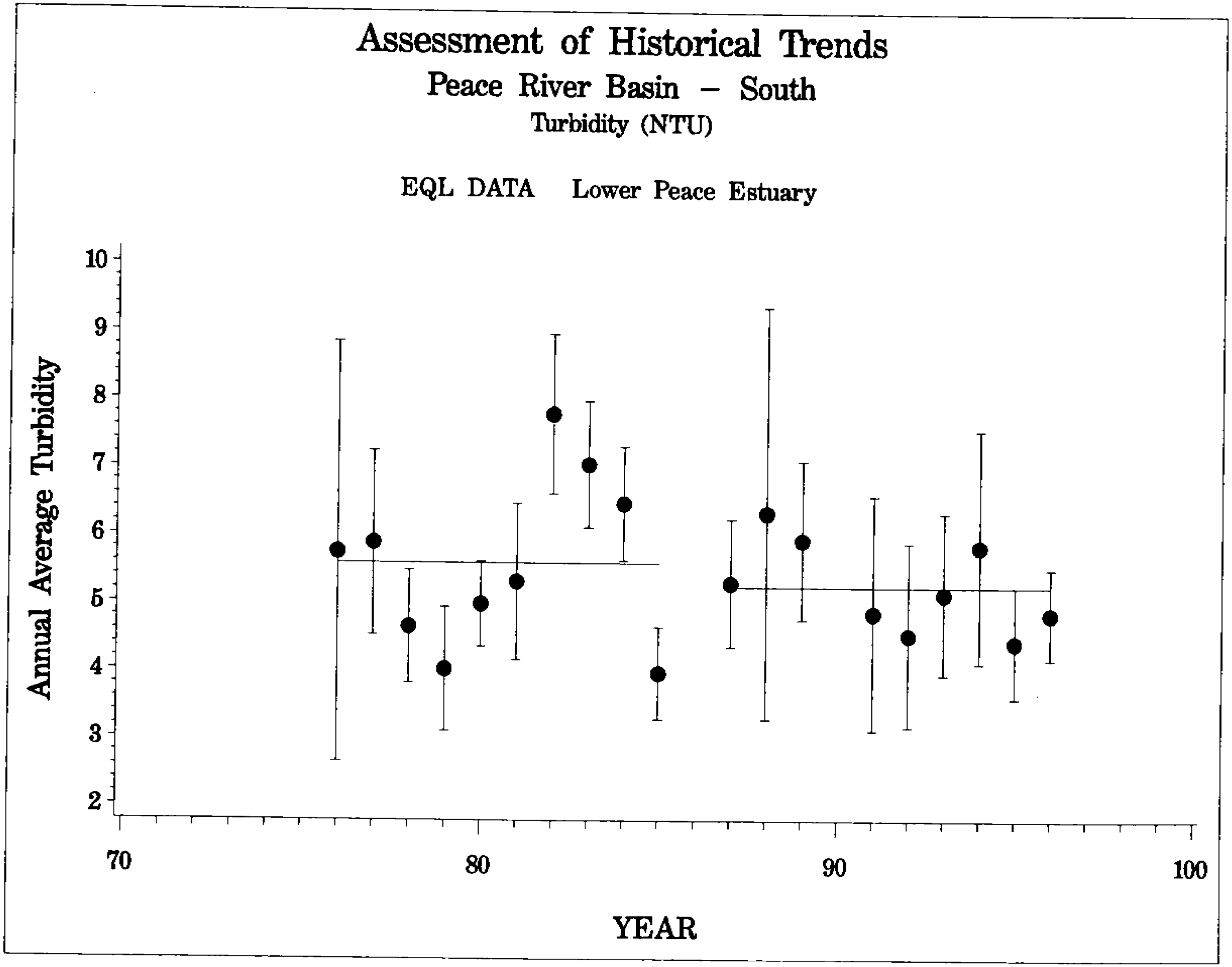
Assessment of Historical Trends
Charlotte Harbor Proper Basin
Nitrite/Nitrate (mg/l)
EQL DATA Upper Charlotte Harbor
Annual Average Nitrite/Nitrate
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
−0.01
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
YEAR

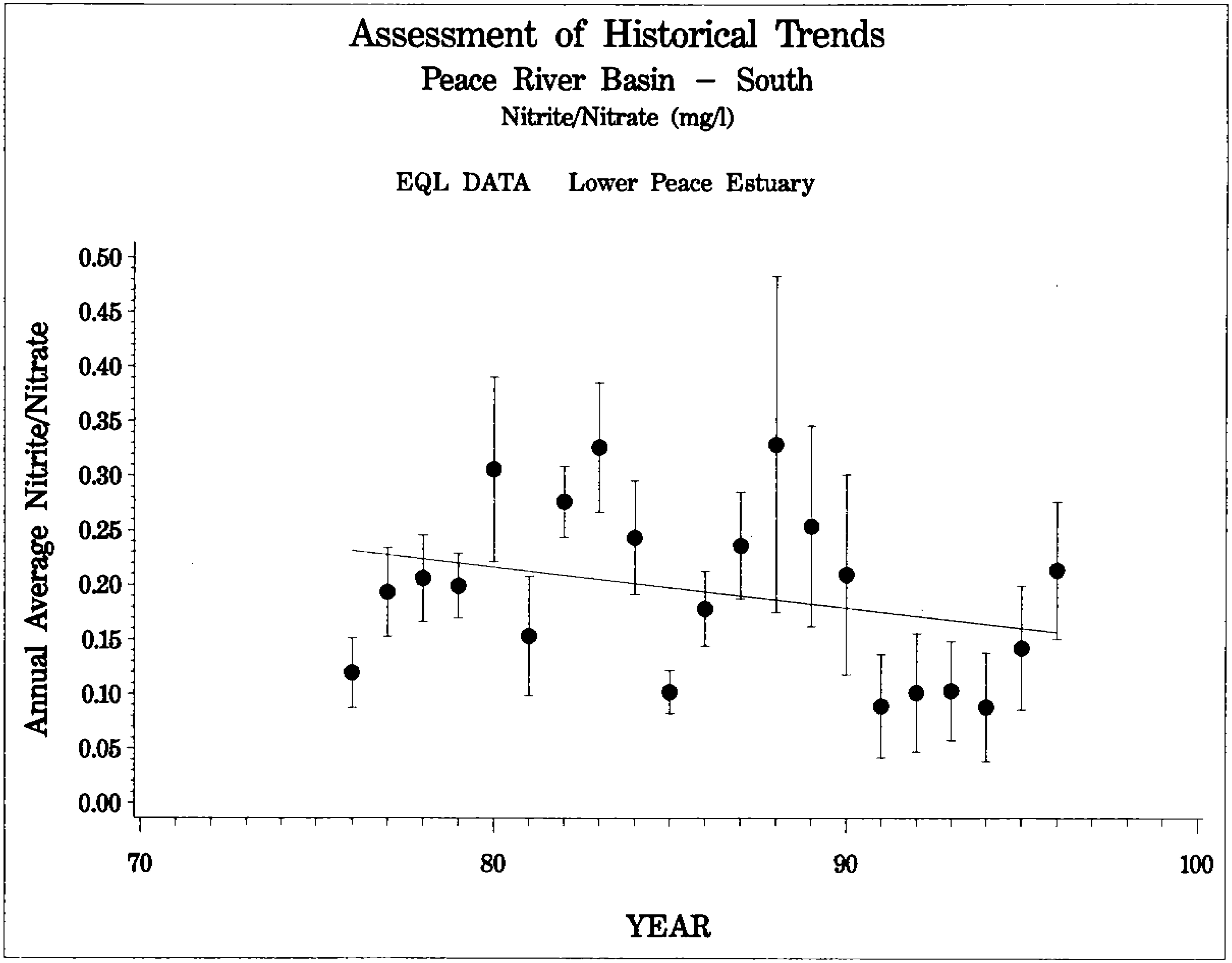

Assessment of Historical Trends
Charlotte Harbor Proper
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Upper Charlotte Harbor
Annual Average Total Kjeldahl Nitrogen
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
80
81
82
84
85
86
87
88
89
90
91
92
93
94
YEAR

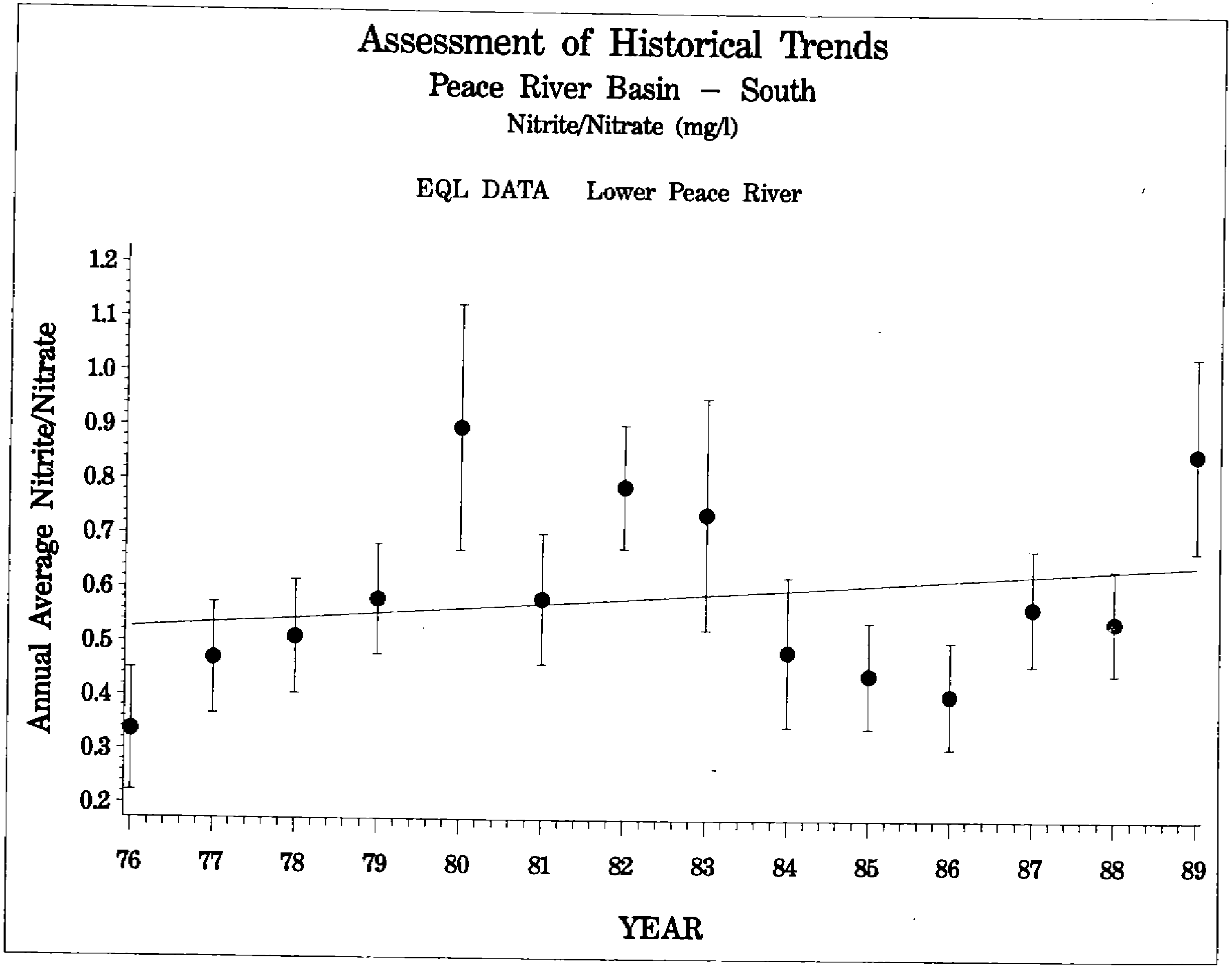

Assessment of Historical Trends
Charlotte Harbor Proper Basin
Ortho – Phosphate (mg/l)
EQL DATA Upper Charlotte Harbor
Annual Average Ortho – Phosphate
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
0.24
0.26
0.28
0.30
0.32
0.34
0.36
0.38
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
YEAR

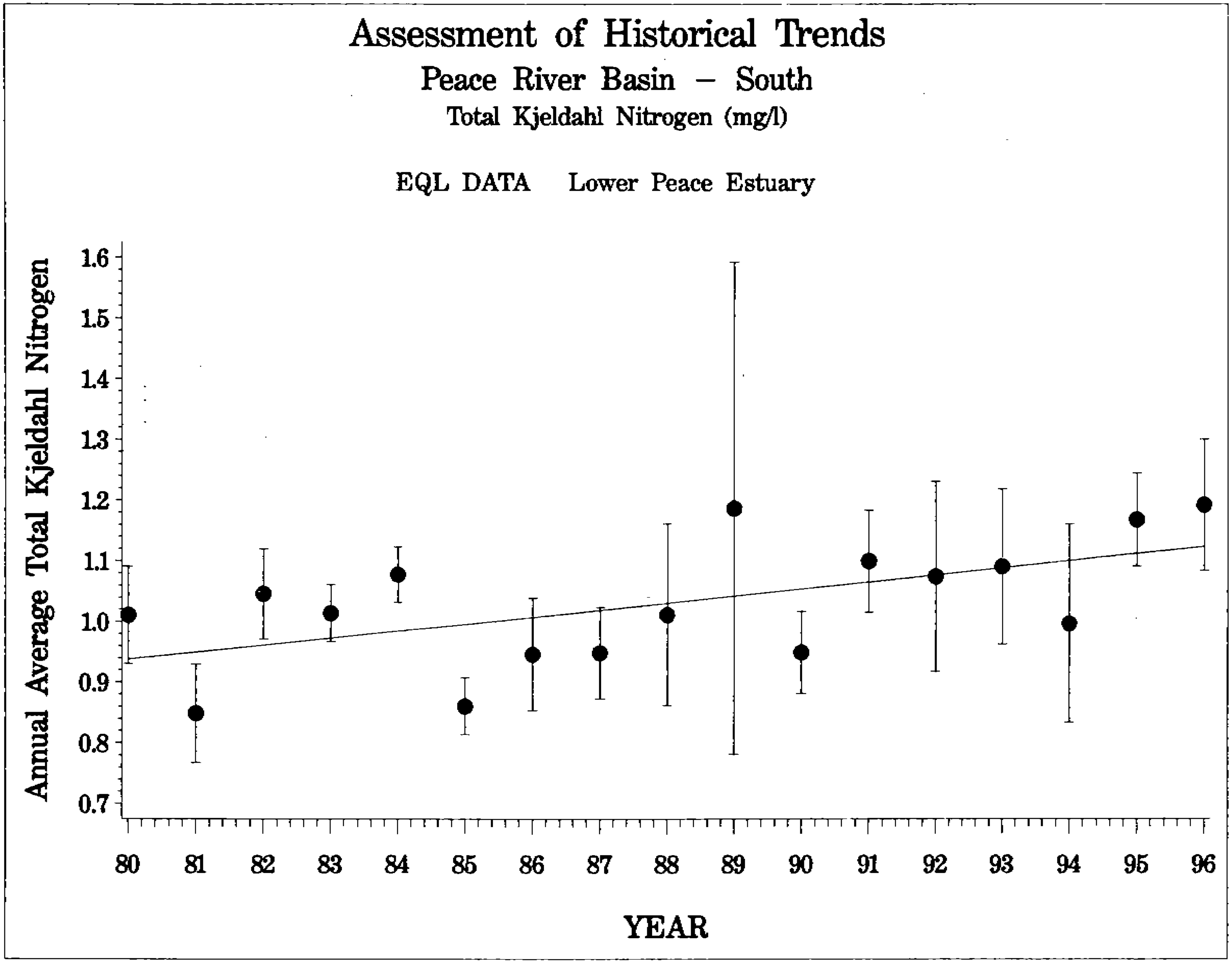

Assessment of Historical Trends
Charlotte Harbor Proper Basin
Total Phosphorus (mg/l)
EQL DATA Upper Charlotte Harbor
Annual Average Total Phosphorus
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
YEAR

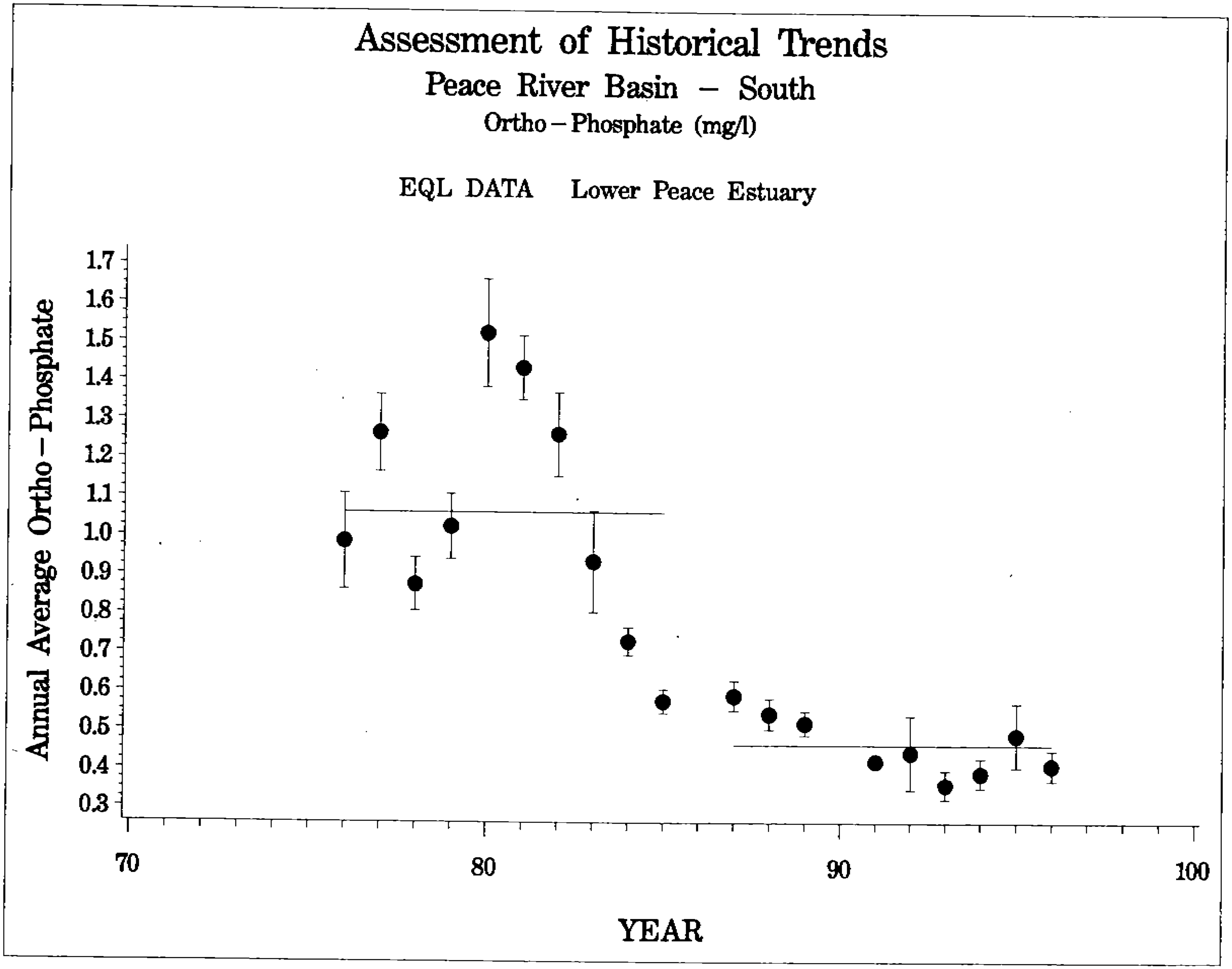

Assessment of Historical Trends
Charlotte Harbor Proper
Chlorophyll a (ug/l)
EQL DATA Upper Charlotte Harbor
Annual Average Chlorophyll a
-10
0
10
20
30
40
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Turbidity (NTU)
EQL DATA Lower Peace Estuary
Annual Average Turbidity
10
9
8
7
6
5
4
3
2
70
80
90
100
YEAR

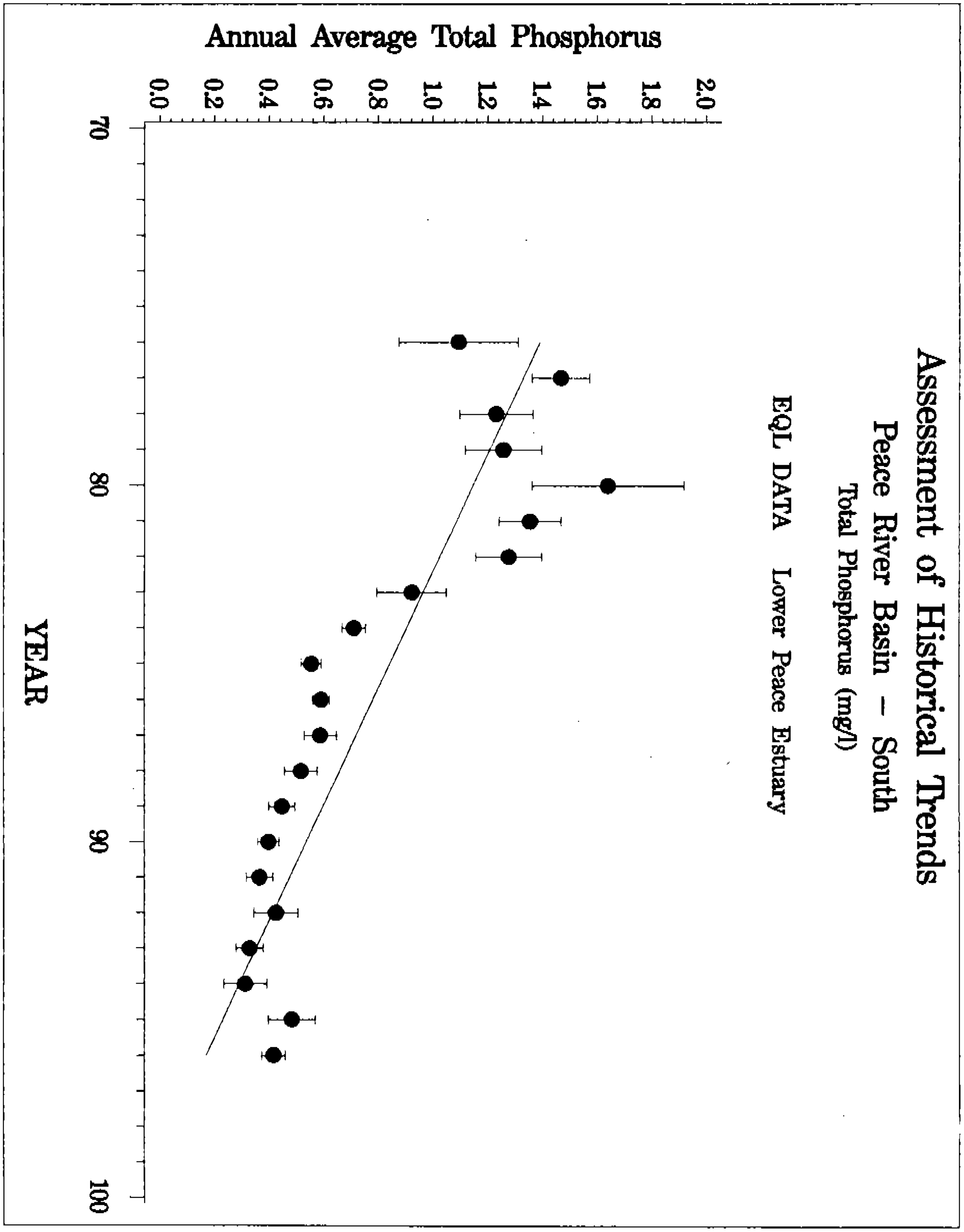

Assessment of Historical Trends
Peace River Basin – South
Nitrite/Nitrate (mg/l)
EQL DATA Lower Peace Estuary
Annual Average Nitrite/Nitrate
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
70
80
90
100
YEAR

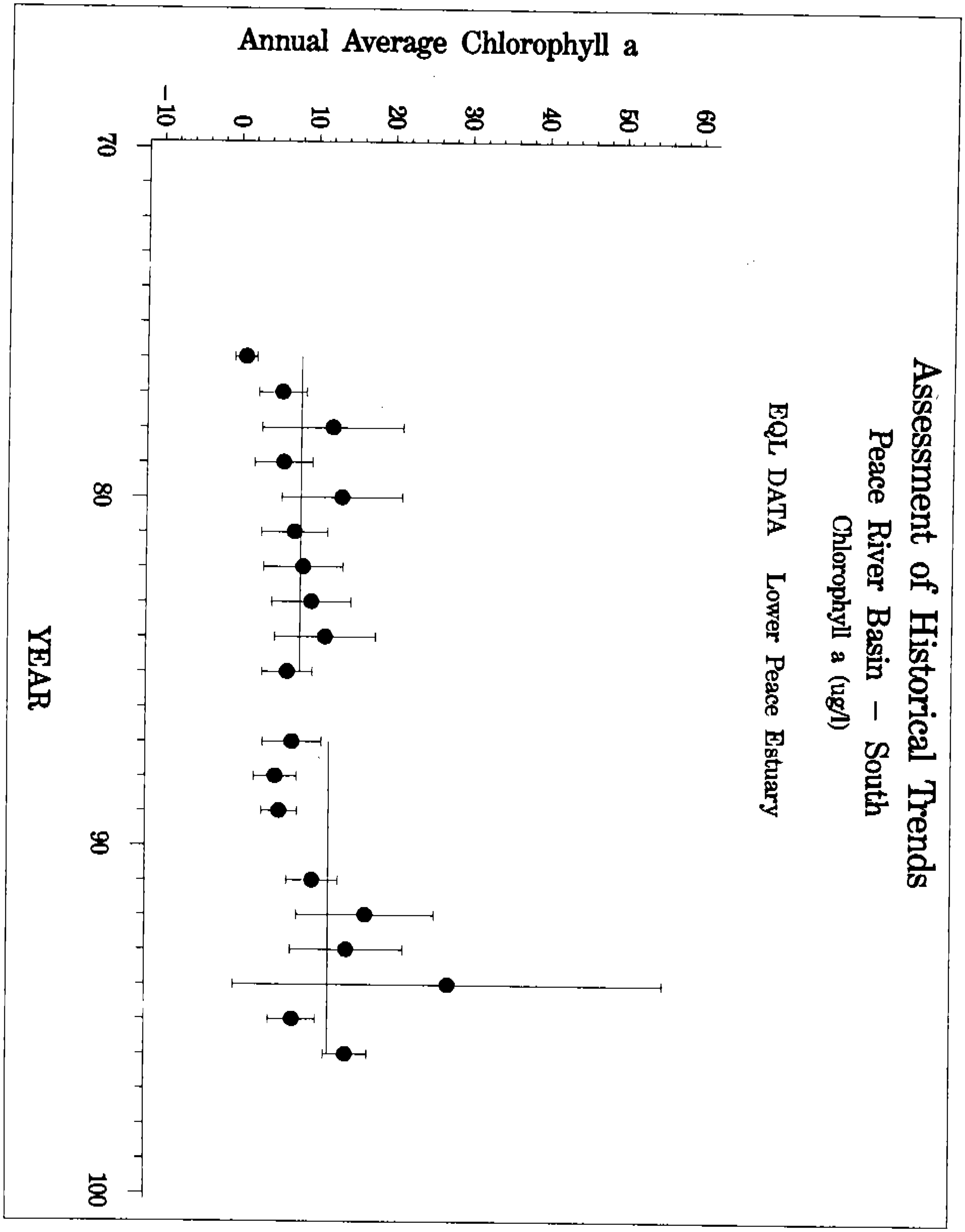

Assessment of Historical Trends
Peace River Basin – South
Nitrite/Nitrate (mg/l)
EQL DATA Lower Peace River
Annual Average Nitrite/Nitrate
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
76
77
78
79
80
81
82
83
84
85
86
87
88
89
YEAR


Assessment of Historical Trends
Peace River Basin – South
Total Kjeldahl Nitrogen (mg/l)
EQL DATA Lower Peace Estuary
Annual Average Total Kjeldahl Nitrogen
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
YEAR



Assessment of Historical Trends
Peace River Basin – South
Ortho – Phosphate (mg/l)
EQL DATA Lower Peace Estuary
Annual Average Ortho – Phosphate
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
70
80
90
100
YEAR


Assessment of Historical Trends
Peace River Basin – South
Total Phosphorus (mg/l)
EQL DATA Lower Peace Estuary
Annual Average Total Phosphorus
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
70
80
90
100
YEAR


Assessment of Historical Trends
Peace River Basin – South
Chlorophyll a (ug/l)
EQL DATA Lower Peace Estuary
Annual Average Chlorophyll a
-10
0
10
20
30
40
50
60
70
80
90
100
YEAR

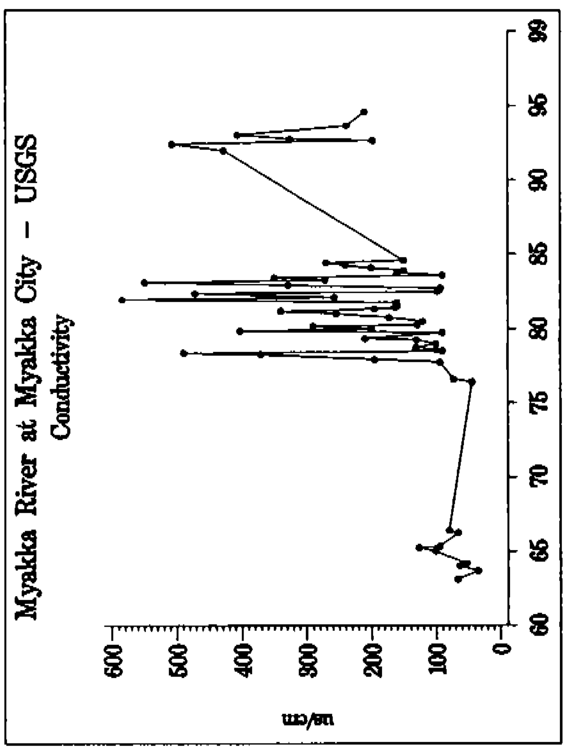
Southwest Florida Water Management District
Charlotte Harbor 'SWIM' Background Monitoring Program

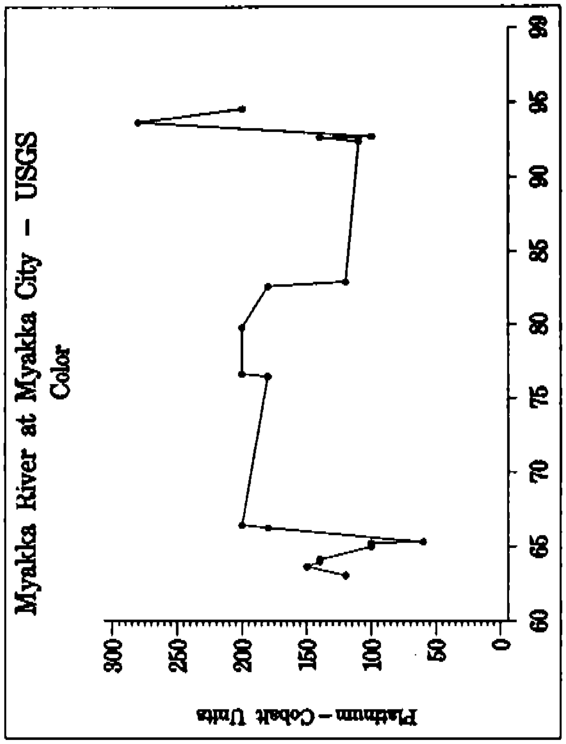
Basin = Peace River (Southern)

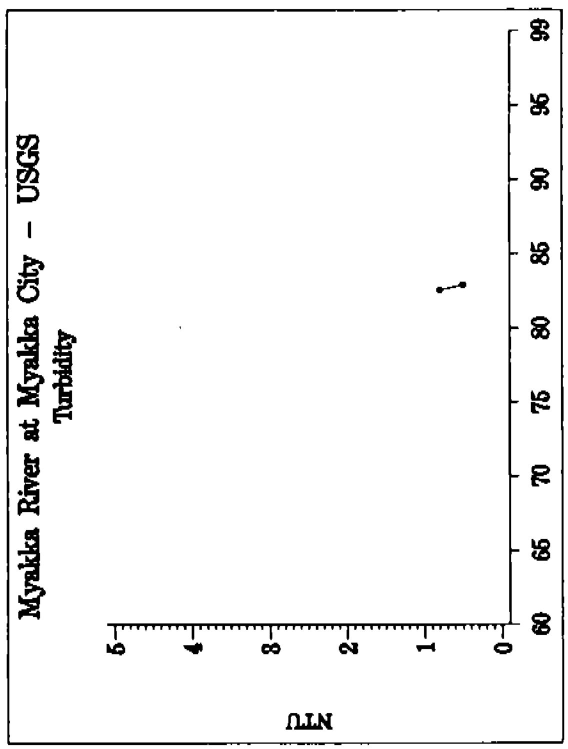
REGION=Lower Peace Estuary

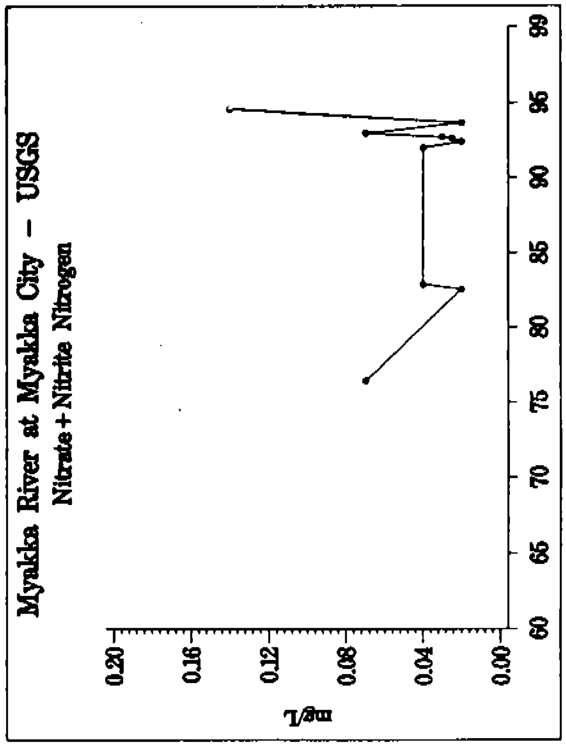
Variable	N	Mean	Std Dev	Minimum	Maximum
NITRATE+NITRITE TOTAL (MG/L)	152	0.164	0.251	0.000	1.545
TOTAL KJELDAHL NITROGEN (MG/L)	191	1.092	0.467	0.135	2.920
PHOSPHOROUS, ORTHO, DISSOLVED (MG/L)	191	0.301	0.205	0.018	1.078
PHOSPHOROUS, TOTAL (MG/L)	192	0.390	0.231	0.050	1.236
SALINITY (PPT)	187	13.112	8.901	0.000	28.025
TURBIDITY (NTU)	190	3.695	2.294	0.300	16.800
COLOR, DISSOLVED (PCU)	189	81.471	69.902	5.000	300.000
CHLOROPHYLL A (TRICHRO.) (UG/L)	190	14.940	22.370	0.687	182.350

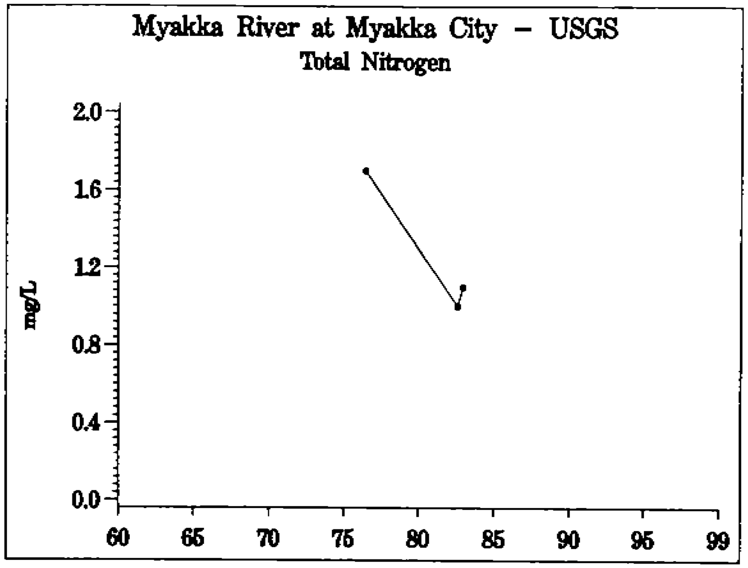
Time Series Plots of USGS Data from Additional Gauging Stations

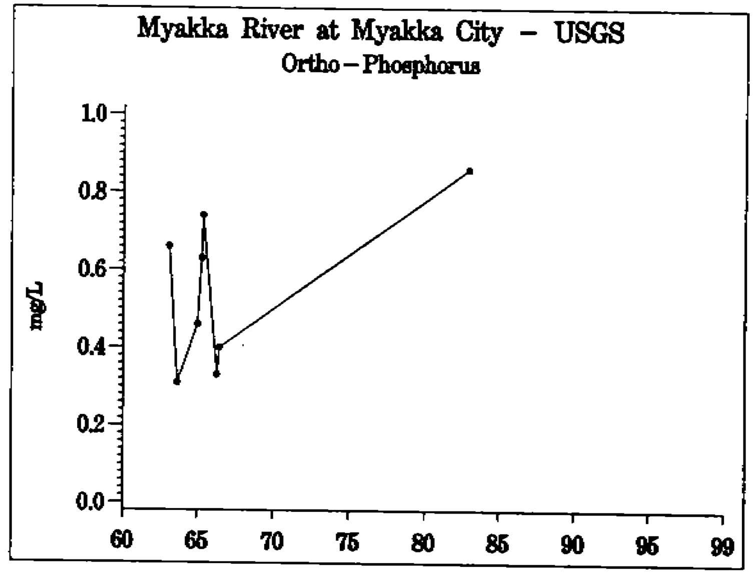

Myakka River at Myakka City - USGS
Conductivity
us/cm

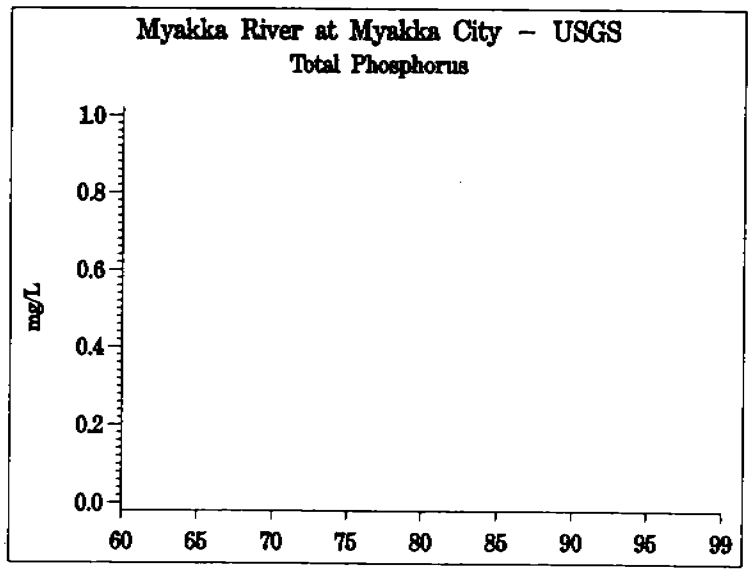

Myakka River at Myakka City - USGS
Color
Platinum - Cobalt Units

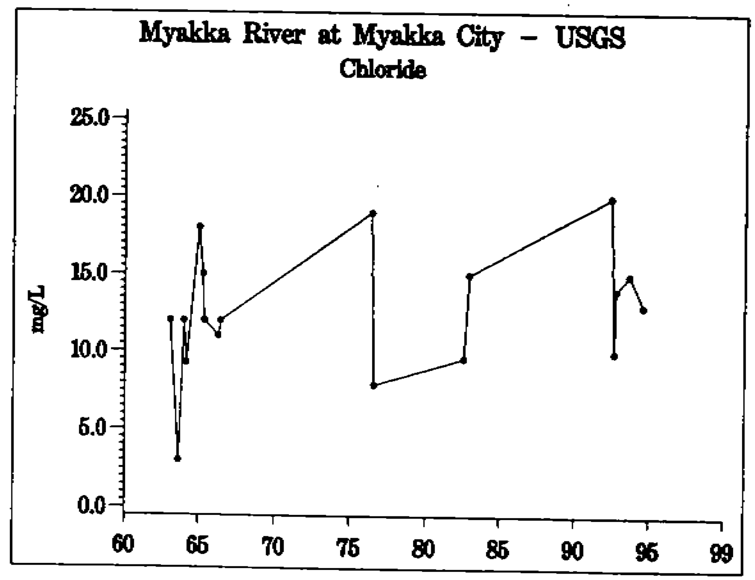

Myakka River at Myakka City - USGS
Turbidity
NTU

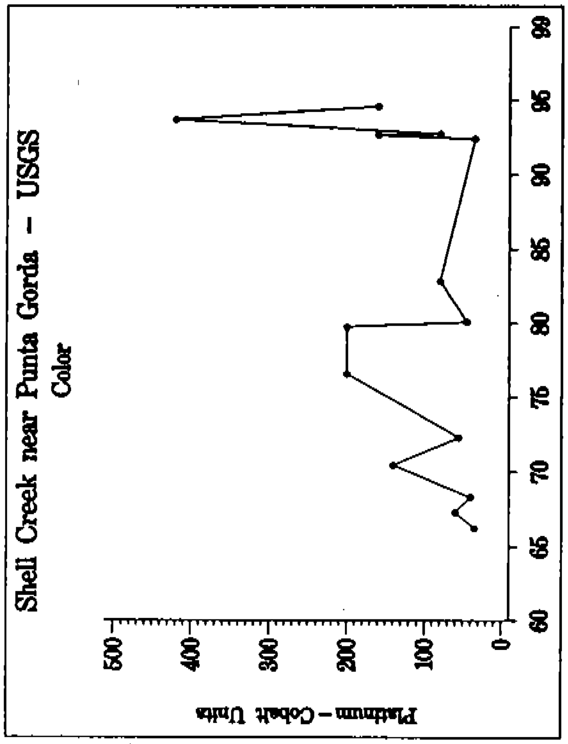

Myakka River at Myakka City - USGS
Nitrate + Nitrite Nitrogen
mg/L

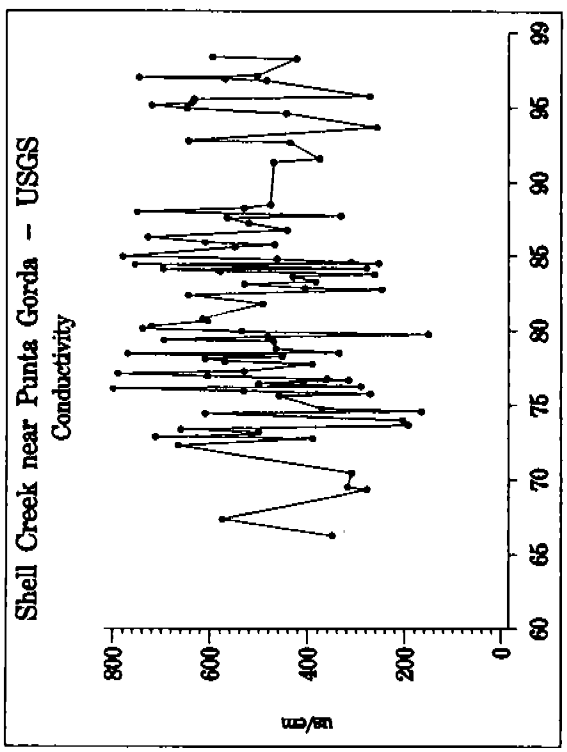

Myakka River at Myakka City – USGS
Total Nitrogen
mg/L
2.0 1.6 1.2 0.8 0.4 0.0
60 65 70 75 80 85 90 95 99

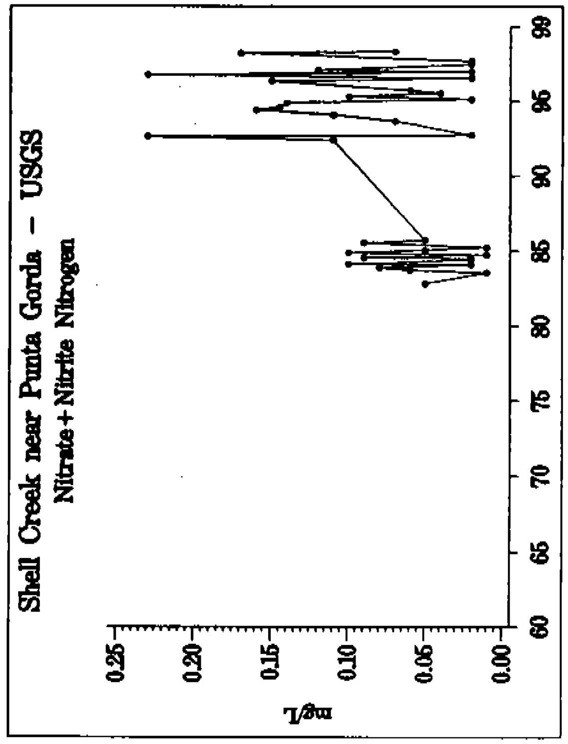

Myakka River at Myakka City – USGS
Ortho – Phosphorus
mg/L
1.0 0.8 0.6 0.4 0.2 0.0
60 65 70 75 80 85 90 95 99

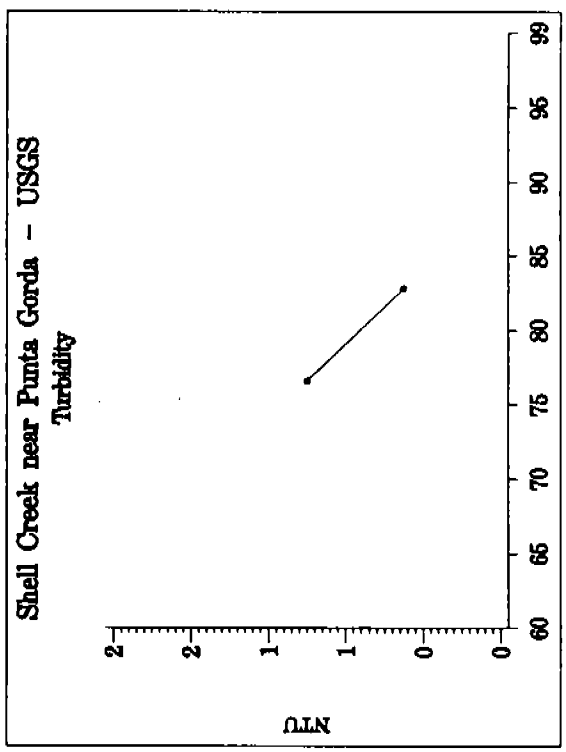

Myakka River at Myakka City – USGS
Total Phosphorus
mg/L
1.0 0.8 0.6 0.4 0.2 0.0
60 65 70 75 80 85 90 95 99

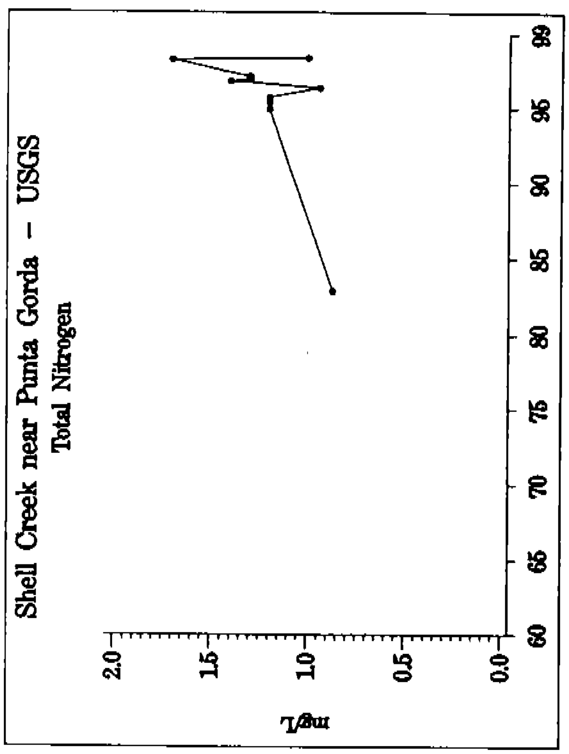

Myakka River at Myakka City – USGS
Chloride
mg/L
25.0 20.0 15.0 10.0 5.0 0.0
60 65 70 75 80 85 90 95 99

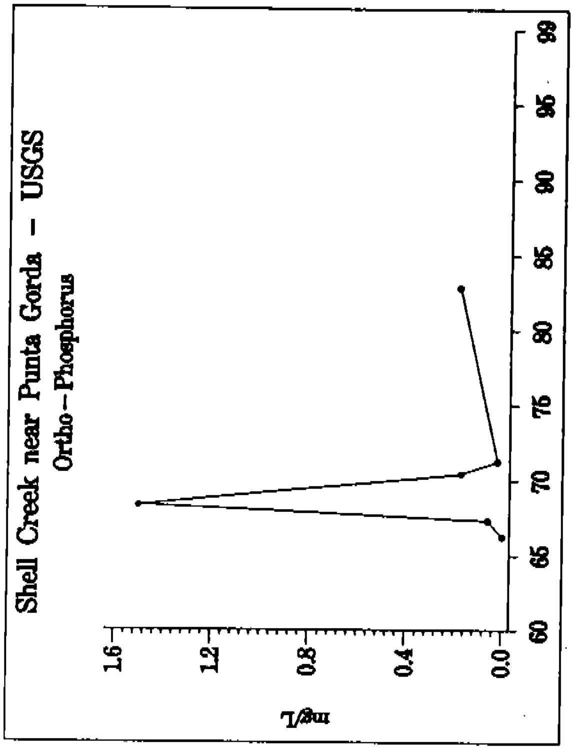

Shell Creek near Punta Gorda - USGS
Color
Platinum - Cobalt Units
500
400
300
200
100
0
60
65
70
75
80
85
90
95
99

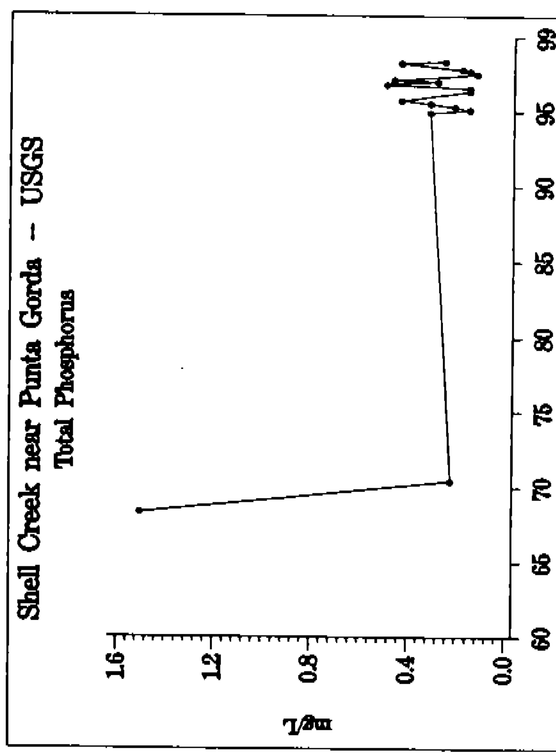

Shell Creek near Punta Gorda - USGS
Conductivity
us/cm
800
600
400
200
0
60
65
70
75
80
85
90
95
99

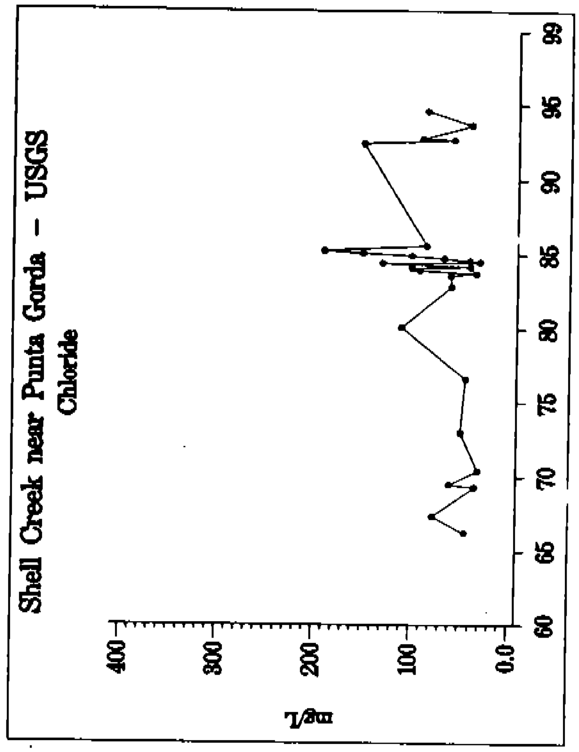

Shell Creek near Punta Gorda - USGS
Nitrate + Nitrite Nitrogen
mg/L
0.25
0.20
0.15
0.10
0.05
0.00
60
65
70
75
80
85
90
95
99

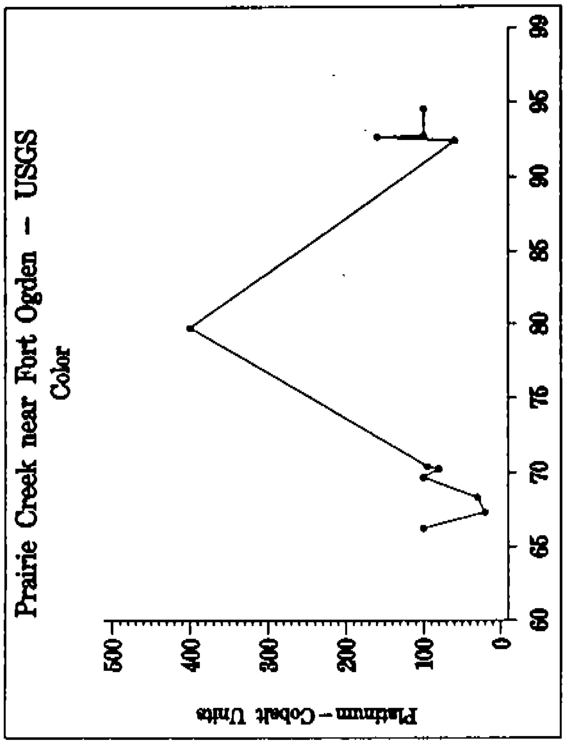

Shell Creek near Punta Gorda - USGS
Turbidity
NTU
2
2
1
1
0
0
60
65
70
75
80
85
90
95
99

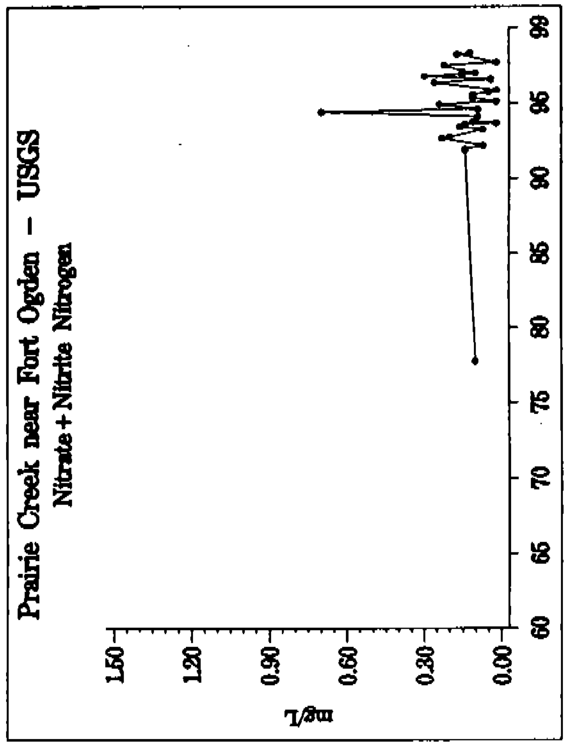

Shell Creek near Punta Gorda - USGS
Total Nitrogen
mg/L
0.0
0.5
1.0
1.5
2.0
60
65
70
75
80
85
90
95
99

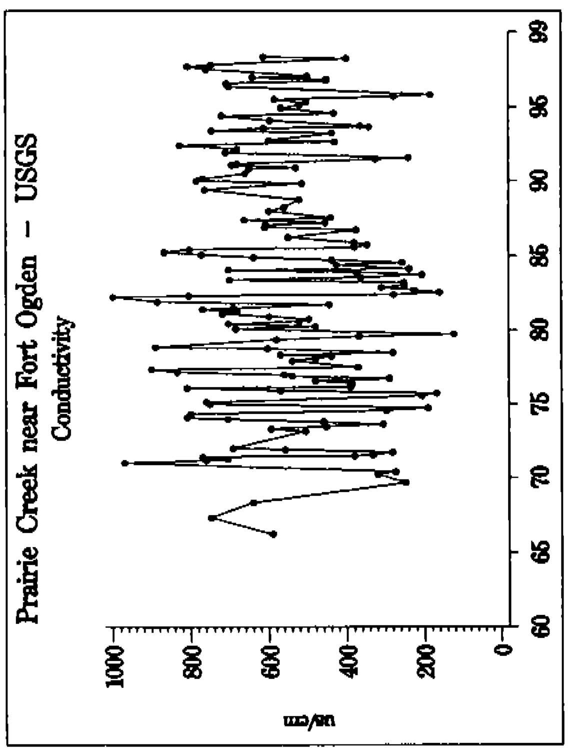

Shell Creek near Punta Gorda - USGS
Ortho-Phosphorus
mg/L
0.0
0.4
0.8
1.2
1.6
60
65
70
75
80
85
90
95
99

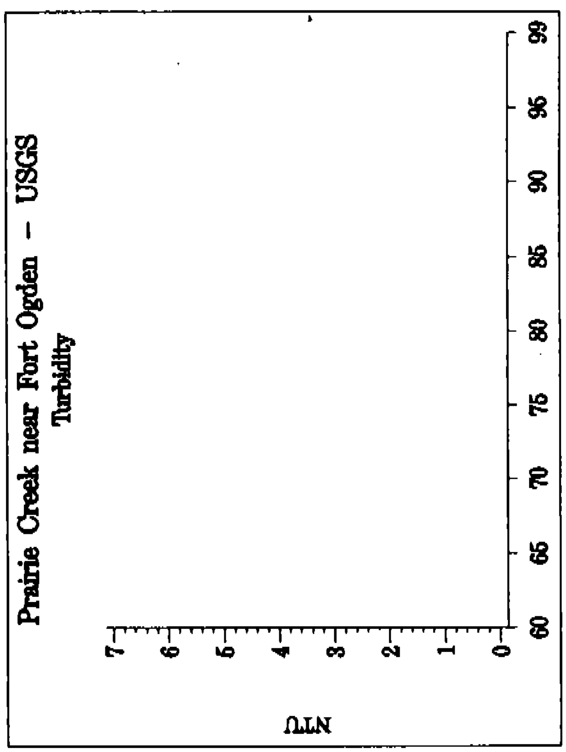

Shell Creek near Punta Gorda - USGS
Total Phosphorus
mg/L
0.0
0.4
0.8
1.2
1.6
60
65
70
75
80
85
90
95
99

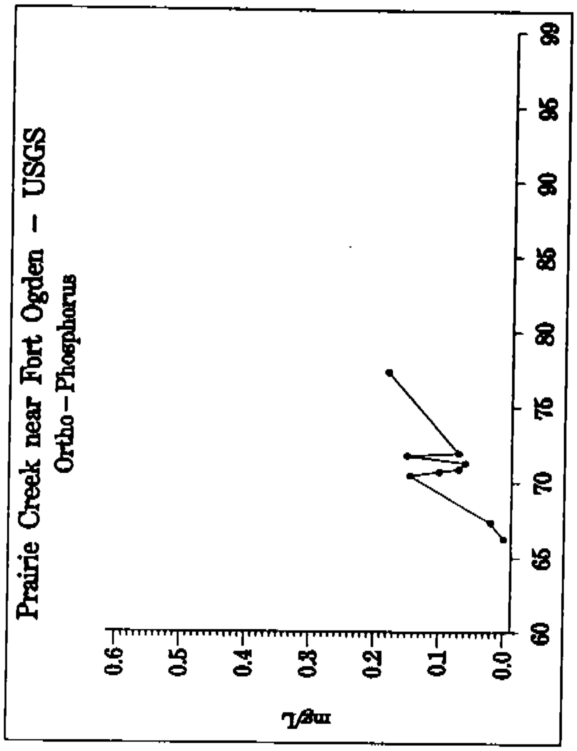

Shell Creek near Punta Gorda - USGS
Chloride
mg/L
0.0
100
200
300
400
60
65
70
75
80
85
90
95
99

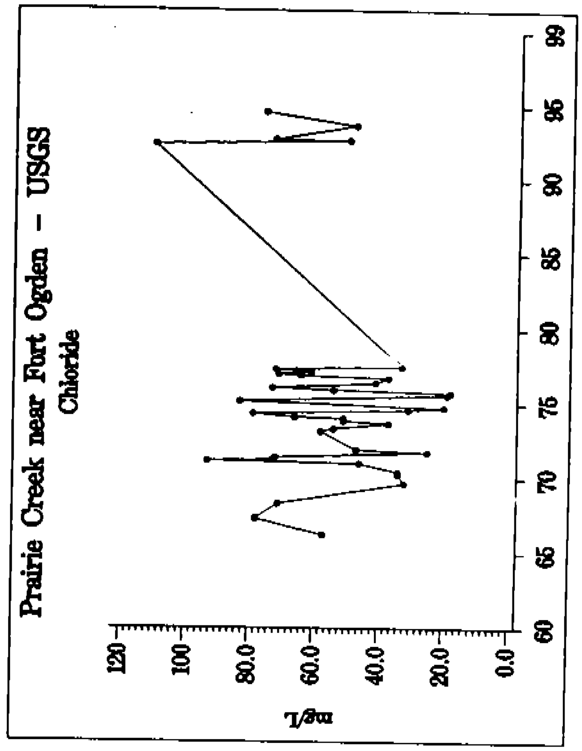

Prairie Creek near Fort Ogden – USGS
Color
Platinum – Cobalt Units
500 400 300 200 100 0
60 65 70 75 80 85 90 95 99

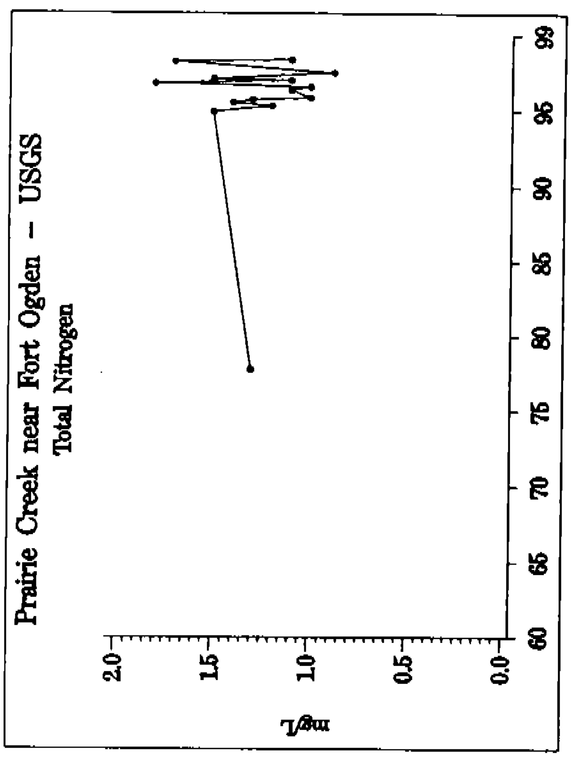

Prairie Creek near Fort Ogden – USGS
Nitrate + Nitrite Nitrogen
mg/L
1.50 1.20 0.90 0.60 0.30 0.00
60 65 70 75 80 85 90 95 99

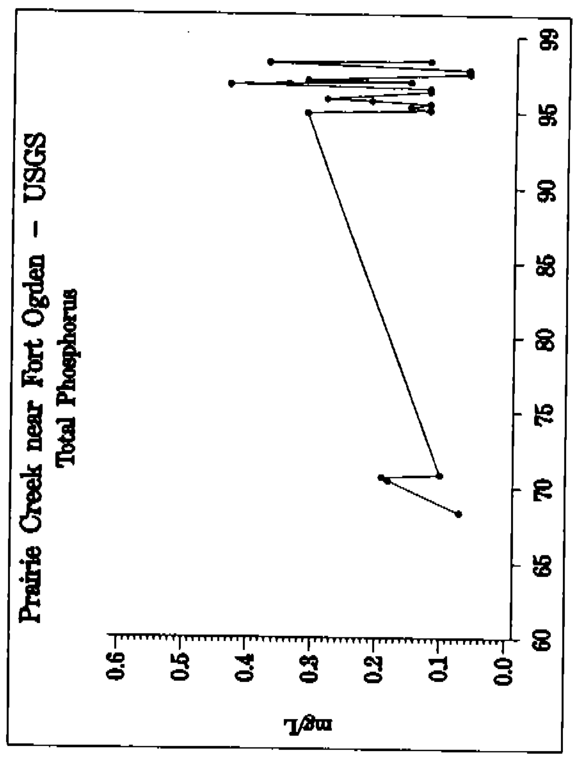

Prairie Creek near Fort Ogden – USGS
Conductivity
us/cm
1000 800 600 400 200 0
60 65 70 75 80 85 90 95 99

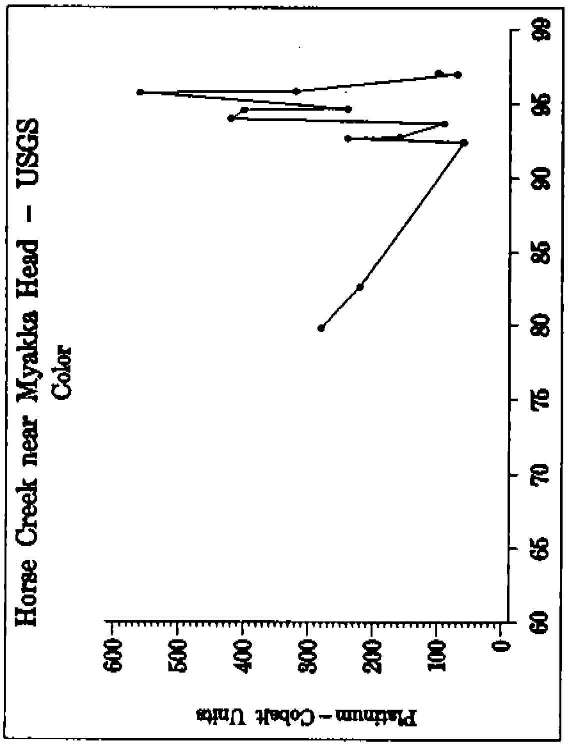

Prairie Creek near Fort Ogden – USGS
Turbidity
NTU
7 6 5 4 3 2 1 0
60 65 70 75 80 85 90 95 99

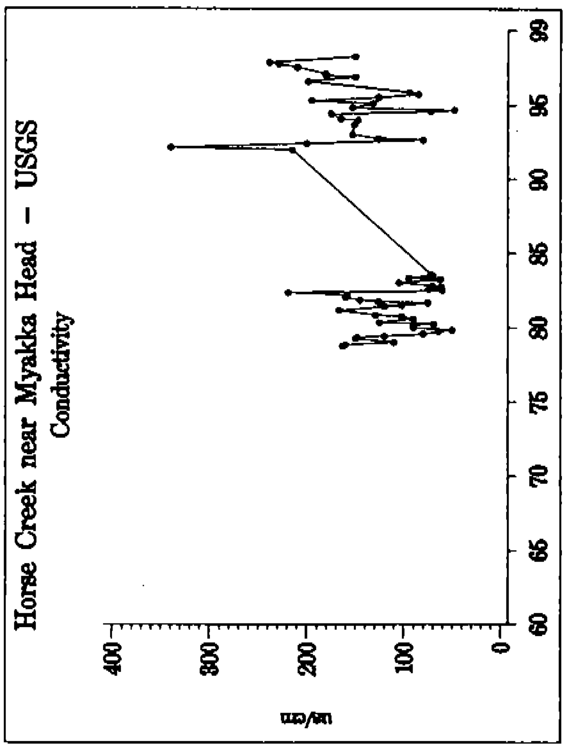

Prairie Creek near Fort Ogden - USGS
Ortho-Phosphorus
mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
60
65
70
75
80
85
90
95
99

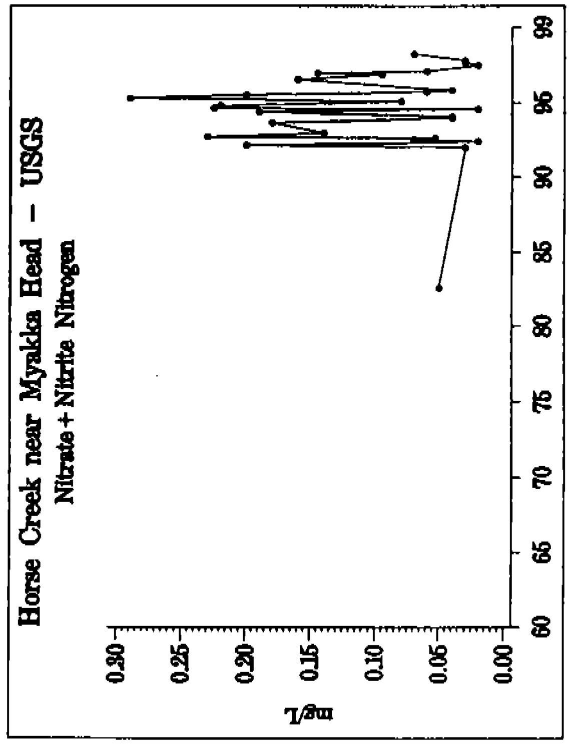

Prairie Creek near Fort Ogden - USGS
Chloride
mg/L
0.0
20.0
40.0
60.0
80.0
100
120
60
65
70
75
80
85
90
95
99

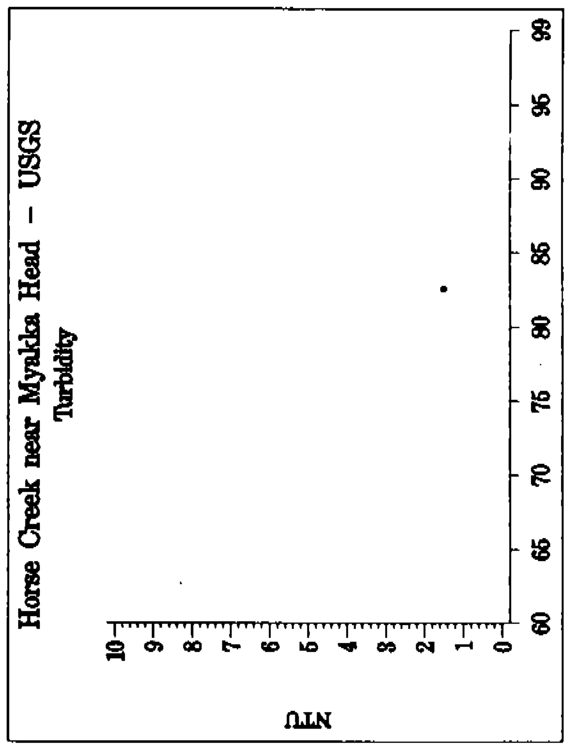

Prairie Creek near Fort Ogden - USGS
Total Nitrogen
mg/L
0.0
0.5
1.0
1.5
2.0
60
65
70
75
80
85
90
95
99

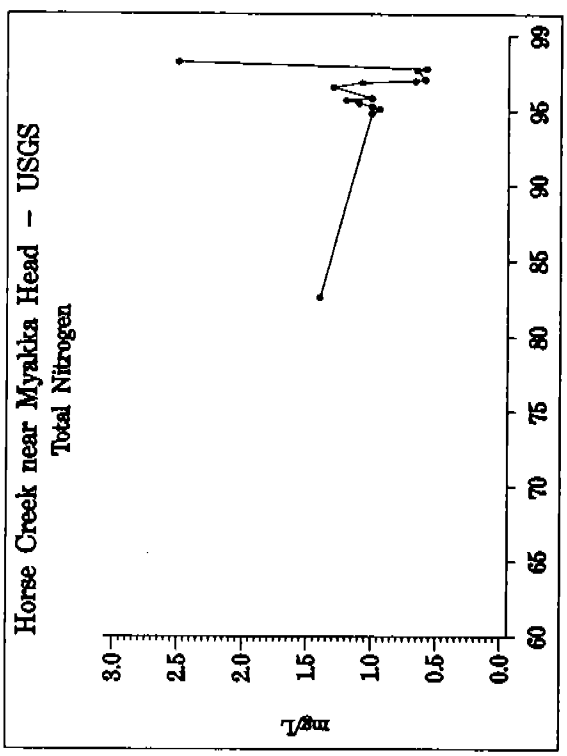

Prairie Creek near Fort Ogden - USGS
Total Phosphorus
mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
60
65
70
75
80
85
90
95
99

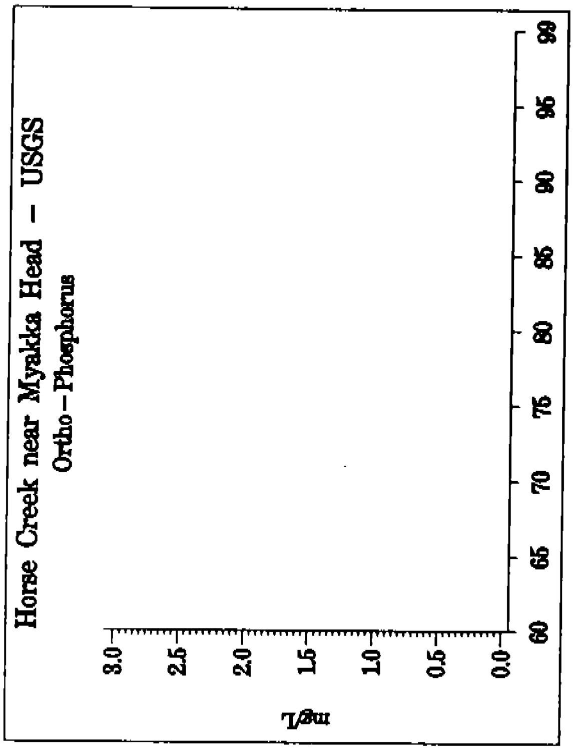

Horse Creek near Myakka Head - USGS
Color
Platinum - Cobalt Units
600
500
400
300
200
100
0
60
65
70
75
80
85
90
95
99

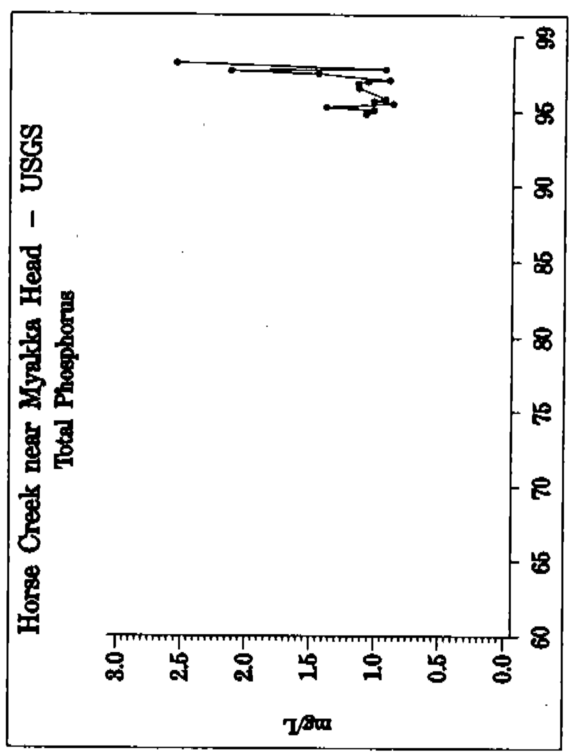

Horse Creek near Myakka Head - USGS
Conductivity
us/cm
400
300
200
100
0
60
65
70
75
80
85
90
95
99

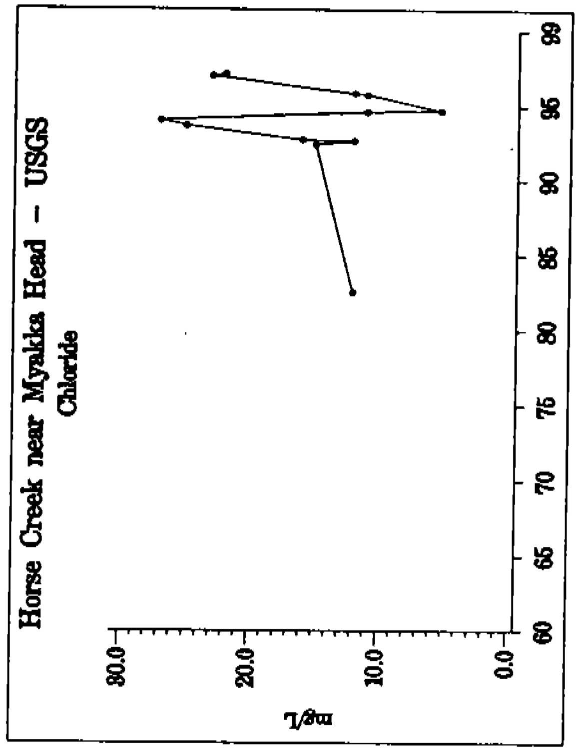

Horse Creek near Myakka Head - USGS
Nitrate + Nitrite Nitrogen
mg/L
0.30
0.25
0.20
0.15
0.10
0.05
0.00
60
65
70
75
80
85
90
95
99

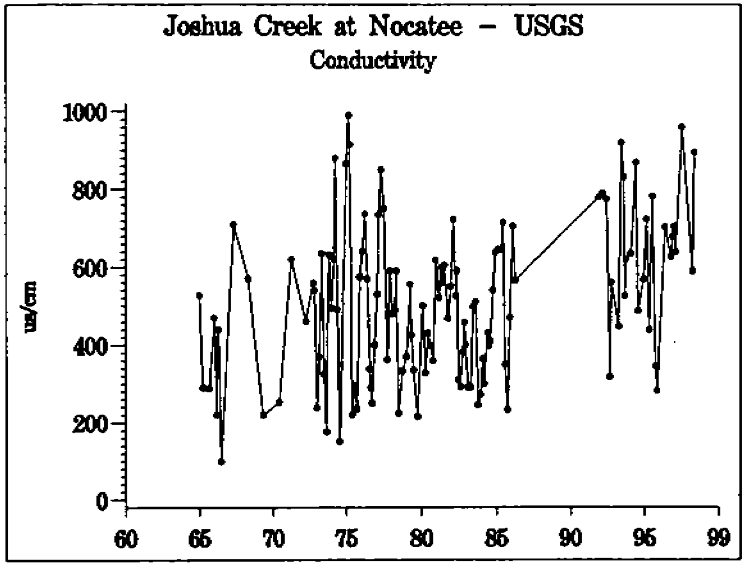

Horse Creek near Myakka Head - USGS
Turbidity
NTU
10
9
8
7
6
5
4
3
2
1
0
60
65
70
75
80
85
90
95
99

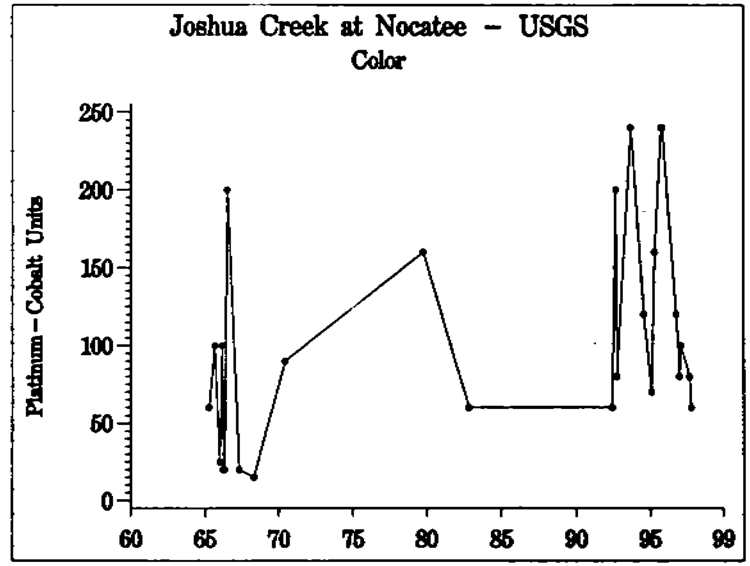

Horse Creek near Myakka Head - USGS
Total Nitrogen
mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
60
65
70
75
80
85
90
95
99

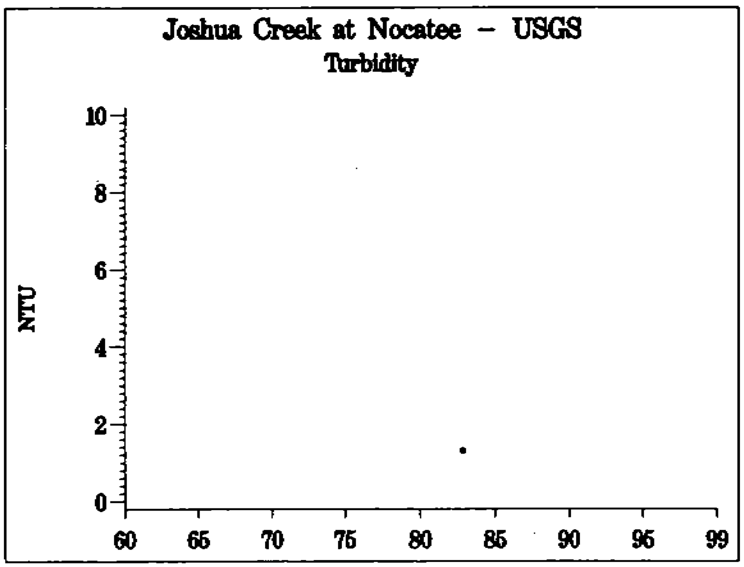

Horse Creek near Myakka Head - USGS
Ortho-Phosphorus
mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
60
65
70
75
80
85
90
95
99

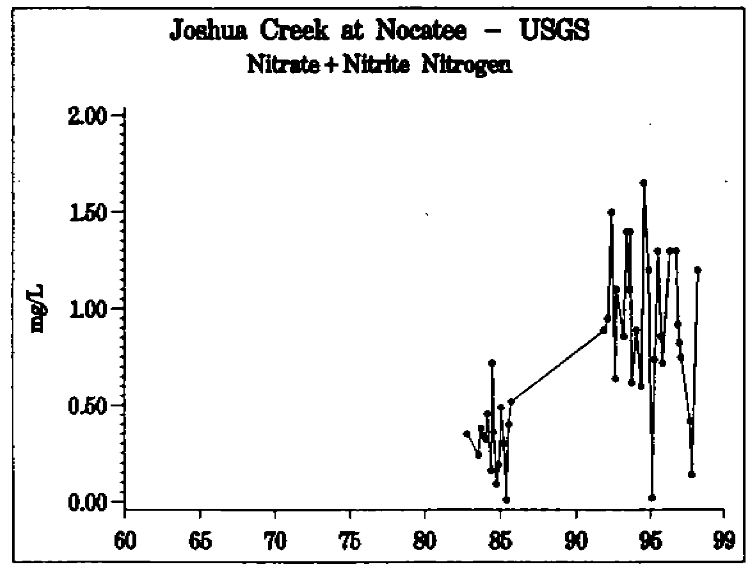

Horse Creek near Myakka Head - USGS
Total Phosphorus
mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
60
65
70
75
80
85
90
95
99

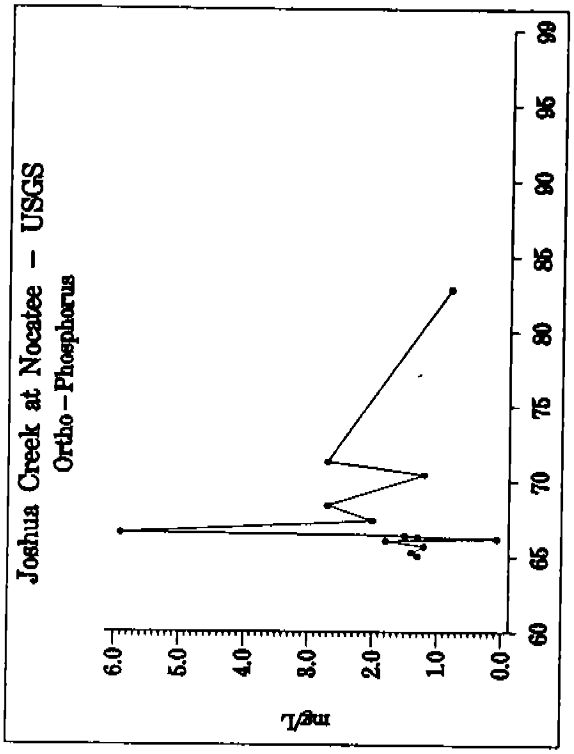

Horse Creek near Myakka Head - USGS
Chloride
mg/L
30.0
20.0
10.0
0.0
60
65
70
75
80
85
90
95
99

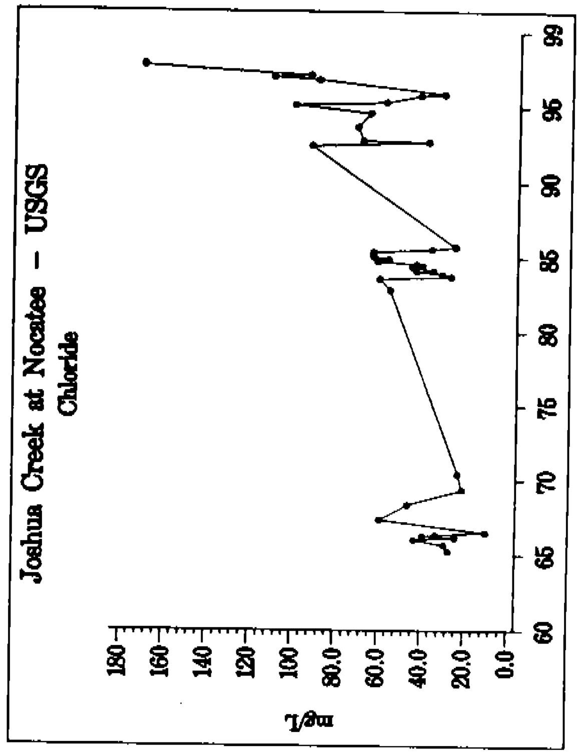

Joshua Creek at Nocatee – USGS
Conductivity
us/cm
1000
800
600
400
200
0
60
65
70
75
80
85
90
95
99

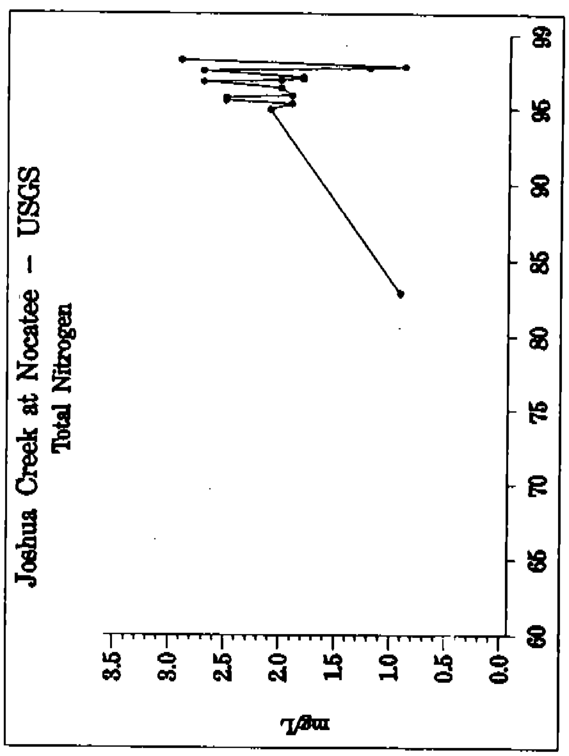

Joshua Creek at Nocatee – USGS
Color
Platinum – Cobalt Units
250
200
150
100
50
0
60
65
70
75
80
85
90
95
99

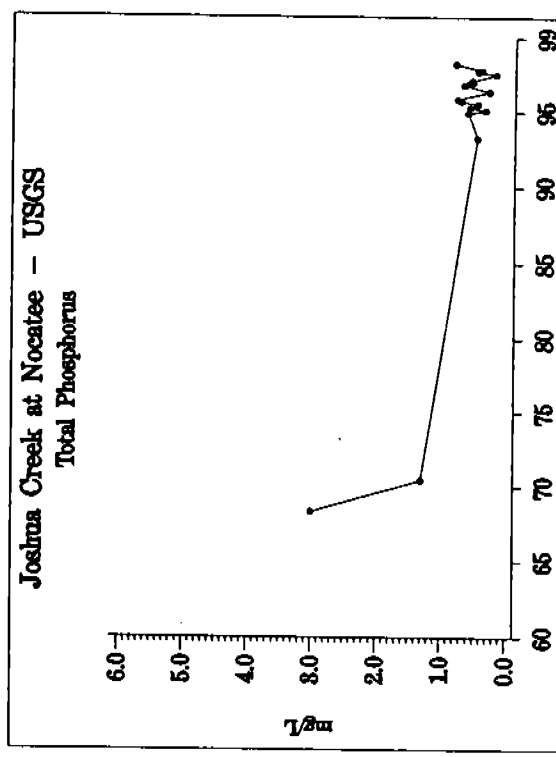

Joshua Creek at Nocatee – USGS
Turbidity
NTU
10
8
6
4
2
0
60
65
70
75
80
85
90
95
99

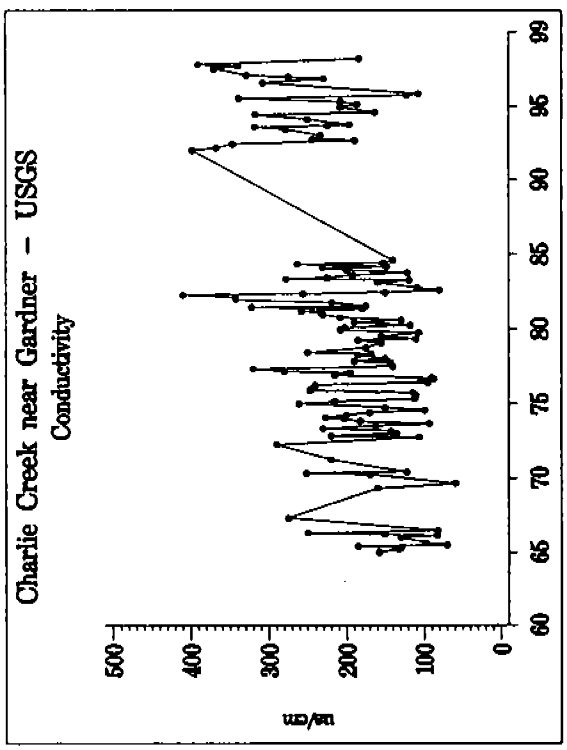

Joshua Creek at Nocatee – USGS
Nitrate + Nitrite Nitrogen
mg/L
2.00
1.50
1.00
0.50
0.00
60
65
70
75
80
85
90
95
99

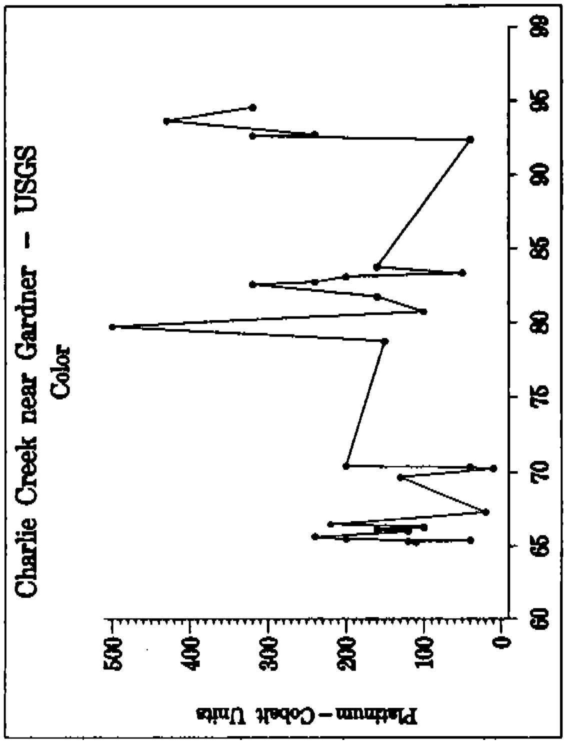

Joshua Creek at Nocatee - USGS
Ortho-Phosphorus
mg/L
0.0 1.0 2.0 3.0 4.0 5.0 6.0
60 65 70 75 80 85 90 95 99

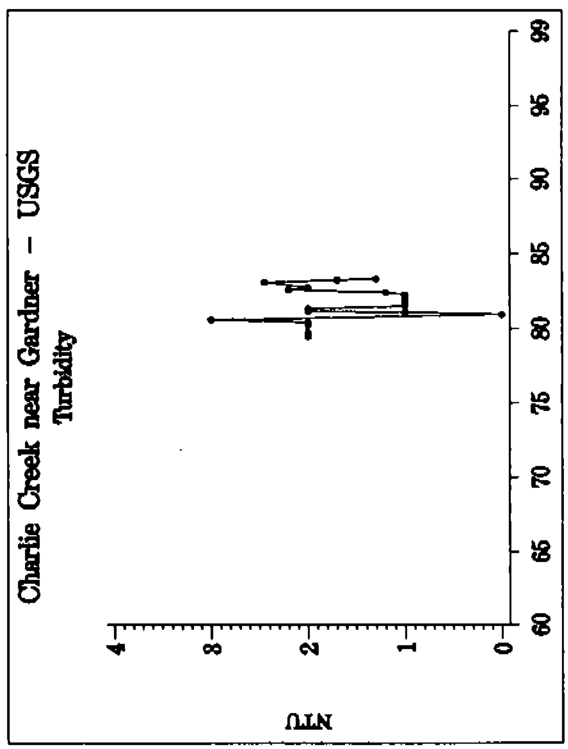

Joshua Creek at Nocatee - USGS
Chloride
mg/L
0.0 20.0 40.0 60.0 80.0 100 120 140 160 180
60 65 70 75 80 85 90 95 99

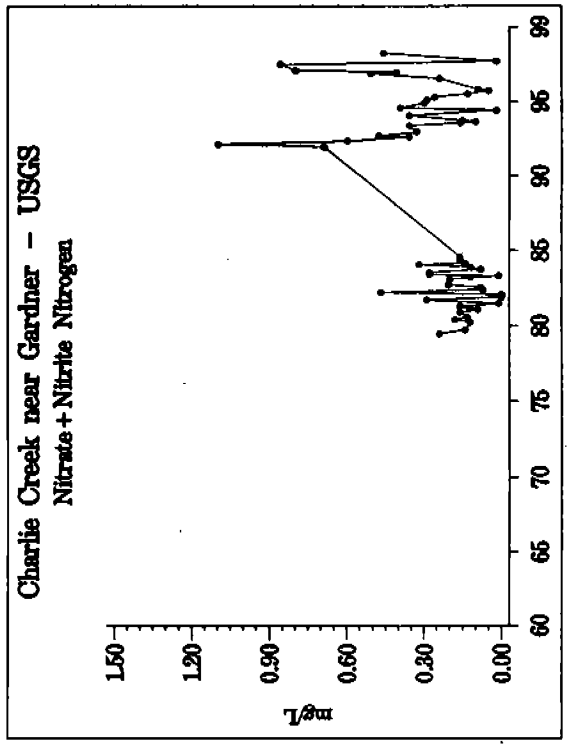

Joshua Creek at Nocatee - USGS
Total Nitrogen
mg/L
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
60 65 70 75 80 85 90 95 99

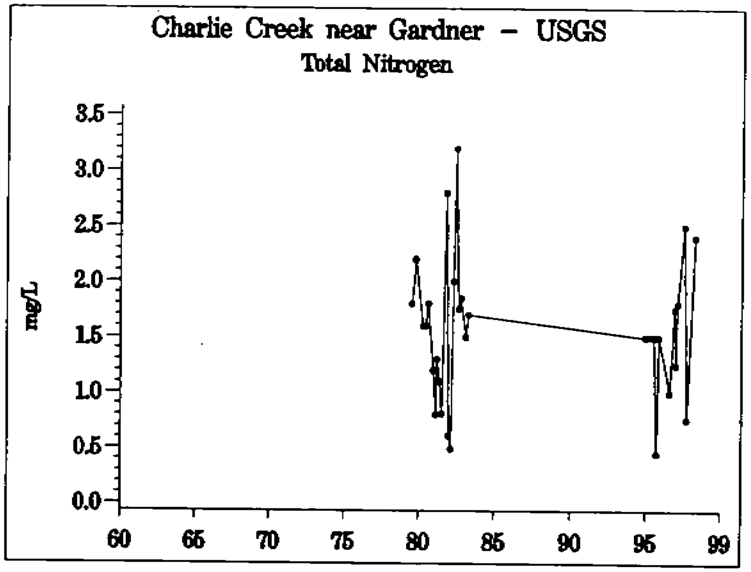

Joshua Creek at Nocatee - USGS
Total Phosphorus
mg/L
0.0 1.0 2.0 3.0 4.0 5.0 6.0
60 65 70 75 80 85 90 95 99

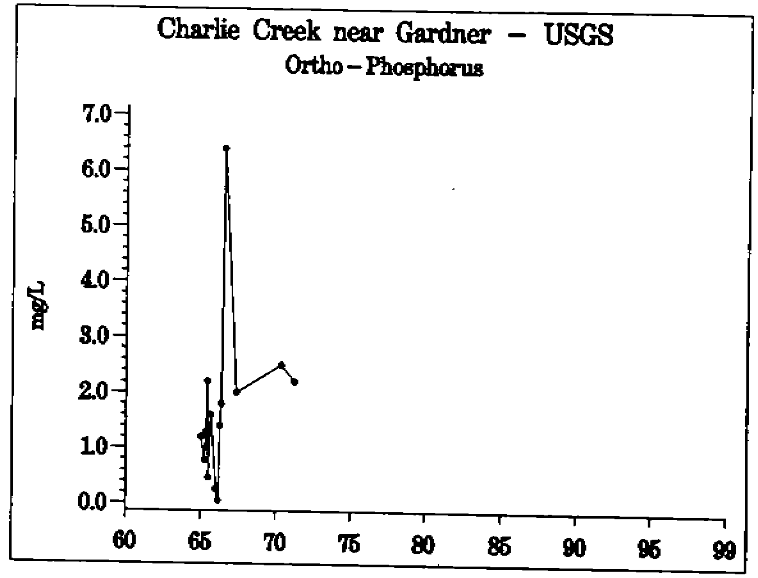

Charlie Creek near Gardner – USGS
Conductivity
us/cm
500
400
300
200
100
0
60
65
70
75
80
85
90
95
99

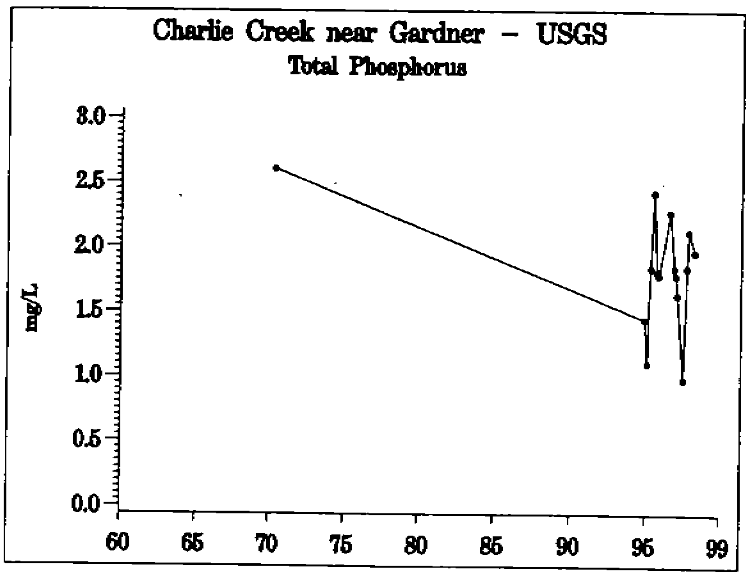

Charlie Creek near Gardner – USGS
Color
Platinum – Cobalt Units
500
400
300
200
100
0
60
65
70
75
80
85
90
95
99

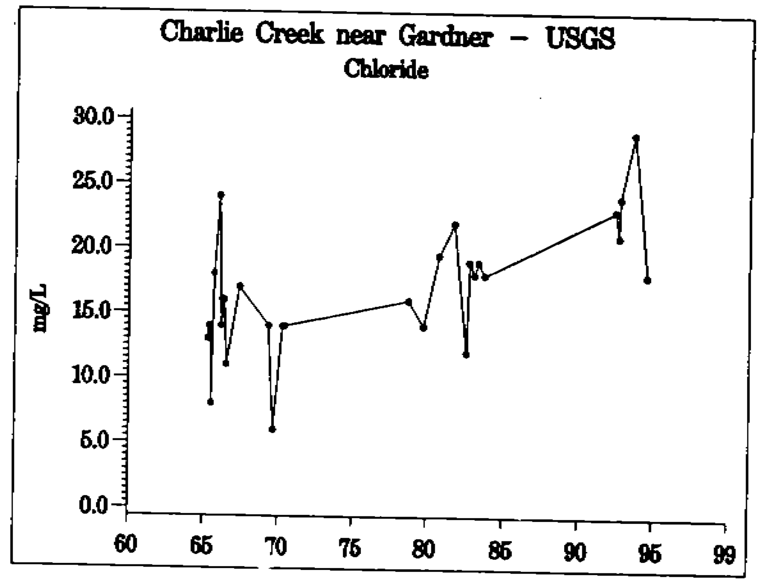

Charlie Creek near Gardner – USGS
Turbidity
NTU
4
8
2
1
0
60
65
70
75
80
85
90
95
99

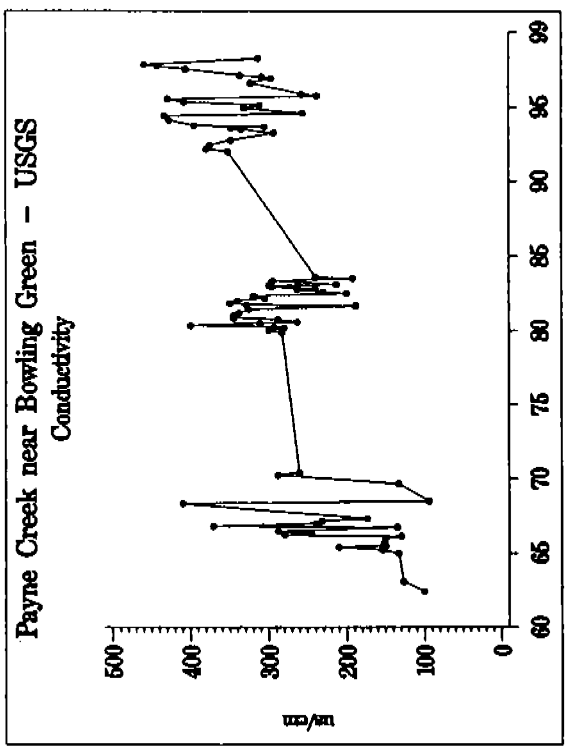

Charlie Creek near Gardner – USGS
Nitrate + Nitrite Nitrogen
mg/L
1.50
1.20
0.90
0.60
0.30
0.00
60
65
70
75
80
85
90
95
99

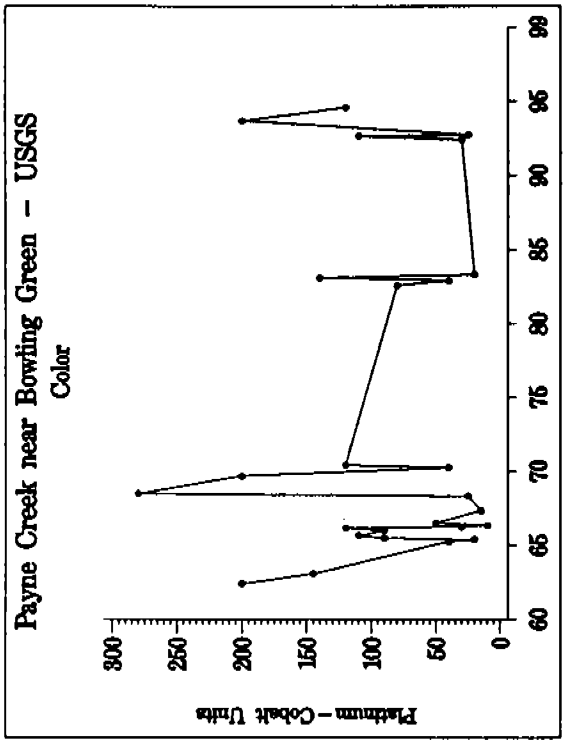

Charlie Creek near Gardner - USGS
Total Nitrogen
mg/L
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
60
65
70
75
80
85
90
95
99

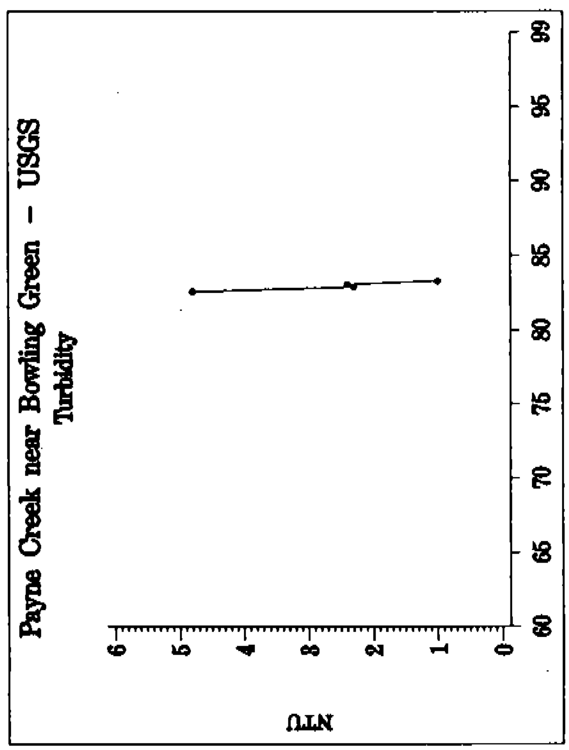

Charlie Creek near Gardner - USGS
Ortho-Phosphorus
mg/L
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
60
65
70
75
80
85
90
95
99

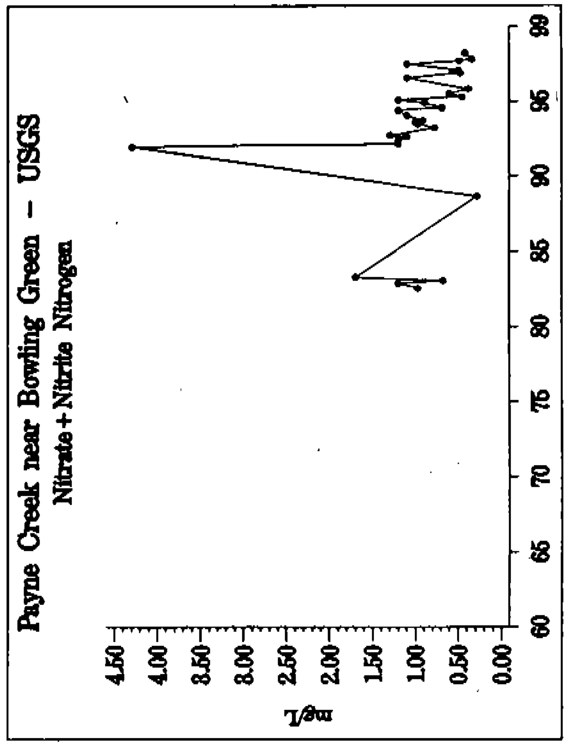

Charlie Creek near Gardner - USGS
Total Phosphorus
mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
60
65
70
75
80
85
90
95
99

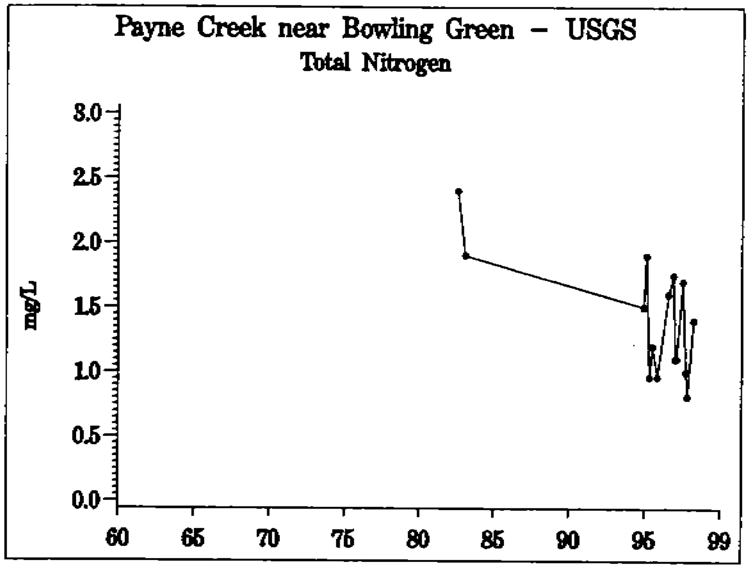

Charlie Creek near Gardner - USGS
Chloride
mg/L
30.0
25.0
20.0
15.0
10.0
5.0
0.0
60
65
70
75
80
85
90
95
99

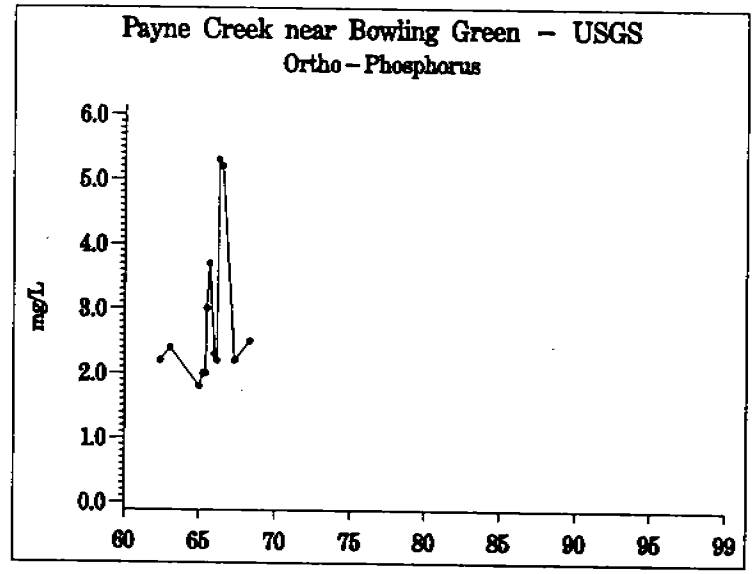

Payne Creek near Bowling Green - USGS
Conductivity
us/cm
500
400
300
200
100
0
60
65
70
75
80
85
90
95
99

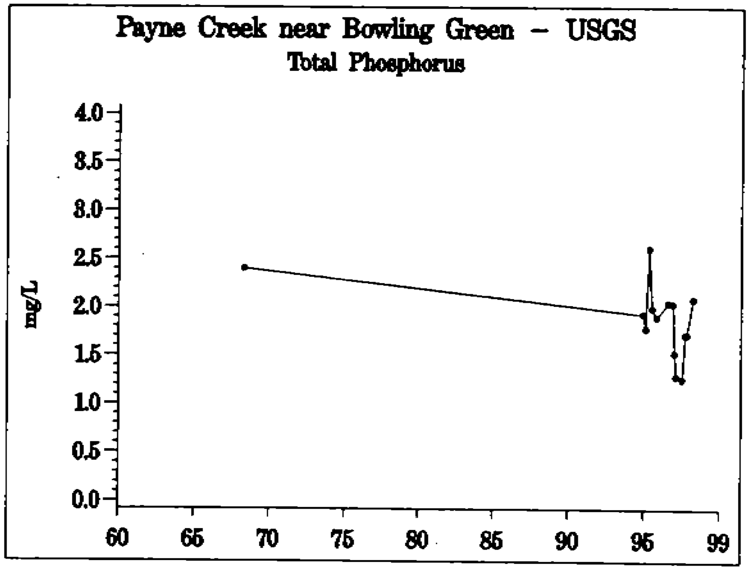

Payne Creek near Bowling Green - USGS
Color
Platinum - Cobalt Units
300
250
200
150
100
50
0
60
65
70
75
80
85
90
95
99

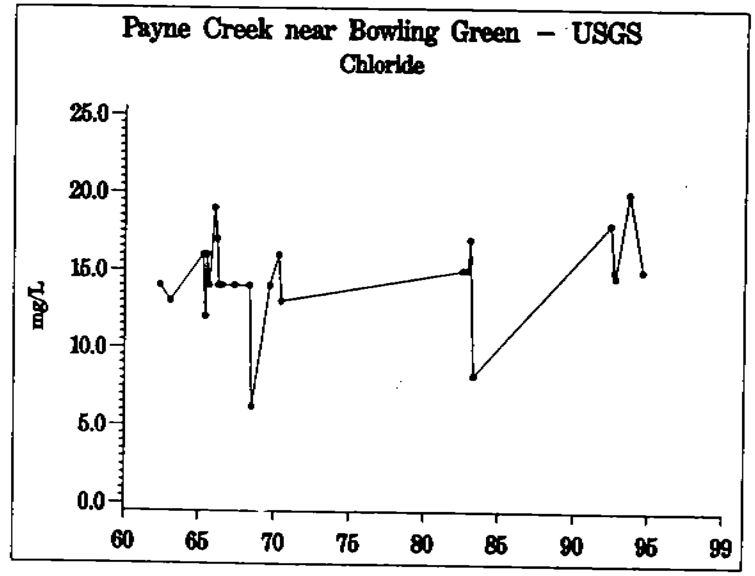

Payne Creek near Bowling Green - USGS
Turbidity
NTU
6
5
4
3
2
1
0
60
65
70
75
80
85
90
95
99

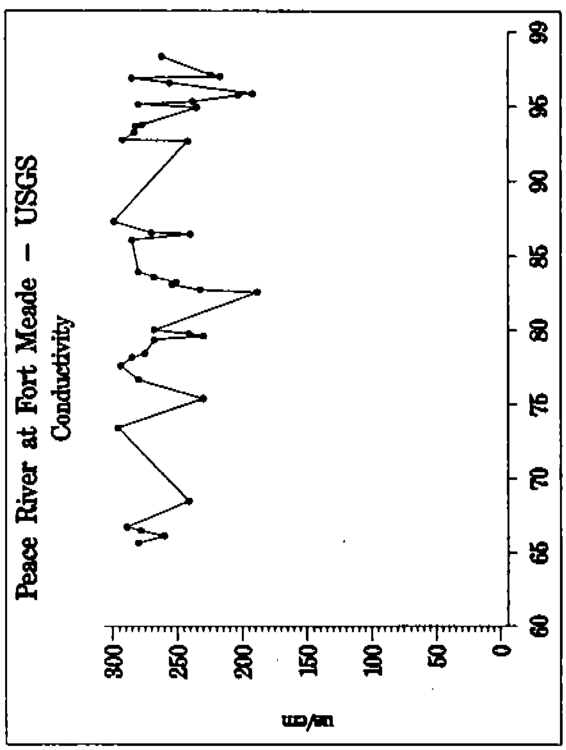

Payne Creek near Bowling Green - USGS
Nitrate + Nitrite Nitrogen
mg/L
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
60
65
70
75
80
85
90
95
99

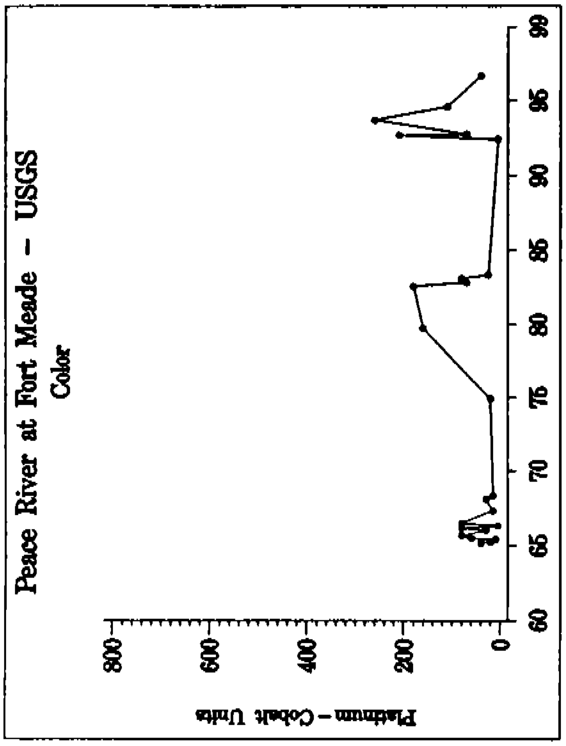

Payne Creek near Bowling Green - USGS
Total Nitrogen
mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
60
65
70
75
80
85
90
95
99

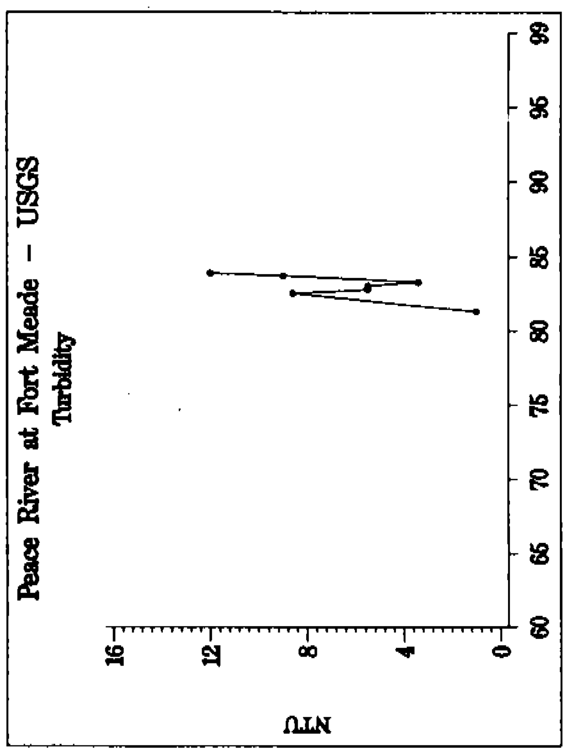

Payne Creek near Bowling Green - USGS
Ortho-Phosphorus
mg/L
0.0
1.0
2.0
3.0
4.0
5.0
6.0
60
65
70
75
80
85
90
95
99

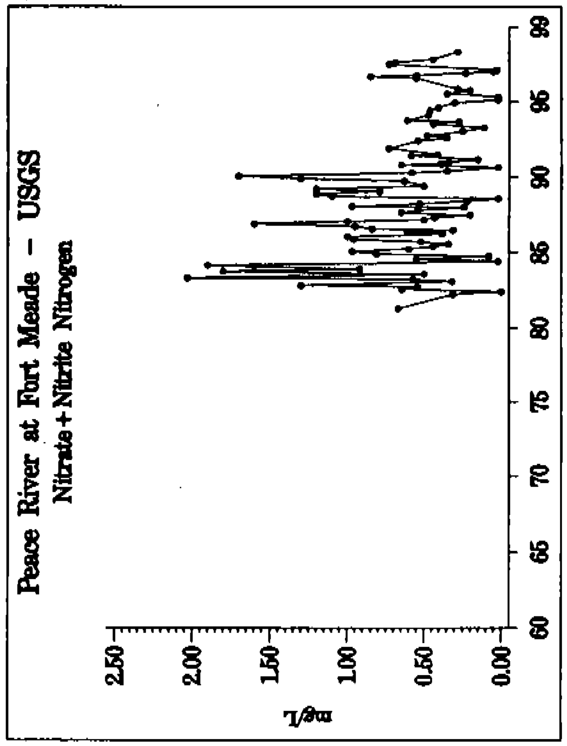

Payne Creek near Bowling Green - USGS
Total Phosphorus
mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
60
65
70
75
80
85
90
95
99

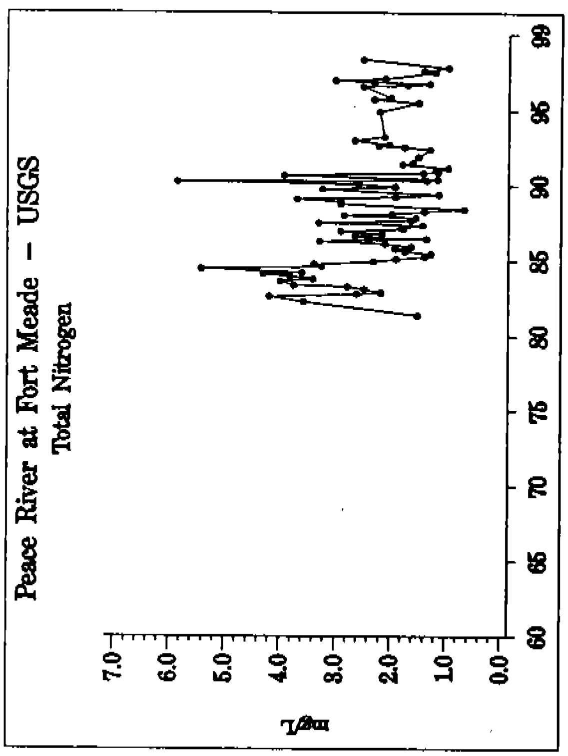

Payne Creek near Bowling Green - USGS
Chloride
mg/L
0.0
5.0
10.0
15.0
20.0
25.0
60
65
70
75
80
85
90
95
99

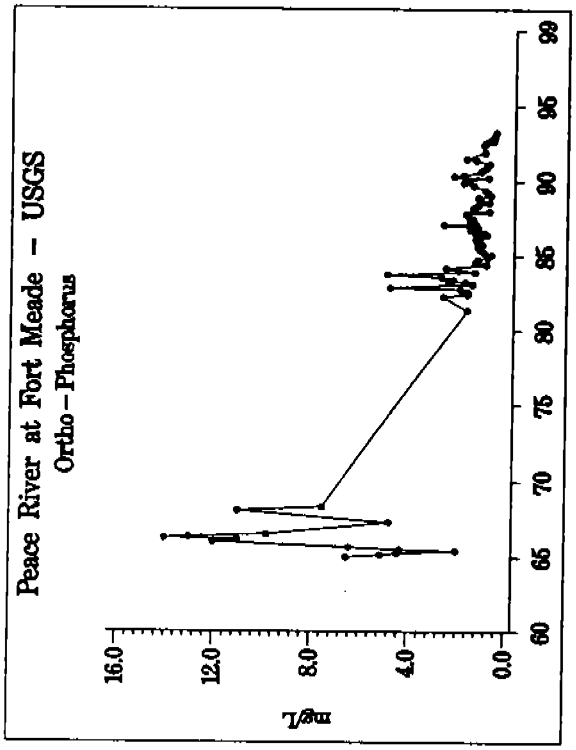

Peace River at Fort Meade - USGS
Conductivity
us/cm
300
250
200
150
100
50
0
60
65
70
75
80
85
90
95
99

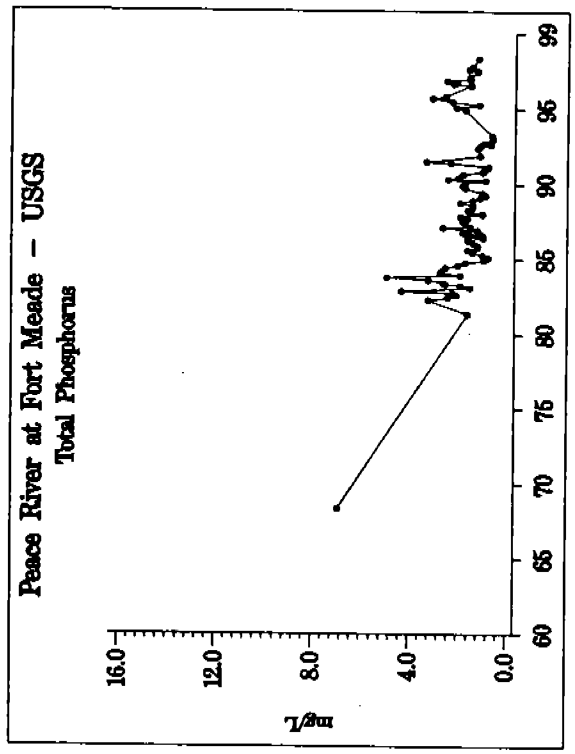

Peace River at Fort Meade - USGS
Color
Platinum - Cobalt Units
800
600
400
200
0
60
65
70
75
80
85
90
95
99

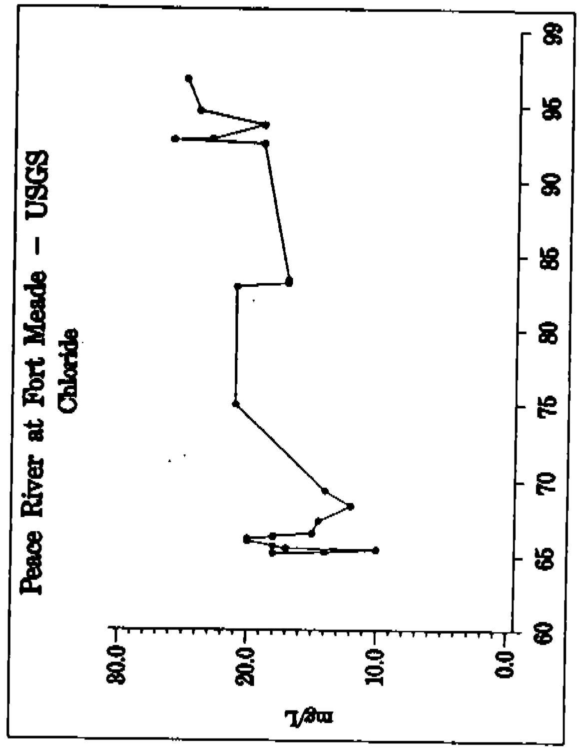

Peace River at Fort Meade - USGS
Turbidity
NTU
16
12
8
4
0
60
65
70
75
80
85
90
95
99


Peace River at Fort Meade - USGS
Nitrate + Nitrite Nitrogen
mg/L
2.50
2.00
1.50
1.00
0.50
0.00
60
65
70
75
80
85
90
95
99


Peace River at Fort Meade - USGS
Total Nitrogen
mg/L
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
60
65
70
75
80
85
90
95
99


Peace River at Fort Meade - USGS
Ortho-Phosphorus
mg/L
16.0
12.0
8.0
4.0
0.0
60
65
70
75
80
85
90
95
99


Peace River at Fort Meade - USGS
Total Phosphorus
mg/L
16.0
12.0
8.0
4.0
0.0
60
65
70
75
80
85
90
95
99


Peace River at Fort Meade - USGS
Chloride
mg/L
30.0
20.0
10.0
0.0
60
65
70
75
80
85
90
95
99

Appendix D

Pollution potential model for basins within the Charlotte Harbor Study Area

Myakka River Basin
Peace River Basin
Charlotte Harbor Basin
Pine Island/ Matlacha Pass Basin
Caloosahatchee River Basin
Estero Bay Basin
Coastal Venice Basin

Estimation of Pollution Potential

Pollution potential was estimated by computing nonpoint source pollution loads based on estimated rainfall, land use, and soil cover by subbasin. The pollution load potential was estimated in order to prioritize subbasins for the CCMP. Thus, the method development was focused on estimating loads in a consistent manner among subbasins. This was done to estimate the most accurate pollutant loads while avoiding biasing the subbasin prioritization.

Specifically, the precipitation, land use, and soil data sources of acceptable quality, accuracy, and precision were selected to meet the following three criteria jointly:

- Current Data - The most current data that met all of the selection criteria were chosen.
- Consistency - The data were chosen from large and comprehensive Water Management District databases to maximize consistency among the subbasins.
- Completeness - A group of datasets was selected that encompassed the entire geographic study area.

Runoff Discharge Methods

Urban, industrial, and agricultural development have changed the natural landscape within the study area, and this has resulted in changes in the physical manner in which runoff responds to rainfall. The detailed rainfall, 1988 SFWMD land cover, SWFWMD 1990 land cover, and USDA soil data that were discussed in Section B-1 were used to estimate relative runoff discharge rates for the subbasins. Using a surface-fitting approach, rainfall values for each month were computed for each of the subbasins by estimating mean monthly values averaged over the years 1970 to 1996 using the equation:

$$\hat{p}_{j,t} = \frac{\sum_{k=1}^{K_j}\left[P_{k,t}\frac{1}{D^2_{j,k}}\right]}{\sum_{k=1}^{K_j}\left[\frac{1}{D^2_{j,k}}\right]}$$

where $\hat{p}_{j,t}$ = the estimated total monthly precipitation in the t^{th} month for the j^{th} subbasin,

K_j = the number of precipitation monitoring stations used to estimate precipitation in the j[th] subbasin,

$P_{k,t}$ = the total monthly precipitation in the t[th] month recorded at the k[th] precipitation monitoring station, and

$D_{j,k}$ = the distance between the geographic centroid of the j[th] subbasin and the k[th] precipitation monitoring station.

The geographic centroid of each subbasin was computed as the area-weighted center of its basin boundary. Monthly specific runoff discharge estimates were then calculated by applying the subbasin specific rainfall estimates to each parcel in the detailed GIS land cover and soil characteristics database. Discharge was computed by multiplying the rainfall estimate by a literature-based runoff coefficient value. Runoff coefficients used for these analyses were specific for south Florida, varied by land use/cover and hydrologic soil group, and were adjusted for wet or dry season conditions. The runoff coefficients used for these analyses are presented in Table D-1. For the final step in this calculation, runoff discharge estimates for each individual land parcel were summed to compute the total expected runoff discharge for each land use within a subbasin using the equation:

$$\hat{q}_{j,t,l} = \sum_{s=1}^{S} A_{j,s,l}\, \hat{p}_{j,t}\, C_{s,l,t}$$

where $\hat{q}_{j,t,l}$ = the estimated total monthly runoff discharge in the t[th] month for the j[th] subbasin for land use l,

$A_{j,s,l}$ = the area of soil type s in land use category l in the j[th] subbasin,

$\hat{p}_{j,t}$ = the estimated total monthly precipitation in the t[th] month for the j[th] subbasin, and

$C_{s,l,t}$ = the runoff coefficient for soil s and land use l in the t[th] month, with season-specific runoff coefficients for south Florida urban land uses.

Hydrologic loadings were estimated based on an "off the land" basis, and it was assumed that all runoff entered the system surface water, whether pumps or gravity flow was used to carry water from the subbasin to the surface water body.

Pollutant Loadings Methods

Agricultural, industrial, and urban development have also led to increased suspended solids (TSS), total nitrogen (TN), and total phosphorous (TP) loadings to the estuary. The runoff discharge model discussed previously was used to estimate relative loading rates for these pollutants for each subbasin. Monthly-specific pollutant loading estimates were computed for each individual parcel of unique land use and soil within a subbasin. Loadings were computed using land use specific pollutant concentration estimates (Table D-1) specific for south Florida. Loading estimates for each pollutant were then computed using the equation:

$$L_{j,t,l} = \hat{q}_{j,t,l} \, E_l$$

where $L_{j,t,l}$ = the estimated monthly pollutant load in the t[th] month for the j[th] subbasin basin for land use l,

$\hat{q}_{j,t,l}$ = the estimated total monthly runoff discharge in the t[th] month for the j[th] subbasin for land use l, as described previously, and

E_l = the pollutant concentration for land use l.

TSS, TN, and TP concentrations reported in the literature have widely varying values. Average concentration values were computed from different studies as listed in Table D-1. The widely varying concentration data resulted in an increased level of uncertainty in the absolute values of the load estimates. However, more intensively developed land uses such as medium and high density residential and intensive agriculture clearly have a higher potential for TSS, TN, and TP loading to the estuary. For management purposes, the pollutant load prioritization of subbasins for this study reflects these load source patterns.

Table D-1. Land Use	Hydrologic Soil Group	Wet Season Runoff Coefficient	Dry Season Runoff Coefficient
Low Density Residential	A	0.15	0.25
Low Density Residential	B	0.18	0.28
Low Density Residential	C	0.21	0.31
Low Density Residential	D	0.24	0.34
Medium Density Residential	A	0.25	0.35
Medium Density Residential	B	0.3	0.4
Medium Density Residential	C	0.35	0.45
Medium Density Residential	D	0.4	0.5
High Density Residential	A	0.35	0.5
High Density Residential	B	0.42	0.57
High Density Residential	C	0.5	0.65
High Density Residential	D	0.58	0.75
Commercial	A	0.7	0.79
Commercial	B	0.74	0.83
Commercial	C	0.78	0.87
Commercial	D	0.82	0.91
Industrial	A	0.65	0.75
Industrial	B	0.7	0.8
Industrial	C	0.75	0.85
Industrial	D	0.8	0.9
Mining	A	0.4	0.5
Mining	B	0.45	0.55
Mining	C	0.5	0.6
Mining	D	0.55	0.65
Institutional,Transportation,Utilities	A	0.4	0.5
Institutional,Transportation,Utilities	B	0.45	0.55
Institutional,Transportation,Utilities	C	0.5	0.6
Institutional,Transportation,Utilities	D	0.55	0.65
Range Lands	A	0.1	0.18
Range Lands	B	0.14	0.22
Range Lands	C	0.18	0.26
Range Lands	D	0.22	0.3
Barren Lands	A	0.45	0.55
Barren Lands	B	0.5	0.6
Barren Lands	C	0.55	0.65
Barren Lands	D	0.6	0.7
Pasture	A	0.1	0.18

Table D-1. Land Use	Hydrologic Soil Group	Wet Season Runoff Coefficient	Dry Season Runoff Coefficient
Pasture	B	0.14	0.22
Pasture	C	0.18	0.26
Pasture	D	0.22	0.3
Groves	A	0.1	0.18
Groves	B	0.14	0.22
Groves	C	0.18	0.26
Groves	D	0.22	0.3
Feedlots	A	0.8	0.9
Feedlots	B	0.8	0.9
Feedlots	C	0.8	0.9
Feedlots	D	0.8	0.9
Nursery	A	0.2	0.3
Nursery	B	0.25	0.35
Nursery	C	0.3	0.4
Nursery	D	0.35	0.45
Row and Field Crops	A	0.2	0.3
Row and Field Crops	B	0.25	0.35
Row and Field Crops	C	0.3	0.4
Row and Field Crops	D	0.35	0.45
Upland Forests	A	0.1	0.18
Upland Forests	B	0.14	0.22
Upland Forests	C	0.18	0.26
Upland Forests	D	0.22	0.3

Land Use	TN Concentration (mg/L)	TP Concentration (mg/L)	TSS Concentration (mg/L)
Low Density Residential	1.88438	0.29625	18.16
Medium Density Residential	2.2475	0.33075	34
High Density Residential	2.08857	0.37593	64.56
Commercial	1.83833	0.26167	73.8833
Industrial	1.668	0.276	93.925
Mining	1.63	0.245	50.3
Institutional,Transportation,Utilities	1.204	0.074	11.0667
Range Lands	2.6	1.3	12.1
Barren Lands	1.18	0.05	10
Pasture	2.66	0.81	8.6
Groves	2.02	0.28783	9.85
Feedlots	19.7	3.8	50
Nursery	2	0.3	55
Row and Field Crops	3.1675	1.295	34.65
Upland Forests	3.79	0.54	55.3

Appendix E

Land Use data from SWFWMD based on Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS), Levels II and III for the Charlotte Harbor Study Area

Myakka River Basin
Peace River Basin
Charlotte Harbor Basin
Pine Island/ Matlacha Pass Basin
Caloosahatchee River Basin
Estero Bay Basin
Coastal Venice Basin