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ANNUAL REPORT OF HYDROLOGIC  
CONDITIONS AND WATER RESOURCE  
ACTIVITIES-1977 WATER YEAR

By

Alfred P Canepa

Donthamsetti V. Rao

Dann K. Yobbi

Water Resources Department  
St. Johns River Water Management District  
Palatka, Florida

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TABLE OF CONTENTS

	Page
INTRODUCTION . . . . .	1
STATUS OF THE RESOURCE . . . . .	2
<u>Rainfall</u> . . . . .	2
<u>Floridan Aquifer</u> . . . . .	8
Water Levels - . . . . .	8
Water Quality - . . . . .	12
<u>Unconfined Aquifer</u> . . . . .	18
<u>Secondary-artesian Aquifer</u> . . . . .	18
<u>Surface Water</u> . . . . .	21
STATUS OF WATER RESOURCES INVESTIGATIONS AND ACTIVITIES . . . . .	29
<u>Departmental Investigations</u> . . . . .	29
Tri-County - . . . . .	29
Upper Etonia Creek Basin - . . . . .	29
Salt Water Intrusion - . . . . .	29
Crescent City - . . . . .	30
Upper St. Johns River Basin - . . . . .	30
Streamflow Frequency Analysis - . . . . .	31
Oklawaha River Basin - . . . . .	31
<u>Cooperative Activities</u> . . . . .	32
U. S. Geological Survey - . . . . .	32
Florida Bureau of Geology - . . . . .	32
Agricultural Stabilization and Conservation Service/Soil Conservation Service - . . . . .	32
<u>Field Station Activities</u> . . . . .	33
PROJECTED INVESTIGATIONS AND ACTIVITIES . . . . .	34
<u>Departmental Investigations</u> . . . . .	34
Consumptive Use Criteria - . . . . .	34
Monitoring Network - . . . . .	34
<u>Cooperative Activities</u> . . . . .	34
National Aeronautics and Space Administration - . . . . .	34
U. S. Geological Survey - . . . . .	35
Florida Bureau of Geology - . . . . .	35
Agricultural Stabilization and Conservation Service/Soil Conservation Service - . . . . .	35
REFERENCES . . . . .	36

ANNUAL REPORT OF HYDROLOGIC CONDITIONS AND WATER  
RESOURCE ACTIVITIES-1977 WATER YEAR

INTRODUCTION

In response to a multitude of questions concerning water resource conditions, on-going projects, and future investigations, the Water Resources Department has prepared an annual report for the water year 1977 (October 1976 through September 1977). This report is directed toward state, regional, and local governmental units, planning agencies, agricultural and business concerns, and interested members of the public; and is intended to provide current information on hydrologic conditions in the District and on the activities of the Water Resources Department.

This report is divided into three parts. The first section deals with the status of the resource. Ground water, surface water, and precipitation data for the 1977 water year are presented and compared with historical data. In the second section, on-going projects, cooperative programs, and field station activities are discussed. Finally, the last section lists new projects and activities for water year 1978. Future annual reports will be expanded and modified, as data become available, to provide more detailed information on water quantity, water use, and other water resource information of interest to the people of the District.

## STATUS OF THE RESOURCE

### Rainfall

Precipitation in the St. Johns River Water Management District occurs primarily as rainfall. In this report, rainfall normals are defined as the means calculated at various U. S. Weather Bureau stations throughout the District for the period 1941-1970. The isohyetal map of mean annual rainfall for this period is shown in Figure 1. Rainfall is not uniformly distributed, varying from 61 inches in the Titusville area to less than 50 inches in the Daytona Beach area. Mean annual rainfall for the entire District is approximately 53.7 inches based upon 15 long term U. S. Weather Bureau stations located within the basin.

Each year's rainfall generates a characteristic isohyetal (areal) pattern. The annual rainfall variation in the District for the water year 1977 is shown in Figure 2. The highest rainfall is found in two areas: the extreme northern portion of the District in Nassau and Baker counties, and a small area south of Lake George in Lake County. Portions of the District which received the least rainfall during the water year 1977 are the Gainesville, Orlando, Melbourne, and St. Augustine areas. Mean rainfall during the water year 1977 calculated from selected stations was approximately 42.5 inches or 11.2 inches less than normal and ranged from 34.4 inches at Melbourne to 58.9 inches at Glen St. Mary.

Figure 3 illustrates the percentage departure from normal rainfall for the water year 1977. Rainfall was 25 percent or more below normal in four areas. These areas are centered around St. Augustine, Gainesville, Lisbon/Orlando, and Titusville/Melbourne. Areas which had a positive departure are located in portions of the northern counties, Baker and Nassau. Rainfall throughout most of the District was at least 10 percent below normal.

Monthly rainfall at selected stations located within the District for the water year 1977 is compared with normal monthly rainfall for each of the stations

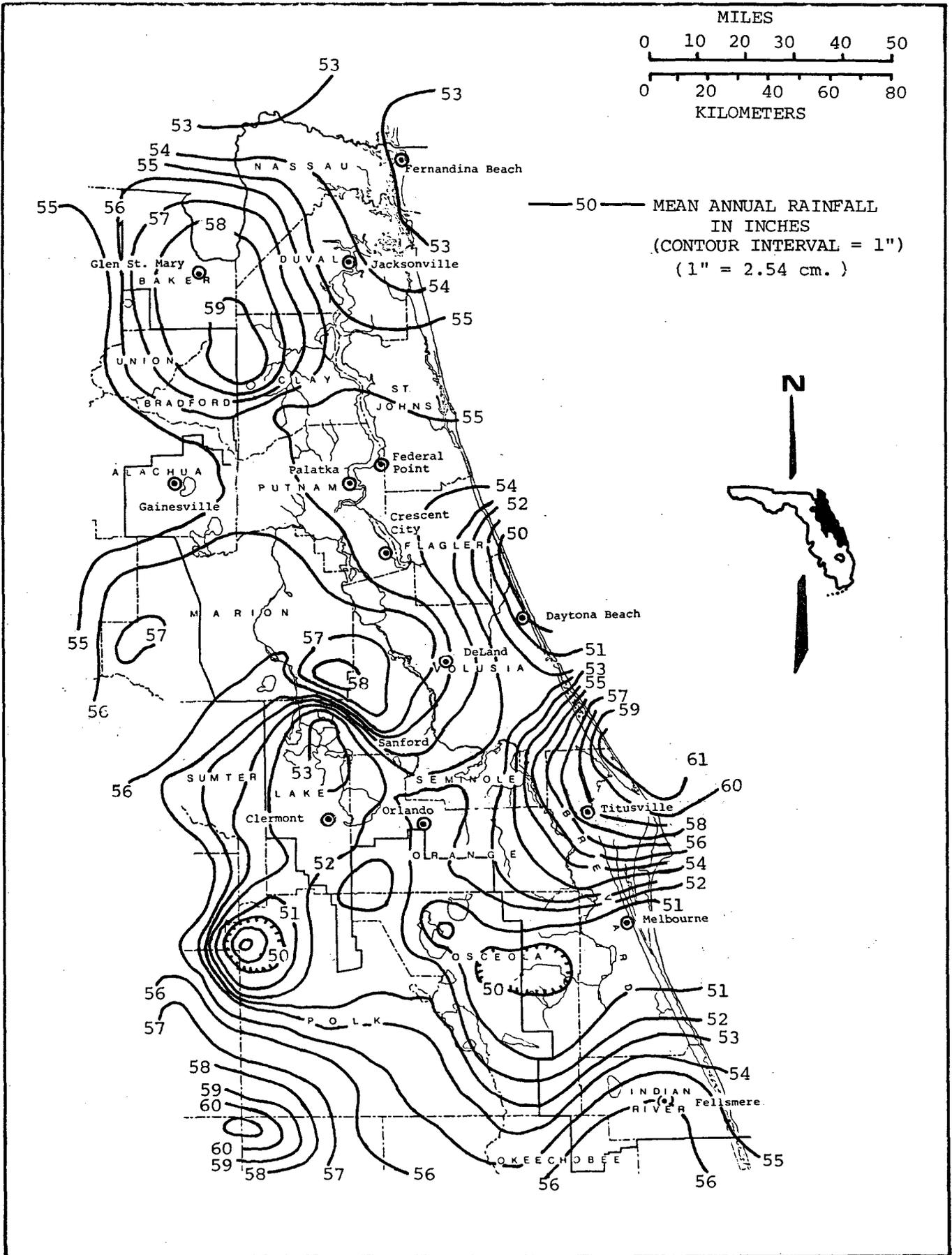


Figure 1. - Mean Annual (Normal) Rainfall in the SJRWMD, 1941 - 1970.

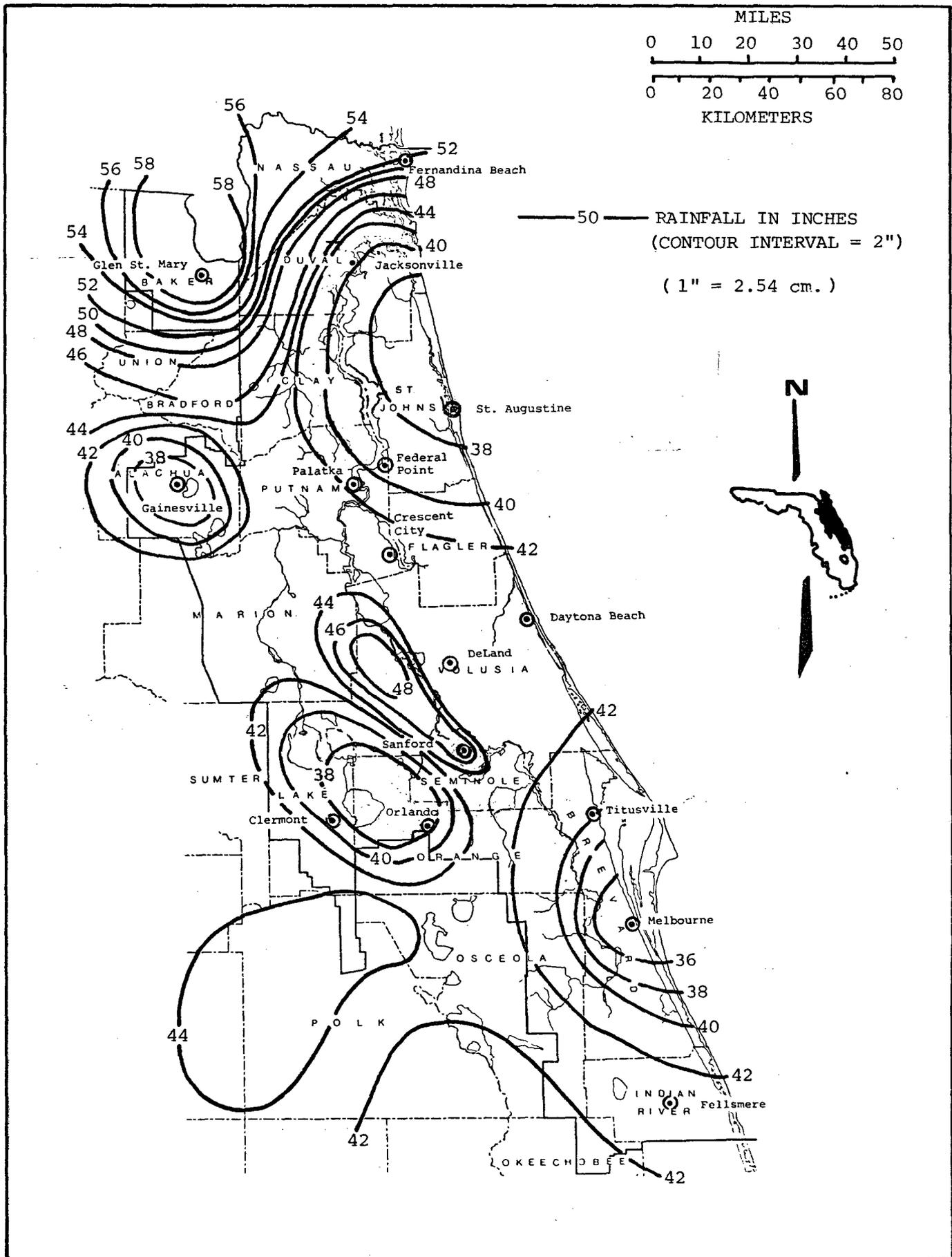


Figure 2. - Rainfall in the SFRWMD for Water Year 1977.

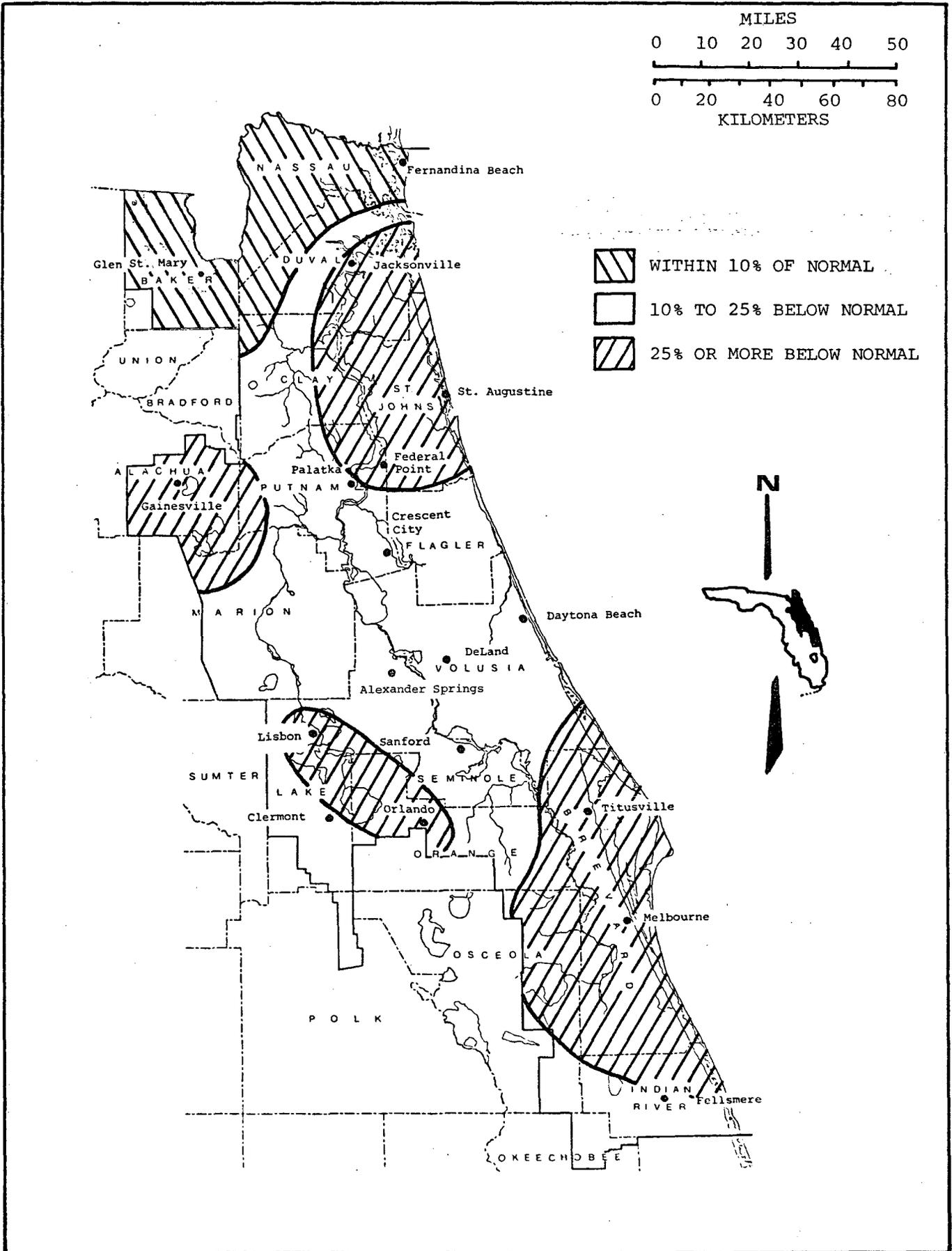


Figure 3. - Percent Departure from Normal Rainfall in the SJRWMD, Water Year 1977.

in Figure 4. Rainfall was generally lower than normal in October, and February through September for all five stations. Rainfall was generally above normal during the three months of November through January. Lowest recorded monthly rainfall was 0.14 inches at Orlando in April. Highest recorded monthly rainfall was 11.34 inches at Alexander Springs in August. During the months of June through September, the interval in which the greatest rainfall is expected, rainfall was considerably below normal.

In summary, the District experienced dryer than normal conditions during the water year 1977 except for a small area of the District located in Nassau and Baker counties which had wetter than normal conditions. Dryest conditions occurred randomly in the District and were centered in four areas: Gainesville, Melbourne, St. Augustine, and Orlando. The average percent departure from the normal was -20.7 and is a result of rainfall deficiencies which persisted through the normally wet season from June through September.

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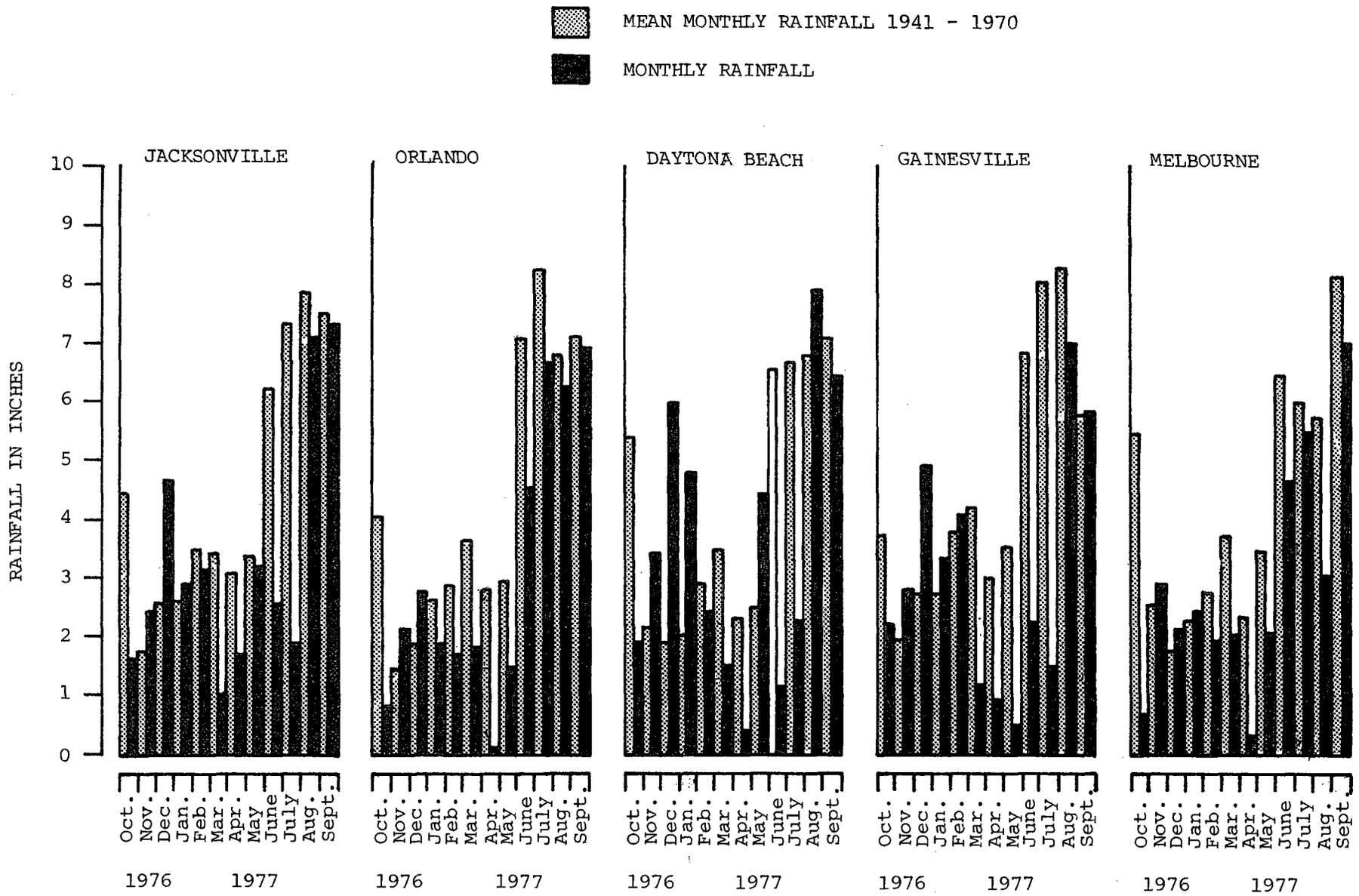


Figure 4. - Mean Monthly Rainfall Compared With Recorded Monthly Rainfall at Selected Stations, Water Year 1977.

## Floridan Aquifer

### Water Levels -

Figure 5 shows the potentiometric surface of the Floridan aquifer in the St. Johns River Water Management District for May 1977. Differences in water levels between July 1961 and May 1977 are shown in Figure 6. Over this 16 year period, the potentiometric surface generally has dropped throughout the District. Changes of less than ten feet are noted in the central and western portions, while changes of ten feet or slightly more are noted in the remainder. One notable exception is the Fernandina Beach area where the potentiometric surface has dropped approximately 100 feet due to heavy industrial pumpage.

Fluctuations in water levels of four wells with long periods of record are shown in Figure 7. Well No. V-1 (Figure 6) is located in a relatively undeveloped area in south central Volusia County about 11 miles southeast of Deland on the flank of the "Volusia Potentiometric High". High and low levels for the period of record (41 years) are within 5.6 feet of each other, while high and low levels for any given year are generally within 2 to 3 feet of each other. There is no significant long term decrease or increase in the water level in this well. This type of variation is thought to indicate an area of the Floridan aquifer which is relatively unstressed by development and responds largely to fluctuations in recharge.

Well No. D-500 (Figure 6) is located in an urban area of the City of Jacksonville, Duval County, in the potentiometric cone of depression centered about Jacksonville. The range in water level fluctuation for the period of record (47 years) is 30 feet. There has been a general water level decline in this well of about 20 feet since 1930 and about five feet since 1962. Well No. B-1 (Figure 6) is located near a developed urban area of Brevard County about four miles northwest of Cocoa. Record high and low levels are within 11 feet of each

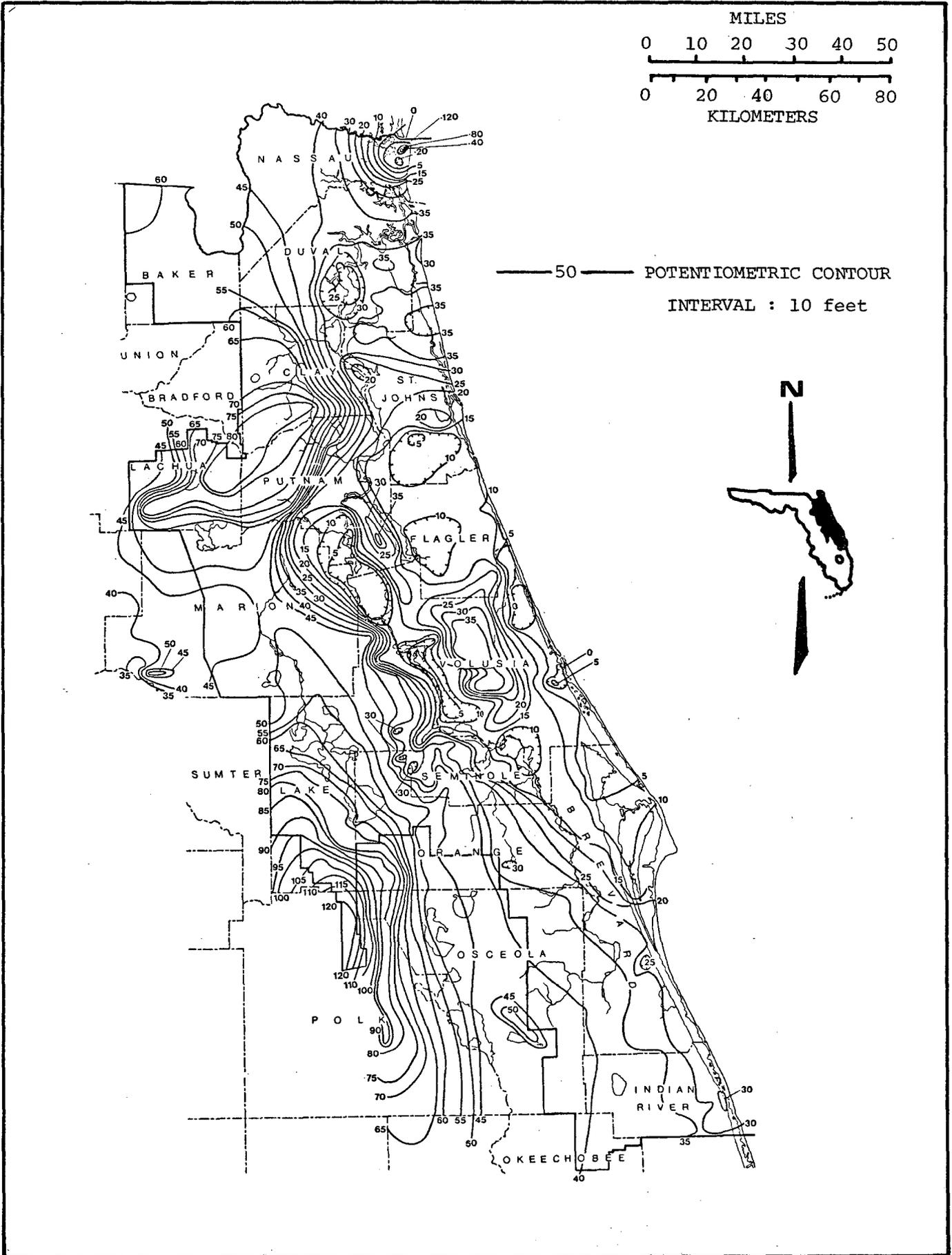


Figure 5. - Potentiometric Surface of the Floridan Aquifer in the SJRWMD, May 1977.

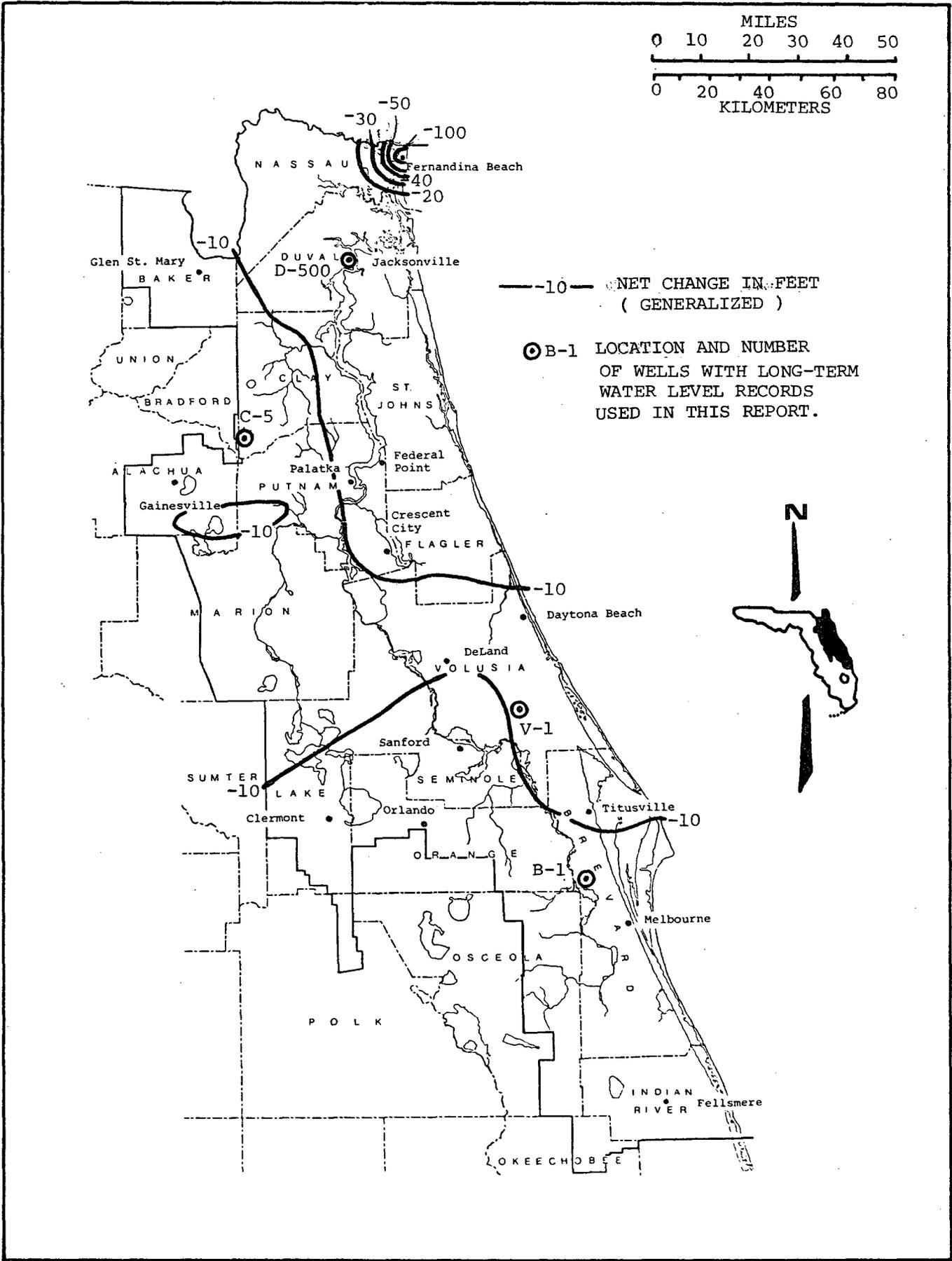


Figure 6. - Net Change of Potentiometric Surface in the Floridan Aquifer Between July 1961 and May 1977.

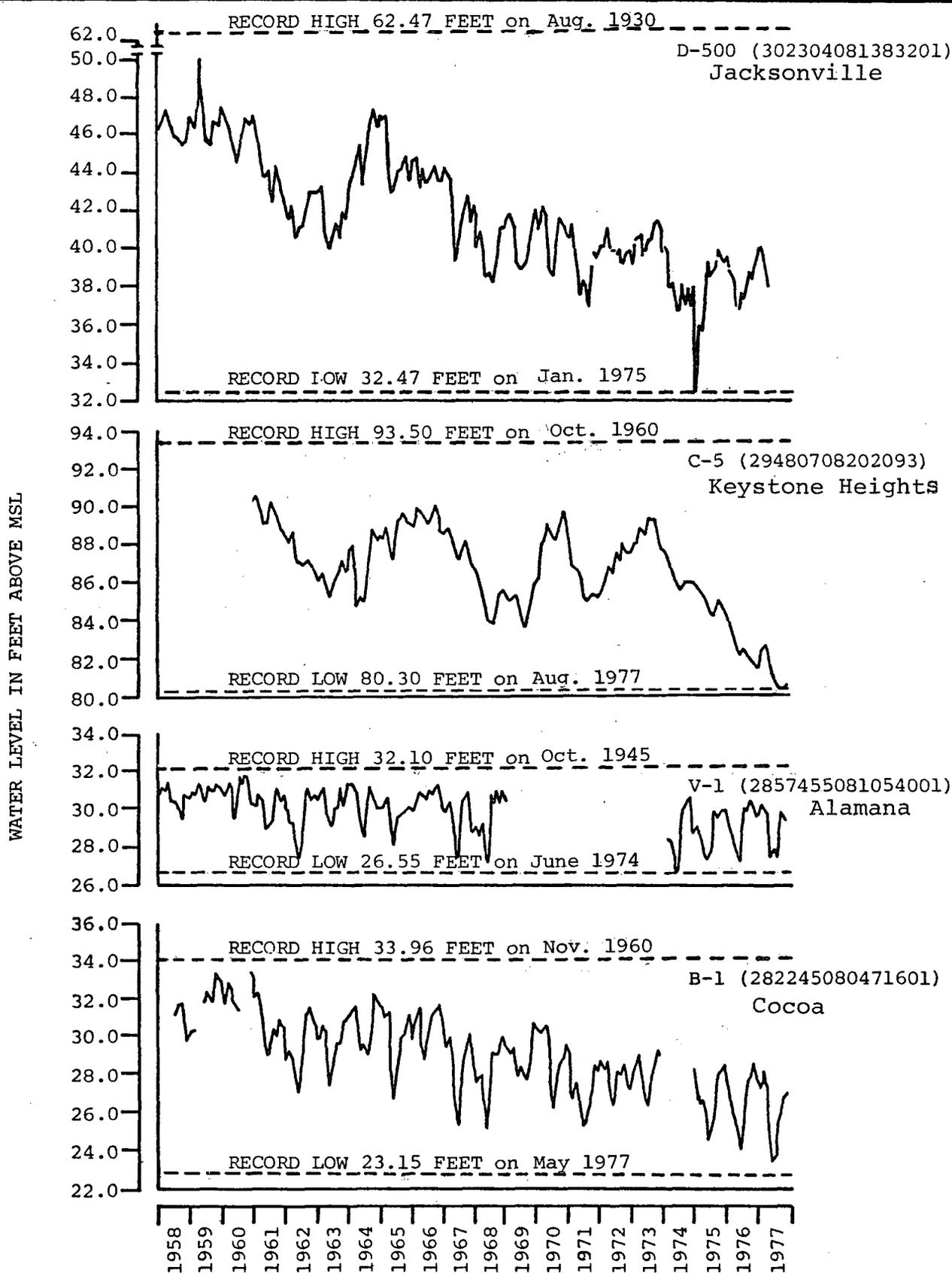


Figure 7. - Hydrographs of Selected Wells in the SJRWMD ( Month-end and Periodic ).

other for the period of record (22 years). A slow long term decline of water levels in this well is shown with a decline of about six feet since 1960. High and low levels for any given year for wells D-500 and B-1 are generally within three to five feet of each other, and variations shown in these wells are indicative of areas where urban, industrial, and agricultural development has placed a stress upon the Floridan aquifer with responses primarily related to increased water use.

Well No. C-5 (Figure 6) is located in a relatively undeveloped lakes region of Clay County about one mile northwest of Keystone Heights and situated in the "Northeast Florida Potentiometric High". High and low levels in this well for the period of record (17 years) are within 14 feet of each other. High and low levels for any given year are generally within three to five feet of each other. A long term decline in water levels of about one foot since 1960 is indicated in this well; however, water level fluctuations appear to be cyclic such that increases generally last one to two years in length, and declines generally persist from two to four years in length. Fluctuations of this type indicate an area of the Floridan aquifer which is not unduly stressed by development, and variation in levels are a result of differences in recharge and discharge.

#### Water Quality -

In some areas, chloride concentration in water withdrawn from the upper part of the Floridan aquifer in the St. Johns River Water Management District measured during the water year 1977 has increased as compared to 1970, but water quality has not changed significantly throughout most of the District. Figure 8 shows the distribution of chloride concentration in upper Floridan waters for June 1977 in Flagler and St. Johns Counties and in eastern Duval, Nassau, and Putnam Counties. Chloride concentration in the Fernandina Beach and Fort George Island areas has increased since the District-wide chloride map was compiled in

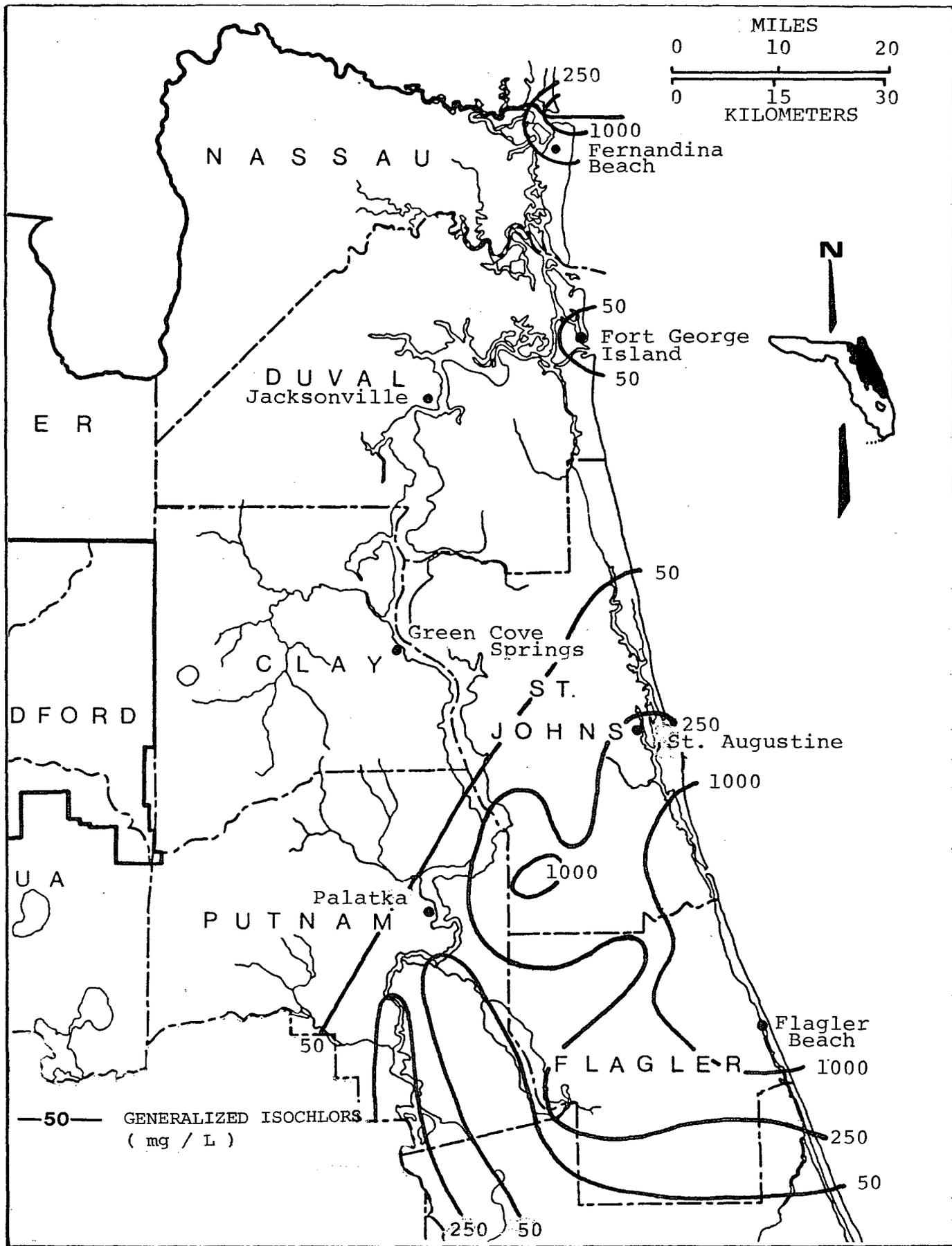


Figure 8. - Chloride Concentration in Water from the Upper Part of the Floridan Floridan Aquifer in Parts of Duval, Flagler, Nassau, Putnam and St. Johns Counties, for June 1977.

1970 (Figure 9). The increased chloride concentration is associated with lower potentiometric levels due to ground water withdrawals in the two areas; however, the chloride concentration in waters from one Fernandina Beach well decreased from 1300 mg/l in June 1977 to 40 mg/l in November 1977. This is a result of potentiometric levels increasing approximately 30 feet during the month of November 1977 in this well due to a pumping shutdown. A comparison of chloride concentration and water levels is graphically shown in Figure 10 for a well on Fort George Island; decreasing potentiometric levels are correlated to increasing chloride concentration. Figure 11 illustrates the long term chloride concentration increase in water for well B-11 in Fernandina Beach. Chloride concentration has increased in well B-11 from 1952 through 1975 corresponding to decreasing potentiometric levels. The chloride concentration has decreased slightly from January 1976 to August 1977 due to relatively stable potentiometric levels in this well during that period. Increased long term ground water withdrawals in this area have enlarged and deepened the cone of depression in the potentiometric surface and have resulted in local upconing of salt water.

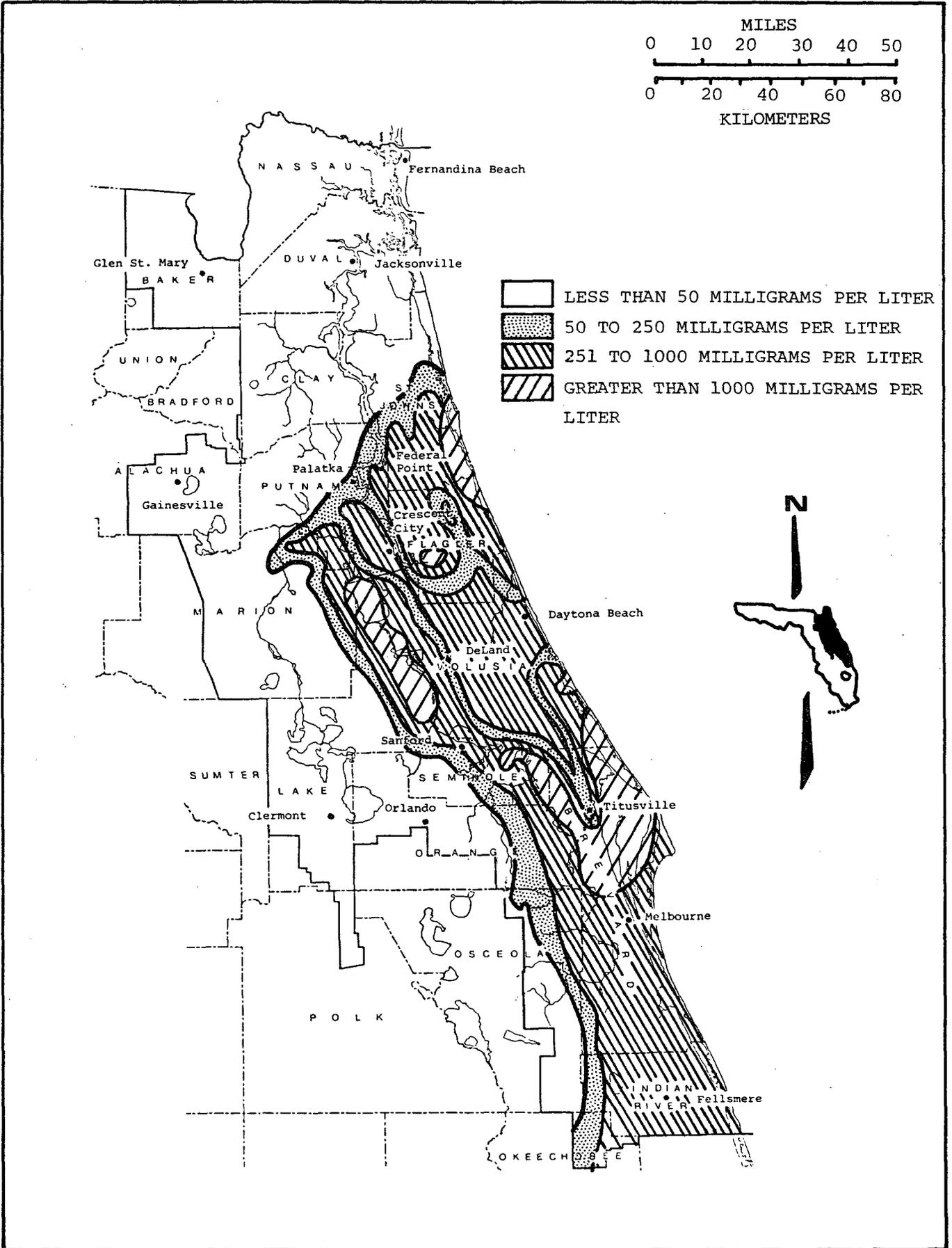


Figure 9. - Chloride Concentration in the Floridan Aquifer in the St. Johns River Basin. ( DNR,1970 )

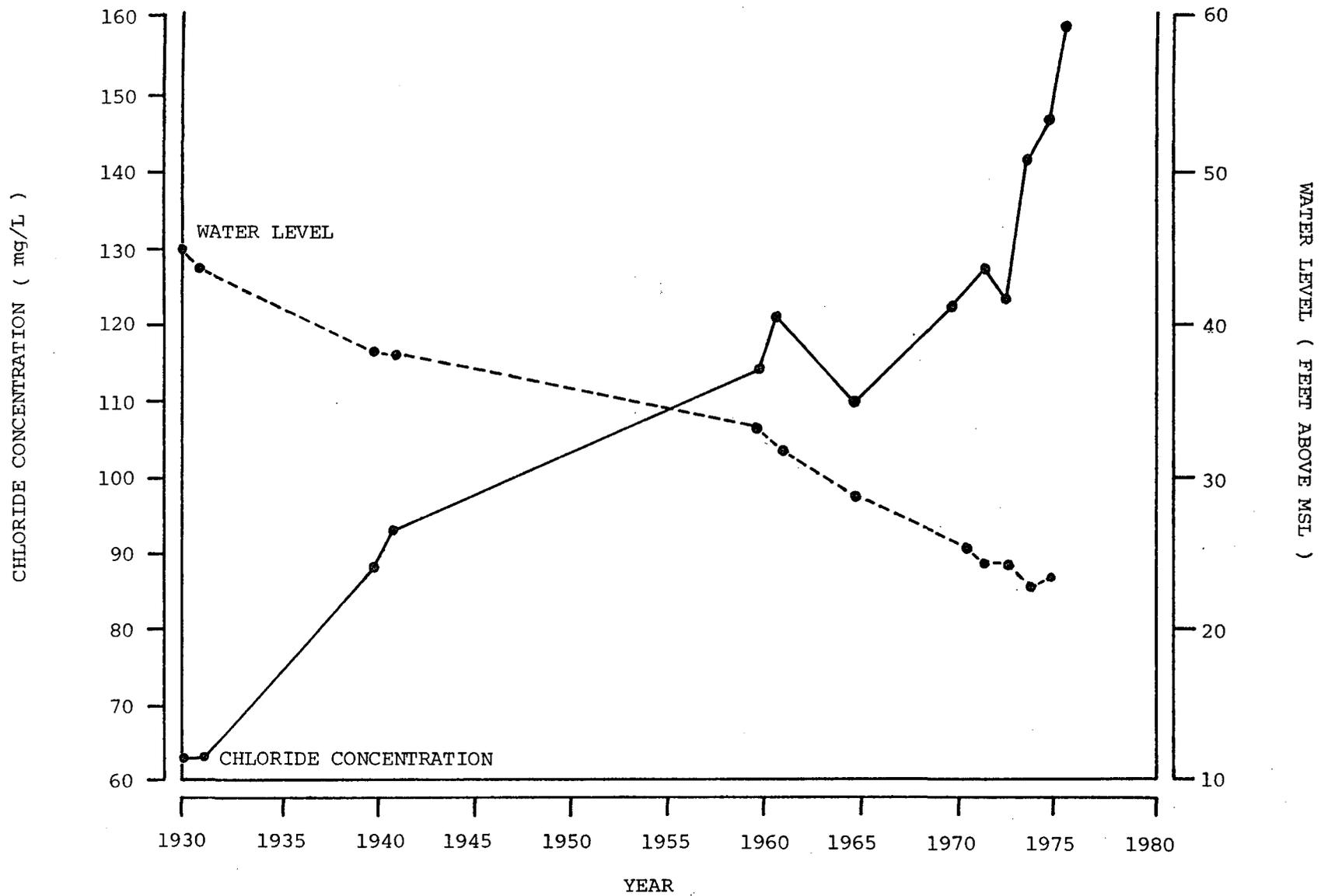


Figure 10. - Water Level and Chloride Concentration for Well D-164, Fort George Island (30253808125311).  
(Modified from Geraghty and Miller, Inc., 1977)

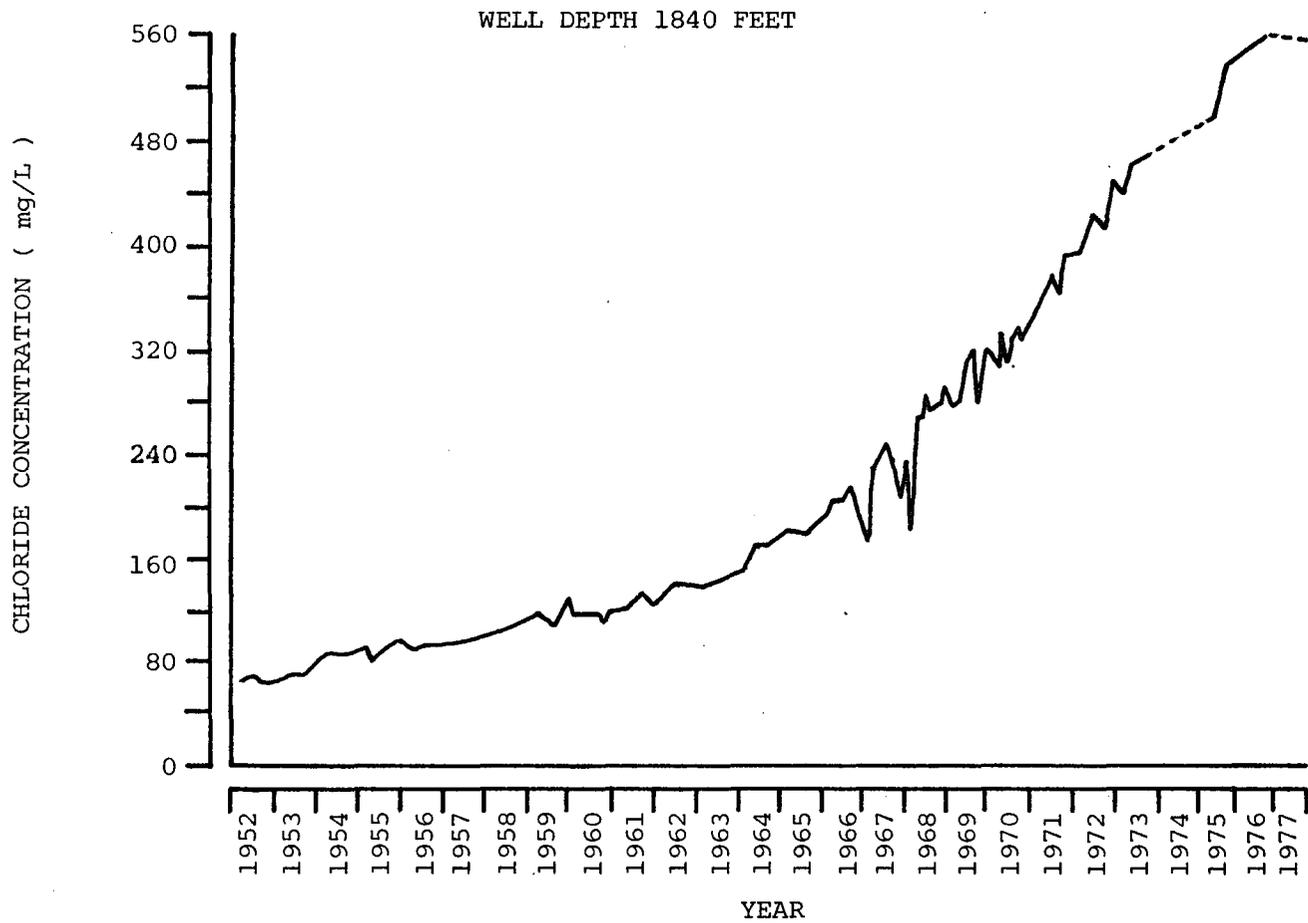


Figure 11. - Chloride Concentration of Water from Well B-11, Fernandina Beach (303933081274602). (Modified from Fairchild and Bentley, 1977, p.18)

### Unconfined Aquifer

The unconfined aquifer, commonly called the shallow water table aquifer, consists mainly of sand, sandy clay, and shell beds of Miocene through Recent ages. Generally, the water table conforms to the topography, but with reduced relief. Due to the irregular local configuration and thickness of this aquifer, an enormous number of observation wells would be necessary to define the conditions District wide. Since significant development of the unconfined aquifer has been mainly restricted to those areas along the coast which have little or no potable water in the lower aquifers, minimal hydrogeologic data is available. In addition, the variation of the unconfined aquifer throughout the District does not allow application of locally derived aquifer constants beyond the area in which they were determined. Therefore, only local descriptive assessments are made.

A recent report published by Geraghty & Miller, Inc., 1976, summarizes the water availability within the unconfined aquifer at Anastasia Island, St. Johns County (Figure 12). Aquifer testing indicated a production zone consisting of loose shells (weathered coquina) extended from land surface down to a depth of 45 to 50 feet. Specific capacity of the pumped well was 88 gpm/ft of drawdown, with an aquifer transmissivity of 300,000 gpd/ft, a storage coefficient of 0.06, and a vertical permeability of 32 ft/day. The chloride content of pumped water was 35 ppm with chloride concentration varying from 50 to 144 ppm at depths of about 40 feet in the observation wells. Chloride content at depths greater than 50 feet ranged from 190 to 900 ppm. Total dissolved solids ranged from 386 to 625 ppm at the 40 foot depth and from 910 to 2,160 ppm in deeper zones.

### Secondary-artesian Aquifer

The secondary-artesian aquifer is discontinuous and variable throughout the St. Johns River District and is sandwiched between the non-artesian and

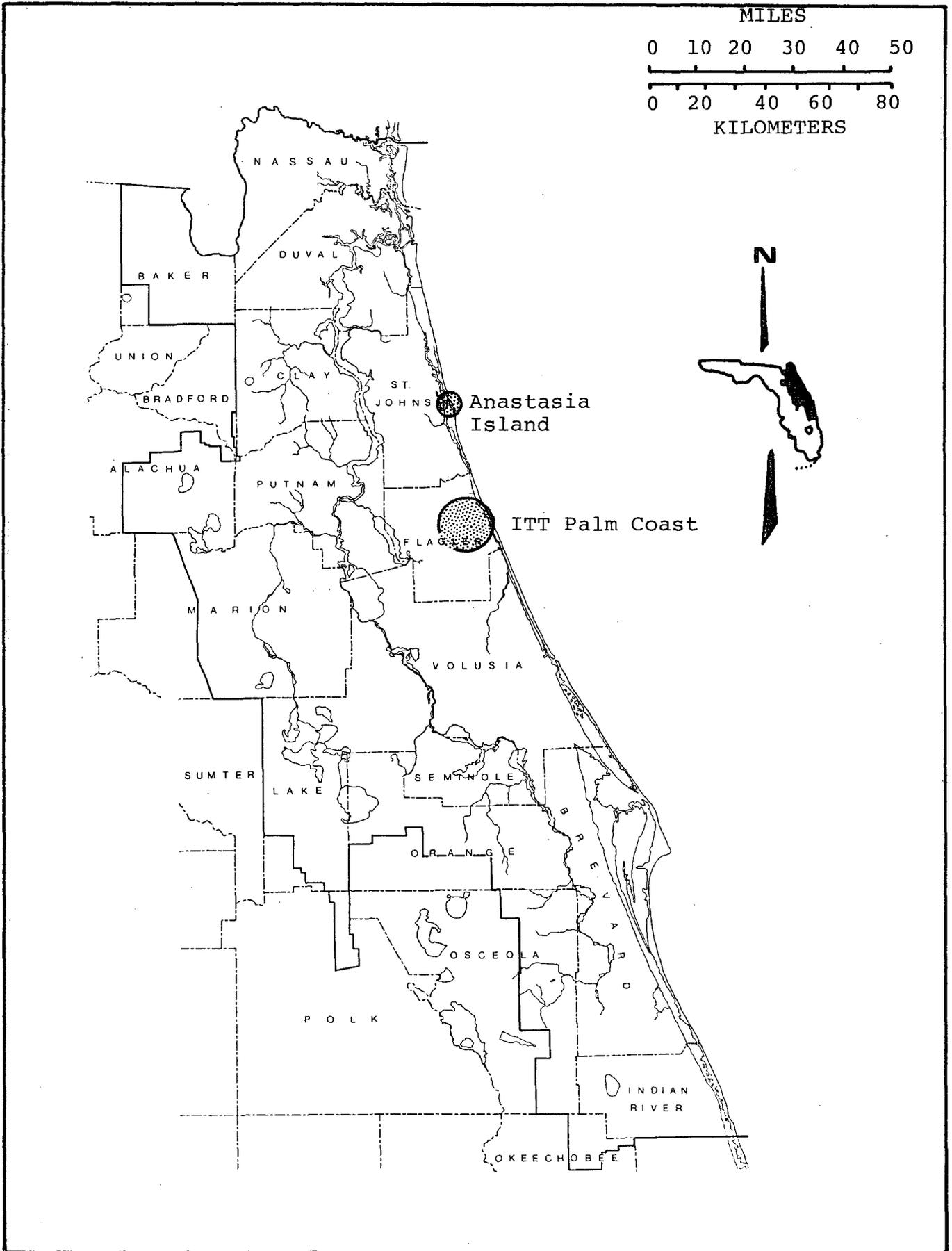


Figure 12. - Location of Anastasia Island Unconfined Aquifer Study and ITT Palm Coast Secondary Artesian Aquifer Study.

Floridan aquifers. This variability limits or precludes the application of measured aquifer characteristics District wide. Since water availability in this aquifer is limited, aquifer development has been minimal, and little hydro-geologic data has been collected.

Additional data has been obtained and published in a report by Black, Crow, & Eidsness (1977) describing water availability within this aquifer in the ITT Palm Coast development in Flagler County (Figure 12). Within the property boundaries, a clean shell interval usually encountered between 60 and 95 feet below land surface produced variable quantities of water. The aquifer is located along a north-south ridge on the higher marine terraces east of Bunnell and is lenticular and discontinuous. Calculated transmissivity values ranged from 6,082 gpd/ft to 52,513 gpd/ft with large local variability in values, storage coefficients ranged from  $1.61 \times 10^{-3}$  to  $1.9 \times 10^{-4}$ , and specific capacities ranged from 4 gpm/ft of drawdown to 22 gpm/ft of drawdown. Specific capacities of most wells which were drilled into the limestone unit of the secondary-artesian aquifer were less than 1 gpm/ft of drawdown. Water quality data showed an average chloride concentration of 48 mg/liter with a range from 20-119 mg/liter and average total dissolved solids of 446 mg/liter with a range from 290-620 mg/liter.

## Surface Water

The streams and rivers of the St. Johns River Water Management District derive their flows from the runoff of precipitation and from ground water discharge. Rainfall was generally below normal for the District during the water year 1977, and these conditions resulted in below median flows in the District except in St. Marys River Basin where the rainfall was above normal.

The values of monthly mean flows in the St. Marys River near Macclenny ranged from 42.9 cfs (May) to 1,833 cfs (September). The 1977 mean flow (637 cfs) exceeded the 1976 mean (308 cfs) by 107 percent, but it was below the mean of 1975 water year (716 cfs). Flow in this river equaled median flow in October, but exceeded and remained above median during November through March (Figure 13). The flows were below median during April through July, but recovered to slightly above the median value in August and well exceeded the median in September. They were about five times their respective median flows during December and January and three times the median during September. During May, June, and July, the mean flows were only about 50, 30 and 9 percent of the respective median flows.

Figure 13 also shows specific conductance and water temperature for St. Marys River near Macclenny. Mean temperatures ranged from 14°C (February) to 28.5°C (September) and were above median for the entire water year. Specific conductance showed a sharp rise (up to 81 micromhos/cm at 25°C) during May, June, and July as a result of low flows.

Monthly mean flows in the St. Johns River near Christmas ranged from 37.7 cfs (May) to 2,847 cfs (October). The water year 1977, with a mean flow of 639 cfs, may be considered a dry year compared to 1975 and 1976 which had mean flows of 805 and 1,249 cfs, respectively. Flows in the St. Johns were below the median in all months except October (Figure 14). The flow decreased

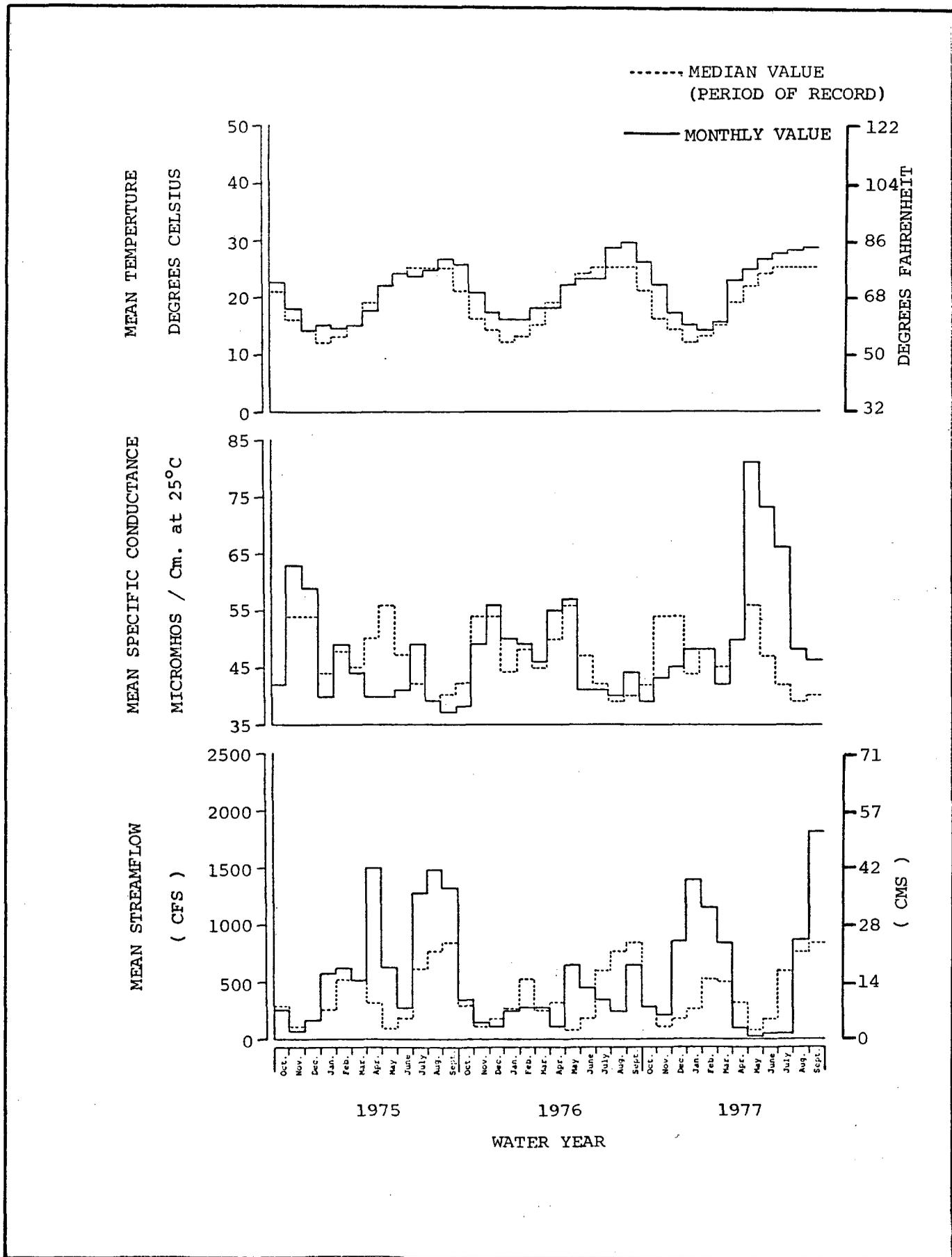


Figure 13. - Temperature, Specific Conductance and Streamflow for St. Marys River near Macclenny, Florida.

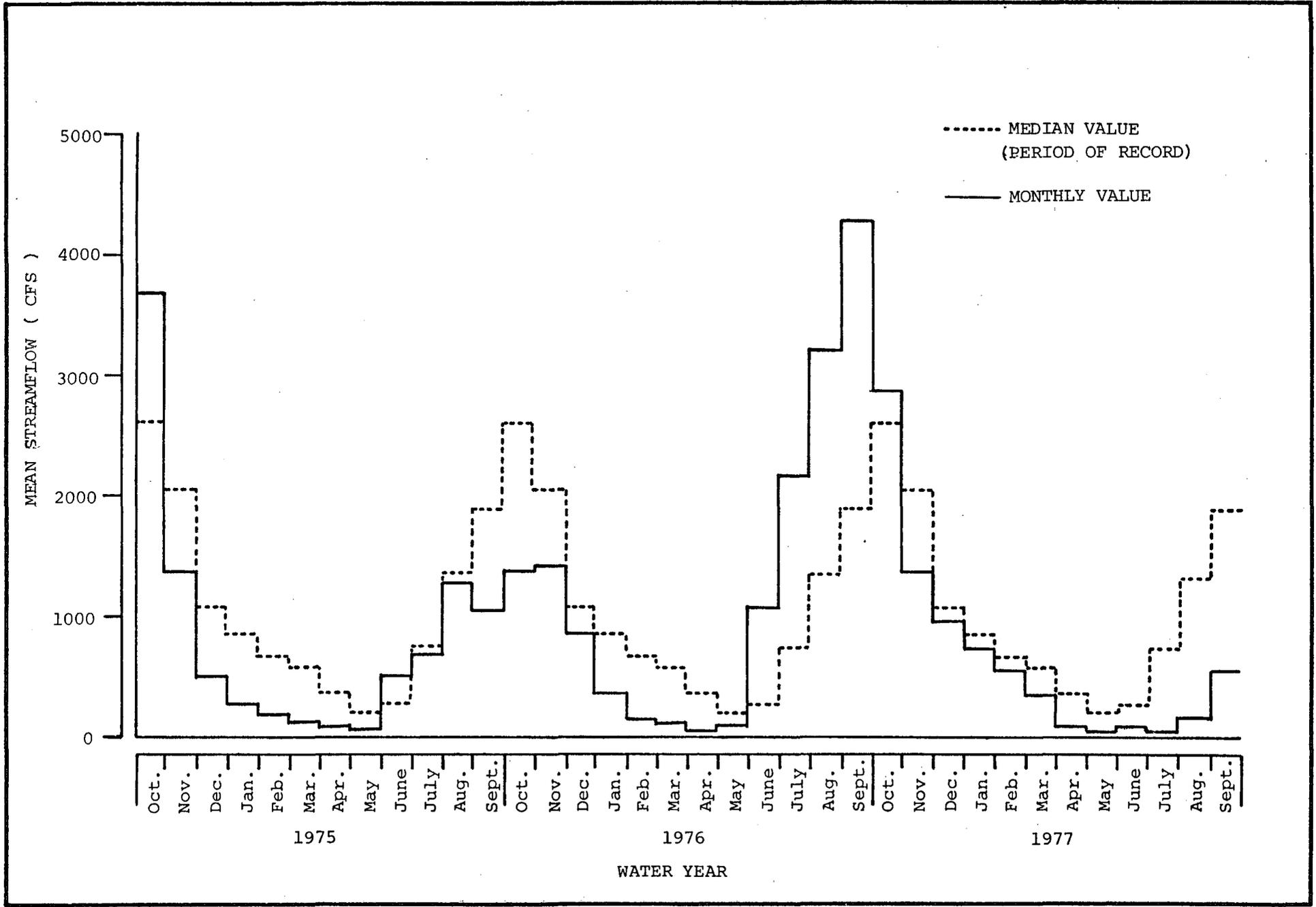


Figure 14. -

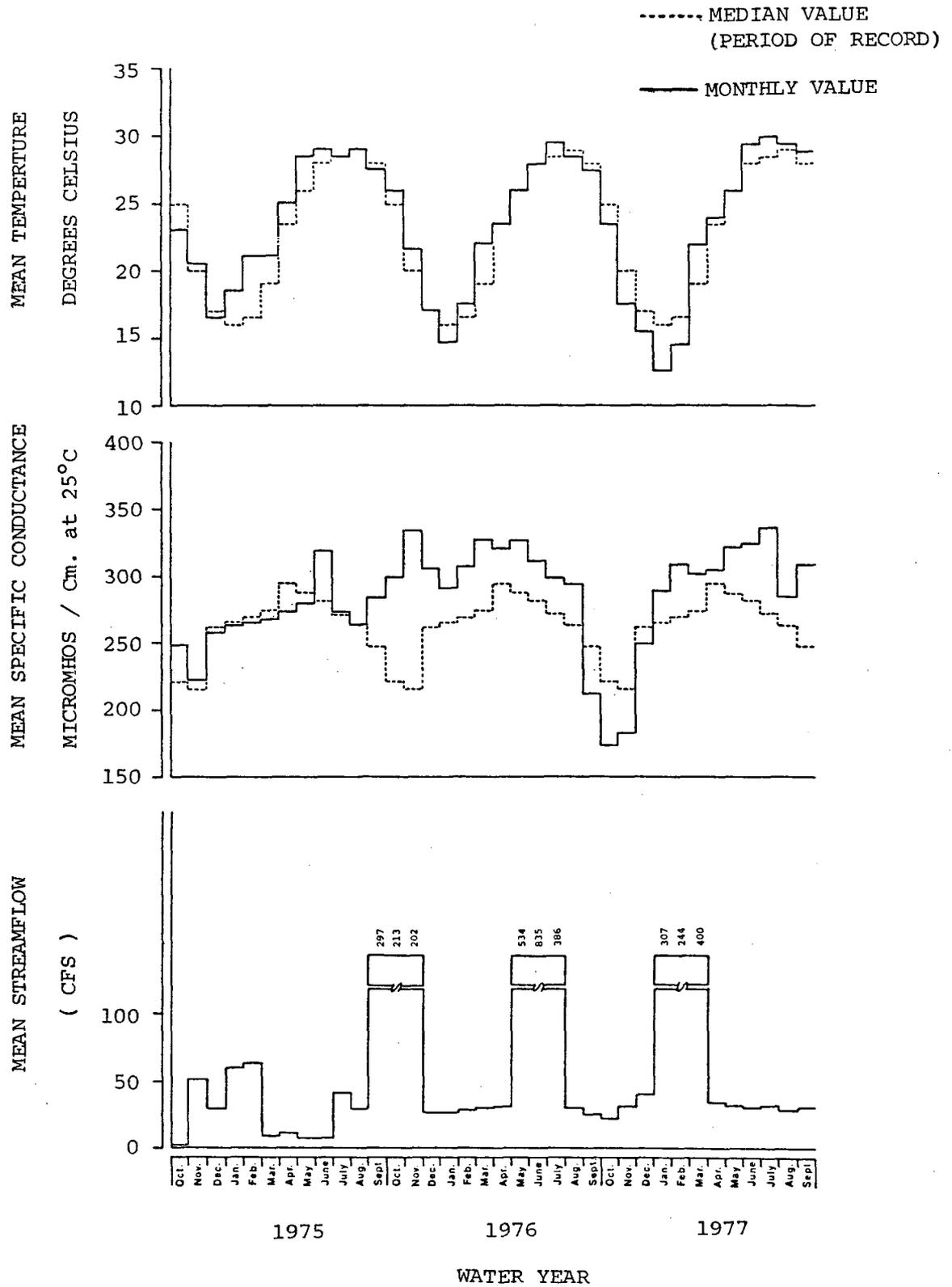
Streamflow, St. Johns River near Christmas, Florida .

contraseasonally during July and was only about 6 percent of the median flow. During the other months from April through September, flows ranged from 13 to 30 percent of the respective median flows.

Monthly mean values of streamflow, specific conductance, and water temperature for the Oklawaha River at Moss Bluff are shown in Figure 15. Flows are regulated at this site to control lake fluctuations upstream, hence, seasonal patterns are severely modified. Due to this reason, no attempt has been made to evaluate monthly median flows. For water year 1977 monthly mean discharges ranged from 22.3 cfs (October) to 400 cfs (March). Mean flow for the year was 102 cfs, which was 54 percent of the mean for 1976. Specific conductance was below median during October through December, but above median during the rest of the year which indicates the general low flow conditions in the basin. Water temperatures, which ranged from 12.5°C (January) to 30°C (July), were below median from October through January and were near or above median for the rest of the year.

Water levels in most of the stream connected lakes in the District are regulated by control structures. Figure 16 shows lake elevations for Lake Washington near Eau Gallie, and Figure 17 shows lake elevations for three lakes in the Oklawaha River Basin (Lake Griffin, Lake Apopka, and Lake Eustis). The mean elevation of Lake Washington for the year 1977 was 13.68 which was only slightly below the 1976 mean elevation of 13.80. The three lakes of the Oklawaha River Basin mentioned above, however, showed a general decline in water elevations as a result of rainfall deficiency in the basin.

In summary, streamflows in the St. Johns River Water Management District were generally below median flows during the water year 1977 as a result of deficient rainfall in the District. The exception was St. Marys River Basin where flows were above median owing to higher than normal rainfall in the basin.



NOTE : MEDIAN STREAMFLOW IS NOT SHOWN BECAUSE DISCHARGE IS STRUCTURALLY CONTROLLED.

Figure 15. - Temperature, Specific Conductance and Streamflow for Oklawaha River at Moss Bluff, Florida.

NOTE : MEDIAN ELEVATION IS NOT SHOWN BECAUSE DISCHARGE IS STRUCTURALLY CONTROLLED.

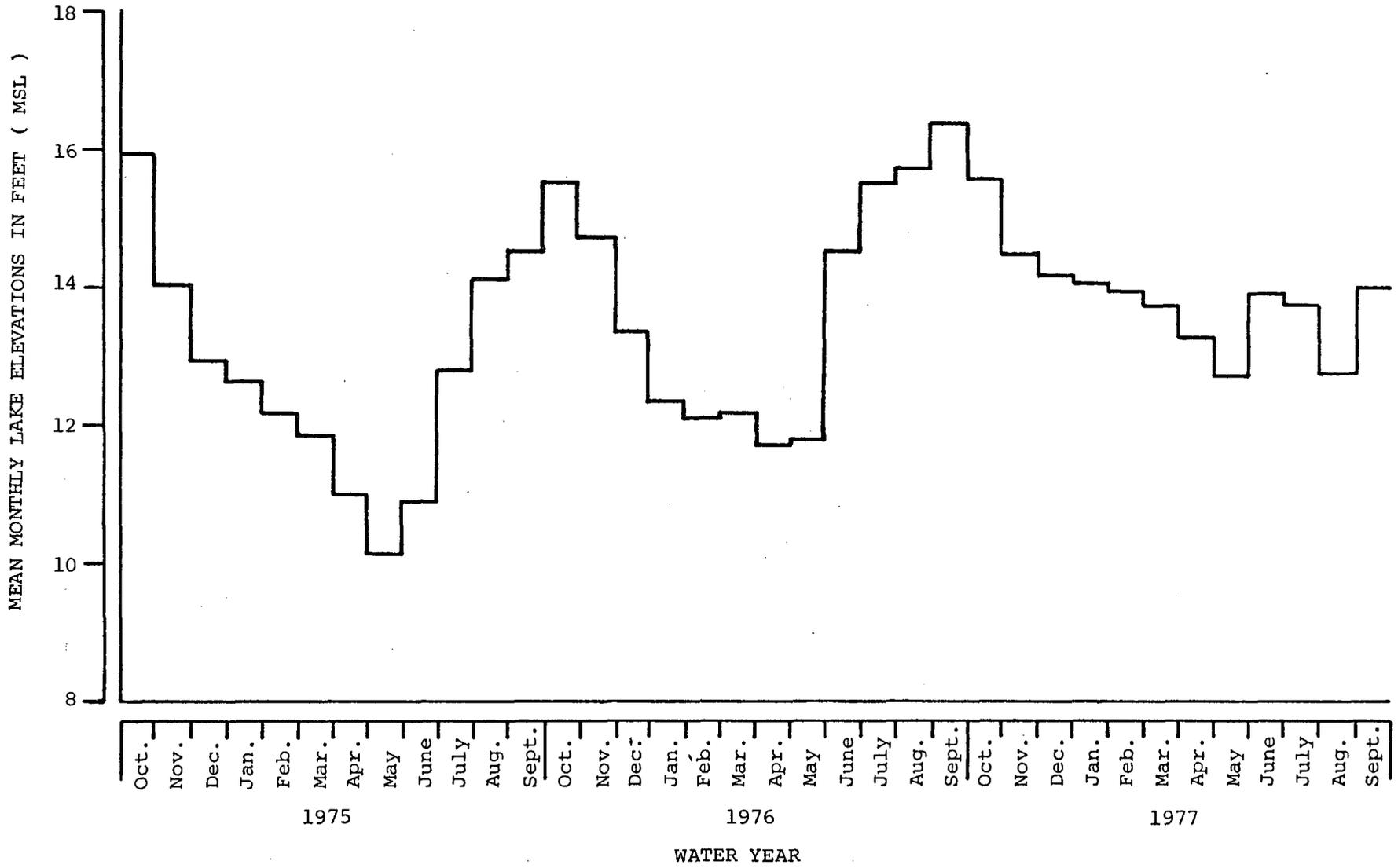


Figure 16. -

Elevation, Lake Washington near Eau Gallie, Florida.

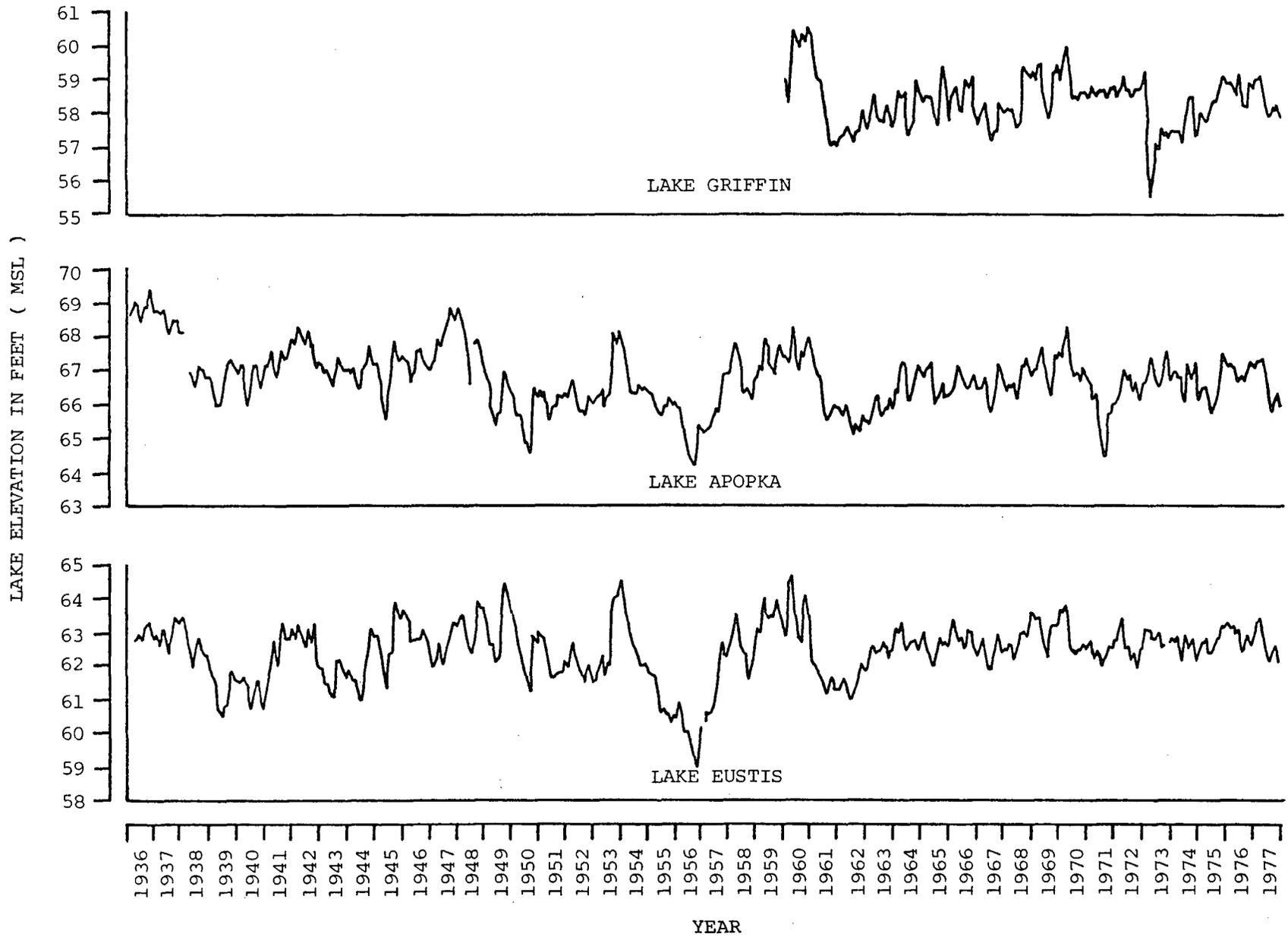


Figure 17. - Elevation, Lake Griffin, Lake Apopka and Lake Eustis, 1936 -1977.

Some stream connected lakes like Lake Washington, however, did not reflect deficient rainfall conditions because the lake elevations were generally regulated.

## STATUS OF WATER RESOURCES INVESTIGATIONS AND ACTIVITIES

### Departmental Investigations

#### Tri-County -

In some agricultural areas of Flagler, Putnam, and St. Johns Counties, intensive ground water withdrawals for irrigation have resulted in contamination of fresh upper zones of the Floridan aquifer by lower saline waters. Climate, hydrology, geology, and water use patterns were investigated to obtain a clearer understanding of the problem. This information was then used to develop a water management plan which could limit or prevent further contamination of the resource. Well construction, well spacing, pumping rates, pumping schedules, and irrigation techniques were found to be the major factors contributing to the deterioration of fresh water zones of the Floridan aquifer in these areas. A report on the Tri-County Study is scheduled for release in mid 1978.

#### Upper Etonia Creek Basin -

A study of the hydrology of the Upper Etonia Creek Basin, located primarily in southwestern Clay and northwestern Putnam Counties, has been completed. The first nine months of the study were performed in cooperation with the U. S. Geological Survey; the remainder was performed as a District project exclusive of the cooperative agreement. Climate, topography, geology, and the hydrologic characteristics of the area were examined to determine their interrelationship and influence on the surface and ground water levels in the basin. A water budget for the basin was developed. The final report is scheduled for release in mid 1978.

#### Salt Water Intrusion -

In the coastal areas of Duval, Flagler, Nassau, and St. Johns Counties, the nature and extent of salt water intrusion is being investigated. The study is being financed in part through a grant from the Coastal Plains Regional

Commission in cooperation with the Florida Department of Environmental Regulation. Three major objectives of this study are to: 1) delineate and monitor the fresh water/salt water interface, 2) quantify the available potable water in the aquifer systems present, and 3) determine the relationship between ground water withdrawals and salt water intrusion in the study area. Water management guidelines for the coastal areas of these counties will be developed from the results of the study. The final report is scheduled for release in late 1979.

#### Crescent City -

A high exists in the potentiometric surface of the Floridan aquifer in the area of the Crescent City Ridge in Putnam County. The hydrologic significance of the high is being investigated by determining such things as the elevation of the top of the Floridan aquifer, the thickness and location of confining units, and the hydrologic characteristics of the aquifers and confining beds in this area. A water budget for this area will be developed. Early 1979 is the anticipated release date for the report on the Crescent City Region.

#### Upper St. Johns River Basin -

The Upper St. Johns River Basin Study will produce a series of alternative water management plans for this basin. The entire basin was divided into 32 hydrologic planning units to simulate the inflows into the river valley. Due to its low and flat watershed, the inflows were simulated with the water budget approach for rainfall, evapotranspiration, soil and surface storage, base flow and overland flow according to land use type and soil classification; and the valley flow with partial differential equations written for overland flow over a grid mesh.

When these models are completed and refined, they will be used to plan alternative designs for flood stage reduction and for maintenance of stage

fluctuations which mimic natural conditions or to produce an artificial regulation schedule consistent with sound water management. Designs will be developed with consideration given to structural and non-structural approaches which produce the desired hydrological conditions.

Following the completion of this study, the alternatives will be presented in a public hearing before the Governing Board for approval, rejection, or modification. After this action, the final report will be presented in a series of public hearings to solicit and accept comments for governmental agencies and all segments of the public.

#### Streamflow Frequency Analysis -

The task of establishing low flows and flood flows for the District's Water Resource Management Plan has led to an investigation of methods used to forecast long term hydrologic events. In order to determine the most applicable method for District streamflow data, a comprehensive study of commonly used 2-parameter and 3-parameter probability distributions is being performed. The bias properties of small size hydrologic samples are also being investigated from the results of synthetic data samples. This research will lead to judicious application of the method of moments which is simple to apply in statistical computations. In addition, an investigation of the more sophisticated statistical methods, the maximum likelihood and least squares, as applied to 3-parameter distributions, is also planned.

#### Oklawaha River Basin -

This program provides the necessary hydrologic and engineering input into water management activities in the Oklawaha River Basin including the State Water Use Plan, inspection of water control structures, input on regulation schedules for water management releases, and basin water resources investigations and data collection activities.

## Cooperative Activities

### U. S. Geological Survey -

The cooperative program with the U. S. Geological Survey for the 1977 water year consisted of three parts: network data collection, semiannual potentiometric maps, and technical assistance. Network data collection involved the maintenance of three existing surface water gaging stations and the establishment of two additional surface water and one ground water gaging stations. Data were collected in May and in September for the compilation of District potentiometric maps. The May map was issued as USGS Open File Report No. 77-629, and the September map is in preparation. Finally, technical assistance covered such things as special data collection and analysis in areas of immediate resource concern and training of District personnel in hydrologic network field maintenance.

### Florida Bureau of Geology -

The Bureau of Geology has developed geologic logs from core borings in their inventory, geologic cross sections, and top of rock and structure contour maps for selected areas in the District. These tasks were accomplished through District funding of the part-time services of a Florida State University geology graduate student working under the supervision of the Bureau. The services provided were flexible and varied as the needs of the Water Resources Department changed during water year 1977.

### Agricultural Stabilization and Conservation Service/Soil Conservation Service -

The cooperative program with these agencies involves the plugging of agricultural artesian wells in order to restore or improve the hydrologic conditions which existed before the well was constructed, and also to eliminate the exchange of water between aquifers. The District provides technical assistance such as logging wells and writing well plugging specifications while the other agencies provide services such as funding for well plugging.

## Field Station Activities

Aquatic weed control in the Upper St. Johns Basin is normally a year round operation; however, spraying was stopped from May to September due to low water levels. During the last week of September, a major hyacinth jam occurred in the St. Johns River at US 192 and required several days of dragline work to clear. In the past year, approximately 900 water hyacinth weevils, Neochetina eichhorniae, and 4,200 hyacinth weevils, Neochetina bruchi, have been distributed from Lake Washington south to Ten Mile Canal area.

In the Oklawaha Basin, the District sprays around locks and spillways and in canals while Lake County sprays the lakes and other areas. Water hyacinth weevils, Neochetina eichhorniae, were introduced into the Oklawaha Basin in August 1977. Approximately 1,300 weevils were seeded along canals and areas not easily accessible by boat for spraying operations.

During the rainy season, the gap on Levee 73 at Structure 161 (Jane Green Creek) usually gets very wet and becomes impassable. This year construction of a bridge and installation of culverts in the gap to raise the level of the roadbed was completed. Approximately 11,200 yards of soil was used to fill the gap. The project began on May 23, 1977 and was completed July 28, 1977.

Levee maintenance, grass seeding, erosion control, and mowing in both basins are on-going projects. Mowing operations usually start in the spring and continue through October. This year three complete passes were mowed over the levees covering approximately 7,250 acres. Approximately 25 miles of fence were repaired and approximately 370 miles were checked.

## PROJECTED INVESTIGATIONS AND ACTIVITIES

In addition to on-going projects described previously, the following investigations are planned for water year 1978.

### Departmental Investigations

#### Consumptive Use Criteria -

Alternative methods of water allocation will be studied to determine an easily implemented and equitable method to be used in the permitting of water use. Once the allocation method is determined, criteria will be developed for various areas of the District to reflect differing hydrologic conditions.

#### Monitoring Network -

Data collection in areas of limited information is anticipated. Included in this activity are water level and quality monitoring in the lakes region of the northwest part of the District, geophysical logging and test drilling District wide, and stream gaging in the canals of the Upper St. Johns Basin. This program is modified during the year to reflect the changing data needs of the Water Resources Department.

### Cooperative Activities

#### National Aeronautics and Space Administration -

A program with NASA on the Florida Water Resources Management Information System (FWRMIS) is planned. It is believed that remote sensing satellite data could be used to help solve the water resource management and related problems of the state. NASA will provide all the remote sensing imagery, and all the equipment, computer software, and personnel required to process the remote sensing data. The District will: a) provide support in developing the long range plan of FWRMIS, b) provide existing data, ground truth data, and evaluate data products developed by NASA, and c) assure that computer models are designed to accept remote sensing data and define follow-up tasks to develop and refine

these models. NASA has a similar cooperative agreement with the University of Florida, Institute of Food and Agricultural Sciences (IFAS) on the FWRMIS project.

U. S. Geological Survey -

Florida Bureau of Geology -

Agricultural Stabilization and Conservation Service/Soil Conservation Service -

Cooperative activities with these agencies in water year 1978 will basically be a continuation of services provided in water year 1977. The only significant change is an addition to the U. S. Geological Survey program. The District is providing in-kind services in an investigation of northwest Volusia County. The study will be directed toward examination of water quantity and quality problems, and sinkhole collapse associated with water withdrawals for fernery frost and freeze protection in the Pierson area. Details of the study will be finalized in late February 1978.

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