**Hydrologic Study within the**

**Myakka River State Park**

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# EXECUTIVE SUMMARY

Management of Myakka River State Park requires an adequate understanding of ecosystem characteristics and processes, and how they have been affected by man's activities. Hydrology is the most important natural environmental influence in wetland ecosystems, and to a large extent in upland systems as well.

We conducted an inventory and analysis of available hydrologic information on Myakka River State Park and its watershed. The study was designed to document current conditions, and assess how changes since man began to develop the area might have affected the hydrology of the park, and in turn, how alterations in hydrology might have affected other environmental components of the park ecosystem. This involved examination of relevant literature on climate, geology, soils, hydrology, and land use in the area and discussions with knowledgeable individuals on these topics, as well as analysis of accumulated climatic and hydrologic data and aerial photography. Fortunately, aerial photography and climatic and hydrology data were available for periods prior to major land use changes on the Myakka River watershed. Inevitably there were some changes that preceded these data sets, and they do not span as lengthy a period prior to the beginning of major changes as might be desired, but they do provide us with a good estimate of predevelopment conditions and the temporal and spatial pattern of the different types of development.

The Myakka River occupies a small watershed along the southwest coast of Florida. A warm, seasonally wet climate, flat topography, and soils with numerous impermeable layers has produced a landscape with numerous depressions occupied by wetland plant communities and a few sizable lakes. The park itself is dominated by upland prairies and pinelands, with many interspersed shallow marshes. Two streams pass through the park, but the Myakka River is the only one with significant annual flows. The broad floodplains along these streams are occupied by extensive areas of a variety of marsh and swamp habitats.

The watershed above the park has gone from a virtually unaltered landscape in the 1940s to one with at least some degree of major alteration over virtually its whole surface in the 1980s. Analysis of water flows at one site on the Myakka River and two sites on rivers in adjacent watersheds has shown no major changes in mean, maximum, or minimum flows for the periods of record at each site. Another more subtle change in the park's hydrology, however, is the increasing use of groundwater in the region, which is showing significant affects on the aquifers that underlie the park and its upstream watershed. There is ample evidence that these aquifers are all interconnected with each other and with the surface water table, although the degree of connection is spatially quite variable. Because the affect will be felt on the water table throughout the park as well as on surface water flows, long term changes in the potentiometric surfaces of these aquifers may ultimately have more affect on the Myakka River State Park ecosystem than other types of changes in the watershed that affect only flows in the Myakka River itself.

A research and monitoring program was recommended to fill gaps in available information on park hydrology. It would also permit evaluation of whether future changes were a result of natural ecosystem processes and variability, or a result of man's activities either within the park or on surrounding lands.

# INTRODUCTION

Management of a natural ecosystem requires an understanding of the characteristics of that system and the processes that produce and maintain those characteristics. However, since ecosystems can be defined at a wide variety of scales, one must first identify the spatial and temporal bounds of interest, and the level of detail that will address relevant questions, while taking into consideration the resources available to do the work. It is a general rule that a study should include not only the area of immediate interest, but also the area at the next higher level of scale. In the case of the hydrology of Myakka River State Park (MRSP), the next higher level of spatial scale would be the watershed above the MRSP. The gentle topographic gradients in this region also require evaluation of a portion of the area downstream of the park to assure that the affects of existing or potential hydrologic alterations in this area can be taken into consideration. The time periods of interest are current conditions, and those going back to a period before man's development activities began to alter the landscape in ways that significantly affected the hydrology of the area.

Hydrology is a major consideration in the management of virtually all ecosystems, but particularly those in Florida. It is the dominant environmental factor determining the distribution and character of wetland communities, and an important influence in other community types. It is also an aspect of the environment that is particularly susceptible to alteration as a result of man's activities, whether it occurs as a planned objective on a particular site or incidental to activities on surrounding lands.

The objective of this study is to assemble and analyze available information relevant to the hydrology of MRSP. This study involved only limited field work, but was designed to identify field studies needed to supplement available information. Specifically, the hydrologic inventory and analysis was intended to provide:

1) identification of existing and potential threats to the hydrologic health of MRSP,
2) a data base upon which to develop an understanding of current and past hydrologic conditions of MRSP and its watershed,
3) identification of research needed to fill information gaps in the data base,
4) a basis for assessing potential hydrologic impacts of proposed development activities in the Myakka River watershed, and
5) a basis for developing monitoring programs designed to interpret whether future changes observed within the park

are a result of natural processes and their variability or man's activities on lands either within or surrounding the park.

## Ecosystem Hydrologic Processes

At the most general level, the hydrologic cycle is the circulation of water from the earth's surface to the atmosphere and back again. While physical processes predominate, biological processes can also significantly influence the pathways involved and the rates at which water moves. Precipitation reaching the earth's surface can evaporate from land or water surfaces, run off to the oceans as surface water, seep into the earth, or return to the atmosphere via plant transpiration.

The descriptive model shown in Figure 1 represents a general statement about the hydrologic cycle that has relevance both to available field data and feasible management options for natural systems as well as those that have been altered by man's activities. **The model illustrates major ecosystem components and their relationships to each other, and the dominant external** inflows and outflows. The system components are functionally, although not physically, isolated from one another. Surface and groundwater may be different portions of the same water body, but the processes of evaporation, transpiration, and water flow affect each quite differently. The characteristics of different types of plant communities can variously influence evaporation, transpiration, and water flow rates of associated surface and groundwaters. The system can exist at a variety of scales, each of which would be associated with different management considerations and types of potential external and internal influences. Examples of systems operating at different scales might include the watershed, the MRSP, or an individual plant community.

## Alteration of Natural Hydrologic Processes

Man's impacts on the hydrology of natural communities include a number of structural and/or land surface alterations that increase or decrease water levels, hydroperiods, and/or flow rates.

Drainage accelerates flows from high sites to lower sites. Increasing outflows from higher sites results in lower water levels and, in wetlands, shortened hydroperiods, while increasing inflows to lower sites results in the opposite hydrologic changes. Probably the most widespread form of drainage involves the construction of canals. These vary in size from relatively shallow ditches that merely connect small depressions with nearby topographically lower areas to systems of deep canals hundreds of miles long and affecting thousands of square miles. The lowered water tables not only significantly alter biotic communities, but can also lead to rapid oxidation and loss of organic soils in former wetlands. An enlarged and straightened river bed produced by channelization permits accelerated downstream flows by increasing the gradient and minimizing frictional forces associated with natural river contours. While the increased flows may reduce flooding in areas adjacent to the channelized portion of the river, they typically produce more severe floods downstream of the channelized section. Both the consistently decreased upstream flooding and increased downstream flooding can adversely affect existing communities in each area. Construction of riverbank levees also limits the spread of flows onto adjacent floodplains and results in the loss of floodplain habitats and aggravated downstream flooding. Drainage practices either eliminate or greatly reduce surface water storage, as well as lower the depth at which saturated soil conditions occur. The smaller amounts of surface or near-surface water in turn lead to reduced evaporative losses.

Impoundments produced by dams or dikes typically result in inundation of upland habitats and deep flooding of relatively flat lowland areas where wetlands are most likely to occur. Disturbance communities frequently dominate the edges of impoundments because the patterns of water level fluctuation associated with their operation for power production, flood control, irrigation, etc. are rarely conducive to the long term survival of stable natural communities. Impoundment normally results in increased surface storage, continuous soil saturation, and greater evaporation losses. Where emergent and floating vegetation is absent from impoundments, transpiration and interception losses are eliminated, but this may be more than compensated for by greater evaporative losses.

Diversions of water, either into or out of a watershed, will produce hydrologic changes similar to those described for impoundment or drainage, respectively. Pumping of water from one place to another can lower the water table at the source site and raise the water table at the location to which the water is being pumped. The degree of impact resulting from either water diversions or pumping depends on the relative amounts and chemical characteristics of water exported or imported compared to the amounts and chemical characteristics of water normally flowing across the system boundaries.

The construction of elevated berms through wetlands, without adequate provision for maintenance of water flows, directly impacts relatively small areas of wetlands. However, indirect impacts of altered water flows can affect water levels and hydroperiods over much more extensive areas and produce dramatic long term changes in these and adjacent upland communities.

Since a number of major inflow-outflow processes are mediated by a site's plant communities, any of man's activities that significantly affect a plant community can be expected to modify that site's hydrologic regime. Grazing, logging, and agriculture represent activities which can produce major changes in plant communities, and thus can be expected to affect evaporation, transpiration, and interception processes which in turn can alter the amounts of water available for surface and groundwater related processes.

In addition to the above smaller scale but more widespread types of landscape alterations that can influence a site's hydrologic regime, a particular concern on the Myakka River watershed is the potential effect of phosphate mining. The kinds of influences that this major land use activity will have on the watershed need to be evaluated on the basis of how this type of land use has affected the hydrology of other watersheds in the past.

# METHODS

## Model Development

Use of a descriptive hydrologic model has allowed initial identification of all system components and processes relevant to the hydrology of MRSP, regardless of whether they might be considered major or minor aspects (Figure 1). Explicit decisions were then made as to which needed to be documented and at what level of detail. The level of detail selected for documentation of each component and process was a function of how finely it integrates with other aspects of the ecosystem, the detail of available data, and its significance to the rest of the ecosystem. Significance is based on the degree to which alterations in the component or process can impact or improve conditions in the park. The model not only facilitated the initial identification of data needs for this study, but also helped to identify needed research to fill data gaps that remained once all currently available information was synthesized. It is designed to provide a framework that can be continually updated as new information becomes available or new information needs develop in the light of changing environmental conditions in the landscape surrounding the MRSP.

We did not attempt to develop quantitative hydrologic models as part of this study. Quantitative models, of sufficient detail and accuracy to be relevant to management of MRSP, were far beyond the resources of this project, in terms of funding, time, and currently available data.

## Data Requirements and Analysis

The number of monitoring stations in and around the study area, the length of their record, and the party conducting the monitoring effort all influence the degree of confidence one has in the resulting hydrologic record for a watershed. Knowing how confident we are about what really happened in the past is crucial, since our ability to estimate the park's future hydrology in response to various development and management scenarios, depends on our ability to describe the past and present hydrology of MRSP.

Climatic data were obtained from the Southwest Florida Water Management District. Daily precipitation records from 22 stations were obtained (Table 1). These comprise any stations available within the watershed, regardless of length or monitoring party, and also longer regional records back as far as 1901 to provide a regional long term record (Figure 2). Monthly and yearly summaries were used for general analyses, but daily data was obtained to provide present and future ready access for in depth studies of a particular region, event, or historic time period.

These data are provided on floppy disks in both ASCII text format and as Systat datafiles (Appendix A). Selected Systat datafiles of monthly and yearly totals are also provided. Directions and programs for transferring future SWFWMD data into Systat file format are also provided (Appendix B). Printouts of monthly summaries are also provided separately.

A total of five rainfall monitoring stations were selected for detailed analyses to avoid bias that is typically associated with any individual site. Using five stations provided a much more accurate description of longer term rainfall trends for the entire watershed than does any one station, even one located in the center of the area of interest.

Daily USGS hydrologic data were obtained through the Sarasota County Ecological Monitoring Division. Streamflow data from 12 stations were obtained (Table 2). All USGS streamflow data stations within the Myakka River watershed north of latitude 27°7' were acquired, plus stations in close proximity to the Myakka River basin and several with long term records in the Peace and Manatee watersheds (Figure 3). Groundwater data from 22 wells in Manatee and Sarasota counties representing the Surficial, Intermediate, and Floridan aquifers, were obtained (Table 3, Figures 4a-4b). Strategy for station selection was the same as described above for precipitation.

These data are provided on floppy disks in ASCII text format and as Systat datafiles (Appendices C and D). Selected Systat datafiles of monthly and yearly mean, minimum, and maximum streamflow are provided separately. Directions and programs for transferring future USGS formatted data into Systat file format are also provided (Appendix E). Printouts of daily records, along with monthly and yearly summary data, are provided separately.

Information on water depths above and below ground, duration of inundation, flows, and water quality in the context of degree, kinds, and timing of disturbance (including no disturbance) have all been synthesized. Water quality studies have been conducted on many of the types of land uses that are occurring or that are likely to occur on the Myakka River watershed. These include residential and urban development; intensive agricultural activity such as citrus, winter vegetable farming, improved pastures, and dairy farming; and the effects of phosphate mining, including both mining and reclamation phases. However, transferring this type of information to sites other than where they were collected, must be done with caution, primarily because of differences in geology and soil characteristics. This data base has been supplemented with information on the operation of existing or proposed wellfields, and information on the location of structures that influence water movement and quality. Ground-truthing of selected sites was conducted to ascertain site-specific and regional responses to known changes in the system.

Data on soils was primarily available from County Soil Surveys conducted by the Soil Conservation Service. These surveys have been done at a variety of times in the past when there were different levels of knowledge about the characteristics of Florida soils and their relationship to natural communities. Invariably, only selected sites were spot checked to assure the accuracy of the maps. Thus, while they are adequate for discussing soils of the watershed outside of MRSP, they need to be ground-truthed on the park itself because of their importance to the distribution and condition of certain community types. This was especially important where there are organic soils or impermeable strata, which could affect water movement within the shallower surface soils.

It was necessary to look at the geologic character of the MRSP area on a scale somewhat larger than that of the watershed, since aquifer withdrawals from beyond the watershed boundary could affect surface water levels within the watershed. Knowledge of Florida's geology, particularly as it relates to subsurface hydrology, is expanding rapidly because of population growth and the resulting need for increasing water supplies to satisfy both agricultural and urban needs. The primary sources for this information included the United States Geological Survey and the Southwest Florida Water Management District, which have the longest and highest quality data sets. In addition, there were numerous consultant reports on specific development projects in the area.

The plant community classification of the Florida Natural Areas Inventory was used as the basis for evaluating relationships between vegetation types and hydrology. However, environmental parameters other than hydrology are important in determining the distribution and development of these communities, and these other factors will also need to be documented before all of the reasons for the occurrence of plant communities on MRSP can be ascertained. Plant communities in the watershed beyond the boundaries of MRSP were only discussed to the extent necessary to understand the hydrologic processes operating at the watershed level.

The level of detail required for various aspects of this study was an important consideration in the identification of information that we needed collect on the MRSP watershed. In some cases, such as determining the location and characteristics of canals, impoundment, or wellfields, the ability to work with fairly fine levels of resolution was crucial. This also applied to evaluating hydrology and vegetation relationships within MRSP.

At the other extreme, many soil types, geologic structures, and many of man's activities could be combined over large areas without loss of relevant information. Thus, type of agriculture or residential development was less important than whether drainage or impoundment were occurring and the amounts of water being pumped from which aquifer. Aerial photography provided the resolution needed to address each of these scales as was appropriate for each kind of activity, hydrologic process, or geographic area.

A search for all available aerial photography was made. Appendix F lists the types of aerial photography which are available for the Myakka River watershed, where the photography can be purchased, and places where the photography is currently available for use near Myakka River State Park. To maximize coverage of the watershed, photo mosaic index sheets for all ASCS photography were purchased. Also, a set of the most current color infrared photography for the watershed was purchased in stereo pairs.

We did not attempt to use Landsat imagery to look at spatial aspects of Myakka River basin hydrology because it did not provide adequate resolution for the interpretation of many aspects of the environment of interest in this study, though it could provide interesting graphical displays and digital information for computer analysis. Incorporation of a great deal of relevant information into a Geographic Information System (GIS) could facilitate the integration and analysis of information in making decisions requiring broad based information relevant to the overall management of the park. However, GIS systems are extremely expensive to acquire and maintain. The SWFWMD currently has a sophisticated GIS setup encompassing the whole watershed. They have already input such information as contours, watershed boundaries, road systems, and soil types. Cooperation and interaction with their efforts seems the best route for dealing with broader questions requiring such a system.

# RESULTS AND DISCUSSION

## Regional Setting

The configuration of a river system is strongly influenced by the topography upon which it develops. The Florida peninsula is a relatively young environment, much of it having been inundated by the ocean as recently as 100,000 years ago. Water is seasonally abundant in the area, and although the soils are easily eroded sands, the flatness of the terrain is not conducive to development of a river system that is able to rapidly remove water from the landscape. The dominant landforms in the Myakka River basin are attributed to erosional and depositional environments created during past higher stands of the ocean over the last million years.

Healy (1975) described the distribution of Pleistocene marine terraces and shorelines through which the Myakka River travels (Figure 5). These terraces represent what are considered to be shallow near-shore environments bounded at their upper end by the ocean shoreline. They developed in areas where the ocean remained at a more or less constant elevation for extended periods of time, and where inundation has not again occurred since they were formed. In order of increasing elevation, they include the Pamlico (8-25 feet), Talbot (25-42 feet), Penholoway (42-70 feet), and Wicomico (70-100 feet). Healy felt the Pamlico Terrace and Shoreline were two of the best developed land-form features of the Florida peninsula because they were the least modified by erosional processes.

White (1970) distinguished three major landforms in the vicinity of MRSP (Figure 6). The lowest were lowlands along the coast, which included most of the Myakka River watershed within Sarasota County. Above this lies the DeSoto Plain at about 60 to 75-85 ft above msl, the boundary of which approximates the Sarasota-Manatee County line. The Polk Upland generally occurs above the Myakka River watershed, although a few of the Myakka River headwater streams do penetrate its periphery.

Drew et al. (n.d.) discussed the DeSoto Slope as a plain that gradually drops from an elevation of about 100 ft to 30 ft above msl. The Wicomico Terrace forms the scarp that separates the flat DeSoto Slope from the higher and more irregular terrain of the Bone Valley Uplands. The toe of the scarp lies about 75-85 ft above msl, and the crest at about 100 ft. Lakes are less common on the DeSoto Slope than on the Bone Valley Uplands, probably due to a less mature karst topography associated with the younger surfaces south of the Wicomico Terrace. Although the DeSoto Slope is generally steep enough for development of a distinct drainage network, lands between river and creek valleys are quite flat and support a variety of wetlands.

Joyner and Sutcliffe (1976) indicated that the maximum elevation within the Myakka River watershed is 116 ft (Figure 7). They also stated that the Myakka River is the only stream channel that is well defined and naturally entrenched throughout its course. The ground surface elevation of Tatum Sawgrass is about 15-20 ft above msl. Upper Myakka Lake has a water surface elevation of 13.6 ft above msl and Lower Myakka Lake of 9.9 ft above msl, at which time they have a surface area of about 1,380 acres.

Hammett (1978) provided a useful description of the Myakka River system which we have summarized as follows. The Myakka River originates near Myakka Head in Manatee County and flows more than 50 mi in a southerly direction through Manatee and Sarasota Counties to Charlotte Harbor in Charlotte County (Figure 7). The Myakka River Basin is bounded by 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. Deer Prairie Creek and Big Slough are its principal tributaries.

## Climate

### Precipitation

Rainfall in the Myakka River watershed is a product of a wet subtropical (humid mesothermal) climate with a warm summer and no dry season (Hela 1952). Annual precipitation on the Myakka River watershed is about 50-55 in (Hammett et al. 1978). There are usually 6-8 months of low rainfall (2.0-2.5 in per month) and 4-6 months of heavy, but spatially variable rains (5-8 in or more per month) (Palmer 1978 in Drew et al. n.d.).

The following information was taken from Palmer (1978 in Drew et al. n.d.). November is the driest dry season month. The absence of both summer convection and winter frontal systems and the shift of tropical storms to the west of Florida produces November's low rainfall. Frontal system rainfall gradually increases through the winter dry season, and is at its maximum in March. In mid-spring the frontal systems move north and the local seabreeze / convection circulation comes to dominate 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 upper air trough that is centered over southern Florida in early and late summer.

Although, it has been suggested that there is a bimodal pattern of wet season rainfall in southern Florida (Drew et al. n.d., Thomas 1974), we did not find this to be the case at any of the five stations examined in this study (Figures 8-12). It is also difficult to consistently identify two distinct periods of relatively heavy rainfall in overlaid annual plots of monthly rainfall data at these weather stations.

Gannon (1978 in Drew et al.n.d.) suggested that soil moisture and surface albedo (ratio of reflected radiation to total radiation) are the two most important factors influencing the strength of the daily sea-breeze circulation, which in turn controls the development of thunderstorms. Thus, as drainage and urbanization have occurred in southern Florida, this may be affecting the amount of rain falling on the area. Palmer (1978 in Drew et al. n.d.) noted a 16 year rainfall deficit in west-central Florida since 1961, and attributed it to urbanization between Tampa and Orlando, lack of hurricane activity during the period, and a permanent climatic change. He also noted a similar shift, beginning in 1961, for Lakeland annual rainfall.

To look for long term changes in rainfall patterns, we plotted cumulative rainfall data from the five oldest weather stations we considered most likely to represent weather patterns in the Myakka River basin (Figures 13-17). None of these showed any trends or pattern of deviation for the period of record at each station. Looking at average annual rainfall for all five stations showed that rainfall was low through the period from 1960-1975, but since then annual amounts have returned to the range observed prior to 1960 (Figure 18). This indicates that the 1961-1975 period of deficit rainfall did not represent a permanent change in rainfall patterns, but merely represented part of the normal range of variation for precipitation in the area.

## Evapotranspiration

Evapotranspiration (ET) is a combination of two processes by which water is returned to the atmosphere. Evaporation is the loss of water from surfaces, whether they be ground, water, or living surfaces. Transpiration is the movement of water through plants to the atmosphere. An important difference between them is that plant root systems are able to obtain water from depths below ground not significantly influenced by evaporation. It is very difficult to measure these parameters separately, so they are often discussed as a single parameter.

Trying to measure ET is difficult at best, and indirect methods are frequently used to estimate it ,rather than to directly measure it. Types of estimates include either Potential ET or Actual ET. Potential ET represents the amount of water that would return to the atmosphere if there were no limitations on its availability for plant transpiration and surface evaporation. It is typically estimated from climatic data, and as such, is really more of an index for comparing conditions at different sites or at a single site in different years than a measure of real quantities of water moving in an ecosystem. Actual ET reflects amounts of water returned to the atmosphere as they are influenced by actual availability at a site. This type of estimate is usually arrived at by difference after other components of a water balance have been accounted for. The amount of work involved in generating either of these estimates is such that there is very little information available for most sites, particularly natural ecosystems.

Dames and Moore (1986) estimated annual runoff and evapotranspiration for the Myakka River watershed and compared it to annual rainfall recorded at MRSP (1944-1985) using a Surface Water Balance Model (SWBM). Estimated evapotranspiration ranged from 31.28 in to 50.70 in. Rainfall ranged from 39.40 to 84.12 in. Runoff plus ET approximated rainfall. Unfortunately, a plot comparing estimated and actual measured runoff at MRSP were quite different for many of the years of record (Figure 19), indicating the ET estimates were also probably not very reliable.

Dohrenwend (1977) estimated Potential and Actual ET for Florida. His estimates for the MRSP watershed area were approximately 47 and 37 in, respectively.

The seasonal pattern of ET is approximated by water loss from an evaporation pan. Water loss from an evaporation pan is lowest (2-3 in/month) during mid-winter. It steadily increases through the spring as temperatures increase, until it peaks (7-8 in/month) in late spring when temperatures are high, but humidity is low. It declines slightly at the onset of the wet season because of higher humidity, but remains high (7-8 in/month) through the warm summer months, before beginning to decline again in September as temperatures cool. Since this cycle also reflects the general pattern of vegetation growth and productivity, transpiration would be expected to follow a similar seasonal pattern.

Since ET represents approximately 70 percent of the rainfall input to the Myakka River watershed, uncertainty about how it is affected by land and water use changes in the region can make it very difficult to identify those developments that will ultimately affect the ecology of MRSP.

## Soils

The following summary of information on soils was taken from Drew et al. (n.d.). Spodosols are the dominant soil order in the Myakka River watershed. Drainage ranges from well to very poorly drained and is inversely related to water table depth and the degree of organic pan (hardpan) development. Histisols have a substantial organic component (peats or mucks) resulting from incomplete decomposition of plant material. They are frequent in wetlands within the watershed. On a map produced by Caldwell and Johnson (1982), they indicated that the Oldsmar-Immokalee-Malabar Soil Association dominated the lower elevations of the Myakka River watershed with more minor occurrences of Adamsville, Eau Gallie, and Myakka soils. At higher elevations near the top of the watershed, the dominant soils were Myakka-Immokalee-Waveland Association with Basinger, Pomello, and Pomona soils representing a minor component.

In the Florida Department of Natural Resources (1986) Unit Plan for MRSP there are numerous references to impermeable strata in wetland community soil profiles, and their importance to maintaining standing water on these sites. In our experience in Florida, these strata do not play a major role in determining water levels in wetlands. Typically, the water table in wetlands is determined by the position of the surficial aquifer in the area, which is why they are so vulnerable to drainage or impoundment on surrounding lands. Impermeable strata in the surficial aquifer tend to be erratically distributed and discontinuous. As a result, they impede drainage in the general area, and maintain a higher water table throughout the area, allowing wetlands to develop in the lower sites and depressions.

## Aquifers

There is general agreement that there are three aquifers in the Myakka River watershed: Surficial Aquifer, Intermediate Aquifer (also referred to as the Secondary Aquifer), and Floridan Aquifer. Some authors recognize Upper and Lower Intermediate Aquifers, and Upper and Lower Floridan Aquifers. The geological strata involved, from the ground surface down, include the surficial sands, undifferentiated Caloosahatchee Marl, Bone Valley Formation, Tamiami Formation, Hawthorn Formation, Tampa Formation, and the Suwannee, Ocala, Avon Park, and Lake City Limestones. The total thickness of the aquifer system and associated confining beds is on the order of 1600-1800 feet at the Carlton Reserve, which lies along the southern border of MRSP (Dames and Moore 1988). Wolansky (1983) reported that these aquifers thickened to the south (Fig. 20). Joyner and Sutcliffe (1976) indicated that the three are all present throughout the Myakka River basin, and that within this region they dipped to the southwest.

### Surficial Aquifer

Duerr and Wolansky (1986) describe the Surficial Aquifer geologic units in central Sarasota County as including undifferentiated terrace deposits underlain by the Caloosahatchee Marl and Bone Valley Formation. Locally the Tamiami Formation may be hydraulically connected to the overlying deposits.

The following information was taken from Dames and Moore (1986). On the Carlton Reserve, the Surficial Aquifer consists of undifferentiated clays and sands ranging in depth from 25 to 70 feet. It is underlain by a relatively impermeable, but discontinuous clay layer that is the upper boundary of the Intermediate Aquifer. These clay layers change laterally to carbonate rock, which results in hydraulic connection between the Surficial and Intermediate Aquifers. The direction of water movement between these aquifers depends on their relative water surface levels at any particular place and time.

Low transmissivities (generally 4,000-12,000 gpd/ft) limit the practicability of extracting significant amounts of water from this aquifer on the Carlton Reserve. The range of transmissivities for 15 test wells there was about 2,500-22,400 gpd/ft. The second highest value was 11,300 gpd/ft, so that the single higher value was considered anomalous (Dames and Moore 1986). Duerr and Wolansky (1986) reported transmissivities of 7,500-13,500 gpd/ft in three tests by Clark (1964) and Geraghty and Miller (1981) in central Sarasota County. Wolansky (1983) reported an average value of about 10,000 gpd/ft (range 4,000-75,000 gpd/ft) for this aquifer in the Sarasota-Port Charlotte area.

Depth below ground to the water table is typically less than 5 ft. In low areas during the wet season, it is normally at or near the ground surface. Where there is significant relief in the vicinity of well defined drainage channels, it can be more than 10 ft below the ground surface (Duerr and Wolansky 1986). Seasonal fluctuation in the water table is usually about 5 ft (Wolansky 1983).

Dames and Moore (1988) described the major inflows and outflows from the Surficial Aquifer on the Carlton Reserve. Rainfall is the major source of recharge, but some is also upward leakage from the Intermediate Aquifer, and lateral groundwater movement. Discharge occurs as ET, seepage to surface streams and wetlands, and downward flows to the Intermediate Aquifer. These same inflows and outflows apply throughout central Sarasota County as well, with additional discharge from well pumping and recharge from irrigation (Duerr and Wolansky 1986). They also stated that groundwater flow is generally towards the southwest.

## Intermediate (Secondary) Aquifer

Some authors have divided this aquifer into two strata; the Upper and the Lower Intermediate Aquifers (Wolansky 1983, Duerr and Wolansky 1986). The upper aquifer includes the Tamiami and upper portions of the Hawthorn Formations, and has been variously identified as "artesian zones 1 and 2" (Sutcliffe 1975, Joyner and Sutcliffe 1976) and "first artesian aquifer" (Clark 1964) among others. The lower aquifer includes lower portions of the Hawthorn Formation and more permeable portions of the upper Tampa Limestone. It has also been called "lower Hawthorn aquifer" (Sproul et al. 1972) and "artesian zone 3" (Sutcliffe 1975, Joyner and Sutcliffe 1976) among others. The total thickness of the Intermediate Aquifer is about 300-375 ft in Sarasota County (Duerr and Wolansky 1986).

Wolansky (1983) reported that transmissivities for both strata averaged approximately 20,000 gpd/ft. Both had lower values of about 4,000 gpd/ft, while the higher end of the range was about 26,000 gpd/ft in the upper aquifer and 75,000 gpd/ft in the lower aquifer.

Duerr and Wolansky (1986) reported that the Tamiami-upper Hawthorn aquifer is recharged by or discharges to the overlying Surficial aquifer depending on location and season. It is also recharged from below by the Lower Hawthorn-Upper Tampa aquifer, which generally has a potentiometric surface 5-10 ft higher than the Tamiami-upper Hawthorn aquifer. Groundwater flows are generally to the west and southwest. They noted that it is the most highly developed aquifer in the coastal area of central Sarasota County for both irrigation and domestic use.

The normal annual vertical fluctuation of the Tamiami-upper Hawthorn Aquifer is about 5 ft, although a range of 20 ft was observed in an irrigation well field for a housing subdivision (Wolansky 1983). In the vicinity of the Myakka River, Wolansky reported the principal recharge to this aquifer is from the lower Hawthorn-upper Tampa aquifer. In these areas the water table of the Surficial Aquifer is below the potentiometric surface of the Tamaiami-upper Hawthorn aquifer.

The lower Hawthorn-upper Tampa aquifer is recharged from below by the Floridan aquifer system, and groundwater flows that generally move form east to west (Duerr and Wolansky 1986). Discharge to the overlying Tamiami-upper Hawthorn aquifer occurs throughout the area, even though this aquifer is also heavily used as source of domestic and irrigation water in the Sarasota-Port Charlotte area (Wolansky 1983).

On the Carlton Reserve, Dames and Moore (1986) considered the Intermediate Aquifer to be a single aquifer that included the entire Hawthorn Formation. In general, they describe the aquifer as consisting of alternating sandy, phosphatic carbonates interbedded with phosphatic marls and clays. These beds range from very pervious to highly impervious, and function regionally as an aquifer system that is partially confined above and below from the Surficial and Floridan Aquifers, respectively. The aquifer ranges in thickness from 140-260 ft on the Carlton Reserve (Dames and Moore 1988).

The principal water bearing zones of this aquifer on the Carlton Reserve are often less than 5 feet thick, but extend to a total depth of 200-255 feet (Dames and Moore 1986). They found transmissivities to range from 2,000-28,500 gpd/ft, and average approximately 15,000 gpd/ft. Dames and Moore (1988) noted that groundwater flow is generally from northeast to the southwest.

The potentiometric surface of the Intermediate Aquifer varies from about 37 ft above msl on the eastern margin of the Carlton Reserve to about 12 ft on its western margin (Dames and Moore 1988). Dames and Moore (1986) reported that on this site, water level differentials between the Surficial and Intermediate Aquifers were 3 ft or less, and average approximately 1 ft. In general, this resulted in upward flow from the Intermediate into the Surficial Aquifer. They measured leakance into the Surficial Aquifer that was generally 0.05-0.005 gpd/ft$^3$, but varied from 0.006-4.0 gpd/ft$^3$. Thus, they felt the Intermediate Aquifer was apparently capable of providing some recharge to the Surficial Aquifer, and may be a factor in sustaining some wetlands, particularly during drought conditions.

Dames and Moore (1986) data (7/81-8/85) from the two ROMP wells (19E, 19W) on the Carlton Reserve show the pieziometric surfaces in the Surficial and Intermediate Aquifers track each other quite closely (Figures 21-22). The Intermediate's water level changes direction about the same time (on a monthly basis) as the Surficial, but more slowly. This results in the Intermediate Aquifer being about 1 ft higher (19E) or lower (19W) than the Surficial water levels for most of the year. At times the higher/lower relationship can reverse, such as when water levels are rising at 19E and when they are falling at 19W. The vertical gradient tends to be from the Surficial Aquifer towards the Intermediate Aquifer during the wet season, and is reversed during the dry season.

Floridan Aquifer

Wolansky (1983) indicated that the top of the Floridan Aquifer was at about 400 ft below msl in the MRSP area. He defined it as being the first persistent rock of early Miocene age, or older, below which clay confining beds did not occur. This surface generally coincided with the lower part of the Tampa Limestone or the top of the Suwannee Limestone. Underlying the Floridan Aquifer was a lower confining bed that generally occurred in the Lake City Limestone. He considered the Floridan to be, functionally, a single hydrogeologic unit, but with two distinct water bearing zones in the Sarasota-Port Charlotte area.

The upper zone included parts of the Tampa, Suwannee, and Ocala Limestones, and the lower more mineralized zone was in the Avon Park Limestone. These zones had been designated as artesian zones 4 and 5, respectively, by Joyner and Sutcliffe (1976). Wolansky and Garbade (1981) estimated the Floridan Aquifer to be about 1600 ft thick in the vicinity of MRSP.

Dames and Moore (1986) identified the top of the Floridan Aquifer on the Carlton Reserve as the top of the Tampa Formation at a depth below ground of approximately 255 ft. Their boundary between this and the Intermediate Aquifer was defined by a sharp increase in groundwater concentration of total dissolved solids. It was confined above by a consistent layer of dense, gray clay at the base of the Hawthorn, and from below by the evaporite beds of the Avon Park and Lake City Limestones.

Dames and Moore (1988) also reported that although the Floridan is a single aquifer, it has two distinct zones. However, they defined these zones differently from other authors. They defined the Upper zone as being comprised of the Tampa and Suwannee Limestones, and the Lower zone as including the Ocala and Avon Park Limestones.

Recharge is primarily from lateral groundwater flows on the Carlton Reserve (Dames and Moore 1988). In northwestern Sarasota County, Wolansky (1983) reported that recharge occurs from the overlying Intermediate Aquifer where the potentiometric surface of the Floridan is lower than that of the overlying aquifer. Elsewhere discharge occurred to the overlying aquifer.

On the Carlton Reserve, the Floridan is a source of recharge to the Intermediate Aquifer where confining beds are thin or absent (Dames and Moore 1986). This has created concern about possible contamination of the Intermediate Aquifer from upward movement of lower quality Floridan Aquifer water with sufficient pumping from the Intermediate Aquifer. Sulfates was their primary concern as far as water use is concerned. This type of problem has been documented at the Verna wellfield north of the MRSP (Hutchinson 1984). Dames and Moore (1988) found mixing of sulfate-rich Floridan Aquifer water in the Upper Floridan and Intermediate Aquifers under the influence of the potentiometric head differential alone. In their studies they reported that the Floridan potentiometric surface averages 10 ft higher than the Intermediate. They also noted that water quality was spatially quite variable, at least in part because of local differences in upward leakage.

Dames and Moore (1986) mention that Geraghty and Miller (1979) calculated transmissivities of 120,000 gpd/ft at the ROMP18 well approximately 4 miles east of the Carlton Reserve. Carlton Reserve pump tests showed transmissivities of 15,000-175,000 gpd/ft (Dames and Moore 1988). Wolansky (1983) calculated an average transmissivity of about 1,000,000 gpd/ft, and a range of 750,000-3,750,000 gpd/ft for the Sarasota-Port Charlotte area.

At the Carlton Reserve, the Floridan Aquifer is typically artesian with the potentiometric water surface ranging from 5-10 ft above the ground surface, which is 30 ft above msl at the western boundary and 40 ft above msl at the southeastern corner (Dames and Moore 1986). They reported the general direction of flow to be to the west and northwest, possibly because of regional groundwater withdrawals in southern Hillsborough and northern Manatee Counties, which have caused significant drawdowns in the Floridan Aquifer (Figure 23). This has amounted to declines of over 30 ft in the area where pumping is occurring. On the Carlton Reserve, declines of only 0-5 ft have been documented. They suggest that continuation of this situation could lead to modification of surface water systems.

Dames and Moore (1986) reported on data (7/81-8/85) from the two ROMP wells (19E, 19W) on the Carlton Reserve, which showed the pieziometric surface in the Floridan Aquifer as being consistently higher than those in the other two aquifers (Figure 21-22). **During this period seasonal fluctuations in the Floridan** Aquifer were generally about 3-5 ft, except during the last year when they reached 9 ft. Examination of 1987-1990 data for ROMP well 19E showed that the annual fluctuation has increased to 10-14 ft (Figure 24). Also, the maximum elevation of the wet season pieziometric surface for all three aquifers appears to be slowly declining, and the dry season Floridan pieziometric surface now drops down to or below the pieziometric surfaces of the two overlying aquifers.

The potentiometric surface of the Florida Aquifer fluctuates 20 ft or more annually in the northeastern portions of the Sarasota-Port Charlotte area in response to large seasonal demands for agriculture (Wolansky 1983). The regional direction of flow was originally to the west (Johnston et al. 1981), but recently has been more to the northwest because of a depression of the potentiometric surface in Manatee County (Wolansky 1983).

## Surface Flows

Foose (1980) estimated the watershed above the mouth of the Myakka River at Charlotte Harbor to be 602 $mi^2$. The watershed of Deer Prairie Creek and Big Slough at their mouths are 44 and 188 $mi^2$, respectively. The watershed above the water level recording station (Myakka River near Sarasota) near the entrance station at MRSP is 229 $mi^2$. Figure 25 shows the sub-basins within the Myakka River watershed as they currently (1990) exist on the GIS system at the Southwest Florida Water Management District.

There are four major depressions along the length of the river: Tatum Sawgrass, Upper and Lower Myakka Lakes, and Flatford Swamp (Figure 7). Flatford Swamp lies just upstream of Myakka City at the boundary between the relatively steeper and flatter portions of the watershed.

In their hydrologic analysis of the Myakka River as a possible water supply source, Dames and Moore (1986) summarized water discharge and rainfall records taken in the vicinity of the entrance station at MRSP for the period 1937-1985. They considered the accuracy of these flow measurements to be good, except at high flows because of cross basin water movement between Myakka River and Vanderipe Slough. Unless otherwise noted, the discussion in the following two paragraphs is taken from their report.

Flows in the Myakka River are quite variable. Highest mean flows occur from June through October, with a weak secondary peak during January through March (Figure 26). Lowest flows occur in May. The 50 years of data measured at MRSP had near zero flow for periods of up to 6 months. Even in a normal year, flows will decline to near zero for periods on the order of 2 months. Monthly average flows of less than 10 cfs have occurred every month of the year except August and September. Average monthly flows in excess of 200 cfs have occurred every month except May. Flows of over 10,000 cfs have occurred, and the typical annual flood flow is in excess of 3400 cfs.

Rainfall for the period 1944-1985 averaged 56.27 in and yearly basin runoff averaged 14.4 in, with ranges of 39.40-81.07 in and 2.73-35.44 in, respectively. They suggested a change was occurring or had recently occurred in the rainfall - runoff relationship, which could possibly be due to pumping of subsurface waters, but they couldn't be certain of a causal relationship.

In an effort to detect any changes in surface flows over time, we plotted cumulative annual mean, maximum, and minimum flows for 1937-1989 at the MRSP water level monitoring station. The mean flows exhibited a steady trend over this 44 year period, indicating no real change in the total annual amounts of water passing this station (Figure 27). Maximum cumulative flows showed a more erratic pattern, which would be expected of parameter that is based on extreme events (Figure 28). However, it also showed no distinct changes in its pattern that would indicate an altered hydrologic regime. The periods 1937-1978 and 1979-1989 each showed a consistent pattern of minimum cumulative flows, but the trend changed dramatically after 1978 (Figure 29). Clearly something happened in 1978-1979 to cause this alteration of the hydrologic regime. Examination of similar sets of cumulative plots for the Manatee River near Myakka Head (1967-1989) and Horse Creek near Arcadia (1951-1989) showed consistent year-to-year patterns for mean, maximum, and minimum annual flows. Several other stations also showed consistent trends for their relatively short periods of record: Howard Creek near Sarasota (1984-1989), Myakka River at Myakka City (1978-1989), and Deer Prairie Slough near North Port Charlotte (1982-1989).

In her analysis of low flows in streams in west-central Florida, Hammett (1985) noted that low flows of 0 cfs discharge were reported for 28 of the 45 years from 1937-1981 for the Myakka River near Sarasota station, which is located near the state park entrance station. However, Flippo and Joyner (1968) reported that in spring 1941 a low concrete dam was constructed at the outlet from Upper Myakka Lake. This replaced a control structure set at a lower elevation, which had partially washed out. An earthen dam had also been installed several years prior to 1941 at the outlet to Lower Myakka Lake, but it had washed out by 1945. It is possible that these dams may have played a role in producing zero flows at this station, both by cutting off low flows from upstream, as well as by impounding downstream flows while the lower dam was still in place. As noted above, since the late 1970s, there have been few years when low flows reached 0 cfs at this station (Figure 30). A number of known factors could have influenced this increase in annual minimum flows: 1) installation of culverts bypassing the dam on Upper Myakka Lake in 1975; 2) permanent removal of stoplog on top of the dam at the Upper Myakka Lake outlet in 1979; and 3) increased dry season irrigation in the watershed (Robert Dye, pers. comm.).

Low flows were attributed by Flippo and Joyner (1968) primarily to the low permeability of the soils in the watershed, so that when rainfall ceases, little water is able to drain from them to maintain river flows. However, they also found that some rainfall events did not increase flows merely because the water is stored in topographic depressions in the watershed and is lost through ET.

Periods of extremely low flows identified by Flippo and Joyner (1968) between 1937-1965 occurred in 1939, 1944, 1945, 1950, and 1956. Each corresponded to moderate to severe meteorological droughts, and were preceded by a year with below normal rainfall. Daily streamflow records collected from 1946-1951 at the outlets from the Upper and Lower Myakka Lakes exhibited similar low flow characteristics to those observed at the long term station near the MRSP entrance. Based on records through 1965, the Myakka River temporarily ceased flowing every 1.3 years on the average. The longest period without flow was 133 days in 1950. Their analysis also showed that flows in the Myakka River at Myakka City, near Sarasota, and below Lower Myakka Lake were less than 2 cfs 20 percent of the time, and less than 0.2 cfs 10 percent of the time between 1940-1964.

Even during low flow periods, Flippo and Joyner (1968) found no evidence of significant quantities of water from natural artesian sources entering surface waters. However, there was some evidence of irrigation water from more mineralized lower aquifers contributing to surface water flows, particularly in the Big Slough drainage.

According to recent discharge measurements, approximately 35 percent of Myakka River flows are shunted around Tatum Sawgrass through Clay Gully, which is a partially cleared natural channel (Hammett et al. 1978).

Myakka River tributaries on the Carlton Reserve have near zero discharge for an average of 8 months per year, and sometimes for periods up to 18 months (Dames and Moore 1986).

## Water Quality

Drew et al. (n.d.) discuss factors affecting water quality in the Charlotte Harbor tributaries. These include urban, agricultural and industrial development. They recognized specific surface water quality problems associated with these types of development as enrichment of streams with organic and inorganic nutrients, and inorganic contamination due to turbidity, radioactivity, and fluorides emanating from phosphate mining activities. In addition, pesticides can enter the system via stormwater runoff from urban and agricultural land uses, aquatic weed control and mosquito control spraying, and deliberate dumping. The concentrations and variety of pesticides were generally greatest in surface waters of the Peace River watershed during the summer wet season (Texas Instruments, Inc. 1978 in Drew et al. n.d.). In a 1976 survey of the Peace River, Aldrin, Dieldrin, Heptachlor, Heptachlor epoxide, Lindane, DDT and derivatives, BHC, and Mirex were commonly found in the water column and sediments.

### Peace River

In the upper Peace River during 1978-1979, phosphorus concentrations averaged 3.08 mg/l at Bartow, which although high was considerably lower than the average of 8.10 mg/l for the period 1960-1977 (Florida Department of Environmental Regulation 1980 in Drew et al. n.d.). Although phosphorus levels are naturally high, these high levels were attributed to phosphate mining activities (Joyner 1973 and Harris 1975 in Drew et al. n.d.). There was a general decline in nitrogen and phosphorus concentrations as one went down the Peace River, and they were lower in the tributaries than in the main channel.

Drew et al. (n.d.) discussed seasonal patterns in water quality based on 1977 data for Horse Creek. Color, total organic carbon, silica, sulfate, and total nitrogen all increased during the wet season's higher flows. Chloride and fluoride decreased at this time. Total phosphorus and turbidity exhibited little variation relative to season, which they felt was due to the absence of phosphate strip mining in the basin. In the headwaters of the Peace River, phosphorus concentrations tended to increase with flow due in part to overflow and leaching from phosphate settling ponds. They felt the decline in fluoride levels with increased flows was also related to the absence of phosphate mining.

Myakka River

Joyner and Sutcliffe (1976) reported that dry season Myakka River basin streamflows were derived largely from groundwater discharge, which resulted in increased levels of chloride, dissolved solids, and hardness. They also mentioned that sulfate followed a similar seasonal pattern, in contrast to an opposite pattern reported by Drew et al. (n.d.) for the 1977 Horse Creek data. Both found that color was higher during the wet season.

Organic and inorganic nitrogen concentrations were low in the Myakka watershed (Florida Department of Environmental Regulation 1982 in Drew et al. n.d.). They found average total phosphorus and total nitrogen values ranged from 0.48-0.53 mg/l and 1.09-1.77 mg/l, respectively.

Priede-Sedgwick (1982) conducted a study of nutrients within Upper Myakka Lake as well as inflows and outflows associated with the lake. Their preliminary results indicated the following ranges of concentrations of nitrogen and phosphorus from 6-10 samples collected monthly between November 1981 and April 1982 at each of 14 sites: $NO_2$+$NO_3$-N (<0.02-0.13 mg/l), $NH_3$-N (<0.02-0.20 mg/l), Kjeldahl-N (0.10-2.92 mg/l), Total-N (0.12-2.94 mg/l), Ortho-P (0.03-0.95 mg/l), Total-P (0.09-1.24 mg/l). A few much higher values included: $NO_2$+$NO_3$-N of 0.190-0,240 mg/l (6 values); $NH_3$ of 0.560, 0.870, and 0.990 mg/l; Kjeldahl-N of 5.65 and 6.51 mg/l; Total-N of 5.18 and 6.53 mg/l; and Ortho-P of 2.62 mg/l.

At two to three Carlton Reserve surface water sites on each of four dates from August to November 1985, Dames and Moore (1986) sampled a variety of water quality parameters. These included; $NO_2$+$NO_3$-N concentrations of <0.001-0.100 mg/l plus one of 0.227 mg/l; Kjeldahl-N of 1.23-3.45 mg/l; and Total-P of 0.10-0.62 mg/l.

Until recently, nutrients had entered the Myakka River marshes in outflows from the MRSP sewage treatment plant. This may be related to a recent increase in cattails in these marshes (Jean Huffman, pers. comm.).

Joyner and Sutcliffe (1976) expressed concern that most deeper wells were only cased to the first hard rock layer, which frequently was only about 200 ft below ground. This allowed the movement of poorer quality water from lower strata, but with a higher head, to migrate up into shallower aquifers. So far there isn't any evidence that these more mineralized waters are entering the surface water system, although Flippo and Joyner (1968) are the only ones who have commented on it.

## Types of Land Use

At present, the dominant land use of the Myakka River watershed above MRSP is agricultural, primarily cattle grazing on improved pastures. Drew et al. (n.d.) reported in the mid-1980s that land use in the Myakka Basin was predominantly rangeland (46 percent) and agriculture (26 percent). Major future changes will most likely be associated with the continued expansion inland of residential development, and migration of the phosphate mining industry down from the north into the area.

Joyner and Sutcliffe (1976) estimated that 40 percent of the total annual water use in the Myakka River basin occurs during the dry spring. During 1965 more water was used for irrigation (29.0 mgd) than for all other uses combined (16.2 mgd), and the largest irrigation use was for pastures (9.6 mgd) (Table AA). Public water supply was about 35 percent of the total. Duerr and Trommer (1981) estimated groundwater use in 1980 for Manatee and Sarasota Counties at about 103 mgd. They divided it into industrial (0.3 mgd), rural (6.7 mgd), public (11.1 mgd), and irrigation (85.3 mgd).

### Agriculture

Agricultural development in the Myakka River watershed necessarily required water management, both to remove excess water during wet periods and to supply water during dry periods. The construction of drainage systems accomplished the former and wells the latter.

Stringfield (1933) described development of water resources in Sarasota County at the beginning of this century. Wells developed for domestic use in the Myakka River watershed, particularly in rural areas, commonly tapped the Surficial Aquifer at depths of 10-25 ft. When larger quantities of water were required, artesian wells were normally developed at depths of 300-1000 ft. Major development of these wells in the vicinity of MRSP began in 1928-1930 at the Palmer Farms, about 3 mi west of Howard Creek and 6 mi northwest of Upper Myakka Lake.

The Sarasota County Chamber of Commerce Bicentennial Committee (1976) provided a detailed description of agricultural development in Sarasota County, which included hydrologic modifications and technological improvements necessary for it to succeed. Construction of the Sugar Bowl Drainage District canal system during 1916-1920 was the first major drainage system in the area. This area is now drained by a major canal, Cow Pen Slough Canal, which lies just to the west of the Myakka River. They also described when the installation of pasture fencing began in 1933 as part of the fever tick control program, and how pasture improvement began in the late 1940s after the development of methods for maintaining suitable forage grasses through fertilization and, where feasible, irrigation. They also mention that logging of the pine forests west of the Myakka River occurred in the 1920s, and again in the 1950s and 1960s. Pinelands east of the Myakka River were logged during the 1940s and 1950s, with the wood going to sawmills in Arcadia.

Flippo and Joyner (1968) reported that the lower portion of Cow Pen Slough had recently been deepened. This was quite obvious in the 1969 aerial photography.

Drew et al. (n.d.) describes one of the common agricultural land development practices that has accelerated conversion of much of the Myakka River watershed from unimproved pastures to improved pastures. It involves ranchers leasing sections of their unimproved pasture to vegetable growers who set up drainage and irrigation systems on the land. After a few years these fields then revert back to the rancher, and are planted to bahia and other pasture grasses. Forage production is greatly enhanced if the fields are irrigated during the drier parts of the year.

Dikes

Dikes can provide protection from floodwaters. They can also be used to isolate portions of naturally flooded areas, so that pumps can then be used to remove water from within the diked area. This has been the fate of much of the area within and near Tatum Sawgrass, just upstream of MRSP. Construction of dikes in this area began in the 1940s and has continued into the 1980s.

Hammett et al. (1978) determined that dikes in Tatum Sawgrass were about 4 ft high, and are constructed of spoil excavated from ditches along the dikes. Those dikes that isolate areas between the Myakka River and Clay Gully, and along the west side of the Myakka River below S.R. 780 are higher. They evaluated the significance of these dikes in terms of their effects on flood flows downstream of Tatum Sawgrass. Effects were greatest at the more frequent lower flood heights, because as flood heights increased, more of the dikes would be overtopped. Within MRSP this would amount to a 0.2-0.4 ft increase in the 2-year recurrence interval flood height. Flood heights associated with greater than 50-year recurrence interval floods would not be affected by the Tatum Sawgrass dikes existing in 1974.

## Wellfields

### Verna Wellfield

The Verna wellfield is the only major site within the Myakka River watershed where water is actively being pumped to supply offsite users. Hutchinson (1984) provides the following information on the development and characteristics of the field. The Verna wellfield was brought into operation in 1966 with the completion of 30 production wells. Nine more production wells had been installed by 1975. All but one are open at depths of 460-714 ft. The one exception is open from 620-1000 ft below ground. Test wells in the upper Intermediate and Surficial Aquifers were not sufficiently productive to justify development. Withdrawals started at 5 mgd in 1967 and increased to 8 mgd by 1981. Seasonal fluctuations in producing zone water levels range from about 10-30 ft, and average water levels in the producing zone have declined 20 ft since 1966. Monitoring of the Surficial, the two Intermediate zones and the Floridan Aquifers from 1977-1982 indicated that only the Surficial Aquifer was not quickly and significantly affected by pumping at the Verna wellfield. In contrast, he noted that in well fields near Tampa distinct cones of depression developed in the surficial water table in areas where leakage was more significant. He felt that the drawdown from the Verna wellfield had only a subtle affect on the potentiometric surface of the Floridan Aquifer.

However, figures in Hutchinson's (1984) paper indicated a very distinct affect of the Verna wellfield during the dry season, and a more subtle affect only during the wet season. Also, when compared to predevelopment conditions, the Verna wellfield has contributed to a 15-40 ft decline in the potentiometric surface of the Floridan Aquifer in the Myakka River basin (Figure 31). Of greater significance to MRSP, he stated that the Surficial Aquifer is a source of water for lower aquifers, and this has been increased as a result of the lowered potentiometric surfaces of these aquifers. He presented a proposal for using connector wells that would further increase the movement of water from the Surficial to the Intermediate Aquifer.

## Carlton Reserve Wellfield

In designing the new Carlton Reserve wellfield, Dames and Moore (1986) identified three Southwest Florida Water Management District (SWFWMD) constraints on well field development on the site: 1) maintenance of natural surface water flow to MRSP; 2) conservation of existing environmentally sensitive wetlands on the Reserve; and 3) maintenance of prescribed drawdowns at property boundaries (3 ft maximum in the Surficial Aquifer, 5 ft maximum in any artesian aquifer). Initial plans to develop the Intermediate Aquifer as a water supply had to be dropped because of problems in meeting these criteria. With this design, maintenance of surface water runoff to MRSP would have eliminated 60 percent of one major wellfield area. Avoiding affects on environmentally sensitive areas (wetlands) further reduced the usable area of all of the wellfield sites.

Dames and Moore's (1988) current plans call for development of a water supply from the Upper Floridan Aquifer (Tampa Formation). Their evaluation of drawdown effects of the planned operating system were based on the SWFWMD standard criteria for modeling pumpage during three consecutive stress periods: 30 days of average pumping (2/3 of maximum), followed by 30 days maximum pumping, followed by 60 days of average pumping. They based their success on not having more than a 3 ft drawdown in the Surficial Aquifer or a 5 ft drawdown in any other aquifer at the Carlton Reserve property boundary at the end of the 120 day period. The results of the 120-day test for the Surficial Aquifer showed a 2 ft drawdown at the property boundary and a 1 ft drawdown that extends over 2 miles onto MRSP (Figure 32). The results of the 30-day test were not shown. This may meet the SWFWMD criteria for acceptable wellfield drawdowns, but if these conditions occurred other than very infrequently, we would expect to see major changes in at least the wetland plant communities affected by the 1 ft drawdown.

Dames and Moore (1988) have identified an extensive grid of wells on the Carlton Reserve that could be used for monitoring effects on the three aquifers of water withdrawals from this wellfield. (Appendix G).

## Phosphate Mining

At the moment there is little influence of phosphate mining in the Myakka River basin. There is only one phosphate mine in the area and that straddles the ridge between the Myakka and Manatee River watersheds (Figure 33). However, a large portion of the watershed of the Myakka River is owned by the phosphate mining industry (Figure 34), and there undoubtedly are plans for them to move into this area in the future. The Pine Level Co-Generation Project (Consolidated Minerals, Inc.) in DeSoto is one phosphate mining operation currently working its way through the regulatory agencies. It would be located on a site 6 mi east of MRSP in the Big Slough watershed.

These projects can affect the hydrology of the region in a variety of ways. The long-term alteration of the mined landscape affects the quantity and timing of surface water movements through the impacted area, as well as its quality. Since reclamation of phosphate mines only returns limited portions of a site to something approximating its original condition, surface waters remain hydrologically altered indefinitely, with their attendant downstream affects. The large amounts of water required for processing the mined materials puts another demand on the aquifers that are already being steadily lowered by agricultural and urban needs.

Drew et al. (n.d.) provided a list of major spills from phosphate mine operations over the last 80 years. While the frequency of these events has been greatly reduced in recent years, they must still be considered inevitable as long as phosphate mines continue to operate in an area. These types of impacts are much easier to document and control than are those associated with modifications of water tables and aquifers. However, the latter types of impacts have the potential for much more significant and long term affects on the MRSP.

Bridges

For much of its length the Myakka River floodplain is relatively wide, and there are few bridges crossing it. While bridges are normally built to efficiently pass virtually all floods that are likely to occur in their watershed, the greatly reduced size of the resulting flowway through the bridge openings undoubtedly slows the flows somewhat. Given the width of the Myakka River floodplain and the great reduction in flowway width, we were concerned that these river crossing might be holding sufficient amounts of water back so that upstream and downstream communities might be being adversely impacted by them.

Examination of plant communities above and below bridges on 1984 NHAP false-color infra-red aerials, however, indicated that any affects that might be occurring are more subtle than can be identified on this scale. This suggests that if there are any hydrologic affects of highway bridges on natural communities, they are relatively minor and localized.

## Land Use Changes (1940-1989)

Land use changes were examined in selected sub-basins of the Myakka River Basin using aerial photography. We selected 14 sub-basins in three areas to describe the land use patterns in the Myakka River Basin. One area is just northwest of Myakka River State Park; this area has been more accessible to urban expansion from the coast and has been developed for a longer period of time. The area northeast of Myakka River State Park was chosen as representative of lower areas with less relief, but remote from coastal development. The northern portion of the watershed was chosen because it represents higher and more topographically variable areas within the watershed.

Watershed and sub-basin boundaries are based on those entered in the Southwest Florida Water Management District GIS system (Figure 25). Interpretations were made using black and white ASCS 1:60,000 index sheets for all but 1984-85 photography. Interpretation for 1984-85 was made using 1984 NHAP 1:60,000 10"X10" color infrared photography in stereo pairs. Photography is available for 1948, 1957, 1969, 1974, and 1985 for Sarasota County. For Manatee County, photography is available for 1940, 1952, 1958, 1970, 1980, and 1984. Percentages are visual estimates only, with no quantitative measurements taken. Due to the small scale of this photography, only major changes were visible. Features were not consistently visible on the photography for all years at the scales used. The types of land use change visible included:

- -- undeveloped (not visibly fenced, logged, or drained)
- -- unimproved pasture (fenced but not ditched)
- -- improved pasture (extensively ditched for drainage and possibly irrigation)
- -- agriculture (row crops such as tomatoes; areas were traditionally used for agriculture for several years during which the area was ditched and a well installed, then converted to pasture after several years of crops)
- -- residential (rural housing or subdivisions of 'ranchettes', usually 1-5 acres in size)

To avoid confusion, the term "ditch" will be used only in reference to row crop or citrus type drainage ditches which are networks or connected ditches within a field or grove area, or found in abandoned agricultural fields converted to improved pasture. The word "canal" will be used only in reference to single long ditches which could be either wide or narrow, shallow or deep. The alteration of natural creek channels will be referred to as "dredged" channels or creeks and these could either follow the natural streambed or be redirected into a straight channel.

Changes in drainage patterns took several forms. Agriculturally ditched areas, often converted to pasture after several years of farming, were extensively ditched with distance between parallel shallow ditches ranging from 25-100 feet. Another drainage practice involved topographic depressions: either seasonal ponds or deep marshes. Depressions were connected by canals, usually in chains which connected to a stream., Long canals were also dug within depressions which were not necessarily connected to a drainage channel, to create more dry ground within the depression. On ground with more relief, canals were also dug to follow the topographic gradients. The other major drainage practice was the dredging of major and minor tributaries. Sometimes this was done on a small scale, following the contours of the natural channel. In other cases the natural channel was straightened. The amount of dredging varied from short sections where the natural channel was least distinct to the whole length of some tributaries.

All 1989 information was obtained from the Sarasota and Manatee U. S. Soil Conservation Service offices in the form of Sarasota and Manatee County land use maps which were completed in late 1989 (Polizos, pers. comm.) (Figure 33). Again, percentages are visual estimates only, with no quantitative measurements taken. The following land use patterns were mapped in Sarasota County:

- -- Tomatoes
- -- Citrus
- -- Sewage/pasture: secondary treated effluent irrigated pasture
- -- Dairy
- -- Sod

These land use patterns were mapped in Manatee County:

- -- Pasture/tomatoes (ditched)
- -- Phosphate Mine
- -- Citrus
- -- Dairy

Three Sub-basins Northwest of Myakka River State Park:
Howard Creek, Indian Creek, Unnamed Ditch Creek east of Howard and Indian Creek

1948 Photography

Approximately 40% of the three sub-basins were being used as unimproved pasture and 5% for agriculture. The northern portion showed the least development. The agriculture was scattered over the south and central area. More than half of the lower 2/3 of the area appears to be fenced. There are trails (cow or vehicle) present throughout the three sub-basins.

There is a square area containing 25 dots in a 5 X 5 grid west of Verna and north of State Road 70 where it curves northeast. There are some small canals connecting depressions. The north end of Howard Creek is channelized. Very small amounts of dredging are visible in Indian Creek and Unnamed Ditch Creek.

## 1957 Photography

There is an increase in agriculture, especially in the west portion of the Howard Creek sub-basin. Approximately 20% of the three sub-basins is now in agriculture. Ditched pastures are also present, representing approximately 30% of the area. These improved pastures could have previously been used for agriculture. Roughly another 20% of the area is unimproved pasture. Approximately 30% of the area remains undeveloped, encompassing mostly forested land or deep wetlands.

There is a canal connecting the east branch of Unnamed Ditch Creek to the branch of the Myakka River located North of Old Myakka where State Road 780 turns west for a short distance, then north again. In the Howard Creek sub-basin, construction of a powerline road or right-of-way grade appears to be accompanied by a drainage canal. Spoil piles are visible along the power line. The elevated portion of the right of way could also be impeding flows on either side of its length. One mile east of Upper Lake Myakka the powerline runs NE/SW for 2 miles; this stretch looks like it is paralleled by a canal. Howard Creek is mostly dredged and channelized north of its intersection with the powerline for 2-3 miles upstream. Portions of Indian Creek and most of Unnamed Ditch Creek also look dredged.

## 1969 Photography

The upper portion of the three sub-basin area is now mostly pasture, and more than half of it ditched. About half of the whole three sub-basins are now ditched pasture. Around 30% is either unimproved pasture or undeveloped forested areas or isolated wetlands. Most of the undeveloped land is located between Howard Creek and Unnamed Ditch Creek in the central and lower portions of the area. Approximately one fifth is in agriculture.

To the west, sometime between 1948 and 1969, Cowpen Slough has undergone a major dredging and straightening. Our 1957 aerial photography did not cover the Cowpen Slough area. To the east, an approximately 2/3 mile canal has been dug in Vanderipe Slough; this canal runs NE to SW in the lower half of the slough.

There is a road system in place for a ranchette subdivision south of Howard Creek and west of Vanderipe Slough and small lots are visible. There is no major additional dredging evident in the Indian Creek main channels or in Unnamed Ditch Creek, though Unnamed Ditch Creek's channel is more apparent in this photography and may have been redredged.

### 1974 Photography

Only about 10% of the marshes are unditched by 1974. Virtually all marshes are pasture. Approximately 20% of the area is forested or deep depressions. It may be too late in the season for row crops to be present, but very little agriculture is visible and the ditched areas look mostly like pasture.

The subdivision east of Upper Lake Myakka has developed and expanded, with more small blocks visible north to the powerline and the edge of Howard Creek.

### 1985 Photography

About 80% of the whole area is now in pasture, most of it ditched. Undeveloped forested areas and deep marshes comprise roughly 10-20% of the area, with forested areas skirting the edges of developed areas. Most of the larger areas of undeveloped land are east of Howard Creek and in the Unnamed Ditch Creek sub-basin or in the northwest portion of Myakka River State Park. Approximately 5% of the area is now rural residential.

Where Horse Creek borders Cowpen Slough drainage north of State Road 780, there is a road network for what looks like a subdivision, though no residential development is visible yet; the area includes branches of streams from both the Cowpen Slough drainage and Howard Creek drainage. There is a large new agricultural area in western portion of the Indian Creek drainage. There are structures and a developed area in the eastern portion of the Indian Creek sub-basin, possibly the dairy operation listed below.

### 1989 Soil Conservation Service Land Use Map (Figure 33)

In the northwest corner of the area, there is a dairy operation encompassing roughly 2 sections of land. About 3 sections were planted in tomatoes in the northern portions of Indian and Howard Creek sub-basins. Approximately 7-8 sections, mostly in the Howard Creek sub-basin, were using secondary treated effluent water to irrigate pasture. They found no citrus or sod farming in these sub-basins.

Five Sub-basins in Southern Manatee County:
Mossy Island Slough, Sardis Branch, Unnamed Ditch north of Sardis Branch, east of the Myakka River, and west of Mud Lake Slough, Mud Lake Slough, and Deer Prairie Creek south to State Road 72:

1940 Photography

The area is virtually (98-99%) undeveloped in 1940. There are about a dozen fields (pasture or agriculture) present, with all but one roughly 5-40 acres in size. Except for the largest area along the east central boundary of Mud Lake Slough, which definitely looks like row crops, it is difficult to tell if fields are pasture or row crops. There is only a trace of grazed fenceline visible in a few spots, so the area is very lightly grazed and/or open range. Some trails (cattle or vehicle) are evident, but not many.

A few depressions are connected by a small canal in the eastern portion of Sardis Branch. Unnamed Ditch looks totally undeveloped. Mossy Island Slough has several less than 1/4 mile dredged sections just north and east of Myakka River State Park and several depressions are connected by canals in the southern half of Mossy Island Slough, some within the Park. The powerline grade also bisects Mossy Island Slough, Deer Prairie Creek, and Mud Lake Slough and State Road 72 crosses Deer Prairie Creek and also Mud Lake Slough just before it joins Big Slough. Either could be impeding flows. Otherwise, Deer Prairie Creek shows no visible hydrologic alteration except possibly just north of State Road 72 where portions of the natural channel may have been dredged. Though Roxy Pond is included in Mud Lake Slough sub-basin, it is connected by what appears to be a natural tributary to Bud Slough, which borders it to the south and east. Mud Lake Slough has a definite channel in the southern half of the sub-basin, but it is not straightened and does not appear to be dredged.

1952 Photography

Conditions have changed little between 1940 and 1952 in terms of fencing or agriculture, but hydrologic alteration including draining depressions and dredging of natural channels has occurred. The network of trails throughout the area is much more extensive than in 1940. It is possible to distinguish the northern boundary of the east peninsula of the Park and the eastern boundary of the northern part of the Park by 1952, but the far east and south boundaries in this area are not discernable.

Sardis Branch shows virtually no change in land use patterns. Unnamed Ditch has fields (pasture or agriculture) south of the creek near its confluence with the Myakka River. There is virtually no change in land use patterns in Mossy Island Slough in the way of obvious fencelines, new fields, or well-defined pastures. Deer Prairie Creek north of the Park has an intriguing spoke type trail network, but no additional fields or fencelines. Grazing is evidently still very light and relatively unfenced, since the only visible line is the Park boundary. Except down in the extreme southwest tip of Mud Lake Slough, there are also no apparent fencelines or additional fields.

Sardis Branch and Unnamed Ditch show no new hydrologic alterations. Mossy Island Slough is dredged for most of its length. In the Mossy Island Slough sub-basin, the area outside the Park contains several long chains of ponds connected by canals which feed into Mossy Island Slough's main channel. Deer Prairie Creek still shows dredging only between the Park boundary and State Road 72; this dredging was probably all present in 1940. At the northern end of the Mud Lake Slough sub-basin, depressions have been connected by an approximately 2 mile long canal south to the northern end of the natural channel. Roxy Pond is not part of the chain. Portions of both the east and west branches of Mud Lake Slough look dredged in the area east of the Park's eastern peninsula. At least part of the dredging could have occurred before 1940, but it is difficult to tell because the 1940 photography was taken during a wetter period.

1958 Photography

The area still appears to be predominantly open range. No line is visible along the far eastern or southern boundary of the Park which could be attributed to grazing, and even part of the northern boundary of the eastern peninsula of the Park is not discernable. Sardis Branch, Unnamed Ditch, and Deer Prairie Creek show no new land use changes. The fields south of the main channel of Unnamed Ditch on the west side of the sub-basin no longer are visible and are probably pasture. Mossy Island Slough contains roughly 5% cleared pasture (palmettos and shrubs removed), but there is no visible ditching of the pastures. There is a small amount of cleared area in the southern end of Mud Lake Slough, but it totals less than 5% of the sub-basin.

Hydrology changed little between 1952 and 1958, though many natural channels were already quite altered. Field ditching is still not a factor in the hydrologic regime. Sardis Branch still shows a connected series of depressions, as in 1940 photography, which could be either natural or manmade. In the Myakka River sub-basin between the Sardis Branch and Unnamed Ditch sub-basins, there is an extensive agricultural ditching network. Since 1952, the powerline has been rerouted south, creating the current hydrologic western boundary of Mossy Island Slough along its grade from the old powerline grade for most of the southern half of that sub-basin boundary. There are also some new canals connecting depressions in the southern tip of Mossy Island Slough.

## 1970 Photography

Land use patterns show a definite change by 1970; ditched pastures, fenced pastures, and additional agricultural fields are present throughout the area. Myakka River State Park occupies approximately 30% of the sub-basins in this area. Of the area outside the Park, roughly 30% is in improved (ditched) pasture or agriculture. It is now possible to distinguish the whole boundary of the Park without difficulty, due to grazing pressure around the perimeter.

About 3/4 of Sardis Branch shows some development, with about 1/4th heavily ditched and the remainder in fenced and cleared pasture. North/south canals connect Sardis Branch, Unnamed Ditch, and Mud Lake Slough. Approximately 1/4th of Unnamed Ditch is heavily dredged and another 1/4th contains wider spaced drainage canals. At least half is cleared pasture.

Mossy Island Slough shows mostly the addition of fenced pastures with a few small fields. Myakka River State Park appears to have planted trees in three areas within the Mossy Island Slough sub-basin in the northern section of the Park east of the Sarasota County line. Cleared pasture to the south extends into the southern tip of Mossy Island Slough below the Park.

About 1/3rd of Deer Prairie Creek north of the Park is ditched and fenced and road networks are present in other portions of the upper sub-basin. Roughly 1/2 mile of the natural channel of Deer Prairie Creek is dredged just north of the Park. The portion of Deer Prairie Creek below the Park and north of State Road 72 shows no change.

Mud Lake Slough north of State Road 780 shows no major changes. The area from State Road 780 south for 1 1/2 miles is fenced into pastures with some ditching. Below this area there is little change except along the west boundary where there is a band of ditched pasture down to the Park boundary and some cleared pasture at the southern boundary.

## 1980 Photography

Only about 1/3rd of the area is undeveloped by 1980. Roughly 40% is heavily ditched. It is not possible to distinguish active agriculture from agricultural fields converted to pasture, but no doubt part of the ditched area is being used for row crops such as tomatoes.

All of the eastern half of Sardis Branch is ditched and the rest of the sub-basin is cleared pasture. About 80% of Unnamed Ditch is ditched and most is in pasture, with some in agriculture. Only small pockets of forested land and a few deep depressions are undeveloped.

In Mossy Island Slough the northwest part of the area east of the slough has been ditched and the fields in the southwest corner appear to be ditched pasture now. South of the Park, there is a cleared field between State Road 72 and the powerline grade.

North of the Park, approximately 80% of Deer Prairie Creek is ditched, but the area south of the Park to State Road 72 is still undeveloped.

Most of the north end of Mud Lake Slough is heavily ditched. Roxy Pond is now connected by a canal to Mud Lake Slough and there looks like a dike blocking flow from Roxy Pond south to Bud Slough. The large wetland in Mud Lake Slough north of State Road 780 has new drainage canals. Less than 10% of the sub-basin south of State Road 780 has been ditched and roughly another 10% is in cleared pasture.

<u>1984 Photography</u>

It is not possible to distinguish ditched from unditched fields in this photography. Therefore interpretations from 1980 photography provide the best information for this period on proportions of ditched to unditched land. Roughly 30-40% of the area remains uncleared outside the Park. If the Park is included, the uncleared area is about 50-60% of the five sub-basins.

Sardis Branch is all developed into pasture or agriculture except for very deep depressions and trees along the west end of the stream channel. Less than 5% is undeveloped.

Unnamed Ditch is also less than 5% undeveloped. Except for a few pine islands and small deep depressions, all is developed, into at least cleared pasture.

Mossy Island Slough north of the Park contains much more forested area and appears to be wetter, with more topographic depressions than Sardis Branch or Unnamed Ditch. Roughly 15% still is covered by woody vegetation and approximately 1/4th is uncleared. Below the Park, Mossy Island Slough contains a new drainage canal with a 3/4 mile total length between the Park boundary and State Road 72. The two fields present comprise less than 10% of this area.

Deer Prairie Creek above the Park is approximately 80% cleared, There are virtually no trees and most depressions have been well drained. Two pastures in the southwest area remain uncleared.

Of the area outside of Park boundaries, Mud Lake Slough is the least developed sub-basin. Probably more than half of Mud Lake Slough remains uncleared. Like Mossy Island Slough, it contains substantial forested areas with numerous depressions, especially east and just a little north of the east end of Myakka River State Park. To the north, there are also sections of uncleared land left with a larger marsh component. The main channel of the slough south of the Park is also wooded, but the area beyond either side of the channel is cleared. Many depressions are found in this area. Despite the relative lack of clearing, virtually all major ponds are drained to some extent and many areas are heavily ditched.

**1989 Soil Conservation Service Land Use Map (Figure 33)**

At the north end of Mossy Island Slough there is about a quarter section of citrus. Sardis Branch is about 90% "pasture/tomatoes". Unnamed Ditch contains approximately 1.5 sections of citrus with the rest in "pasture/tomatoes". The northeast corner of Mud Lake Slough in the Roxy Pond area is the south end of a 1.5 section diary, with roughly a half section in the Mud Lake Slough sub-basin. There are also about 2 sections of "pasture/tomatoes" present.

The Headwaters Area:
Taylor Creek, Johnson Creek, Wingate Creek, Unnamed Creek between Wingate Creek sub-basin and the uppermost reaches of the Myakka River, The Myakka River sub-basin from its origin to its confluence with Young Creek, and Young Creek

1940 Photography

The area encompassed by this 6 sub-basin region is about 99% undeveloped in 1940. In this photography, it is not possible to see any sign of ditched fields or if fields are planted in row crops. There are virtually no fencelines visible, so grazing is open range or extremely light. There are trails present throughout the area, but they are relatively few in number. Most of the cleared areas are small enough to probably have been cleared for agriculture, at least initially.

There are 3 small canals and one fenceline visible in the Myakka River sub-basin east of Wingate Creek. The headwaters area is dotted with fewer than ten 5-40 acres fields plus a cluster of fields in the upper end of the Myakka River sub-basin. This cluster of fields comprises roughly 5% of the Myakka River sub-basin area. State Road 64 crosses the headwaters region and could impede flows, especially in the Johnson Creek, Wingate Creek, and Myakka River sub-basins.

## 1952 Photography

There is still no sign of large fenced pastures. The area covered by cleared fields has increased in size. Once again, no visible ditching of fields can be seen in this photography, but most are probably agricultural fields since they are in blocks which would be very small for pasture. Most cleared areas are concentrated along the axis of the Myakka River main channel, leaving the outer extremes of the watershed undeveloped. Approximately 5-10% of all the land has been cleared within the headwaters area by 1952.

There are additional manmade drainage canals present. Unnamed Creek sub-basin contains one almost 2 mile long canal and another roughly 3/4 mile long to the north, both running NE/SW. There are also several other new small canals present in the Unnamed Creek sub-basin. Wingate Creek sub-basin contains 2 drainage canals each about 3/4 mile long. Johnson Creek contains a 3/4 mile drainage canal lengthening the main natural creek channel. Taylor Creek also has a 3/4 mile canal extending its main stream.

## 1958 Photography

Approximately 10-15% of the area has now been cleared. Since 1952, fields have been cleared along the northern and northeastern boundary of the watershed. These areas are large enough to be pasture, so they may be cleared only and not necessarily ditched.

There is also a larger than 1/2 section agricultural field area north of State Road 64 and the confluence of Wingate and Johnson Creeks. This area is in both the Johnson and Wingate Creek sub-basins. A 3/4-mile-long major canal runs N/S along its west border. This is the only area which has visible ditching to date; it is heavily ditched. There is also a 3/4-mile-long canal running NW/SE in the upper portion of the Wingate Creek sub-basin.

The northernmost long canal in the Unnamed Creek sub-basin has been extended another half mile and a new quarter mile canal drains a wetland between the two long canals in this sub-basin. The Myakka River and Young sub-basins contain no obvious major drainage projects outside of cleared fields. Taylor Creek is the only sub-basin which still contains no cleared areas.

### 1970 Photography

About 15-20% of the land in these sub-basins has now been cleared. Portions of the Taylor Creek sub-basin now show signs of clearing, or at least fencing, for pasture. Johnson Creek has added several large agricultural areas along its east boundary which also reach over into the Wingate Creek sub-basin. More agricultural fields have been added to the central and northern stretches of the Myakka River area. In its eastern region, the Young Creek sub-basin contains an agricultural area roughly a quarter section in size.

No new canals are visible except north of the large field which first appeared in the 1958 photography along the Johnson-Wingate Creek sub-basin border; this forked canal is approximately 1 mile in total length.

### 1980 Photography

Since 1970 much additional land has been cleared and development has spread though the whole headwaters area. Roughly 40% of the area is now cleared. This appears to be for both pasture and agriculture, mainly based on the field size and consistency of surface pattern. Ditching of fields is visible, especially in the Johnson, Wingate, and Unnamed Creek areas, but the scale and quality of the photography does not allow definite assessments of all fields present. Based on The Soil Conservation Service land use map, deep, wide ditches used for citrus may be the only ditching pattern consistently discernable on these aerials. There is also a large new agricultural field complex in the Wingate and Unnamed Creek sub-basins.

About a half mile of additional drainage canals have been added in the Wingate and Unnamed Creek sub-basins. The forked canal on the Johnson-Wingate Creek boundary has been lengthened by about another half mile. There is also one quarter mile of canal in the Young Creek sub-basin.

### 1984/1985 Photography

The eastern portion of the 6 sub-basin region was photographed in 1984 and the western portion was photographed in 1985.

Overall, approximately 70% of the land has at least been cleared and fenced. Agriculture is an active part of the region in 1985. The only phosphate mine in the watershed has located in this area.

Forested areas, either along natural drainages or pine islands dense enough to make clearing difficult without removing the trees, comprise most of the undeveloped areas within the headwaters region. Virtually all the original marsh land is used for pasture or agriculture. There are some large areas in the Johnson and Wingate Creek sub-basins which have either never been cleared or haven't been maintained.

Hydrologic alterations have been less intensive, probably because the land is at a higher elevation than the other two regions studied above. Also, this region has more relief than much of the lower part of the watershed and more defined sub-basin stream channels. Long canals have been the main means of alteration outside of internal ditching of fields.

Taylor Creek sub-basin contains new agricultural fields and cleared pasture. There is also a new half-mile-long canal.

There is a phosphate mine located along the boundary between Johnson and Wingate Creek sub-basins, with the settling pond in the Wingate Creek sub-basin and the plant just above the northern border of the Wingate Creek sub-basin. The settling pond covers the north end of Wingate Creek's main channel. The agricultural areas above and below the mining area, which were visible in earlier photography, can now be distinguished as citrus groves. These groves are in both the Johnson and Wingate Creek sub-basins. Portions of the southwest Johnson Creek sub-basin have been cleared, probably for pasture. Wingate Creek sub-basin also has new cleared areas which appear to be in both pasture and agriculture.

The majority of the Unnamed Creek sub-basin is cleared pasture, but no close parallel ditching is visible, though much of the area has been drained by several larger long canals for many years.

The Myakka River sub-basin area contains pasture, citrus, and agricultural fields. The Myakka River sub-basin above Young Creek is second only to the Johnson-Wingate Creek border area in agriculture and citrus development.

Young Creek sub-basin also has pasture and agriculture. The lower central portion is part of a heavily ditched large agricultural complex which extends to the south outside the watershed.

1989 Soil Conservation Service Land Use Map (Figure 33)

Taylor Creek sub-basin contains less than one section of "pasture/tomatoes" (ditched). The Johnson Creek sub-basin is virtually all developed, with the western portion in pasture (about 2 sections), the eastern lower portion containing the phosphate mine, and the northern portion in citrus. The Wingate Creek sub-basin contains more of the phosphate mining operation and citrus grove, plus "pasture/tomatoes" along its northern boundary. The Unnamed Creek sub-basin is mostly "pasture/tomatoes". At its northern and southern extent, the Myakka River sub-basin above Young Creek contains less than one section of citrus, and about one section of "pasture/tomatoes" are present in the northwest corner. The Young Creek sub-basin contains about 1-1/4 sections of "pasture/tomatoes" and about 1-1/2 sections of the western portion of the sub-basin are part of a large citrus grove.

Summary

In the 1940s photography, both the southern Manatee county area and the headwaters area showed only minor hydrologic alterations and virtually no sign of development. Virtually no fence lines were visible until the 1970 photography.

The area northwest of Myakka River State Park developed much sooner than the headwaters area or southern Manatee county. By 1957 about 70% of this area was developed (about 20% agriculture, 30% ditched pasture, and 30% unimproved pasture). At about the same time (1958), only about 5% of the southern Manatee county area was even cleared, and the headwaters area included roughly 10-15% cleared land.

For all three regions, the time between the early 1940s and early 1950s was a period of hydrologic alteration in the form of dredging streambeds and digging canals for drainage. These activities usually preceded, but no doubt paved the way for additional land use changes. Canals and dredging were continued through the 1985 photography throughout the watershed.

Another form of hydrologic alteration was the intensive ditching of fields, which were used both for draining and irrigation. The area northwest of the Park was about half ditched agricultural fields or ditched pasture by 1958. The headwaters area and southern Manatee county did not reach this level of ditching until the early 1980's.

The headwaters area relied mainly on long canals as a means of draining the area; little dredging of streambeds was evident. On flatter ground to the south, the other two regions show more use of canals to connect and drain depressions, and streambed dredging.

## Plant Communities

Based on the habitat map in the MRSP Unit Plan (Florida Department of Natural Resources 1986), the park is dominated by upland plant communities, although most people tend to think of it more as being dominated by the Myakka River and its floodplain forests and marshes. More of the park is covered by dry prairie than any other habitat. Within the uplands are patches, some quite large, of mesic flatwoods, and smaller but more frequent depression marshes. There are extensive areas of mesic flatwoods only in the southernmost portion of the park below Lower Myakka Lake. A limited area of sandhill habitat lies north of Upper Myakka Lake. The dominant lowland habitat is the hydric hammock, with significant but smaller areas of floodplain and basin marshes. The lowland habitats are concentrated primarily along the Myakka River, with more limited areas of each along Deer Prairie Slough.

A variety of environmental and biological factors play a role in determining the distribution and characteristics of MRSP's plant communities. Hydrology is certainly one of the more important, and not only for the wetland communities. While the upland communities may not be regularly inundated, with the exception of the sandhill community, all are influenced by a water table that is near the ground surface for at least several months each year.

A number of studies have described the hydrologic regime of wetland and riparian communities similar to those found at MRSP. However, most have only looked on upland communities as upslope boundaries of wetland habitats, and there exists little information characterizing their hydrologic regimes.

Intensive studies of plant communities at Corkscrew Swamp Sanctuary in South Florida indicated that the major plant community types were distributed primarily on the basis of hydroperiod (the annual period of inundation) (Duever et al. 1986). Long hydroperiods eliminated species intolerant of extended inundation, and short hydroperiods resulted in the elimination of species intolerant of the more frequent and severe fires that occurred on these sites. Major community types included pinelands or hardwood hammocks, shallow mineral soil marshes, cypress forests, and deep marshes or ponds. Whether an upland site was dominated by dry prairie, palmetto, pine, or hardwood forests was largely a function of fire frequency. However, the occurrence of fires was also influenced by the hydrology of the landscape surrounding elevated sites, particularly those occupied by hammocks. Substrate was also a factor that affected the structure and taxonomic composition of these major community types. Again, site hydrology can influence substrate characteristics, such as the development of organic (peat, muck) and marl (calcitic clay) deposits.

In studies at the Okefenokee Swamp in south Georgia and Lake Hatchineha in central Florida, the habitat patterns, while still present, were not as clear as they had been at Corkscrew Swamp (Duever et al. 1985). Each of these sites had been more disturbed by man's activities, which had affected hydrologic and fire regimes, and which in turn had affected the distribution and characteristics of plant communities. However, once variations in terminology, site history, or community characteristics had been accounted for, the similarities in the hydroperiods among these and other sites became apparent (Table 5).

An 18-month study of the hydrology of 28 wetlands on the Carlton Reserve, which lies along the southern edge of MRSP, was conducted during 1985-1986 (CH2M Hill 1988). Average hydroperiods for undisturbed herbaceous marsh communities were 213-338 days for the one full year of the study, while for woody communities it was 308-320 days. Since these are average values for the mid-point of these communities, the actual boundaries of these habitats had both higher and lower hydroperiods than those listed here. An important aspect of this study was that both ditched and unditched sites were monitored. They both attained similar wet season maximum water levels, but water levels in the ditched sites declined more rapidly during the dry season, so that their minimum dry season water levels and their hydroperiods were significantly lower than in unditched sites.

Plant communities in MRSP, except for the sandhill and shell mound communities, are likely to have natural hydroperiods similar to those described by Duever et al. (1985) and CH2M Hill (1988). However, it is also likely that other environmental factors are interacting with the hydrological characteristics of individual sites to produce a larger variety of community types than would be present solely on the basis of hydrologic influences. Other than the more extreme positions on the moisture gradient, without site specific information from MRSP, it is very difficult to decide how the park's communities would sort out in terms of hydrologic parameters.

Also, the studies that have been done on Florida wetland communities, have been done on non-riverine sites. Thus, they may be quite representative of sites on MRSP that are at some distance from the Myakka River, but not at all representative of sites along the river. Hydrologic conditions at sites remote from major drains, whether natural or created by man, tend to fluctuate much more slowly, while riverine sites are more "flashy" and fluctuate over a greater vertical range. It is also possible that maximum or minimum water levels may be more important than hydroperiods in determining plant community distributions on riverine sites.

## Recommendations for Future Research and Monitoring

The greatest research need on MRSP is for site specific data on hydrology and other environmental characteristics of park plant communities. This would allow an assessment of how the characteristics of these communities relate to those of similar disturbed and undisturbed ecosystems in other areas. It would also provide a baseline for effective ecosystem monitoring to detect adverse influences either from management activities on MRSP or development activities on lands surrounding the park. It can provide a firm basis for objecting to activities that produce unacceptable impacts, and not objecting to activities that produce insignificant impacts.

The most effective approach to obtaining this type of information is the establishment of transects along which occur the spectrum of major habitat types on MRSP. It is unlikely that all habitats will occur on a single transect, but with enough transects, all should be represented in sufficient numbers to provide adequate replication. The transects should be selected on the basis of five criteria. First, the more habitats on a single transect, the better. This allows one to characterize the various environmental gradients as they change or do not change between habitats. Second, orient transects along environmental gradients, such as moisture, elevation, and soil type. Third, locate them in areas where there is likely to be a gradient away from an existing or potential anthropogenic disturbance, such as a wellfield, raised roadway, or nutrient source. Fourth, disperse the transects so that all portions of the park are represented. Fifth, access to all study sites along each transect should not be excessively difficult, so that data are not regularly lost because of access problems. Missing data can make analysis of the resulting data sets maddeningly difficult. Often the missing data are also some of the most important, because they occur during extreme events such as major floods or droughts.

Along each transect, representative sites of each of the major habitats should be selected. Then a shallow well should be installed in the center of each habitat to minimize edge effects. The site should be characterized in terms of the vegetation, soil profiles, and elevations near the well. Soil profiles and elevations should also be determined along the entire transect, particularly in the ecotones between habitats to determine if they are significant to the location of the boundary between the two communities. Water level recorders should be installed on at least one well on each transect. A recording rain gauge should also be installed on each transect to assist in interpreting the hydrologic data.

These transects should be operated for at least three years to allow estimation of year-to-year variability of the climatic and hydrologic parameters. Certain sites could then be selected for the long-term monitoring program. Obviously much more research could be done at these sites as opportunities permit, but the above would provide the basic understanding of major ecosystem characteristics and processes and how they vary over time.

In addition to the transect studies, establishment of monitoring stations for water flows and water quality at points where the major flowways (Myakka River, Clay Gully, Howard Creek, Deer Prairie Slough) enter and leave the park would provide valuable information on how these parameters are changing over time. In particular, nutrient inflows from Howard Creek would be important to document, given the application of secondarily treated sewage in much of that sub-basin.

Specific hydrologic questions in specific areas of the park could also be addressed by special studies. In the past we have used annual tree ring patterns to identify when environmental conditions changed dramatically on a site, either by aging new colonizers on the site or by identifying the timing of distinct changes in a tree's growth rates. Loss of organic soils around the bases of still standing trees can indicate reduced flooding on a site. Soil profiles can provide clues as to whether a hydrologic regime on a site has been modified. Simply monitoring staff gauges on the two sides of a dike or roadway can document the affect this structure is having on water levels in the area.

Working with other scientists and agencies would greatly expand the amount of information that could be generated at any particular funding level. Examples include the U.S. Geological Survey water level and water quality monitoring programs, the wellfield monitoring programs at the Verna wellfield and Carlton Reserve, the wetland monitoring program on the Carlton Reserve, and Sarasota County's Myakka River water quality monitoring program. An important aspect of these cooperative arrangements is that MRSP needs to be an active collaborator in them. This would insure that a natural area protection perspective was part of the input along with whatever other points of view might be represented. Also, the possibility always exists that a program the park is depending on could be modified by an agency's changing priorities or funding or could simply disappear. It would be one thing to lose future information at this point, but it is also possible that without the park's involvement, past information could be completely lost as offices or computer files are cleaned out, or individuals move on to other jobs. Also, different individuals or agencies are often interested in very different aspects of a data set. So, if these data are going to be of use in meeting the park's own objectives, park staff should keep up-to-date on its collection and interpretation, as well as have copies available in their own files.

# CONCLUSIONS

Some rainfall and hydrologic data and aerial photography are available for the Myakka River watershed and nearby lands for periods prior to when there was any significant development in this area.

The watershed above MRSP has gone from a virtually unaltered landscape in the early 1940s to one with at least some degree of major alteration over virtually its whole surface in the 1980s. Three portions of the watershed were selected for more intensive analysis. These were areas in: southern Manatee County, the top of the watershed, and northwest of MRSP.

In the 1940s photography, both the southern Manatee County area and the headwaters area showed only minor hydrologic alteration and virtually no sign of development. Few fencelines were visible until the 1970 photography.

The area northwest of Myakka River State Park developed much sooner than the headwaters area or southern Manatee County. By 1957 about 70 percent of this area was developed (about 10 percent agriculture, 30 percent ditched pasture, and 30 percent unimproved pasture). At about the same time (1958), only about 5 percent of the southern Manatee County area was even cleared, and the headwaters area included roughly 10-15 percent cleared land.

For all three regions, the time between the early 1940s and early 1950s was a period of hydrologic alteration in the form of dredging streambeds and digging canals for drainage. These activities usually preceded, and no doubt paved the way for additional land use changes. Continuing expansion of canal systems and dredged channels was still apparent in 1985 photography throughout the watershed.

Another form of hydrologic alteration was the intensive ditching of fields, which was used both for drainage and irrigation. The area northwest of the Park was about half ditched agricultural fields or ditched pasture by 1958. The headwaters area and southern Manatee County did not reach this level of ditching until the early 1980s.

The headwaters area relied mainly on long canals as a means of draining the area; little dredging of streambeds was evident. On flatter ground to the south, the other two regions show more use of canals to connect and drain depressions and streambed dredging.

Analysis of rainfall at five long term weather stations within or near the Myakka River watershed indicated that there have been no major changes in annual rainfall for the period of record in the area.

No good actual ET data exist for the Myakka River watershed, despite the fact that 70 percent of the water leaving this ecosystem is lost to the atmosphere by this route.

Water levels in much of the watershed are high not because wetlands are located on perched water tables, but rather because poor drainage throughout the very flat and seasonally wet landscape results in a high regional water table. Upward seepage from lower artesian aquifers may also contribute to this higher water table, or at least may have in the past.

Water flows at one site on the Myakka River and two sites on rivers in adjacent watersheds have shown no major changes in mean, maximum, or minimum flows for the periods of record at each site.

With the increasing use of groundwater in the region for irrigation, phosphate mining, and urban use, significant lowering of the piezometric surface of aquifers underlying the park and its upstream watershed is occurring. There is ample evidence that these aquifers are all interconnected with each other and with the surface water table, although the degree of connection is spatially quite variable. Because the affect could be felt on the water table throughout the park, as well as on surface water flows, long-term changes in the potentiometric surfaces of these aquifers may ultimately have more affect on the Myakka River State Park ecosystem than other types of changes in the watershed that affect only flows in the Myakka River itself.

While there are some data on plant community distributions in relation to hydrology that are most likely applicable to MRSP communities, we are uncertain as to how well this very limited data set applies to any, if not all, of the actual park communities.

We recommend a research and monitoring program involving the establishment of transects through representative habitats and areas of the MRSP to develop an understanding of the park's current hydrologic condition. It would also provide a basis for evaluating whether future changes were a result of natural ecosystem variability, or a result of man's activities either within the park or on surrounding lands.

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Table 1. Daily precipitation station information. Data were provided by the Southwest Florida Water Management District.

| PRECIPITATION DATA | | | | | | |
|---|---|---|---|---|---|---|
| STATION NAME | BASIN | LATITUDE/LONGITUDE | PERIOD OF RECORD | FIRST DAY YR MO DY | LAST DAY YR MO DY | FIGURE NO. |
| Arcadia | Peace River | 0271343081512820027 | 1907-90 | 07 07 01 | 90 04 30 | 1 |
| Avon Park | Peace River | 0273539081313420055 | 1902-90 | 02 01 01 | 90 04 30 | 2 |
| Bartow | Peace River | 0275358081503520105 | 1901-90 | 01 01 01 | 90 08 31 | 3 |
| Bradenton | Manasota | 0272702082290221081 | 1911-90 | 11 01 01 | 90 07 31 | 4 |
| Carlton Ranch | Manasota | 0271050082061321115 | 1976-90 | 76 09 01 | 90 05 31 | 5 |
| Fort Green NWS | Manasota | 0273417082080721081 | 1955-90 | 55 09 01 | 90 04 30 | 6 |
| Ft. Myers | Outlying | 0263455081514599071 | 1901-90 | 01 01 01 | 90 08 31 | 7 |
| Four Corners Mine | Alafia River | 0273841082051611057 | 1978-90 | 78 09 01 | 90 07 31 | 8 |
| Hardee | Peace River | 0273652081581420049 | 1979-90 | 79 03 01 | 90 08 31 | 9 |
| Kibler Tower | Manasota | 0272826082141421081 | 1975-90 | 75 10 01 | 90 08 31 | 10 |
| Myakka River State Park NWS | Manasota | 0271431082102821115 | 1943-90 | 43 09 01 | 90 01 31 | 11 |
| Ona Research Center | Peace River | 0272353081562820049 | 1976-90 | 76 01 01 | 90 08 31 | 12 |
| Parrish NWS | Manasota | 0273430082260321081 | 1958-90 | 58 01 01 | 90 04 30 | 13 |
| Punta Gorda | Peace River | 0265009081582220015 | 1914-90 | 14 05 01 | 90 08 31 | 14 |
| RG-2 | Peace River | 0273742081565220049 | 1980-90 | 80 01 01 | 90 07 31 | 15 |
| RG-3 C & F Ind. | Peace River | 0273345082002320049 | 1976-90 | 76 01 01 | 90 08 31 | 16 |
| Sandy (central) | Manasota | 0271437082033521081 | 1980-90 | 80 01 01 | 90 07 31 | 17 |
| St Petessburg | Pinellas Anclote | 0274545082375316103 | 1914-90 | 14 08 01 | 90 08 31 | 18 |
| Tampa Int'l A.P. | Northwest Hillsborough | 0275737082313714057 | 1901-90 | 01 01 01 | 90 08 31 | 19 |
| Venice NWS | Manasota | 0270600082261721115 | 1955-90 | 55 04 01 | 90 08 31 | 20 |
| Verna Wellfield | Manasota | 0272255082175721115 | 1077-90 | 77 01 01 | 90 06 30 | 21 |
| Wauchula | Peace River | 0273407081490320049 | 1933-90 | 33 01 01 | 90 04 30 | 22 |

Table 2. Daily United States Geological Survey streamflow station information. Data were obtained through the Sarasota County Ecological Monitoring Division.

| USGS STREAMFLOW DATA | | | | | | |
|---|---|---|---|---|---|---|
| STATION NUMBER | STATION NAME | UNITS | MEASURED | FIRST DAY YR MO DY | LAST DAY YR MO DY | PERIOD OF RECORD |
| 02299470 | BIG SLOUGH NEAR MURDOCK | cfs | Discharge | 63 03 01 | 72 09 30 | 1980-90 |
| 02299410 | BIG SLOUGH NEAR MYAKKA CITY | cfs | Discharge | 80 10 01 | 90 03 07 | 1962-72 |
| 02299700 | COW PEN SLOUGH NEAR BEE RIDGE | cfs | Discharge | 63 02 01 | 66 06 30 | 1962-66 |
| 02299160 | DEER PRAIRIE SLOUGH NEAR NORTH PORT | cfs | Discharge | 81 04 01 | 90 06 10 | 1980-90 |
| 02297310 | HORSE CREEK NEAR ARCADIA | cfs | Discharge | 50 05 01 | 90 08 28 | 1949-90 |
| 02298760 | HOWARD CREEK NEAR SARASOTA | cfs | Discharge | 83 10 19 | 90 07 30 | 1983-90 |
| 02299950 | MANATEE RIVER NEAR MYAKKA HEAD | cfs | Discharge | 66 04 20 | 90 08 09 | 1965-90 |
| 02298880 | MYAKKA RIVER AT CONTROL NEAR LAUREL | feet | Gage Ht | 88 10 06 | 90 07 26 | 1989-90 |
| 02298900 | MYAKKA RIVER NEAR LAUREL | feet | Gage Ht | 85 02 26 | 90 08 27 | 1984-90 |
| 02298608 | MYAKKA RIVER NEAR MYAKKA CITY | cfs | Discharge | 63 02 05* | 90 07 29* | 1962-66<br>1977-90 |
| 02298830 | MYAKKA RIVER NEAR SARASOTA | cfs | Discharge | 36 09 01 | 90 06 12 | 1936-90 |
| 02296750 | PEACE RIVER NEAR ARCADIA | cfs | Discharge | 31 04 01 | 90 08 12 | 1930-90 |

* There are no data for WaterYear 1966-1977.

Table 3. Daily United States Geological Survey groundwater station information. Data were obtained through the Sarasota County Ecological Monitoring Division.

| USGS GROUNDWATER WELL DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| WELL NUMBER | USGS WELL NAME | AQUIFER OR FORMATION | DEPTH (ft) | DATUM (ft) | BASIN | PERIOD OF RECORD* | COUNTY & FIGURE NUMBER | |
| 271832082064801 | Edgeville Deep Well 3 at Edgeville | limestone aquifer | 600 | 70 | Myakka | 1978 | Manatee | 1 |
| 272058082143701 | Verna T Well 0-2 near Verna | Tampa limestone | 530 | 68.92 | Myakka | 1978 | Manatee | 2 |
| 272356082181302 | Verna Deep Well 1A near Verna | Suwannee limestone | 480 | 81.94 | Manatee | 1975-78 | Manatee | 3 |
| 272404082161701 | Verna T Well 0-1 near Verna | Floridan aquifer system | 480 | 98.92 | Manatee | 1978 | Manatee | 4 |
| 272838082142201 | Kibler Deep Well 26B near Bethany | Floridan aquifer system | 1123 | 101 | Myakka | 1978 | Manatee | 8 |
| 270952082095901 | Mabry Carlton Well 13 near Arcadia | Tampa limestone | 287 | 30 | Myakka | 1987-90 | Sarasota | 11 |
| 270959082203001 | ROMP 19 WLAM Well near Sarasota | Suwannee limestone | 425 | 20 | Myakka | 1987-90 | Sarasota | 12 |
| 270959082203002 | ROMP 19 WUAM Well near Sarasota | Hawthorn formation | 205 | 20 | Myakka | 1987-90 | Sarasota | 12 |
| 271021082151601 | ROMP 19 ELAM Well near Sarasota | Suwannee limestone | 419 | 31 | Myakka | 1987-90 | Sarasota | 13 |
| 271021082151602 | ROMP 19 EUAM Well near Sarasota | Hawthorn formation | 121 | 31 | Myakka | 1987-90 | Sarasota | 13 |
| 271021082151603 | ROMP 19 ES Well near Sarasota | Nonartesian sand aquifer | 34.5 | 31 | Myakka | 1987-90 | Sarasota | 13 |
| 271134082092201 | Big Slough Deep Well near Arcadia | Hawthorn formation | 100 | 33.26 | Myakka | 1987-90 | Sarasota | 15 |
| 271134082092202 | Big Slough Shallow Well near Arcadia | Nonartesian sand aquifer | 25 | 33.26 | Myakka | 1977-78<br>1987-90 | Sarasota | 15 |
| 271227082084801 | Mabry Carlton Well No. 6 near Myakka City | Tampa limestone | 369 | 40 | Myakka | 1987-90 | Sarasota | 16 |

* Period of Record lists only data which was consistently recorded for several months. There may be additional data for shorter time periods in this file. There may also be periods of missing data within this time period.

Table 3 continued. Daily United States Geological Survey groundwater station information. Data were obtained through the Sarasota County Ecological Monitoring Division.

| USGS GROUNDWATER WELL DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| WELL NUMBER | USGS WELL NAME | AQUIFER OR FORMATION | DEPTH (ft) | DATUM (ft) | BASIN | PERIOD OF RECORD* | COUNTY & FIGURE NUMBER | |
| 272220082151401 | KME Test Well 09 near Verna | Tampa limestone | 575 | 72.92 | Myakka | 1976-78<br>1987-90 | Sarasota | 25 |
| 272248082175201 | KME Well 14A near Verna | Hawthorn formation | 107 | 80.14 | Manatee | 1977-78<br>1987 | Sarasota | 26 |
| 272255082172202 | KME Recharge Well near Verna | Avon Park formation | 1200 | 78.77 | Manatee | 1976-78 | Sarasota | 27 |
| 272256082175901 | Verna T Well 0-3 near Verna | Tampa limestone | 500 | 81.13 | Myakka | 1978 | Sarasota | 19 |
| 272258082181701 | KME Water Table Well 09 near Verna | Hawthorn formation | 42 | 79.00 | Manatee | 1977-78<br>1987 | Sarasota | 28 |
| 272258082195301 | KME Well 04 near Verna | Tampa limestone | 440 | 62.25 | Manatee | 1976-78<br>1987 | Sarasota | 29 |
| 272301082191401 | KME 02 Well near Verna | Floridan aquifer system | 860 | 71.95 | Manatee | 1977-78<br>1987 | Sarasota | 30 |
| 272307082173801 | KME Well 16A near Verna | Hawthorn formation | 131 | 79.07 | Manatee | 1977-78 | Sarasota | 23 |

* Period of Record lists only data which was consistently recorded for several months. There may be additional data for shorter time periods in this file. There may also be periods of missing data within this time period.

Table 4. Estimated groundwater pumpage in the Myakka River basin area in 1965. (Joyner and Sutcliffe, 1976)

| | | | Duration of Pumping (days) | Pumping rate (million gallons per day) | Amount pumped (billion gallons per year) |
|---|---|---|---|---|---|
| Public-water supply | | | 365 | 6.8 | 2.5 |
| Industrial-Commercial[a] | | | 365 | 0.4 | .1 |
| Rural Domestic | | | 365 | 9.0 | 3.3 |
| Irrigation | Citrus | | 50 | 19 | 1.0 |
| Irrigation | Truck Farming | Vine crops | | | |
| Irrigation | Truck Farming | Spring | 90 | 20 | 1.8 |
| Irrigation | Truck Farming | Fall | 90 | 2.9 | .3 |
| Irrigation | Truck Farming | Row crops | | | |
| Irrigation | Truck Farming | (Spring and fall) | 120 | 4.3 | .5 |
| Irrigation | Improved Pasture | | 40 | 95 | 3.8 |
| Irrigation | Golf courses (8 in area) | | 300 | 5 | 1.5 |
| Irrigation | Lawns | | 120 | 14 | 1.7 |
| Total | | | --- | --- | 16.5 |
| Weighted average daily pumpage | | | --- | 45 | --- |

a/ Principally used for cooling air-conditioner condensers.

Table 5. Average hydroperiod for driest and/or wettest examples of major community types and number of years for which data are available from six southeastern United States wetlands.*
(Duever et. al., 1985)

| PLANT COMMUNITY | YEARS OF RECORD | DRIEST | WETTEST |
|---|---|---|---|
| Deep Marsh | | | |
| Corkscrew Swamp | 14 | 310 | 346 |
| Lake Okeechobee | 20 | - | 361 |
| Lake Hatchineha | 22 | 325 | 347 |
| Okefenokee Swamp | 3 | 308 | 365 |
| Cypress Forest | | | |
| Big Cypress Swamp | 7-26 | 105 | 299 |
| Corkscrew Swamp | 14 | 133 | 296 |
| Lake Hatchineha | 22 | 172 | 248 |
| North Florida domes | 1 | 211 | 319 |
| Okefenokee Swamp | 3 | 147 | 232 |
| Shallow Marsh | | | |
| Big Cypress Swamp | 7-26 | 73 | 260 |
| Corkscrew Swamp | 14 | 111 (45) | 278 |
| Lake Hatchineha | 22 | 44 | 88 (248) |
| Okefenokee Swamp | 3 | 193 | 318 |
| Pine | | | |
| Big Cypress Swamp | 14 | 0 | 74 |
| Corkscrew Swamp | 14 | 0 | 59 |
| Lake Hatchineha | 22 | 0 | 40 |
| Okefenokee Swamp | 3 | 0 | 50 |

* Data sources are: Big Cypress Swamp - Gunderson and Loope 1982a, b, c, Gunderson et al. 1982; Corkscrew Swamp - Duever et al. 1978; Lake Okeechobee - Pesnell and Brown 1977; Lake Hatchineha - this study; north Florida cypress domes - Marois and Ewel 1983; Okefenokee Swamp - Duever unpublished data.

# APPENDIX A.

## INFORMATION ON COMPUTER FILES: PRECIPITATION DATA

Data were provided by the Soutwest Florida Water Management District. Files containing daily precipitation data for these stations are provided on IBM DOS format floppy diskettes. The ASCII text files contain information on estimated and cumulative data.

INFORMATION ON COMPUTER FILES
PRECIPITATION DATA

| STATION NAME | PERIOD OF RECORD | FIRST DAY YR MO DY | LAST DAY YR MO DY | SWFWMD STATION # | ASCII TEXT FILENAME | SYSTAT NAME | NO OF DAYS (CASES) | BYTES |
|---|---|---|---|---|---|---|---|---|
| Arcadia | 1907-90 | 07 07 01 | 90 04 30 | ATM0003 | ARCADIA.PRN | PARCADIA | 30,255 | 665,818 |
| Avon Park | 1902-90 | 02 01 01 | 90 04 30 | ATM0005 | AVONPARK.PRN | PAVONPK | 31,745 | 698,598 |
| Bartow | 1901-90 | 01 01 01 | 90 08 31 | ATM0009 | BARTOW.PRN | PBARTOW | 32,688 | 719,344 |
| Bradenton | 1911-90 | 11 01 01 | 90 07 31 | ATM0018 | BRADENTO.PRN | PBRADENT | 28,992 | 638,032 |
| Carlton Ranch | 1976-90 | 76 09 01 | 90 05 31 | ATM0700 | CARLTON.PRN | PCARLTON | 4,965 | 149,084 |
| Fort Green NWS | 1955-90 | 55 09 01 | 90 04 30 | ATM0239 | FTGREEN.PRN | PFTGRNWS | 9,361 | 206,414 |
| Ft. Myers | 1901-90 | 01 01 01 | 90 08 31 | ATM0182 | FTMYERS.PRN | PFTMYERS | 32,750 | 720,708 |
| Four Corners Mine | 1978-90 | 78 09 01 | 90 07 31 | ATM0226 | FOURCORN.PRN | P4CORNER | 4,352 | 95,952 |
| Hardee | 1979-90 | 79 03 01 | 90 08 31 | ATM0224 | HARDEE.PRN | PHARDEE | 4,202 | 92,652 |
| Kibler Tower | 1975-90 | 75 10 01 | 90 08 31 | ATM0333 | KIBLER.PRN | PKILBER | 5,387 | 118,722 |
| Myakka River State Park NWS | 1943-90 | 43 09 01 | 90 01 31 | ATM0101 | MYAKKRIV.PRN | PMYRIVSA | 16,682 | 367,212 |
| Ona Research Center | 1976-90 | 76 01 01 | 90 08 31 | ATM0105 | ONA.PRN | PONA | 5,363 | 118,194 |
| Parrish NWS | 1958-90 | 58 01 01 | 90 04 30 | ATM0240 | PARRISH.PRN | PPARRISH | 8,307 | 182,962 |
| Punta Gorda | 1914-90 | 14 05 01 | 90 08 31 | ATM0117 | PUNTAGOR.PRN | PPUNTAGO | 27,882 | 613,612 |
| RG-2 | 1980-90 | 80 01 01 | 90 07 31 | ATM0279 | R-2.PRN | PRG2 | 3,837 | 84,622 |
| RG-3 C & F Ind. | 1976-90 | 76 01 01 | 90 08 31 | ATM0118 | R-3.PRN | PRG3 | 5,357 | 118,062 |
| Sandy (central) | 1980-90 | 80 01 01 | 90 07 31 | ATM0183 | SANDY.PRN | PSANDY | 3,883 | 85,560 |
| St Petersburg | 1914-90 | 14 08 01 | 90 08 31 | ATM0142 | STPETE.PRN | PSTPETE | 27,759 | 610,906 |
| Tampa Int'l A.P. | 1901-90 | 01 01 01 | 90 08 31 | ATM0148 | TAMPA.PRN | PTAMPA | 32,750 | 720,708 |
| Venice NWS | 1955-90 | 55 04 01 | 90 08 31 | ATM0705 | VENICE.PRN | PVENICE | 12,903 | 284,074 |
| Verna Wellfield | 1077-90 | 77 01 01 | 90 06 30 | ATM0203 | VERNA.PRN | PVERNA | 4,929 | 108,646 |
| Wauchula | 1933-90 | 33 01 01 | 90 04 30 | ATM0155 | WAUCHULA.PRN | PWAUCHUL | 20,939 | 460,866 |

# APPENDIX B.

## INFORMATION ON

## TRANSFERRING SWFWMD PRECIPITATION DATA INTO SYSTAT DATA FILES

The programs described in this documentation are provided on IBM DOS format floppy diskettes.

# TRANSFERRING SWFWMD PRECIPITATION DATA INTO SYSTAT DATA FILES

## Preparing Files using Wordperfect:

1. Create a subdirectory on your hard drive to use for transferring files. Include copies of the following files in the subdirectory:

   the SWFWMD ASCII datafile(s)
   BLANK.WP
   TrRain.cmd
   TrRain1.cmd
   TrRain2.cmd

2. Call up BLANK.WP. This is an empty file set up with wide margins and small typeface so the long lines in the file will remain on a single line and not wrap around. You will probably have to make your own version of BLANK.WP since these settings are printer dependent.

3. From the Wordperfect List Files listing, highlight the SWFWMD ASCII datafile and, using Ctrl-F5, Text In/Out, put the SWFWMD ASCII datafile into the BLANK.WP file.

4. Check the first line to make sure you have the right file, then delete the initial ID line so that the file begins with the first line of rainfall data.

5. Check the number of variables in the dataset. The data we received came in three formats, and there are 3 corresponding Systat .CMD programs for transferring those 3 formats. Variables were deleted as necessary by SWFWMD staff when they downloaded the files from their mainframe in order to make the files more compact and able to fit on floppies. So you may receive the data in slightly different formats too.

This is the data file description information supplied by Lois Bono, the "Rainlady" at SWFWMD, with additional comments from us in [brackets]:

## Heading Line [initial ID line]

| COLUMNS | DESCRIPTION |
|---|---|
| 1 | Record Identifier (1) |
| 3-9 | Station Number |
| 10-39 | Station Name |
| 40-53 | Latitude/Longitude |
| 54-55 | Basin Number |
| 56-58 | County Code |
| 59-80 | Basin Name |

## TRANSFERRING SWFWMD PRECIPITATION DATA INTO SYSTAT DATA FILES

Data Lines

| COLUMNS | DESCRIPTION |
|---|---|
| 1 | Recorder Identifier (2) |
| 3-9 | Station Number [SWFWMD's number, the only alphanumeric variable] |
| 11-16 | Parameter Code [00045 is rainfall in inches] |
| 18-23 | Data Value Collected value-stated to .000 [therefore you must divide this number by 1000 to get precipitation in inches] |
| [beyond 25 | Estimated or Cumulative reading indicators:<br>4020402099 = estimated amount<br>4020402077 with previous variable (precipitation) = 0 marks the beginning date of a cumulative measurement. This is only available for relatively recent years of data.<br>4020402077 with previous variable (precipitation) > 0 indicates a cumulative measurement, ie includes more than one day's rainfall.] |

Check the data to determine how many variables are present and which in the sequence is the alphanumeric variable. The field that contains the codes for estimated and cumulative data will probably not be apparent, but it is the last variable in the dataset, so add it to your total even if it's not apparent.

-If there are 6 variables, rainfall is the 5th, and the 2nd is the alphanumeric one, you will use TrRain.CMD to transfer this file.

-If there are 5 variables, rainfall is the 4th, and the 2nd is the alphanumeric one, you will use TrRain1.CMD to transfer this file.

-If there are 7 variables, rainfall is the 6th, and the 3rd is the alphanumeric one, you will use TrRain2.CMD to transfer this file.

-If you have yet another combination, you will have to alter one of the TrRain.CMD files to fit your dataset.

5. Go to the end of the file and delete any non-data lines so that the final line in the file contains the last line of rainfall data with a hard carriage return at the end of the line.

6. Save this only-data file using the Text In/Out method so the file is saved as an ASCII textfile: Press Ctrl-F5, 1 (DosText), 1 (Save), and type in a filename with a .DAT extension (the file must have a .DAT extension).

7. Exit Wordperfect and enter the Systat Data module.

# TRANSFERRING SWFWMD PRECIPITATION DATA INTO SYSTAT DATA FILES

## Running Systat Conversions

Edit the TrRain.CMD file that matches your data (see above). Make the changes in filenames and variable names indicated in the program rem statements, and run the program. It will create a Systat datafile with a .sys extension for use in Systat or Sygraph analyses.

Below is the complete TrRain.cmd program and the INPUT and DROP lines only from TrRain1.cmd and TrRain2.cmd. The rest of these 2 programs are the same as TrRain.cmd.

---

```
rem  TrRain.CMD
rem  PURPOSE:  Transfer SWFWMD rainfall data, with beginning
rem            and end non-data lines deleted in Wordperfect,
rem            to a SYSTAT .SYS file.  Rainfall is in inches.
rem  USE WITH:  original data that has 6 variables.  If number
rem        of variables is not 6 or the 2nd variable is
rem        not the alphanumeric variable, use TRRAIN1.CMD
rem        or  TRRAIN2.CMD or adjust the INPUT and DROP lines
rem        to the right number and type variables you need.
rem        The systat file will have the .SYS extension and
rem        contain 3 variables:
rem       DATE with Year as 1st 2 digits
rem              Month as 2nd 2 digits
rem              Day as last 2 digits
rem       Pvariable which is amount of rainfall in inches
rem       Pvariable$ where "cumTotal" = cumulative rainfall,
rem                "cum", when present (which is only for more
rem         recent data), marks the first date included in
rem         the cumulative total, and
rem         "Est." means the data for that date is
rem         estimated.
rem  CHANGE: get filename.DAT [R3], final save Pfilename [pPR3],
rem        Pvarname [pPR3], and Pvarname$ (3 times) [pRG3$].
rem            That's 6 places.
rem  RUN IN: data
rem  --------------------

new
GET R3
SAVE templ
LRECL=375
INPUT no2 sta$ raincode date pdata estcum \
RUN
use templ
save pRG3 / single "This is single precision"
let  pRG3 = pdata/1000
if estcum = 4020402077 and pdata= 0 then let         pRG3$='cum'
  else if estcum = 4020402077 and pdata > 0 then let*pRG3$='cumTotal'
  else if estcum = 4020402099 then let               pRG3$= 'EST.'
DROP no2 sta$ raincode pdata estcum
```

TRANSFERRING SWFWMD PRECIPITATION DATA INTO SYSTAT DATA FILES

```
run

rem ------------------------
rem The End.
```

---

```
rem  TrRain1.CMD
rem  -----------
INPUT no2 sta$  date pdata estcum \
DROP no2 sta$ pdata estcum
```

---

```
rem  TrRain2.CMD
INPUT caseno no2 sta$ raincode date pdata estcum \
DROP caseno no2 sta$ raincode pdata estcum
```

---

When done, you can delete all the file(s) with a .DAT extension and the <u>copies</u> of the SWFWMD ASCII datafiles and the .CMD files. The .SYS extension files is all you need to save.

# APPENDIX C.

## INFORMATION ON COMPUTER FILES: STREAMFLOW DATA

Data were provided by the Sarasota County Ecological Monitoring Division. Files containing daily streamflow data for these stations are provided on IBM DOS format floppy diskettes. The ASCII text files contain information on estimated data. The ASCII text files also list monthly and yearly statistics for each Water Year represented.

INFORMATION ON COMPUTER FILES
USGS STREAMFLOW DATA

| STATION NUMBER | STATION NAME | PERIOD OF RECORD | FIRST DAY YR MO DY | LAST DAY YR MO DY | NO OF DAYS (CASES) | ASCII TEXT FILENAME | SYSTAT NAME | BYTES |
|---|---|---|---|---|---|---|---|---|
| 02299470 | BIG SLOUGH NEAR MURDOCK | 1980-90 | 63 03 01 | 72 09 30 | 3,502 | BIGNMUR.470 | FBIGMURD | 35,214 |
| 02299410 | BIG SLOUGH NEAR MYAKKA CITY | 1962-72 | 80 10 01 | 90 03 07 | 3,445 | BIGNMYC.410 | FBIGMYC | 34,644 |
| 02299700 | COW PEN SLOUGH NEAR BEE RIDGE | 1962-66 | 63 02 01 | 66 06 30 | 1,246 | COWNBEE.700 | FCOWPEN | 12,654 |
| 02299160 | DEER PRAIRIE SLOUGH NEAR NORTH PORT | 1980-90 | 81 04 01 | 90 06 10 | 3,358 | DEERNPC.160 | FDEERPRS | 33,774 |
| 02297310 | HORSE CREEK NEAR ARCADIA | 1949-90 | 50 05 01 | 90 08 28 | 14,730 | HORSENAR.310 | FHORSEAR | 147,494 |
| 02298760 | HOWARD CREEK NEAR SARASOTA | 1983-90 | 83 10 19 | 90 07 30 | 2,477 | HOCRK.760 | FHOWARDS | 24,964 |
| 02299950 | MANATEE RIVER NEAR MYAKKA HEAD | 1965-90 | 66 04 20 | 90 08 09 | 8,878 | MANAMYH.950 | FMANATEE | 88,974 |
| 02298880 | MYAKKA RIVER AT CONTROL NEAR LAUREL | 1989-90 | 88 10 06 | 90 07 26 | 294 | MYRIVCON.880 | FMYRIVCL | 3,134 |
| 02298900 | MYAKKA RIVER NEAR LAUREL | 1984-90 | 85 02 26 | 90 08 27 | 2,009 | MYRIVLA.900 | FMYRIVLA | 20,284 |
| 02298608 | MYAKKA RIVER NEAR MYAKKA CITY | 1962-66<br>1977-90 | 63 02 05* | 90 07 29* | 6,019 | MYCITY.608 | FMYRIVMC | 60,384 |
| 02298830 | MYAKKA RIVER NEAR SARASOTA | 1936-90 | 36 09 01 | 90 06 12 | 19,643 | NRSARA.830 | FMYRIVSA | 196,624 |
| 02296750 | PEACE RIVER NEAR ARCADIA | 1930-90 | 31 04 01 | 90 08 12 | 21,684 | PEACEAR.750 | FPEACEAR | 217,034 |

* There are no data for WaterYear 1966-1977.

# APPENDIX D.

## INFORMATION ON COMPUTER FILES: GROUNDWATER DATA

Data were provided by the Sarasota County Ecological Monitoring Division. Files containing daily groundwater data for these stations are provided on IBM DOS format floppy diskettes. The ASCII text files contain information on estimated data. The ASCII text files also list monthly and yearly statistics for each Water Year represented.

INFORMATION ON COMPUTER FILES

USGS GROUNDWATER WELL DATA

| USGS WELL NUMBER | USGS WELL NAME | PERIOD OF RECORD* | ASCII TEXT FILENAME | SYSTAT NAME |
|---|---|---|---|---|
| 271832082064801 | Edgeville Deep Well 3 at Edgeville | 1978 | EDGEDEEP.WLR | GEDGED3 |
| 272058082143701 | Verna T Well 0-2 near Verna | 1978 | VERNAT02.WLR | GVERT2 |
| 272356082181302 | Verna Deep Well 1A near Verna | 1975-78 | VERNAD01.WLR | GVERD1A |
| 272404082161701 | Verna T Well 0-1 near Verna | 1978 | VERNAT01.WLR | GVERT1 |
| 272838082142201 | Kibler Deep Well 268 near Bethany | 1978 | KIBLE268.WLR | GKIBD268 |
| 270952082095901 | Mabry Carlton Well 13 near Arcadia | 1987-90 | CARLT13.WLR | GCARL13 |
| 270959082203001 | ROMP 19 WLAM Well near Sarasota | 1987-90 | ROMP19WL.WLR | GRMP19WL |
| 270959082203002 | ROMP 19 WUAM Well near Sarasota | 1987-90 | ROMP19WU.WLR | GRMP19WU |
| 271021082151601 | ROMP 19 ELAM Well near Sarasota | 1987-90 | ROMP19EL.WLR | GRMP19EL |
| 271021082151602 | ROMP 19 EUAM Well near Sarasota | 1987-90 | ROMP19EU.WLR | GRMP19EU |
| 271021082151603 | ROMP 19 ES Well near Sarasota | 1987-90 | ROMP19ES.WLR | GRMP19ES |
| 271134082092201 | Big Slough Deep Well near Arcadia | 1987-90 | BIGSLDEE.WLR | GBIGSLD |
| 271134082092202 | Big Slough Shallow Well near Arcadia | 1977-78<br>1987-90 | BIGSLSHL.WLR | GBIGSLS |
| 271227082084801 | Mabry Carlton Well No. 6 near Myakka City | 1987-90 | CARLTON0.WLR | GCARL6 |
| 272220082151401 | KME Test Well 09 near Verna | 1976-78<br>1987-90 | KMETST09.WLR | GKMET9 |
| 272248082175201 | KME Well 14A near Verna | 1977-78<br>1987 | KME14A.WLR | GKME14A |
| 272255082172202 | KME Recharge Well near Verna | 1976-78 | KMERECHR.WLR | GKMER |
| 272256082175901 | Verna T Well 0-3 near Verna | 1978 | VERNAT03.WLR | GVERT3 |
| 272258082181701 | KME Water Table Well 09 near Verna | 1977-78<br>1987 | KMEWTW09.WLR | GKMEWT9 |
| 272258082195301 | KME Well 04 near Verna | 1976-78<br>1987 | KMEWELL4.WLR | GKMEW4 |
| 272301082191401 | KME 02 Well near Verna | 1977-78<br>1987 | KMEWELL0.WLR | GKMEW2 |
| 272307082173801 | KME Well 16A near Verna | 1977-78 | KMEWL16A.WLR | GKMEW16A |

* Period of Record lists only data which was consistently recorded for several months. There may be additional data for shorter time periods in this file. There may also be periods of missing data within this time period.

# APPENDIX E.

# INFORMATION ON

# TRANSFERRING SWFWMD DATA FORMAT INTO SYSTAT DATA FILES

The programs and macros described in this documentation are provided on IBM DOS format floppy diskettes.

The following directions are written using USGS Streamflow data as an example. The same procedures may be used with groundwater data.

Preparing Files using Wordperfect:

1. Create a subdirectory on your hard drive to use for transferring files. Include the following files in the subdirectory:

a copy of the USGS ascii datafile(s)
BLANK.WP
Tr1GS30.cmd
Tr2GS30.cmd
Tr3GS30.cmd
Tr4GS30.cmd

Make sure that the macros alta.wpm, altb.wpm, and altc.wpm are in your designated Wordperfect (WP) area.

2. Call up BLANK.WP. This is an empty file set up with wide margins and small typeface so the long lines in the file will remain on a single line and not wrap around. You will probably have to make your own version of BLANK.WP since these settings are printer dependent. But name your file BLANK.WP too because macro altc.wpm calls this file.

3. From the Wordperfect List Files listing, highlight the USGS ascii datafile and, using ctrl-F5, Text In/Out, put the USGS file into the BLANK.WP file.

4. Using F2, search for 9999 in the file. Most likely it will not be present. If it is, make a note of the date(s), and when the file is all transferred into Systat, go into the file in Systat EDIT and put the correct datapoint (9999) into the file for that date. "9999" is used as a missing data flag for the file transfer process, so any real data which is 9999 will be converted to a ".", which is Systat's missing data flag, during this process.

5. Run the WP macro alta.wpm by pressing the <alt> and A keys at the same time. (This macro searches for --- and replaces it with 9999, searches for <space><space>e and replaces it with <space><space><space>, and searches for [Hrt][Hrt] and replaces it with [Hrt]. This converts the missing data symbol to one systat can accept as a numeric entry, gets rid of the preceding data if it is estimated since systat won't accept "e22.3" as a numeric entry, and removes the hard carriage returns between every 5 days of data in the USGS ascii file format.)

6. Look to see what the date of the first actual datapoint is and write it down for later. You'll need to plug it into TR4GS30.cmd.

7. Make sure the cursor is at the top of the file. For each Wateryear of data in the USGS file, follow these steps:

A. As a check, write down the beginning year of the data, ie the September 19xx year, and the Sep 1 streamflow data value.

B. Run the WP macro altb.wpm by pressing the <alt> and B keys at the same time. (This macro searches for "SEP[Hrt]<space><space><space>1<space>", turns on the Block feature, searches for "[Hrt]<space><space><space>31<space>", goes to the end of the line, closes the block, and designates that the block is to be copied. Then the macro switches to document 2, calls up BLANK.WP, copies the block from document 1 into blank.wp and tells WP to save the file as an ascii textfile, using Text In/Out, and types out "yb19".)

C. Type in the rest of the year on the screen, ie for 1965 you'd see the filename: "yb19" on the screen, type in 65. DON'T put anything like a space or hit <Enter> after the 65. Check the year carefully and that the first datapoint matches the one you just wrote down.

D. Use the WP macro altc.wpm by pressing the <alt> and C keys at the same time. (This macro adds a ".DAT" to the end of the filename, saves the file, exits document 2 and returns to document 1, searches for "<space><space><space>DAY<space>", so you are set up for the next wateryear's data and can see the next year on the screen.)

E. Repeat steps A through D until you are at the end of the file.

F. Check and write down the last date that has an actual datapoint in the file. You will need this information to plug into TR4GS30.cmd.

--The file you have been using should be not be saved since it was necessary to alter it for the transfer process.

--You will have a YB19xx.DAT file for each year of data.

8. Exit WP and enter Systat's DATA module.

## Running Systat Conversions

There are 4 TRxGS30.CMD files that need to be run to convert the data to a Systat format. Once you have a feel for what's going on, you may want to combine the 4 .cmd files into one, but they are separate here to give you a better idea of what's going on and to make sure you change the necessary filenames and varnames (variable names) etc.

You may want to edit all 4 files to fit your dataset at the beginning *before* you run them. Directions on what needs to be changed appear at the beginning of each .cmd (command) file. The command files are ASCII files and can be edited with Systat's Fedit program or any wordprocessing program, as long as the final product is saved as an ASCII textfile. I saved the longest version of the TRxGS30.cmd files that I used, which will transfer data from 1930 - 1990, since it's easier to delete than add sections to the programs.

## What each program is doing:

**TR1GS30.CMD transfers each of the YB19xx.DAT ASCII textfiles** which contains one year's data from Oct. through Sept., to Systat datafiles, .SYS files. It then converts the 9999's to "." which is the Systat missing data flag. Here are the introductory part of the program and one section. There need to be additional sections for each year in the program you run:

```
rem  Tr1GS30.CMD
rem  LAST REVISED: 11/12/90
rem  PURPOSE:  Transfer USGS Streamflow ascii text files, cleaned
rem              up in Wordperfect with macros alt-a, alt-b and
rem              alt-c, into systat.
rem            -- This version of Tr1GSxx.CMD transfers data from
rem              files called YB19xx.DAT for xx= 30, ie 1935
rem              through 1989.
rem            -- All 9999's are changed to "." for missing data.
rem            -- The text file must have a .DAT extension.
rem  CHANGE:  Add or delete years so that there is one section
rem              for each year in your dataset.  The year should
rem              match the beginning year of the first datapoint
rem              in the WaterYear, ie if your dataset includes
rem              October 1965 - September 1966, your ybyear should
rem              be YB1965.  So what USGS calls WaterYear 1966
rem              should have been given the filename YB1965.DAT.
rem  RUN IN: data
rem  BEFORE: clean up ascii file in Wordperfect
rem  NEXT:   run Tr2GS30.cmd.
rem  ------------------------------------------
NEW
```

```
GET yb1989
SAVE temp
LRECL=375
INPUT day oct nov dec jan feb mar apr may jun jul aug sep
RUN

use temp
save yb1989
code oct nov dec jan feb mar apr may jun jul aug sep/9999 = .
run
dos 'del temp.sys'
rem -------------------
rem The end.
```

TR2GS30.CMD takes the data out of matrix format and puts it in a single field. A date variable is created which reflects the year in the first 2 digits, month in the second 2 digits, and day in the final 2 digits, ie November 26, 1989 would be "891126". The conversion is done one month at a time, then the months are combined vertically into a new year file which contains only 2 variables: date and streamflow.

The streamflow data is identified with an F at the beginning, then a station name code. Then at a later date, if you want to put streamflow and precipitation for the same station in one file, you won't have to change the variable names, or if you want to put streamflow from several stations into one file, you won't need to change the variable names.

Here are the introductory part of the program and one section. There need to be additional sections for each year in the program you run:

```
rem  Tr2GS30.CMD
rem  PURPOSE:  For the years 1930-1989, create a year file with
rem              daily records of data.
rem            -- Create a DATE variable to indicate
rem              year-month-day.
rem            -- Give the data variable the same name in all
rem              files, so they can be combined with Tr3GS30.cmd.
rem  CHANGE:   -- fVarname to the station name code preceded by an
rem              'F' to indicate streamFlow data.
rem            -- Add or delete years so that there is one section
rem              for each year in your dataset.  The year should
rem              match the beginning year of the first datapoint
rem              in the WaterYear, ie if your dataset includes
rem              October 1965 - September 1966, your ybyear should
rem              be YB1965.  So what USGS calls WaterYear 1966
rem              should have been given the filename YB1965.SYS.
rem  RUN IN: data
```

```
rem  BEFORE: clean up ascii file in Wordperfect and run
rem              Tr1GS30.cmd
rem  NEXT:   run Tr3GS30.CMD
rem --------------------
REM  *****1989*****
use yb1989 (day oct)
save oct
let fvarname = oct
let date = 891000 + day
drop day oct
run
use yb1989 (day nov)
save nov
if day = 31 then delete
let fvarname = nov
let date = 891100 + day
drop day nov
run
use yb1989 (day dec)
save dec
let fvarname = dec
let date = 891200 + day
drop day dec
run
use yb1989 (day jan)
save jan
let fvarname = jan
let date = 900100 + day
drop day jan
run
use yb1989 (day feb)
save feb
rem  if leap year, change 28 to 29
if day > 28 then delete
let fvarname = feb
let date = 900200 + day
drop day feb
run
use yb1989 (day mar)
save mar
let fvarname = mar
let date = 900300 + day
drop day mar
run
use yb1989 (day apr)
save apr
if day = 31 then delete
let fvarname = apr
let date = 900400 + day
drop day apr
run
```

```
use yb1989 (day may)
save may
let fvarname = may
let date = 900500 + day
drop day may
run
use yb1989 (day jun)
save jun
if day = 31 then delete
let fvarname = jun
let date = 900600 + day
drop day jun
run
use yb1989 (day jul)
save jul
let fvarname = jul
let date = 900700 + day
drop day jul
run
use yb1989 (day aug)
save aug
let fvarname = aug
let date = 900800 + day
drop day aug
run
use yb1989 (day sep)
save sep
if day = 31 then delete
let fvarname = sep
let date = 900900 + day
drop day sep
run
save a
append oct nov
save b
append a dec
save c
append b jan
save d
append c feb
save e
append d mar
save f
append e apr
save g
append f may
save h
append g jun
save i
append h jul
save j
```

```
append i aug
save y89
append j sep
rem -----------------------
rem  The end.
```

*TR3GS30.CMD* takes all the individual year files and puts them together vertically into one file.

Here are the introductory part of the program and a section showing how to combine 9 years of data from 1981-89. There need to be additions to cover each year in the program you run:

```
rem Tr3GS30.CMD
rem  PURPOSE:  Combine the year files created by Tr2GS30.cmd
rem              into one file for the station.
rem  CHANGE:  Add or delete years so that there is one section
rem              for each year in your dataset.  The year should
rem              match the beginning year of the first datapoint
rem              in the WaterYear, ie if your dataset includes
rem              October 1965 - September 1966, your y-year should
rem              be Y65.  So what USGS calls WaterYear 1966
rem              should have been given the filename Y65.SYS.
rem  BEFORE:  Run Tr2GS30.cmd
rem  NEXT:    Run Tr4GS30.CMD.
rem  RUN IN:  Data.
rem -------------
save a
append y81 y82
save b
append a y83
save c
append b y84
save d
append c y85
save
append d y86
save f
append   y87
save g
append f y88
save tempyr
append g y89
rem  ----------------------------------
rem  The end.
```

TR4GS30.CMD removes the dates which contain no data at the beginning and end of the file. You will need to plug in the date information you wrote down when you were working with the file in Wordperfect. The file is finally saved with a filename the same as the variable name, beginning with an F and then a station code. It is saved in Single precision, which means that your data will be accurate to only 6 significant digits, which is plenty for the accuracy of these data.

Here are the program:

```
rem  Tr4GS30.CMD
rem  PURPOSE: -- remove cases with no data at the beginning
rem              and end of the file.
rem           -- arrange file with date first, then
rem              the flow variable.
rem           -- save as single precision, ie only
rem              6 digits are recorded for each datapoint.
rem  CHANGE:  The final file name in save.
rem           The streamflow varname in use to the one you used
rem              in Tr2GS30.cmd.
rem           The first and last date code to those that have
rem              real data.
rem              Date codes are year= 1st 2 digits
rem                            month= middle 2 digits
rem                              day= last 2 digits
rem              Be sure and put the last date first and the
rem              first date last in the line.
rem  RUN IN:  Data.
rem  BEFORE:  Run TR3GS30.cmd.
rem  AFTER:   Copy the final file created to a permanent
rem              location.  Then delete all .SYS and .DAT files.

USE TEMPYR (date fVARNAME)
SAVE fFILENAME / single "This is single precision"
if date > 900325 or date < 301129 then delete
run
rem  -----------------------------
rem  The  end.
```

The easiest way to clean up the mess of files created by this transfer is to copy the final file to another directory, then delete all the *.sys files and *.dat files before you do another transfer or quit.

Don't forget, if you had any real datapoints that were 9999, you need to correct the Systat datafile using the Systat EDIT module.

# APPENDIX F.

## INFORMATION ON AERIAL PHOTOGRAPHY

Florida Department of Transportation Aerial Photography

ASCS Aerial Photography

USGS 7.5° Quad Size Aerial Photography

U. S. Air Force Early Aerial Photography

Tobin Research Aerial Photography

Photo mosaic index sheets for all ASCS and SCS photography covering the Myakka River Watershed are provided. 10' X 10" color infrared stereo pairs for 1984/85 NHAP photography covering the Myakka River Watershed also accompany this report.

**FLORIDA DEPARTMENT OF TRANSPORTATION**
**AERIAL PHOTOGRAPHY**

| **SARASOTA COUNTY** | | | |
|---|---|---|---|
| Date | PD Number | Flight Lines | Scale (inch=ft) |
| 10/30/64 & 11/64/ | WFM* | 3-8 | 1:2000 |
| 1/13/69 & 1/16/69 | 738 | 8-13 | 1:2000 |
| 12/19/72 & 1/30/73 | 1205 | 8-13 | 1:2000 |
| 12/7/77 & 1/10/78 | 2180 | 9-15 | 1:2000 |
| 3/12/83 | 2947 | 9-15 | 1:2000 |
| 12/20/85 & 1/15/86 | 3443 | 9-15 | 1:2000 |
| 12/22/89 & 1/13/90 | 3814 | 9-15 | 1:2083 |

| **MANATEE COUNTY** | | | |
|---|---|---|---|
| Date | PD Number | Flight Lines | Scale (inch=ft) |
| 3/10/65 | 335 | 1-6 | 1:2000 |
| 12/19/72 & 1/30/73 | 1205 | 10-13 | 1:2000 |
| 2/22/73 & 3/22/73 | 1271 | 15-19 | 1:2000 |
| 12/7/77 & 1/10/78 | 2180 | 12-16 | 1:2000 |
| 12/7/77 & 1/10/78 | 2179 | 16-20 | 1:2000 |
| 4/6/80 & 10/5/80 | 2549 | 16-20 | 1:2000 |
| 4/25/84 | 3116 | 16-20 | 1:2000 |
| 2/10/87 & 4/5/87 | 3625 | 16-20 | 1:2000 |
| 4/21/80 | 3767 | 1H<br>1L | 1:1600<br>1:400 |

* Not available at Bartow DOT office. All Flights not marked with an asterisk are available at their office.

Also available are 24" X 24" SCS aerials:
- 1948 Sarasota Co (virtually complete set + index)
- 1940 Manatee Co (virtually complete set + index)

# FLORIDA DEPARTMENT OF TRANSPORTATION
# AERIAL PHOTOGRAPHY

Available at:

Dept. of Transportation
P. O. Box 1249
801 North Broadway
Bartow, FL 33830
813/533-8161
SunCom 557-2309
Contact persons: W. Cornelison,
District Surveyor Administrator
W. Roberson
Assistant District Location Surveyor
both from Locations Surveys

Purchase from:

Attention Donald E. Merkel
Chief of Topography
Bureau of Topography
Florida Department of Transportation
605 Suwannee Street
Tallahassee, Florida 32301
Mail Station 5L
(904) 488-8911

## ASCS Aerial Photography

Photo mosaic index sheets for the SCS and ASCS photography listed below accompany this report. 10" x 10" color infrared stereo pairs for all NHAP photography listed below also accompany this report.

| SARASOTA COUNTY | | | | | |
|---|---|---|---|---|---|
| Date | Scale | Film Type | Agency* | Purchase from: | Availabl e at: |
| 1948 | 1:20,000 | B & W | ASCS | I | A,B |
| 1957 | 1:20,000 | B & W | ASCS | II | A |
| 1969 | 1:40,000 | B & W | ASCS | II | A |
| 1974 | 1:20,000 | B & W | ASCS | II | A |
| 1984 | 1:60,000 | B & W<br>color infrared | NHAP | II | A |

| MANATEE COUNTY | | | | | |
|---|---|---|---|---|---|
| Date | Scale | Film Type | Agency* | Purchase from: | Availabl e at: |
| 1940 | 1:20,000 | B & W | SCS | I | C,B |
| 1952 | 1:20,000 | B & W | ASCS | II | C |
| 1958 | 1:20,000 | B & W | ASCS | II | C |
| 1970 | 1:40,000 | B & W | ASCS | II | D |
| 1980 | 1:40,000 | B & W | ASCS | II | D |
| 1984 | 1:60,000 | B & W<br>color infrared | NHAP | II | D |

* SCS is the U.S. Dept. of Agriculture Soil Conservation Service
ASCS is the U.S. Dept. of Agriculture Agricultural Stabilization and Conservation Service
NHAP is National High Altitude Photography

## ASCS Aerial Photography

Purchase from:

I. National Archives and Records Service
Cartographic and Architectural Branch
General Services Administration
Washington, D. C. 20408
(703) 756-6700
Contact Person: Richard Smith

II. Department of Agriculture
Agricultural Stabilization and Conservation Service
2222 West, 2300 South
P.O. Box 30010
Salt Lake City, Utah 84130
(801) 524-5856
Contact Person: Mary Porter

Available at:

A. Sarasota County Office
Soil Conservation Service
Extension Services Building
2900 Ringling Blvd.
Sarasota, Florida 34237
(813) 951-4210
Contact Person: Nona Shawhan, District Secretary

B. Locations Surveys
Department of Transportation
801 North Broadway
P. O. Box 1249
Bartow, Florida 33830
(813) 533-8161
SunCom 557-2309
Contact Persons: W. Roberson
Assistant District Location Surveyor
W. Cornelison
District Surveyor Administrator

C. Manatee County Historical Records Library
1405 4th Ave. W.
Bradenton, Florida 34205
(813) 749-7162
Contact Persons: Stephanie Mashburn, Records Librarian
Tissie Watson, Records Librarian

**ASCS Aerial Photography**

D. Manatee County Office
Agricultural Stabilization and Conservation Service
1303 17th Street West
Palmetto, Florida 34221
(813) 748-7468
Contact Person: Judy Vigeant

## USGS 7.5° QUAD SIZE AERIAL PHOTOGRAPHY

The quality of the 1-15-79 photography is much poorer than the 1972-73 photography. As of summer, 1990, it was still possible to obtain copies of the 1972-73 photography for the quads listed below. Those marked with an X in the 1979 column were only available for that date.

| 1:24,000 Aerial Photography in Quad Format | | |
|---|---|---|
| USGS 7.5° QUADRANGLE NAME | DATE | |
| | 1972-73 | 1-15-79 |
| Bee Ridge | | X |
| Duette | X | |
| Edgeville | X | |
| Keentown | X | |
| Laurel | | X |
| Lower Myakka Lake | X | |
| Murdock | | X |
| Murdock N.E. | | X |
| Murdock N.W. | X | |
| Myakka City | X | |
| Myakka City N.W. | | X |
| Myakka Head | X | |
| Myakka River | | X |
| Old Myakka | X | |
| Verna | X | |

The 1972-73 photography was produced by Mark Hurd Aerial Surveys.
The 1-15-79 photography was obtained by the U.S. Geological Survey for the Corps of Engineers, Jacksonville District and enlarged by the State Topographic Office, Florida Dept. of Transportation, Tallahassee, Florida.

## USGS 7.5° QUAD SIZE AERIAL PHOTOGRAPHY

Selected quads for both dates are available from:

Florida Resources and Environmental Analysis Center
The Florida State University
Tallahassee, Florida 32306
(904) 644-2007

The 1-15-79 quads are available from:

Mapping & Graphics Section
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34609-6899
(904) 796-7211 or (800) 423-1476
Suncom 684-0111

## U.S. AIR FORCE EARLY AERIAL PHOTOGRAPHY

Large 22" X 24" flight maps showing flight lines and frame numbers for the aerial photography listed below are provided with this report.

| Early U.S. AIR FORCE AERIAL PHOTOGRAPHY | | | |
|---|---|---|---|
| DATE | SCALE | QUALITY | GENERAL LOCATION [CITY AT LATITUDE EQUIVALENT TO UPPER AND LOWER ENDS OF FLIGHT LINE] |
| 3/4/43 | 1:14,750 | excellent | 5 N/S lines from Upper Lake Myakka west [northern Sarasota to Murdock] |
| 3/23/43 | 1:12,500 | excellent | ca 7 N/S lines from the center of Upper Lake Myakka east to Venice [northern Sarasota to Murdock] |
| 4/28/43 | 1:12,500 | fair | 2 N/S lines just west Lower Lake Myakka [Sarasota to Laurel] |
| 4/28/43 | 1:12,500 | fair | patchy 3 N/S lines east of Lower Lake Myakka [Sarasota to Laurel] |
| 10/31/43 | 1:40,000 | excellent | area west of the center of Upper Lake Myakka to the coast [Palmetto to Venice] |
| 11/11/43 | 1:12,000 | excellent | 1 N/S line just east of Upper Lake Myakka [Bee Ridge to Murdock] & many lines along the coast east of the River |
| 11/12/43 | 1:20,000 | excellent | 2 N/S lines through MRSP* [Bradenton to Venice] |
| 3/13/45 | 1:20,000 | good | W/E flight from Venice across the Myakka River |
| 11/13/45 | 1:40,00 | excellent | 2 N/S lines west of DeSoto Co. line to east edge of Tatum Sawgrass [Palmetto to Murdock] |

## U.S. AIR FORCE EARLY AERIAL PHOTOGRAPHY

Purchase from:

National Archives and Records Service
Cartographic and Architectural Branch
General Services Administration
Washington, D. C. 20408
~~(703) 756-6700~~ (301) 713-7040
Contact Person: Richard Smith
[include information underlined in blue on flight line maps as ID codes with orders]

## TOBIN RESEARCH AERIAL PHOTOGRAPHY

Tobin Research flies their own photography. The following is a list of their aerial photography for latitude 27°00' to 27°32'30" and longitude 82°00' to 82°22'30". Their photography is expensive; for example in September 1990, the price for 308 prints, alternate exposures (ie not stereo pairs), 8" X 10" was $8,000, or about $25 each. However, this photography might be useful for answering questions on a specific area or trying to determine as closely as possible when a change occurred.

| TOBIN RESEARCH AERIAL PHOTOGRAPHY | | |
|---|---|---|
| Date | Scale | Area Covered |
| 1940/42 | 1:1,667 | Hardee County |
| 1942 | 1:1,667 | DeSoto County |
| 1948 | 1:1,667 | Sarasota County |

Purchase from:

Tobin Research
P. O. Box 2101
114 Camp Street
San Antonio, TX 78297
(512) 223-6203
Contact Person: Lauri Korzekwa
[File of flight paths is stored under
"Myakka River State Park"]

# APPENDIX G.

# CARLTON RESERVE GROUNDWATER MONITORING

(from Dames and Moore, 1988a)

## TABLE 3.1

## SUMMARY OF DRILLING PROGRAM

| Borehole Designation | Number of Boreholes | Drilling Depth | | | Installed For |
|---|---|---|---|---|---|
| | | Minimum | Maximum | Average | |
| Ground Penetrating Radar Wells | 10 | 31 | 86.5 | 48 | Calibration of geophysical survey and monitoring of Surficial Aquifer |
| Wetland Monitoring Wells | 8 | 15 | 36.5 | 25 | Sampling soils under and adjacent to wetlands |
| Test/Monitor Wells | | | | | |
| Surficial aquifer | 118 | 9 | 76 | 35 | Sampling, monitoring, testing of Surficial aquifer |
| Intermediate aquifer | 21 | 76 | 258 | 201 | Sampling, monitoring, testing of Intermediate aquifer |
| Upper Floridan aquifer (Tampa zone) | 13 | 251 | 640 | 395 | Sampling and Monitoring Floridan aquifer |
| Upper Floridan aquifer (Suwannee zone) | 9 | 420 | 690 | 562 | Sampling and Monitoring Floridan aquifer |
| Ocala Semi-confining unit | 2 | 750 | 1000 | 875 | Sampling and Monitoring Floridan aquifer |
| Production Wells | 12 | 400 | 715 | 477 | Sampling and well-field production |
| Total | 193 | | | | |

For consumptive use permitting purposes, drawdown impacts in the Surficial aquifer, Intermediate aquifer, upper Floridan aquifer and lower Floridan aquifer need to be monitored. With the exception of the two wells mentioned above, the present monitoring network is sufficient to address property boundary impacts.

The following paragraphs detail the proposed long-term monitoring plan for the RMT well-field for each aquifer. The proposed plan for each aquifer is to monitor the areas in the center of the well-field in addition to monitoring a ring around the well-field near the property boundaries.

## 3.1 SURFICIAL AQUIFER

Wells 5 and 8, drilled during the initial well cluster program will be used to monitor withdrawal impacts on the surficial aquifer near the center of pumpage. Well 5 is located near Production Well SP 21 and Well 8 is located near Production Well TP 33. Wells 6G, ROMP 19E-S, 14GN, 14S, 9, 3G, and ROMP 19W-S will be used to monitor an outer ring around the well-field area. These wells average 44 feet in depth and range from 25 feet to 67.5 feet in depth. Figure 3.1 shows the location of these wells in reference to the production well sites.

## 3.2 INTERMEDIATE AQUIFER

Well HM 21, located near SP 21, and HM 40, located near TP 32, will be used to monitor the effects of ground water withdrawals near the center of pumpage and the eastern portion of the well-field. Wells 6C, ROMP 19E- Int., 14E-S, 3C, and ROMP 19W-Int. will be used to monitor an outer ring around the well-field area. Well 10, located near the northern most boundary of the RMT, will be used to determine background water levels. The intermediate aquifer monitor well network averages 206 feet in depth and varies from 121 feet to 258 feet in depth. This large variation is due to discontinuous confining layers at the base of the aquifer which may or may not be present at each well site.

### 3.3 UPPER FLORIDAN AQUIFER (Production Zone)

The RMT well-field production zone consists of the Tampa Limestone and Suwannee Formations. Water levels and water quality will be monitored daily in each of the twelve existing and two future production wells to obtain accurate pumping levels and determine raw water quality to the treatment plant. Wells TP 27, TP 30, TP 31, TP 32, TP 33, TP 38, and TP 39 will produce from the Tampa Limestone; Well SP 21 will produce from the Suwannee Limestone; and Wells STP 22, STP 23, STP 24, and STP 26 will produce from both the Tampa and Suwannee zones. Wells TP 25 and TP 29 have not been drilled (proposed for 1989), but will probably produce from the Tampa Limestone.

In addition to the production wells, Well TM 21 will monitor water levels and water quality in the Tampa zone and Wells SM 21A and SM 21B will be used to monitor water levels and water quality in the Suwannee zone.

To determine the regional drawdown impacts within the well-field, a ring of monitor wells surrounding the well-field will be used. In the Tampa Limestone, these wells are 14 E-S, 14 H-S, and 3 H. In the Suwannee Formation, these wells are 3 F, ROMP 19E, 14 F-S, 6 F, and ROMP 19W. Also, Wells 10H and TM 37, both located on the northern portion of the RMT, will be used to monitor background levels in the Tampa Limestone, which is the main production zone of the upper Floridan aquifer. The proposed monitor well network for the Tampa Limestone, independent of the production wells, averages 359 feet in depth and ranges from 304 feet to 435 feet in depth. The proposed monitor well network for the Suwannee Limestone, independent of the production wells, averages 554 feet in depth and ranges from 425 feet to 690 feet in depth.

### 3.4 OCALA SEMI-CONFINING UNIT

The Ocala Group represents the semi-confining unit which separates the upper Floridan aquifer from the lower Floridan aquifer. The lower Floridan aquifer within the RMT contains highly mineralized water that can potentially migrate upwards if well-field withdrawals are not accurately controlled and monitored. Two wells, OM 21 and OM 41, will be used to monitor water levels and water quality in the Ocala semiconfining unit. The purpose of these wells will be to detect any upconing of lower Floridan aquifer water into the well-field production zone.

Well OM 21 is constructed with casing that extends into the Ocala Group to a depth of 690 feet. The total depth of the well is 1,000 feet. The location of OM 21 is within the area of the largest projected withdrawal impacts and will monitor the potential for upconing of mineralized water in the western portion of the well-field.

Well OM 41 is constructed with casing that extends into the Ocala Group to a depth of 700 feet. The total depth of the well is 750 feet. This well will monitor the water in the eastern portion of the well-field. Together, OM 21 and OM 41 will provide sufficient coverage of the rate and extent of upward movement of lower Floridan aquifer ground water caused by the well-field.

## FIGURES

Figure 1. A descriptive model of ecosystem hydrology.

Figure 2. Location of weather stations from which we assembled available precipitation data. See Table 1 for the station names that correspond to these numbers. Myakka River State Park is shown at Station 11.

Figure 3. Location of streamflow monitoring stations from which we assembled available streamflow data. See Table 2 for the station names that correspond to these numbers.

Figure 4a. Location of groundwater monitoring stations in Sarasota County from which we assembled available groundwater level data. See Table 3 for the station names that correspond to these numbers.

Figure 4b. Location of groundwater monitoring stations in Manatee County from which we assembled available groundwater level data. See Table 3 for the station names that correspond to these numbers.

Figure 5. Pleistocene marine terraces in southwest Florida (Healy 1975).

Figure 6. Topographic sketch showing the DeSoto Plain and coastal lowlands which are traversed by the Myakka River in Sarasota and Manatee Counties (modified from White 1970).

**Figure 7. Principal topographic and drainage features of the Myakka River basin area (Joyner and Sutcliffe 1976).**

Figure 8. Monthly precipitation (1944-1989) at Myakka River State Park. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

Figure 9. Monthly precipitation (1956-1989) at Fort Green 12 WSW. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

Figure 10. Monthly precipitation (1933-1989) at Wauchula 2 N. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

Figure 11. Monthly precipitation (1914-1989) at Bradenton. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

Figure 12. Monthly precipitation (1908-1989) at Arcadia. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

Figure 28. Cumulative maximum annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park.

Figure 29. Cumulative minimum annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park.

Figure 30. Minimum annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park. The horizontal line is the mean annual flow for the period of record.

Figure 31. Estimated decline in the potentiometric surface of the Floridan Aquifer since predevelopment conditions (Hutchinson 1984).

Figure 32. The projected drawdown in the Surficial Aquifer resulting from a 120-day stress test on pumping from the Floridan Aquifer on the Carlton Reserve (Dames and Moore 1988).

Figure 33. Land uses as of 1989 in the Myakka River watershed upstream of or near Myakka River State Park. It is overlaid on a reduced copy of Figure 25, which shows more clearly the location of Myakka River State Park and the names of the Myakka River sub-basins.

Figure 34. The hatched area indicates the location of lands owned by phosphate mining companies in the Myakka River watershed (Sarasota Herald Tribune 1976). Numbers refer to the company that owns the land: (1) Beker Phosphate Corporation, (2) International Minerals & Chemical Corporation, (3) Phillips Petroleum, (4) Swift Chemical Company, (5) Texaco, (6) WR Grace & Company. It is overlaid on a reduced copy of Figure 25, which shows more clearly the location of Myakka River State Park and the names of its watershed sub-basins.

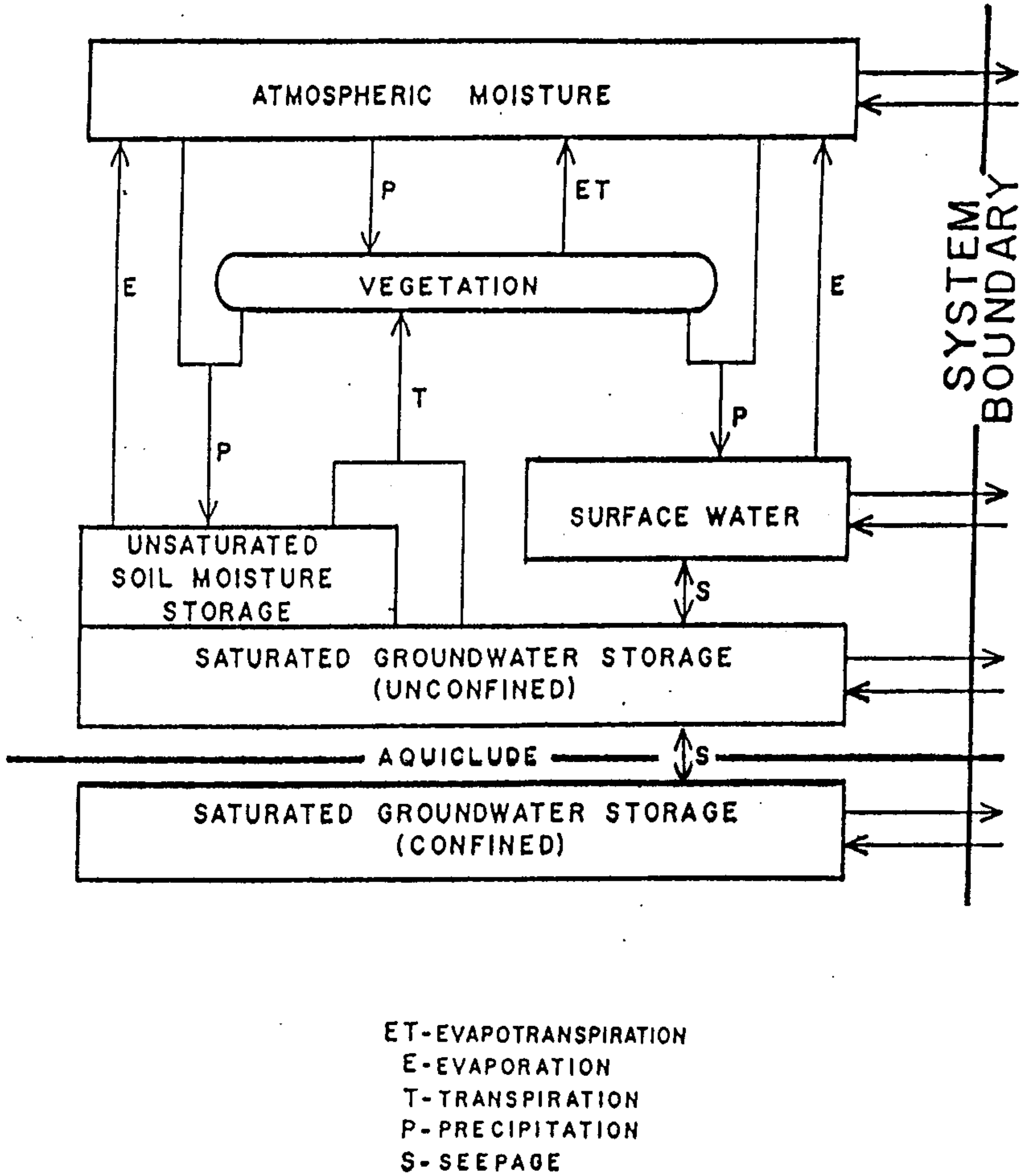



Figure 1. A descriptive model of ecosystem hydrology.

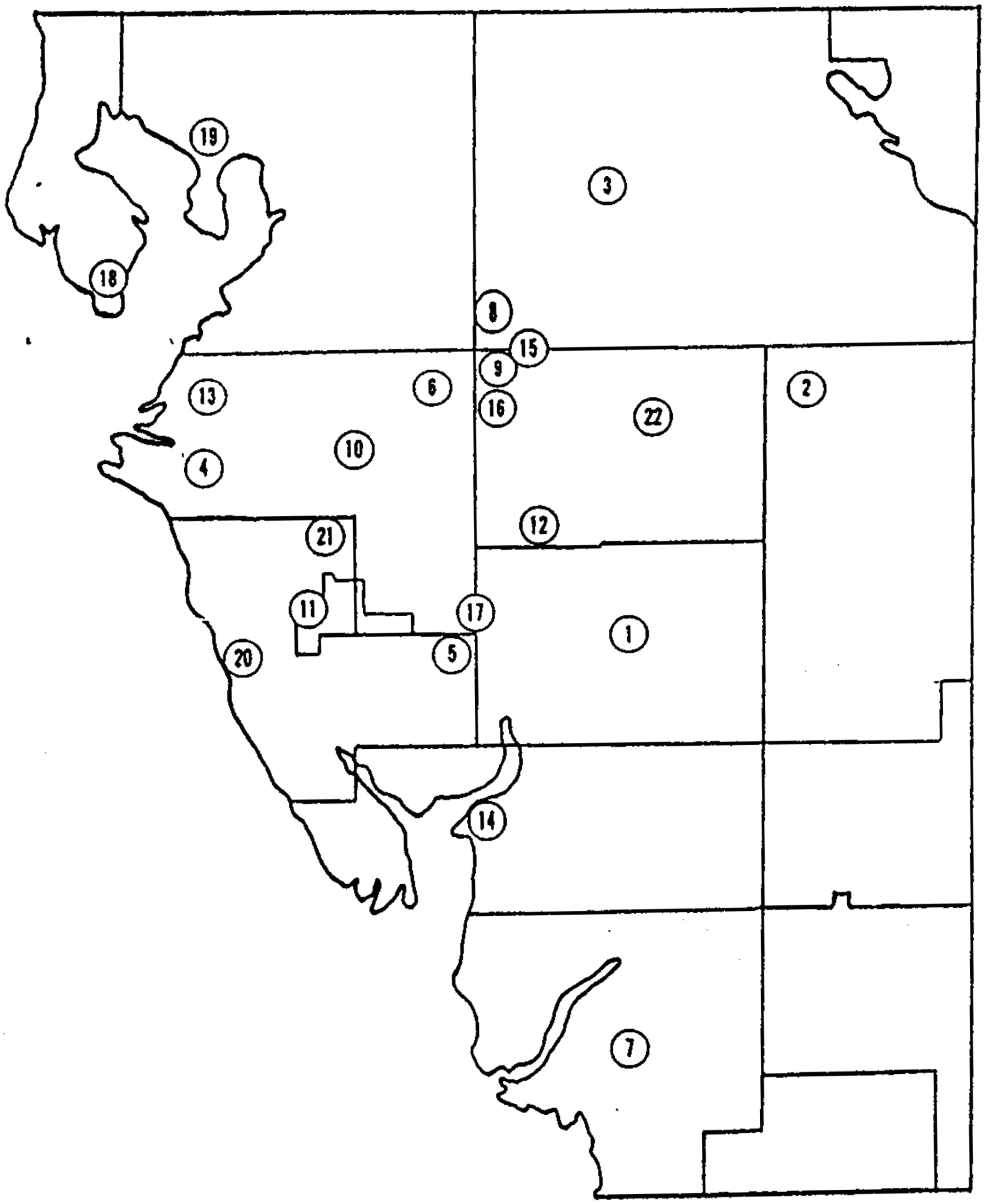



Figure 2. Location of weather stations from which we assembled available precipitation data. See Table 1 for the station names that correspond to these numbers. Myakka River State Park is shown at Station 11.

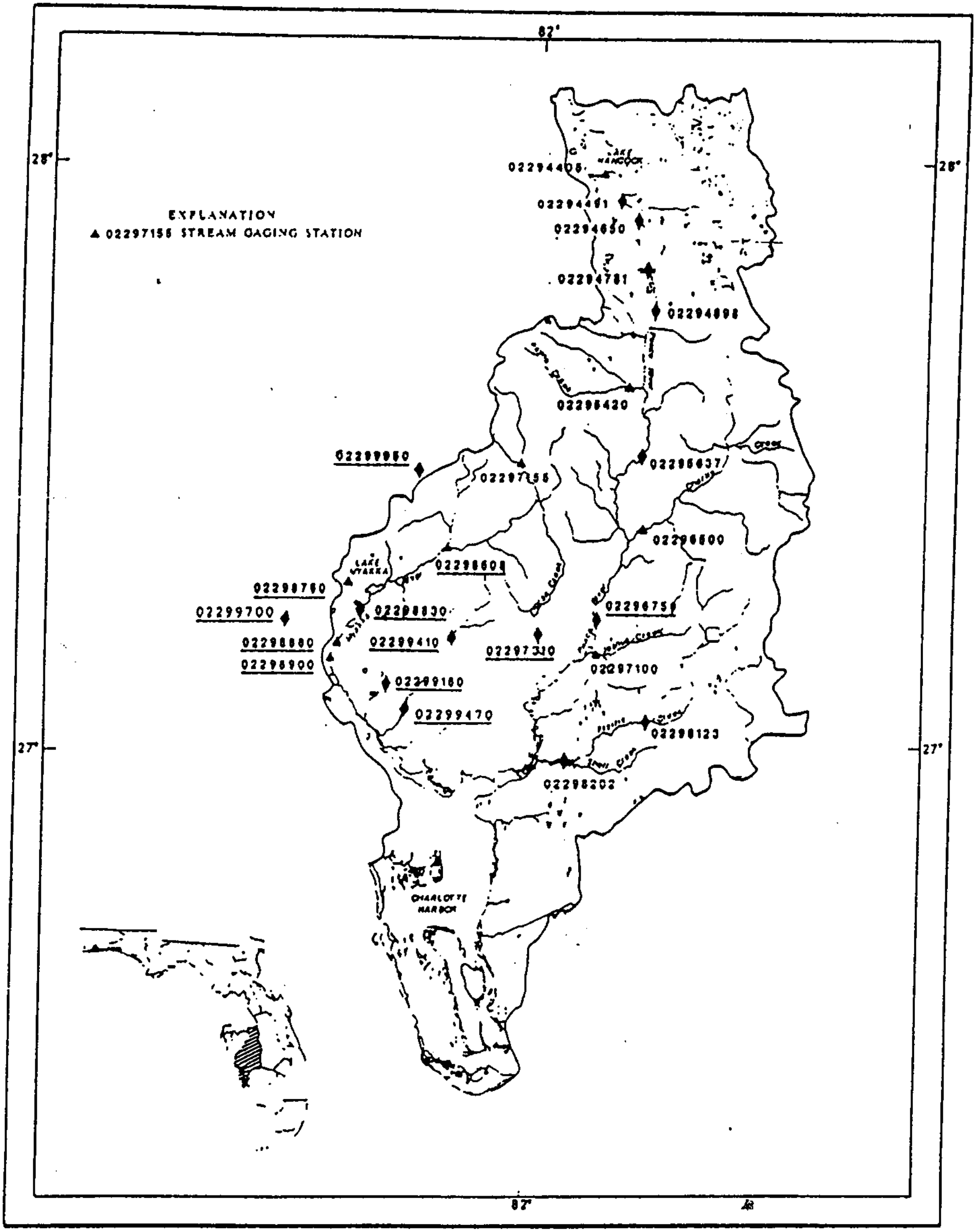



Figure 3. Location of streamflow monitoring stations from which we assembled available streamflow data. See Table 2 for the station names that correspond to these numbers.

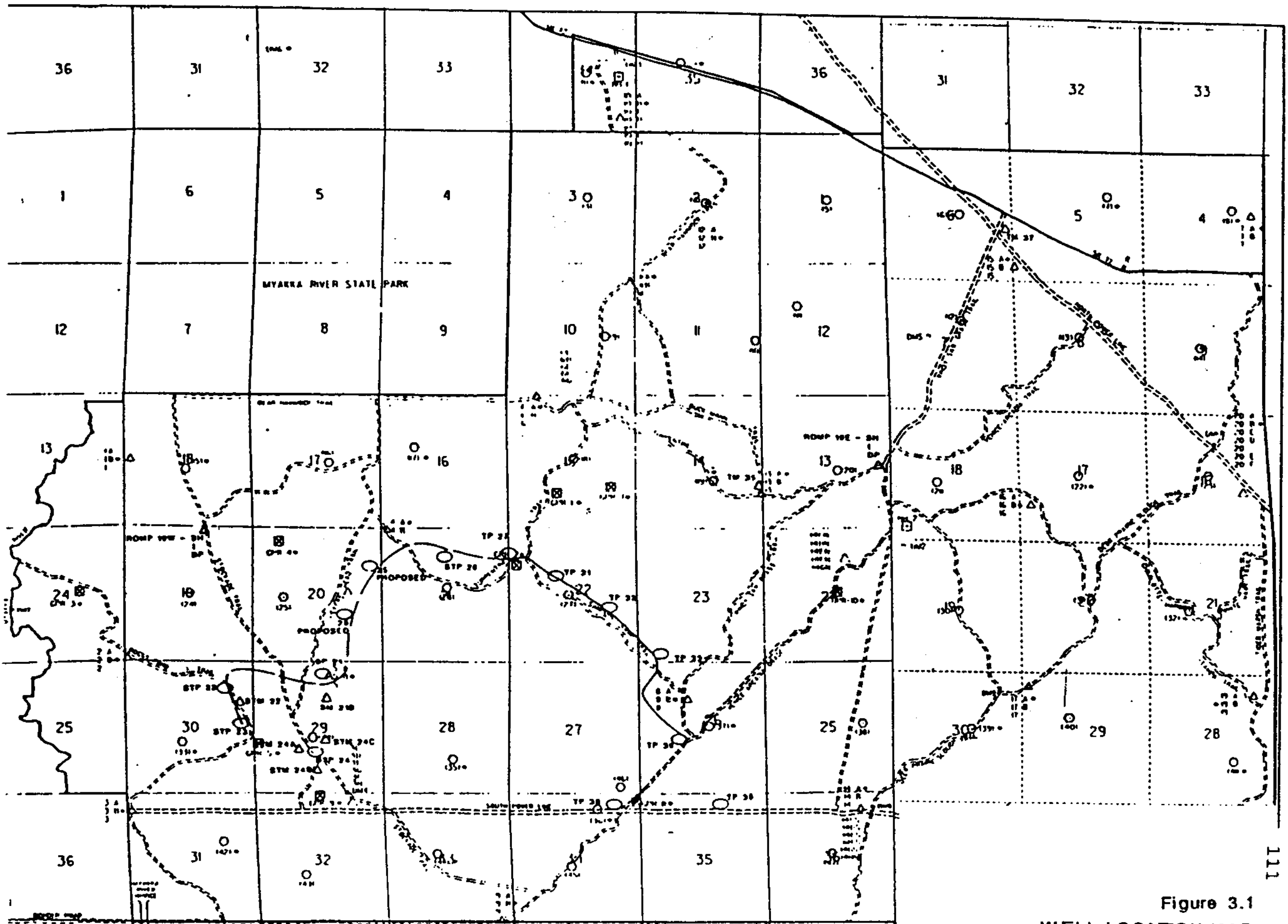



Figure 3.1
WELL LOCATION MAP

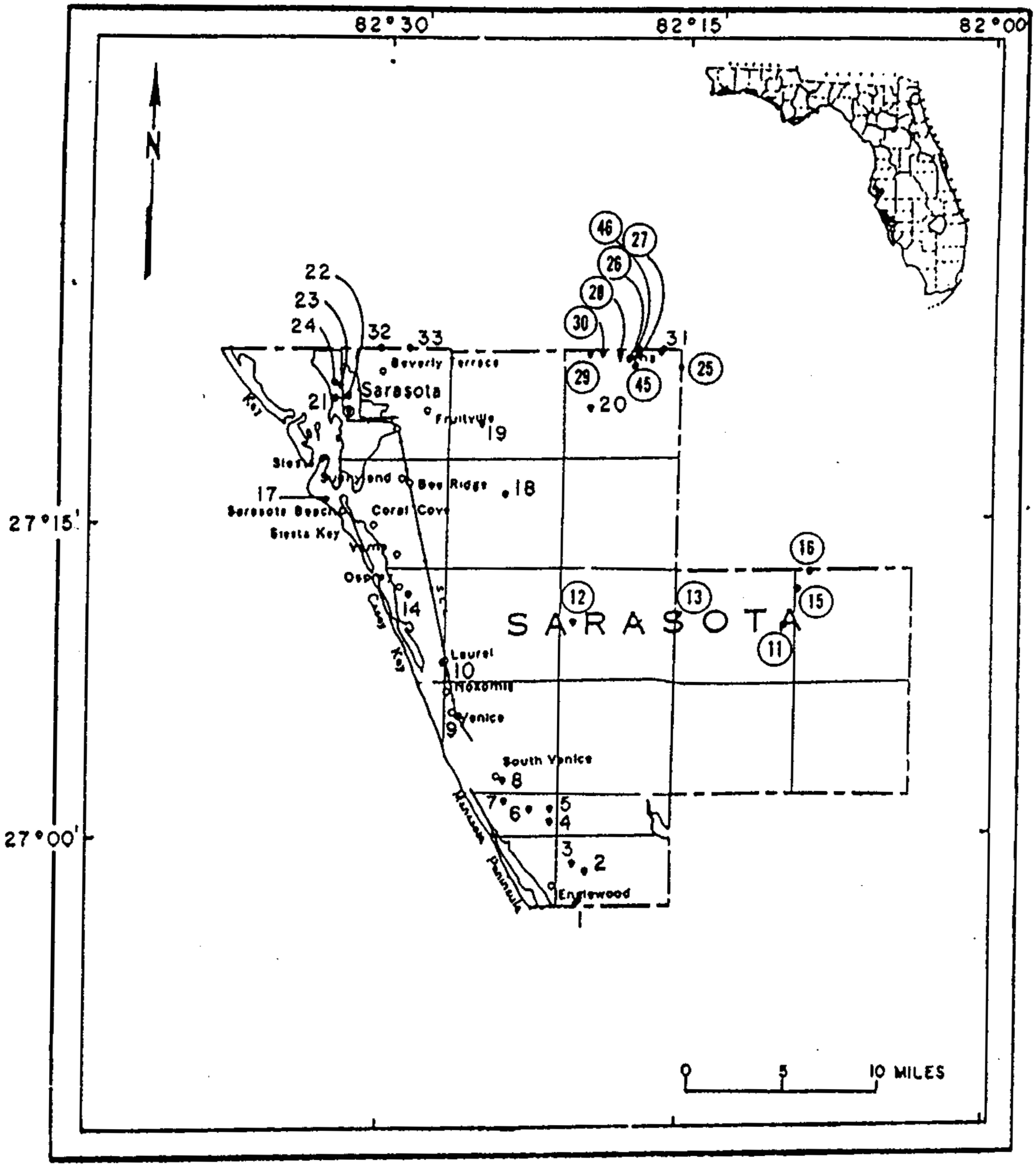



Figure 4a. Location of groundwater monitoring stations in Sarasota County from which we assembled available groundwater level data. See Table 3 for the station names that correspond to these numbers.

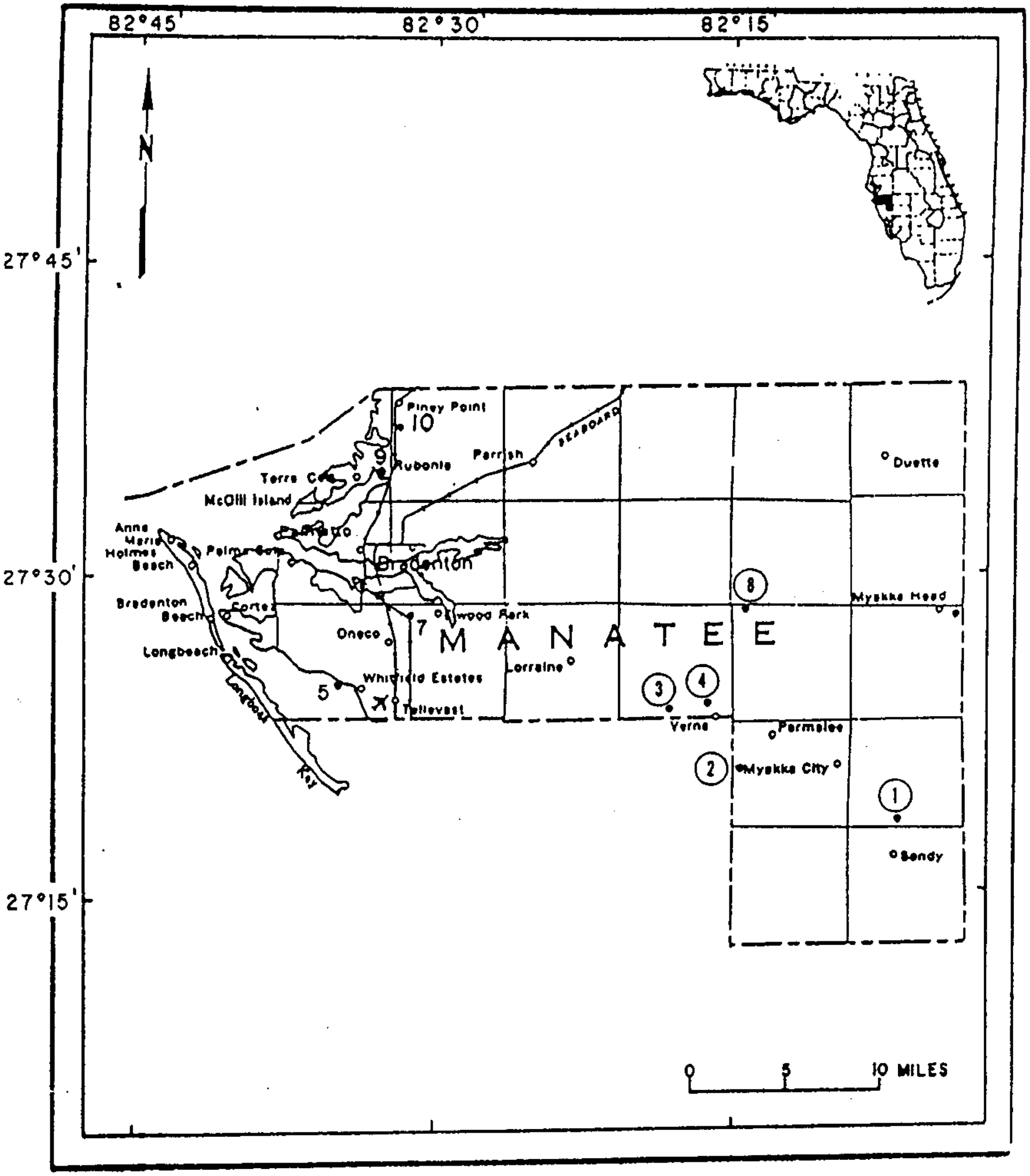



Figure 4b. Location of groundwater monitoring stations in Manatee County from which we assembled available groundwater level data. See Table 3 for the station names that correspond to these numbers.

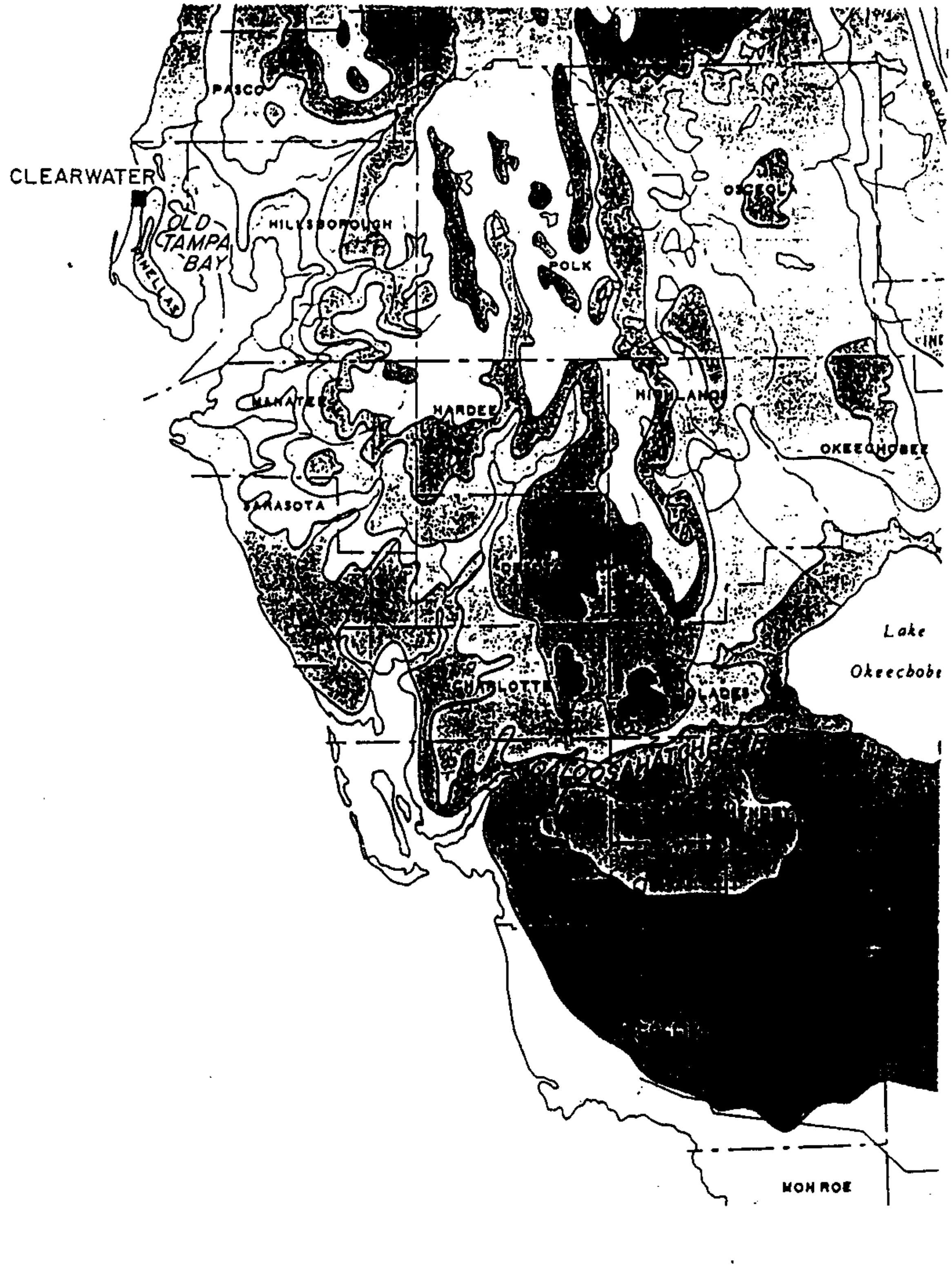



Figure 5. Pleistocene marine terraces in southwest Florida (Healy 1975).

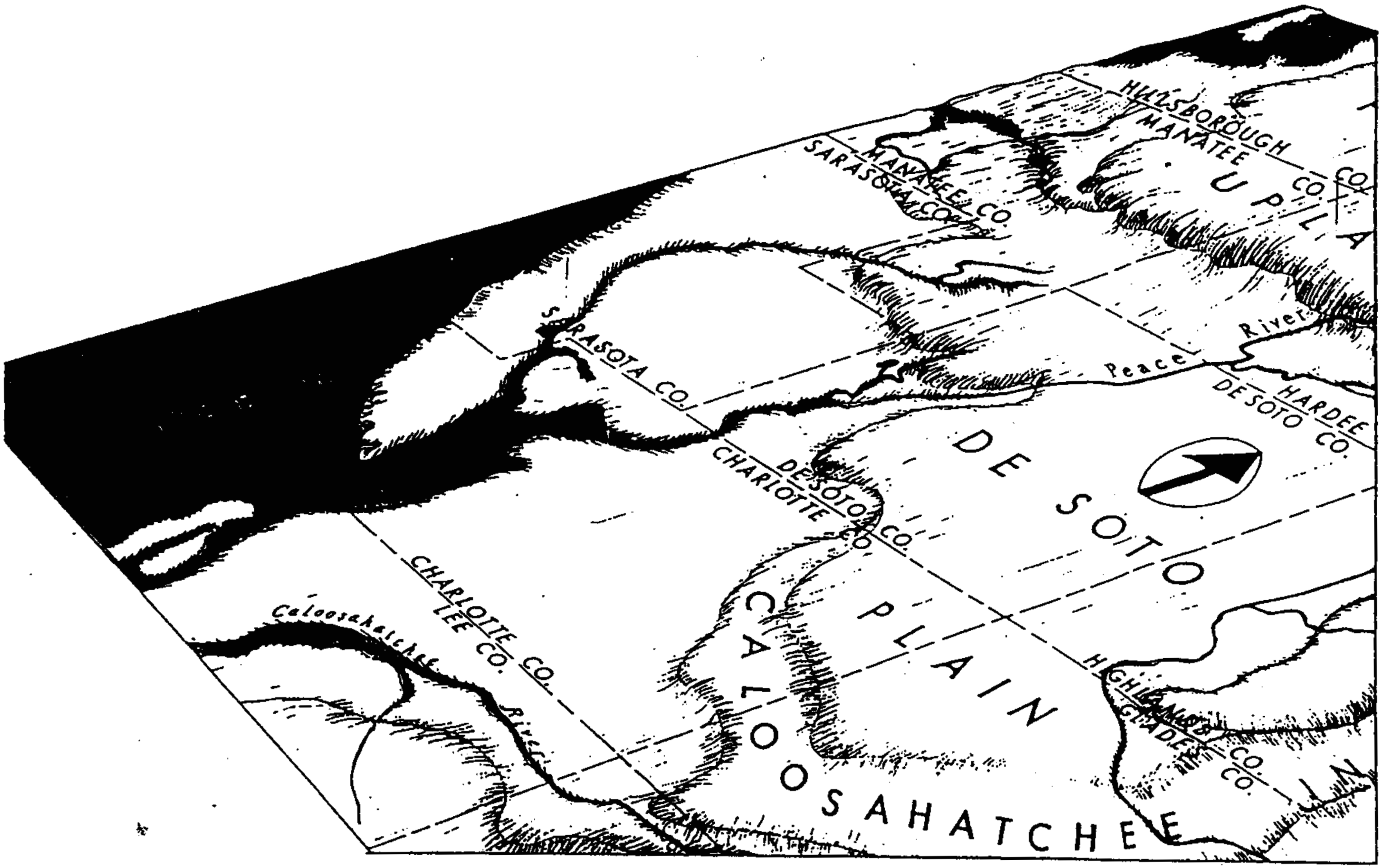



Figure 6. Topographic sketch showing the DeSoto Plain and coastal lowlands which are traversed by the Myakka River in Sarasota and Manatee Counties (modified from White 1970).

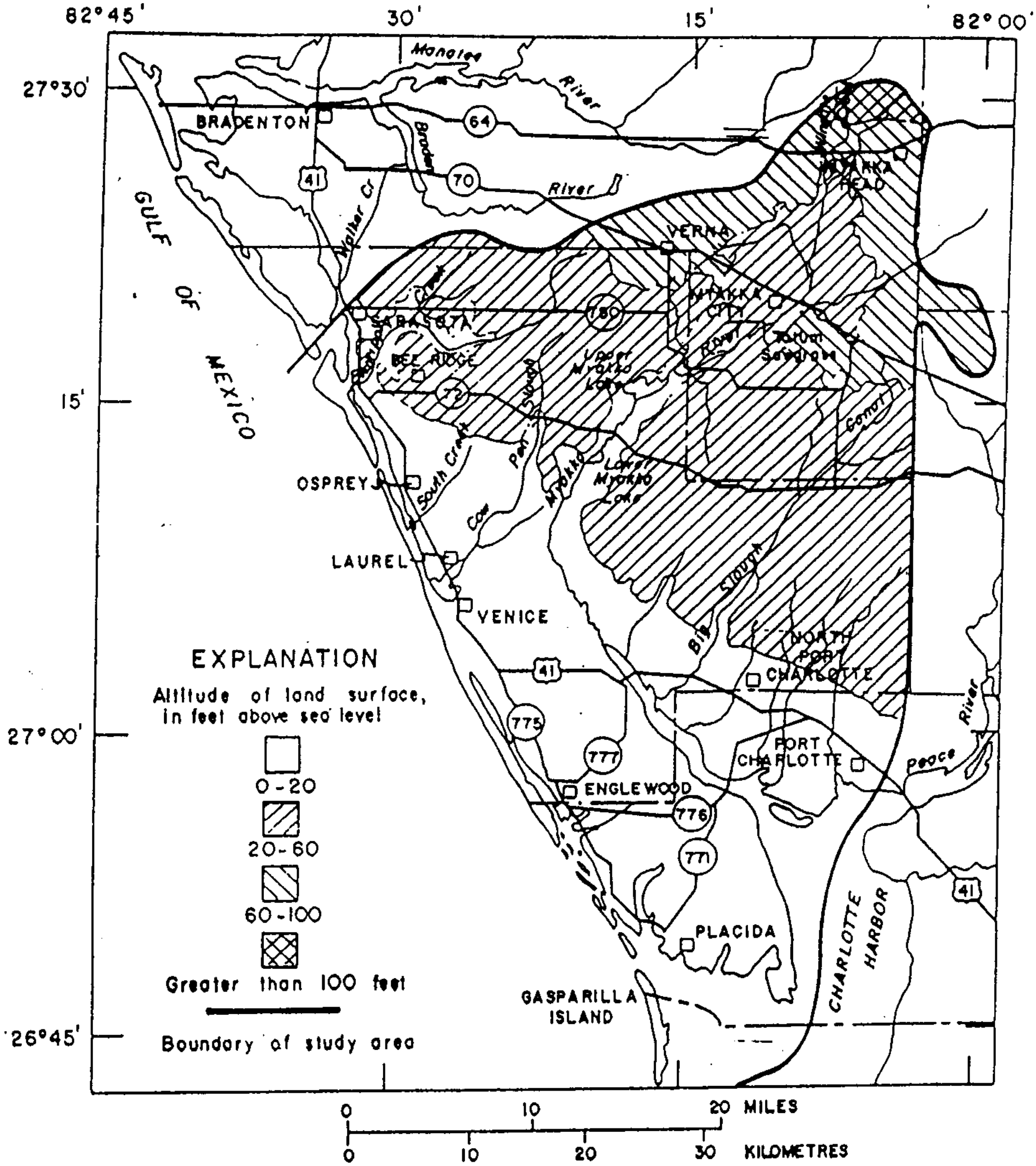



Figure 7. Principal topographic and drainage features of the Myakka River basin area (Joyner and Sutcliffe 1976).

Figure 8. Monthly precipitation (1944-1989) at Myakka River State Park. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

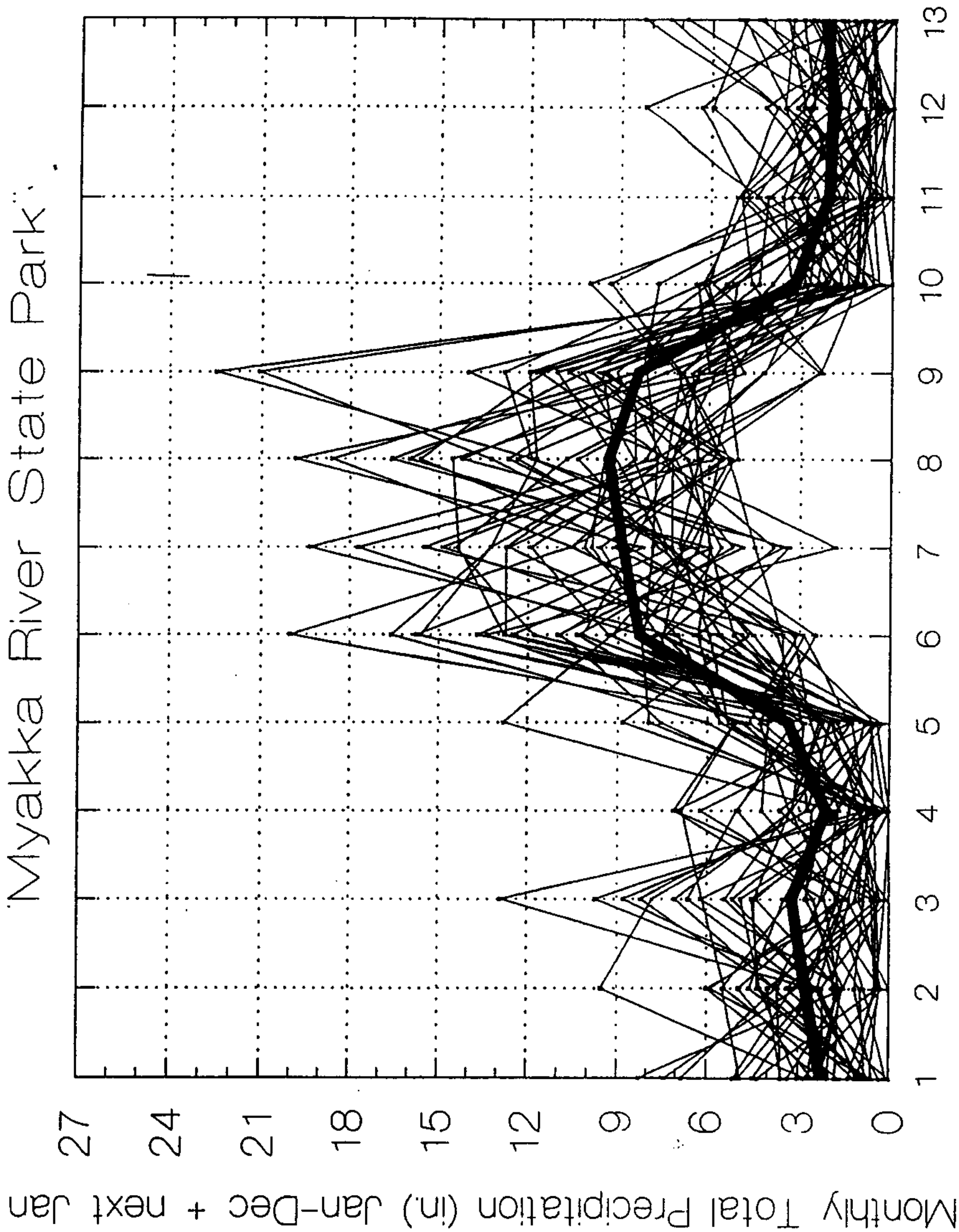
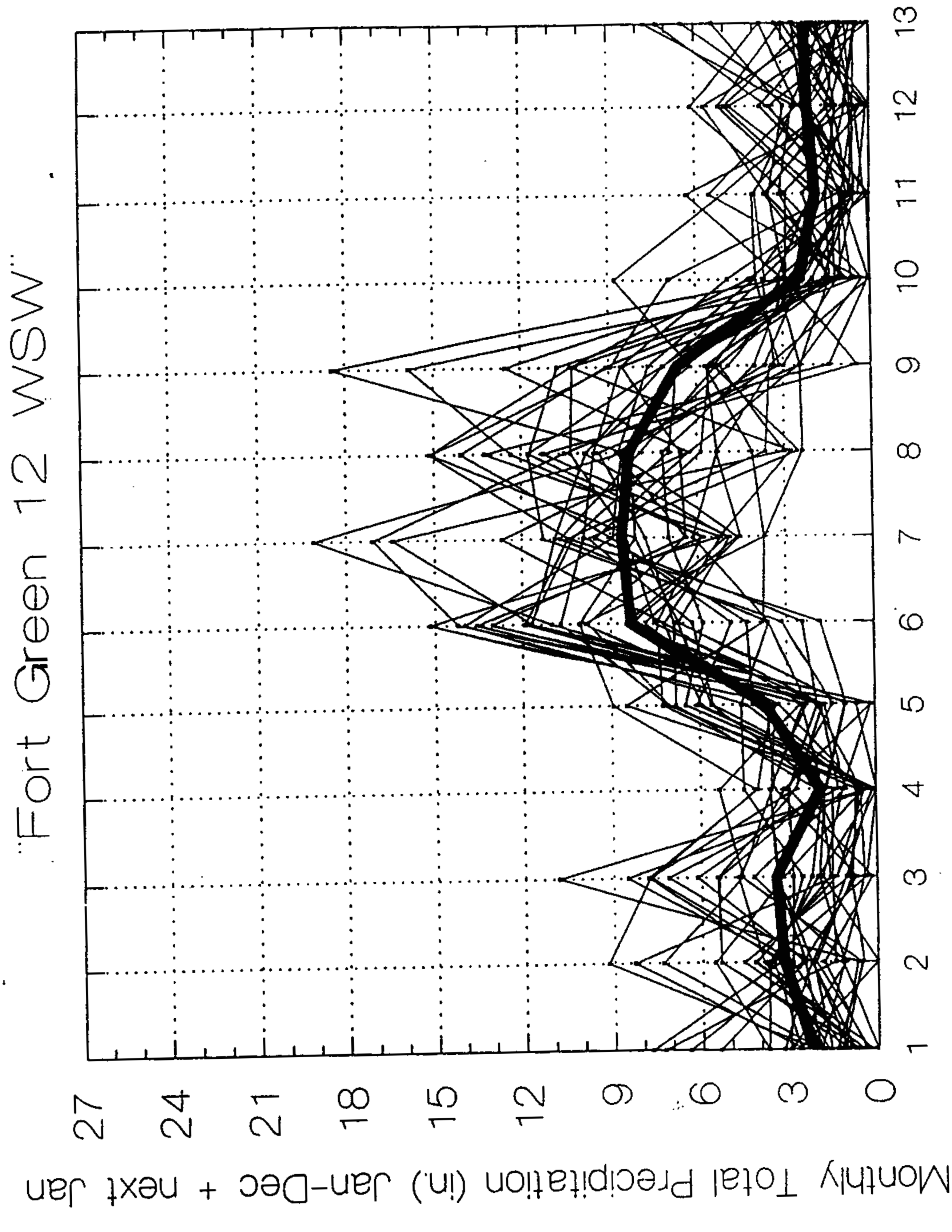


Figure 9. Monthly precipitation (1956-1989) at Fort Green 12 WSW. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.



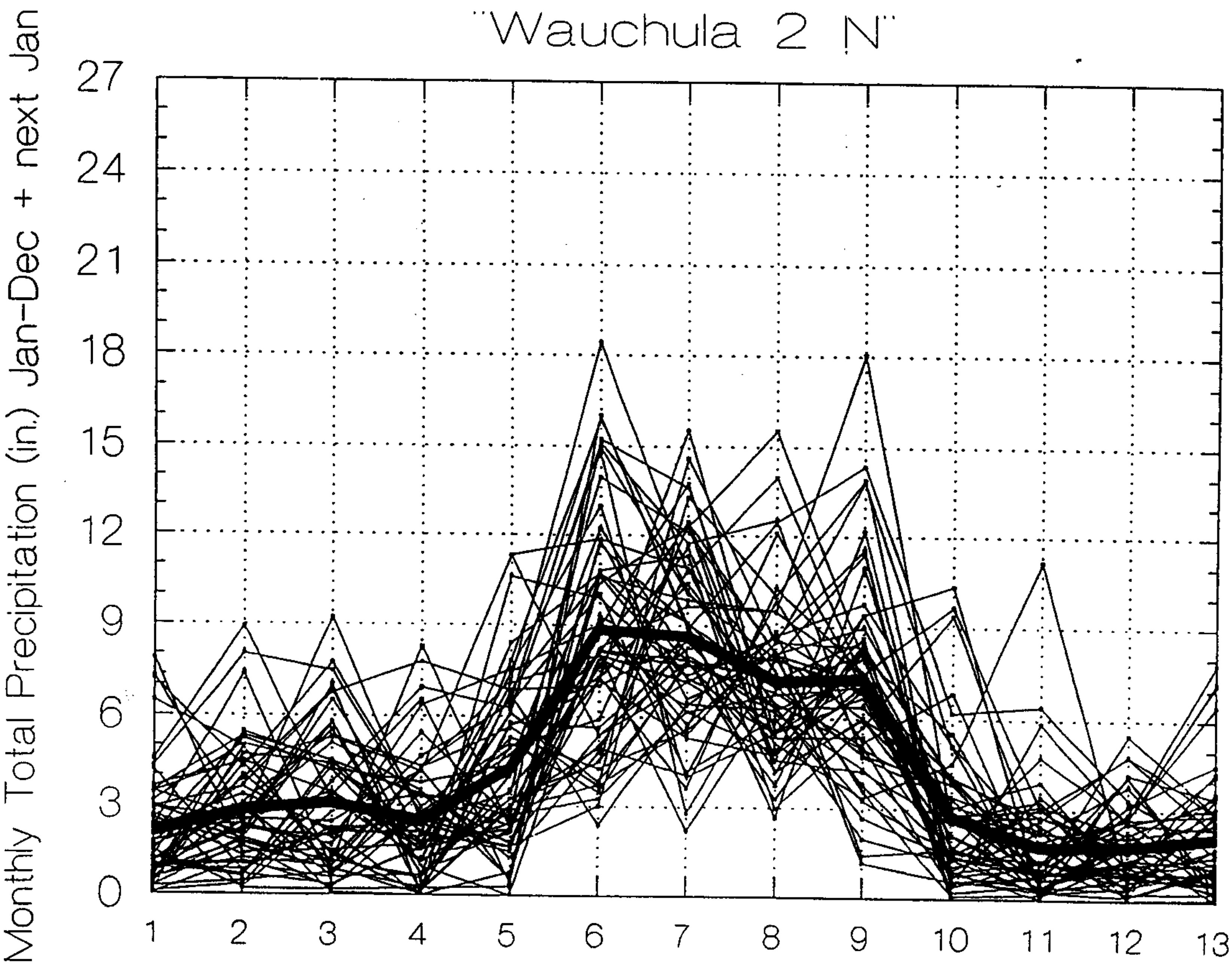
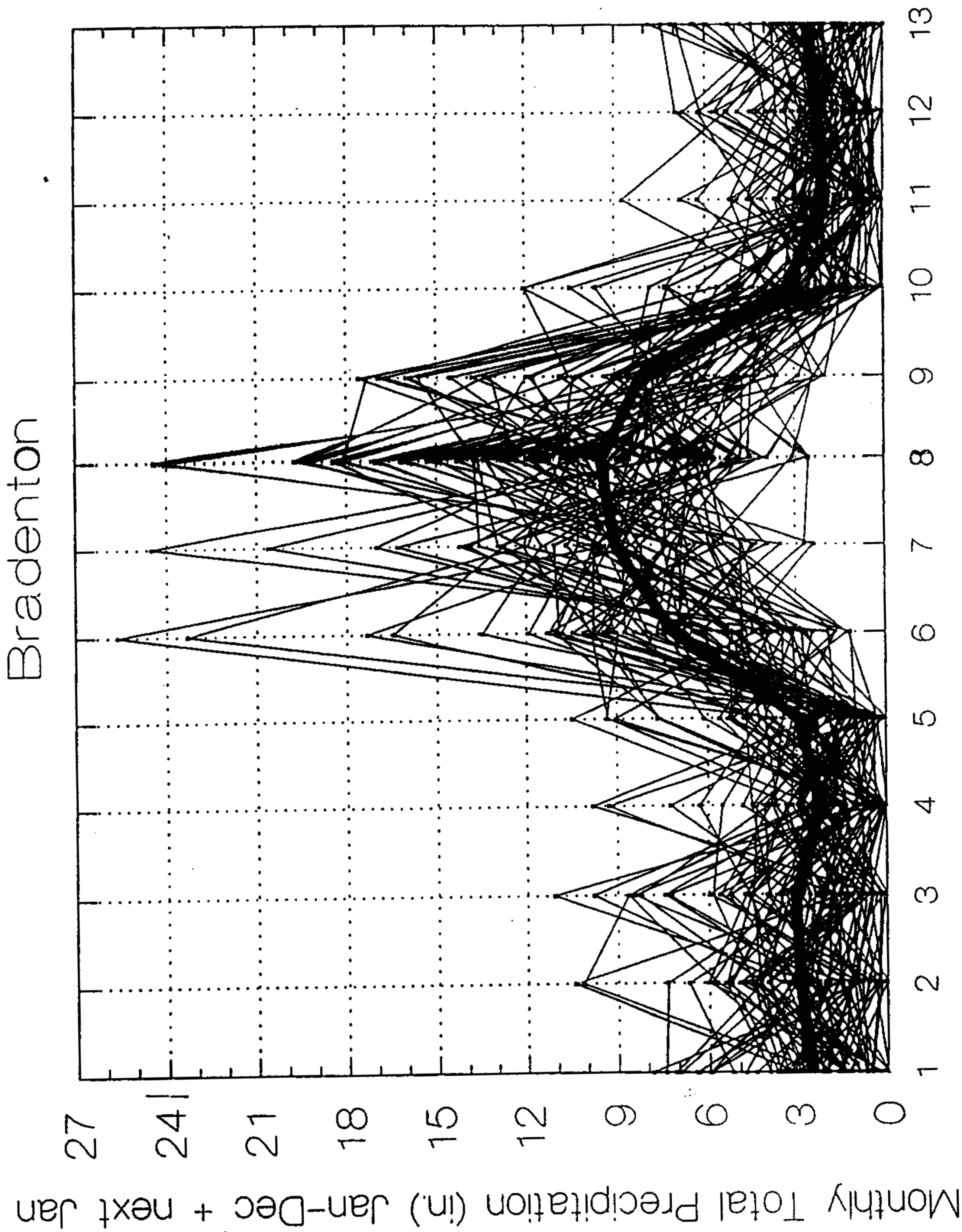



Figure 10. Monthly precipitation (1933-1989) at Wauchula 2 N. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

Figure 11. Monthly precipitation (1914-1989) at Bradenton. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.



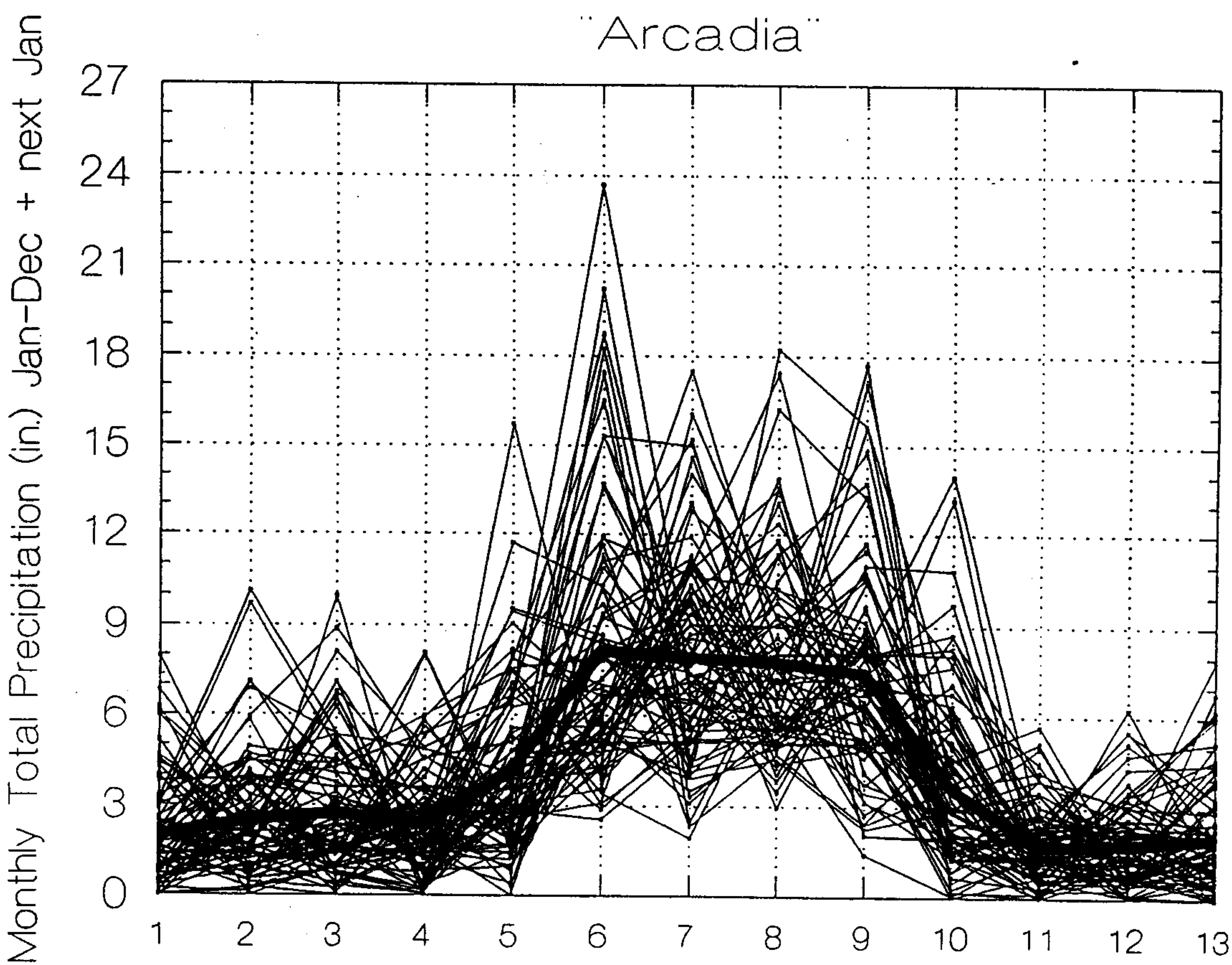



Figure 12. Monthly precipitation (1908-1989) at Arcadia. Each year's data is plotted as an overlay. The heavy line is mean monthly precipitation for the period of record.

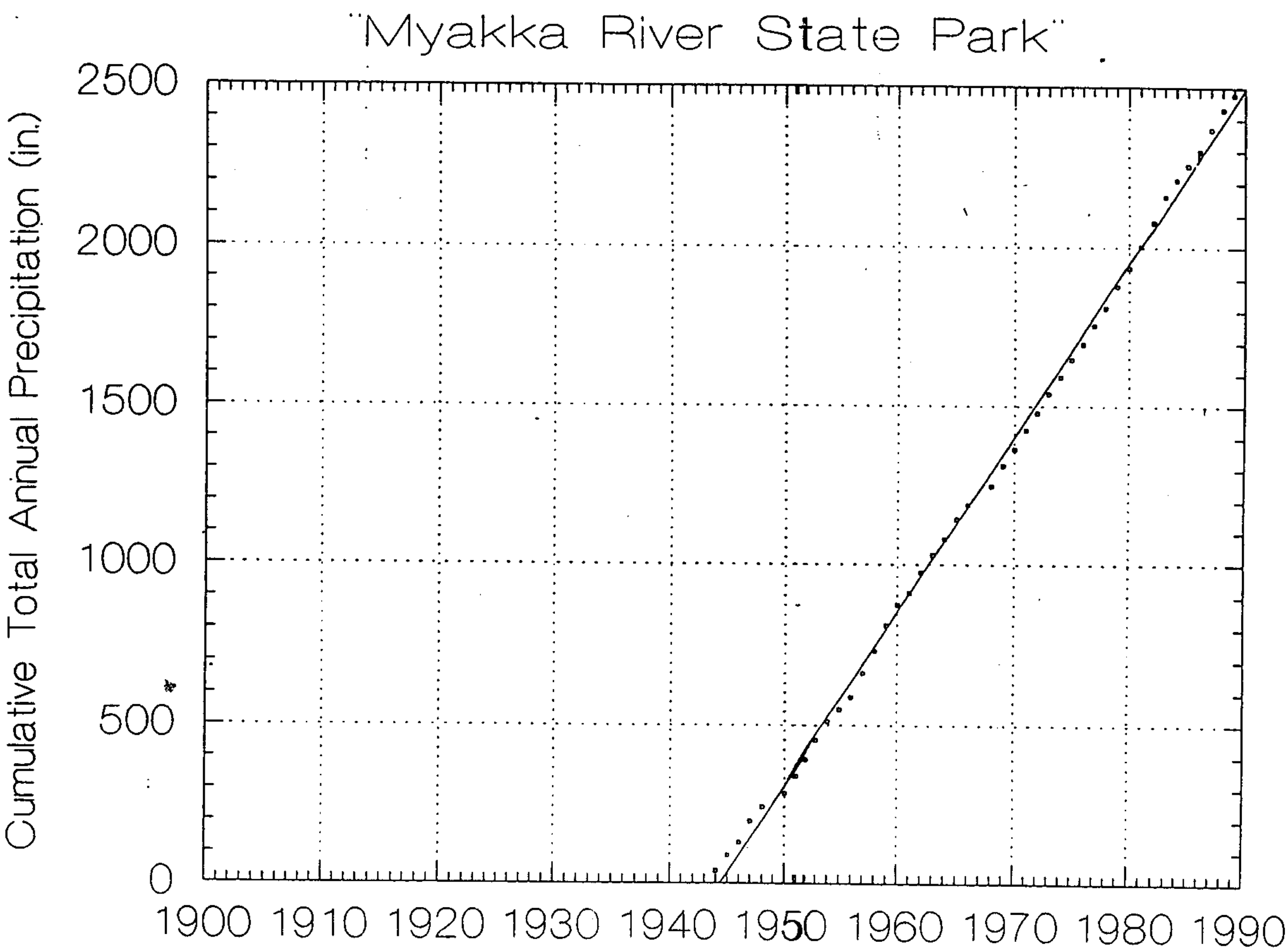



Figure 13. Cumulative total annual precipitation at Myakka River State Park.

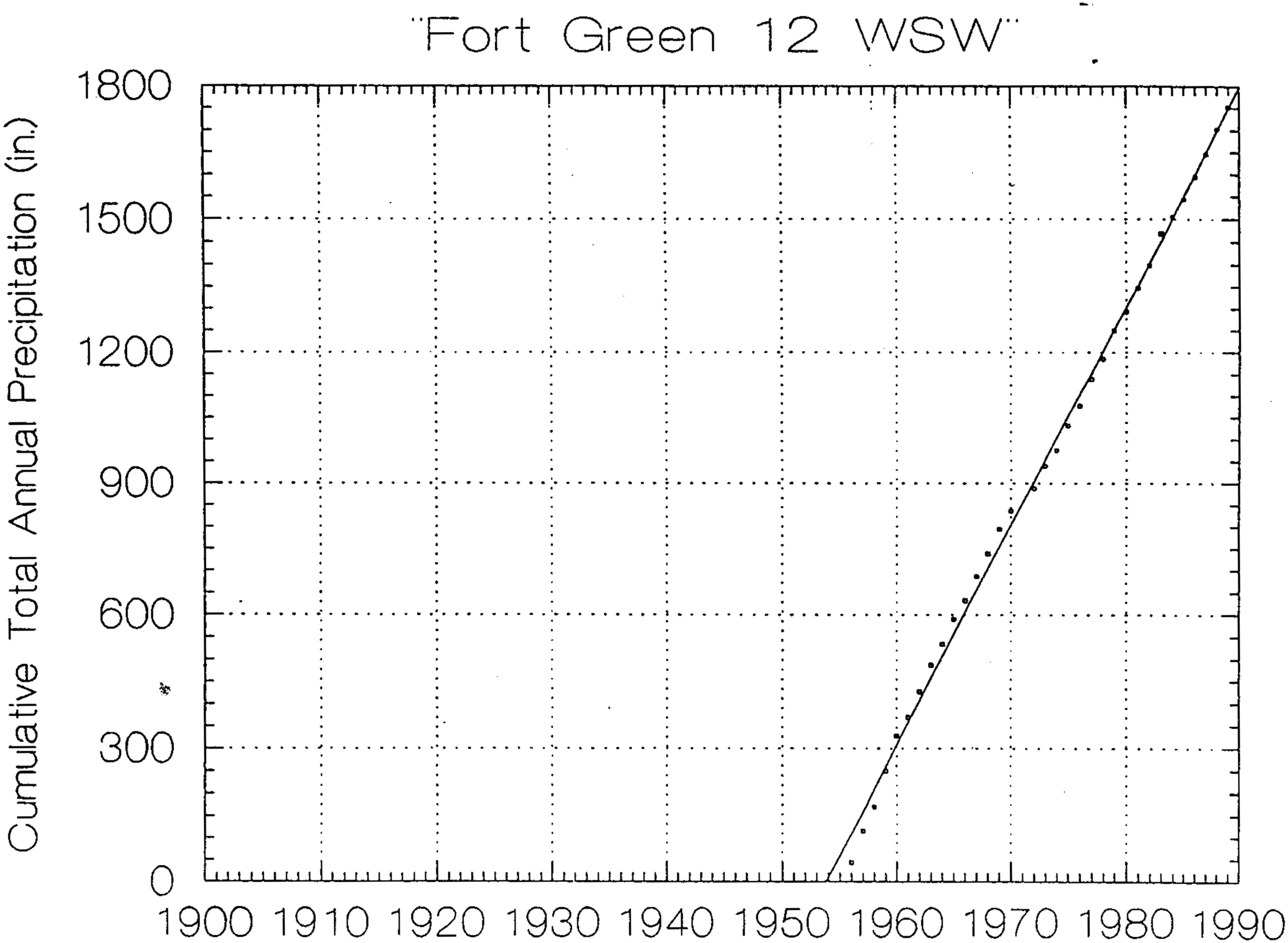



Figure 14. Cumulative total annual precipitation at Fort Green 12 WSW.

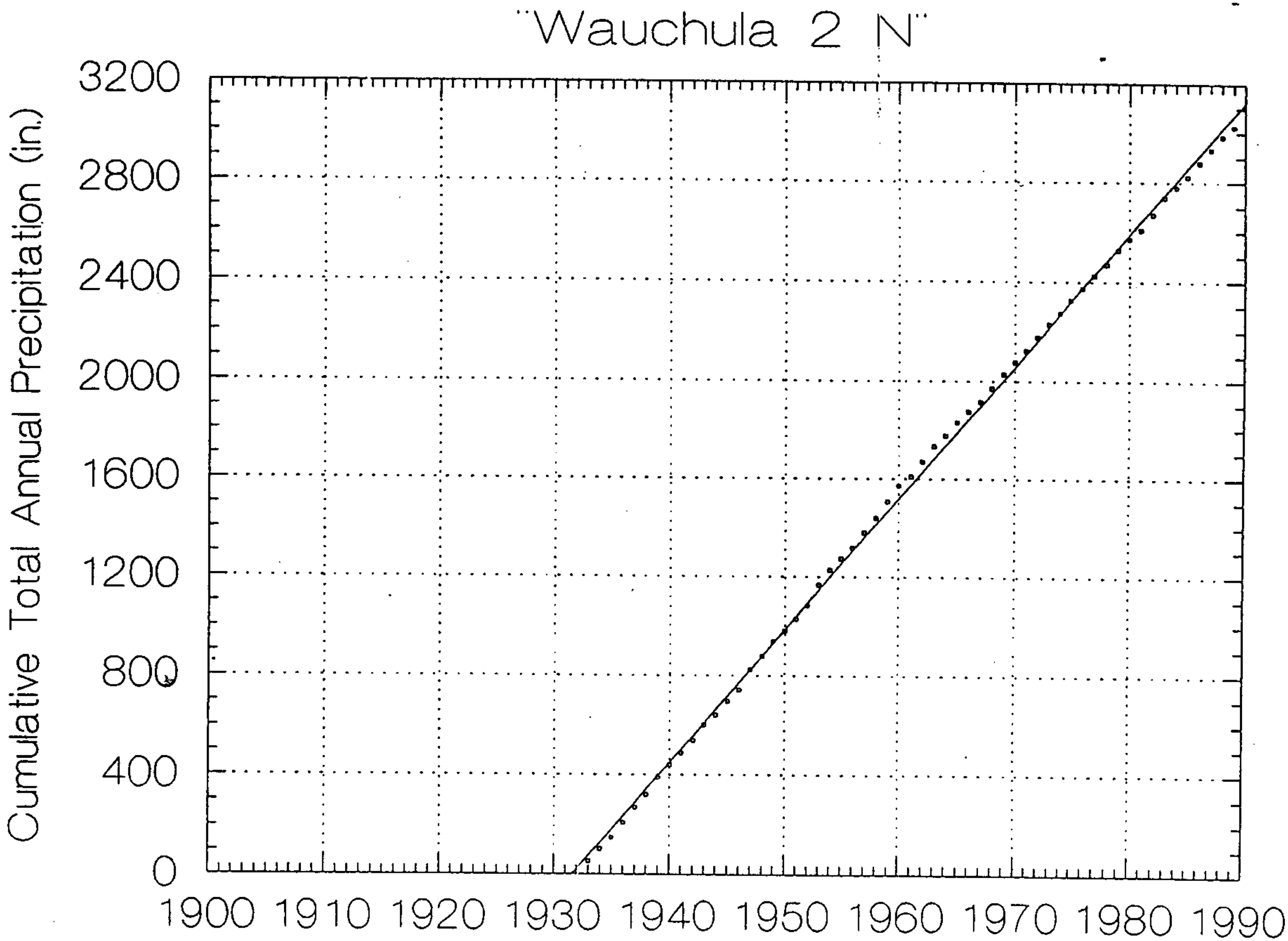



Figure 15. Cumulative total annual precipitation at Wauchula 2 N.

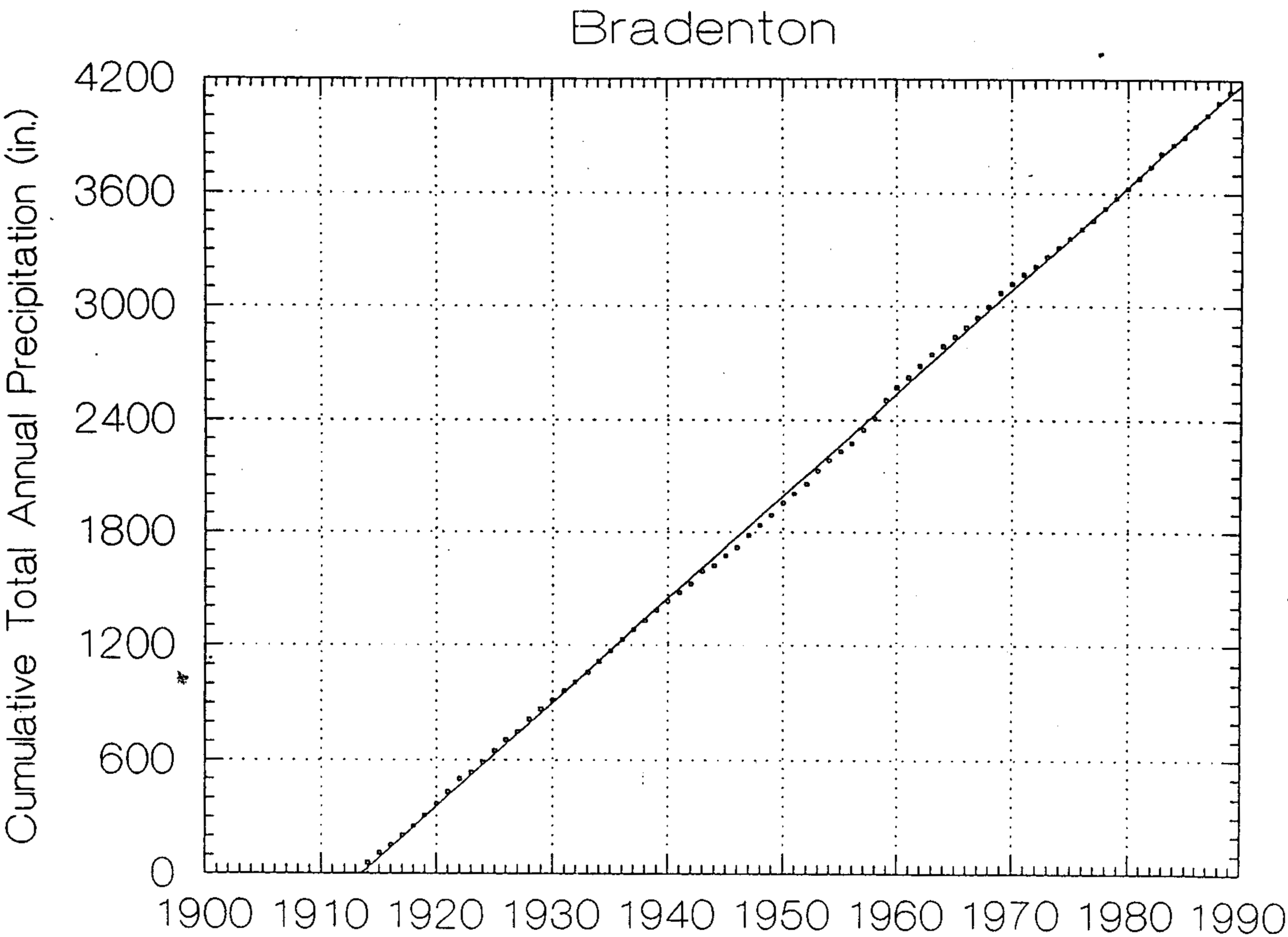



Figure 16. Cumulative total annual precipitation at Bradenton.

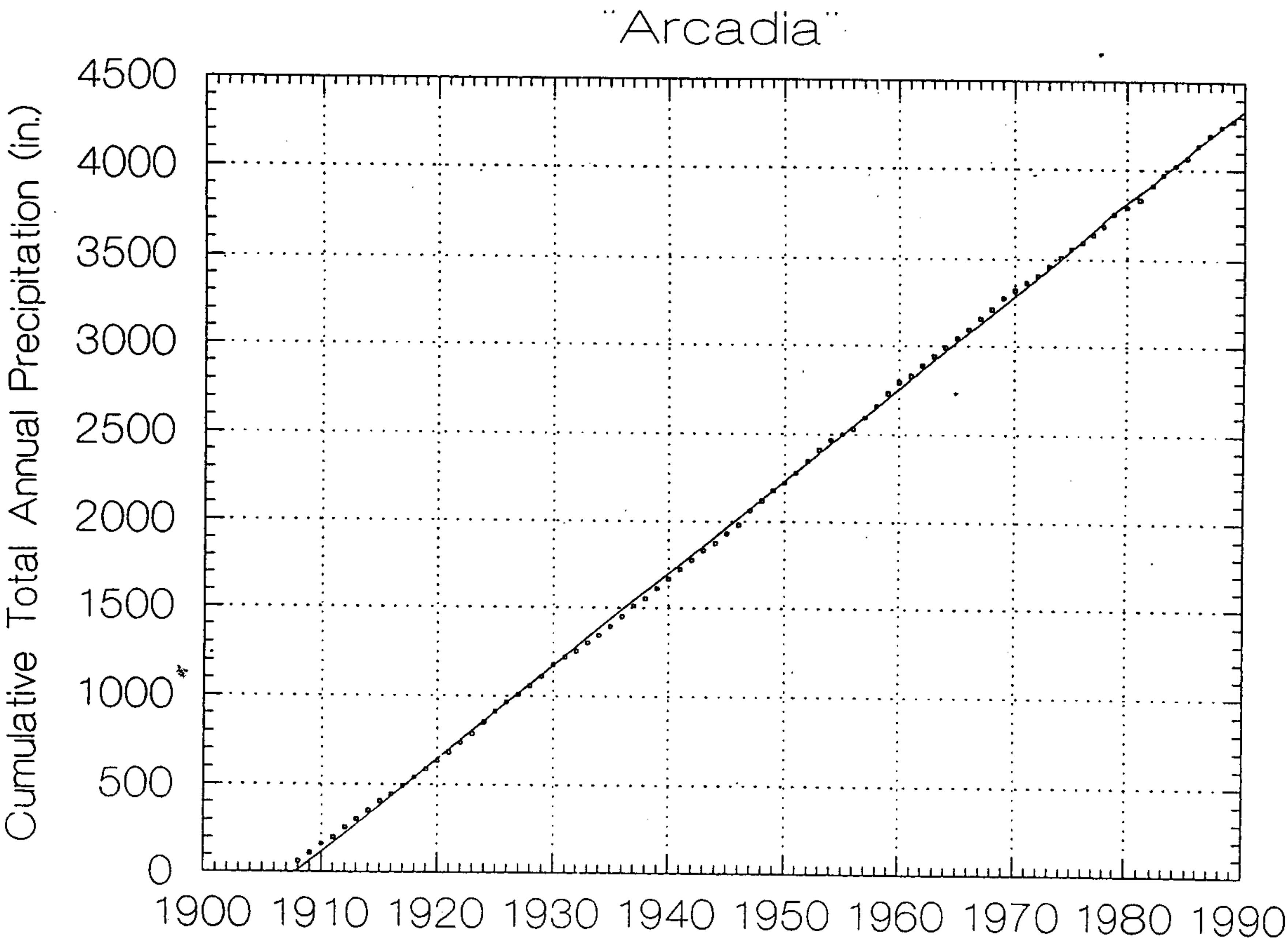



Figure 17. Cumulative total annual precipitation at Arcadia.

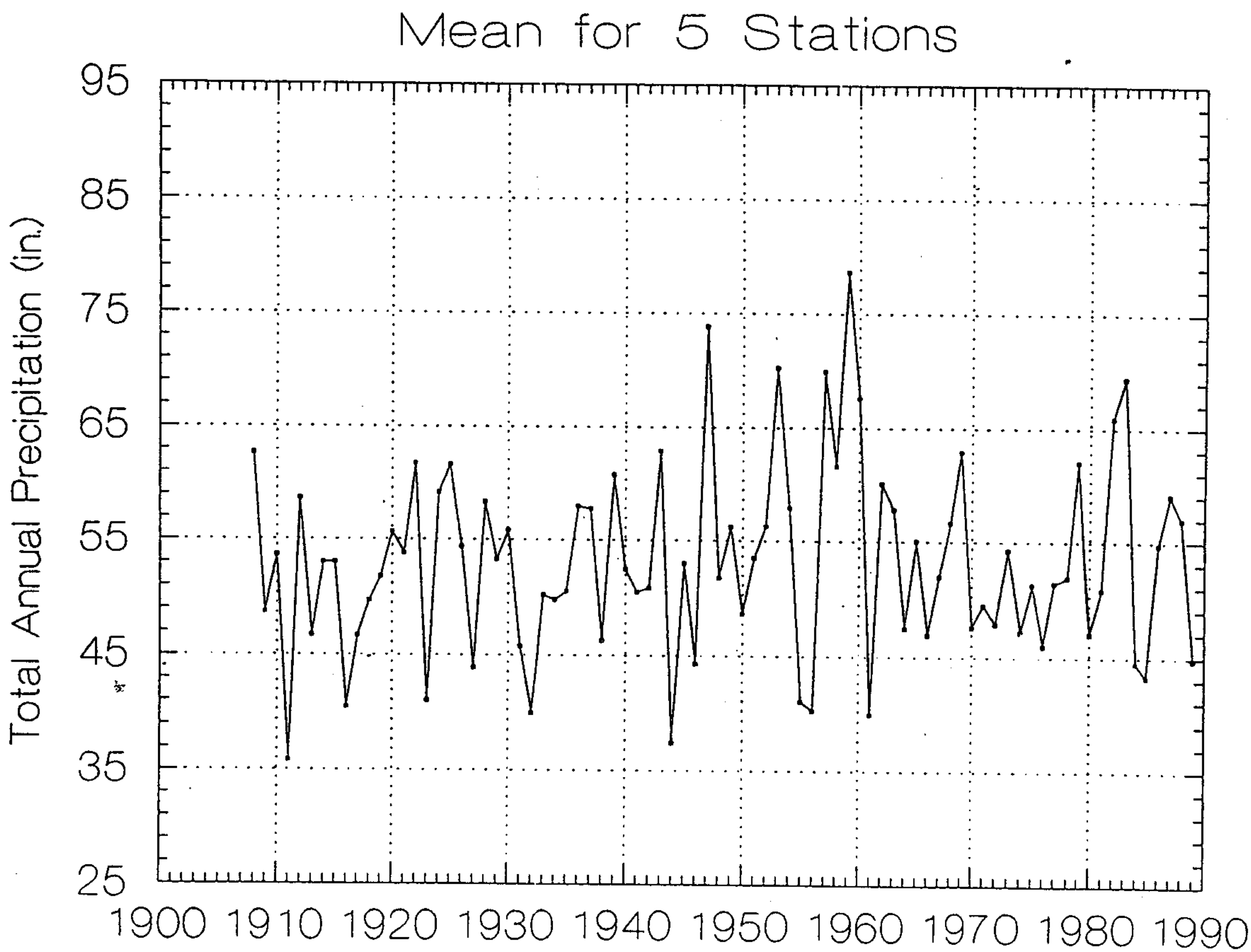
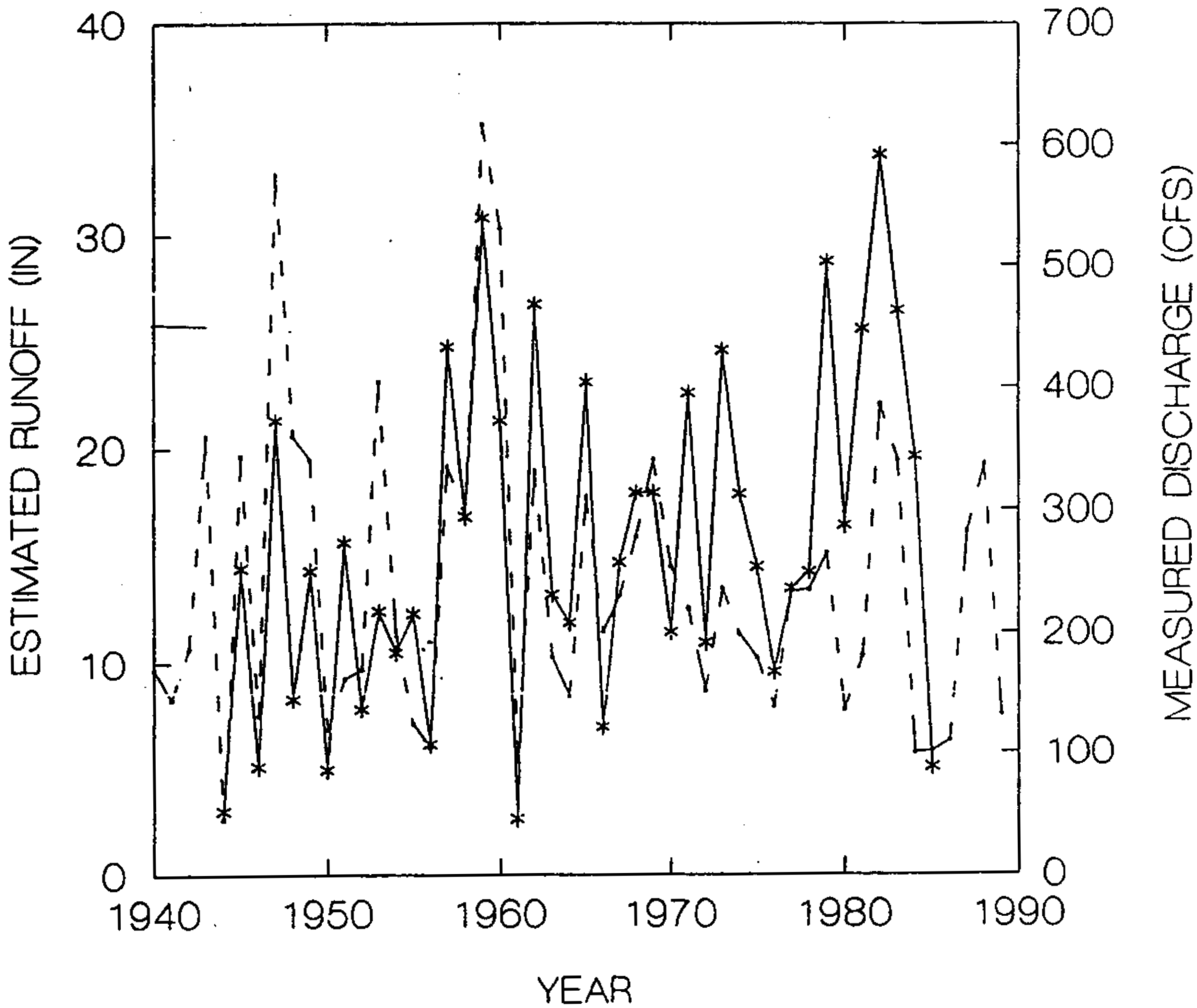



Figure 18. Mean total annual precipitation for five stations in the vicinity of Myakka River State Park.

Figure 19. Measured discharge (dashed line) of the Myakka River at Myakka River State Park in comparison to runoff (solid line) estimated by Dames and Moore (1986) on the basis of a Surface Water Balance Model.



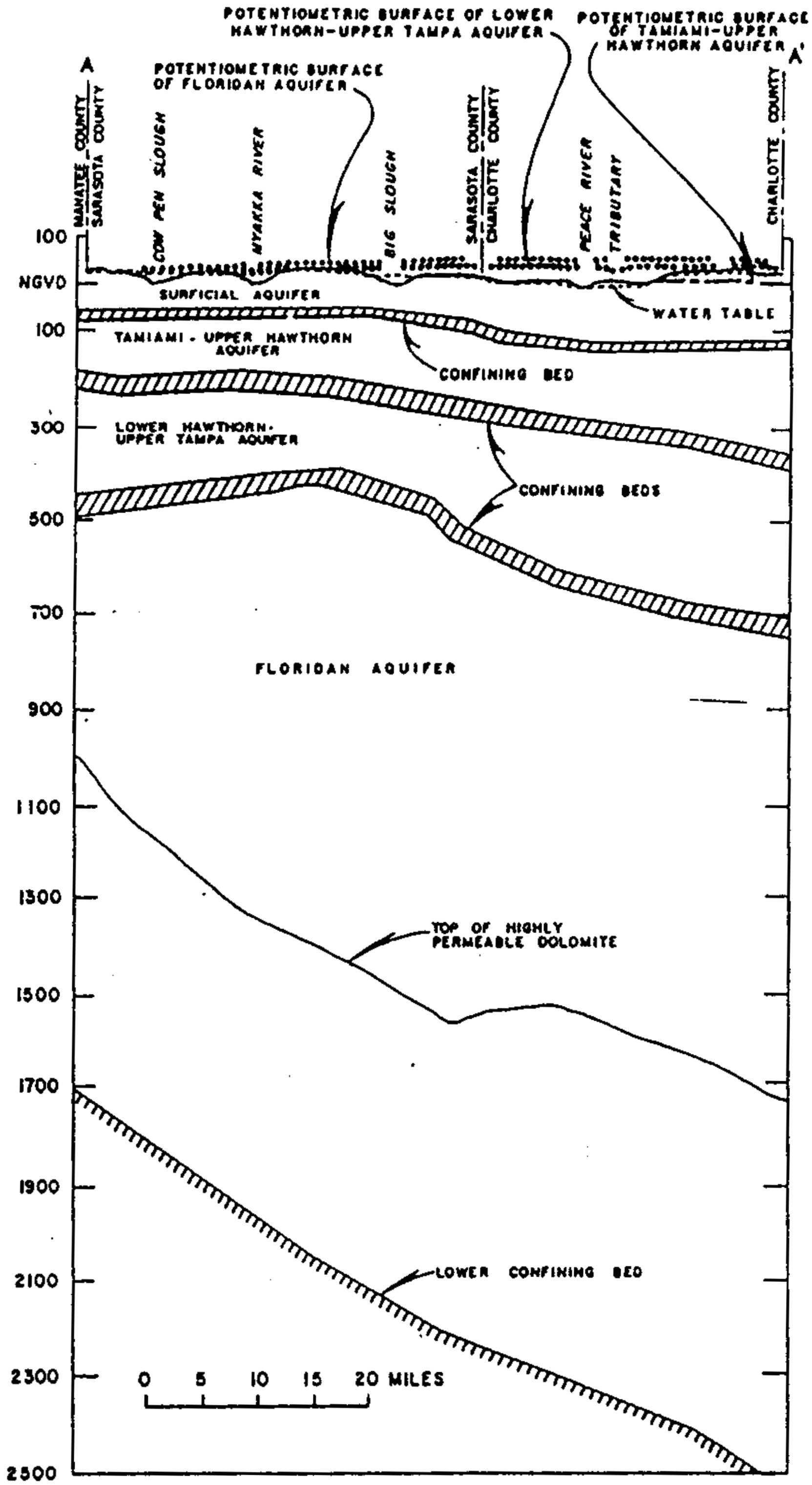
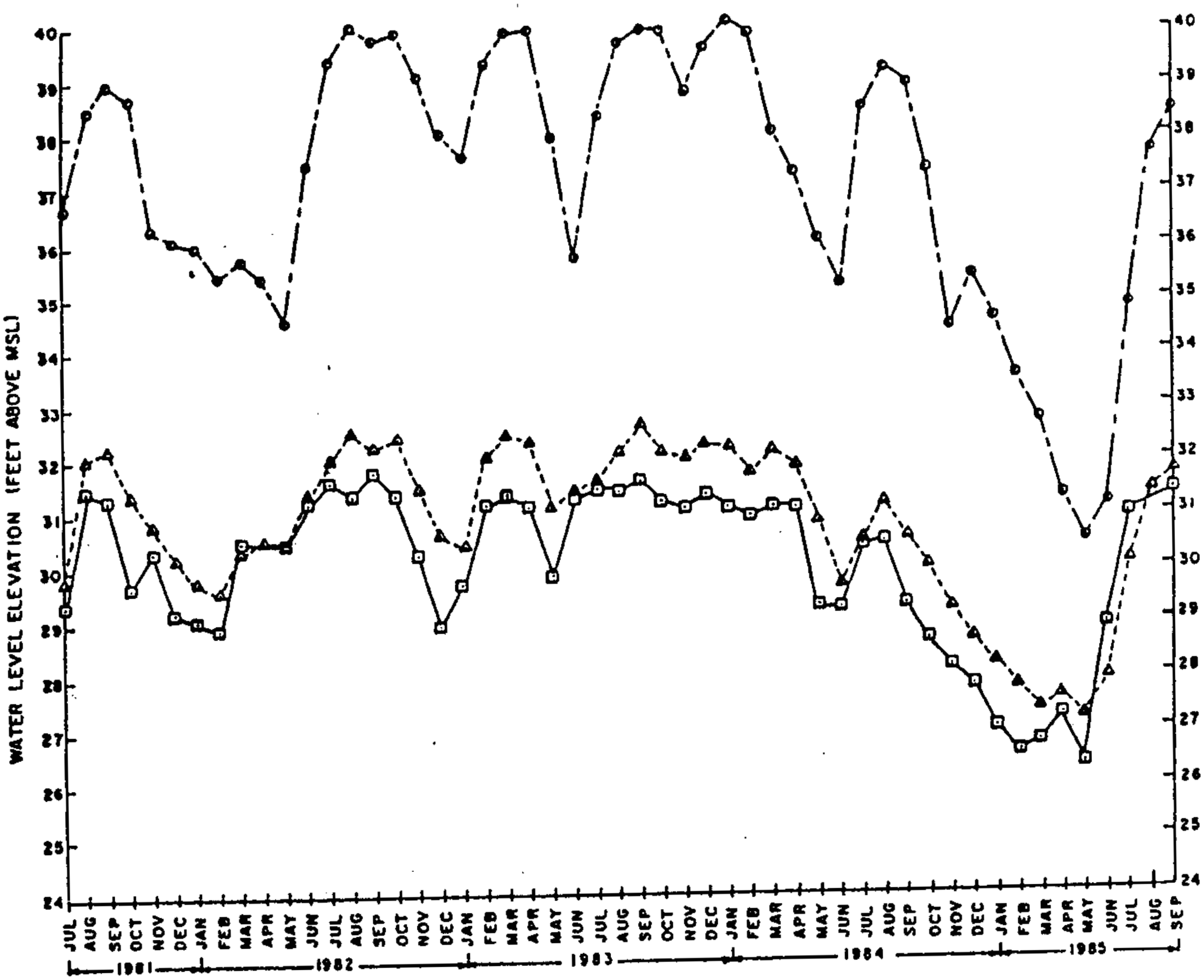
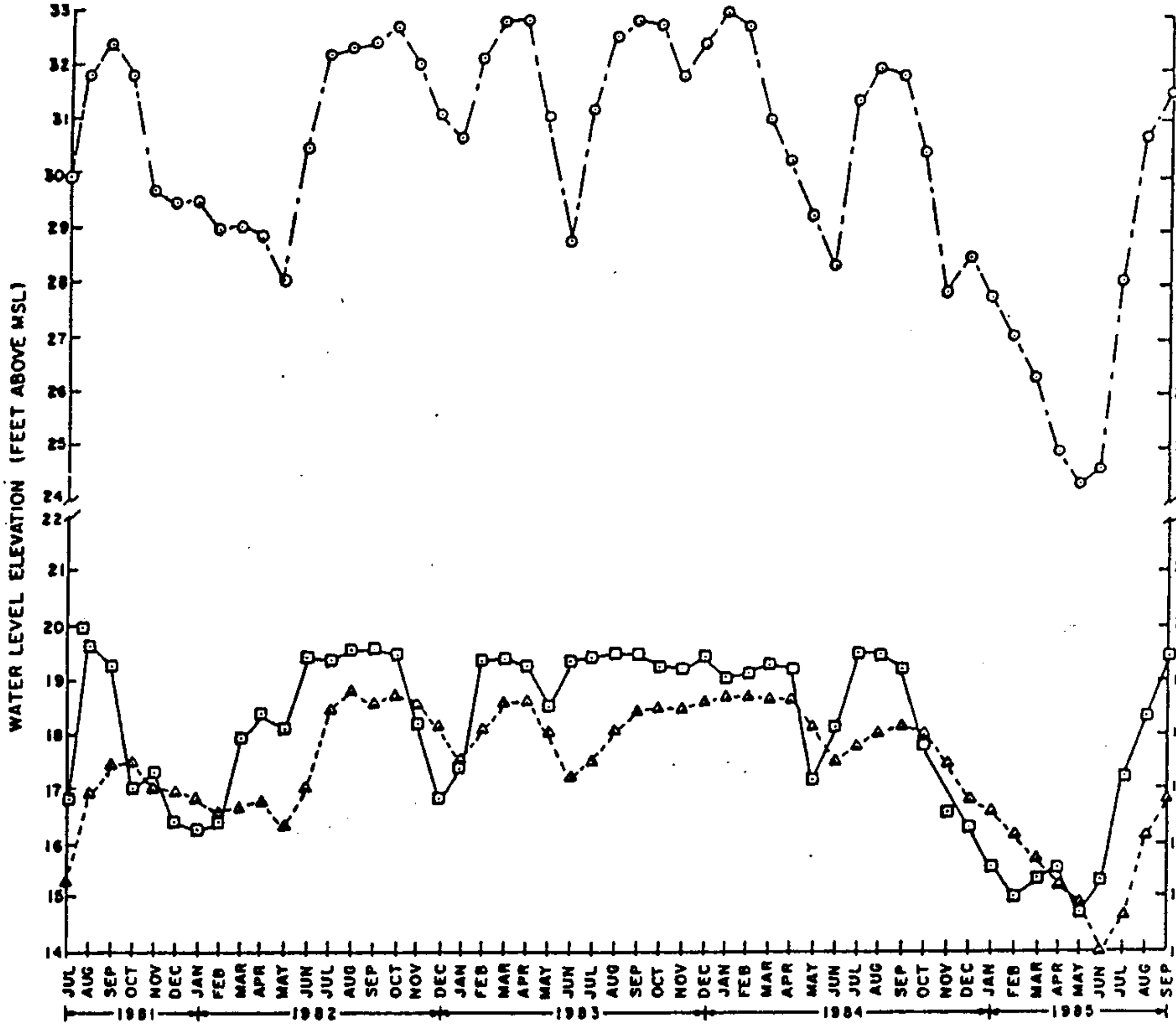



Figure 20. Generalized hydrogeologic section along a line extending from the Manatee-Sarasota County line northwest of Myakka River State Park to the Charlotte-Lee County line just east of U.S. Route 41. It crosses the Myakka River just above Lower Myakka Lake (Wolansky 1983).




Key:
- ⊡ Surficial Aquifer Water Level Measurement
- △ Secondary Aquifer Water Level Measurement
- ⊙ Floridan Aquifer Water Level Measurement

Figure 21. Groundwater hydrographs for the three aquifers monitored by the ROMP 19E well grid on the Carlton Reserve (Dames and Moore 1986).




Key:
⊡ Surficial Aquifer Water Level Measurement
△ Secondary Aquifer Water Level Measurement
⊙ Floridan Aquifer Water Level Measurement

Figure 22. Groundwater hydrographs for the three aquifers monitored by the ROMP 19W well grid on the Carlton Reserve (Dames and Moore 1986).

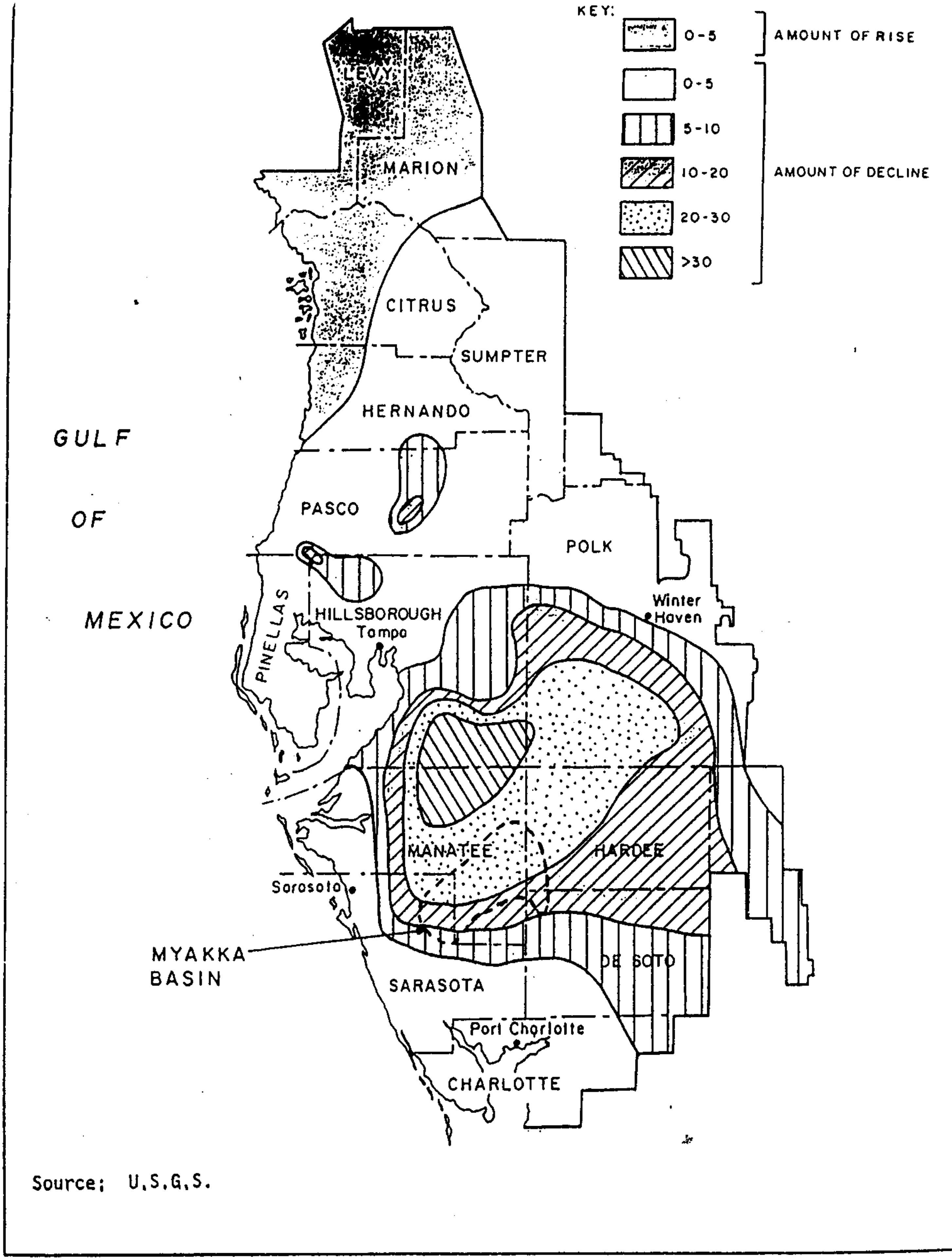



Figure 23. Floridan Aquifer water level declines 1960-1980 (Dames and Moore 1986).

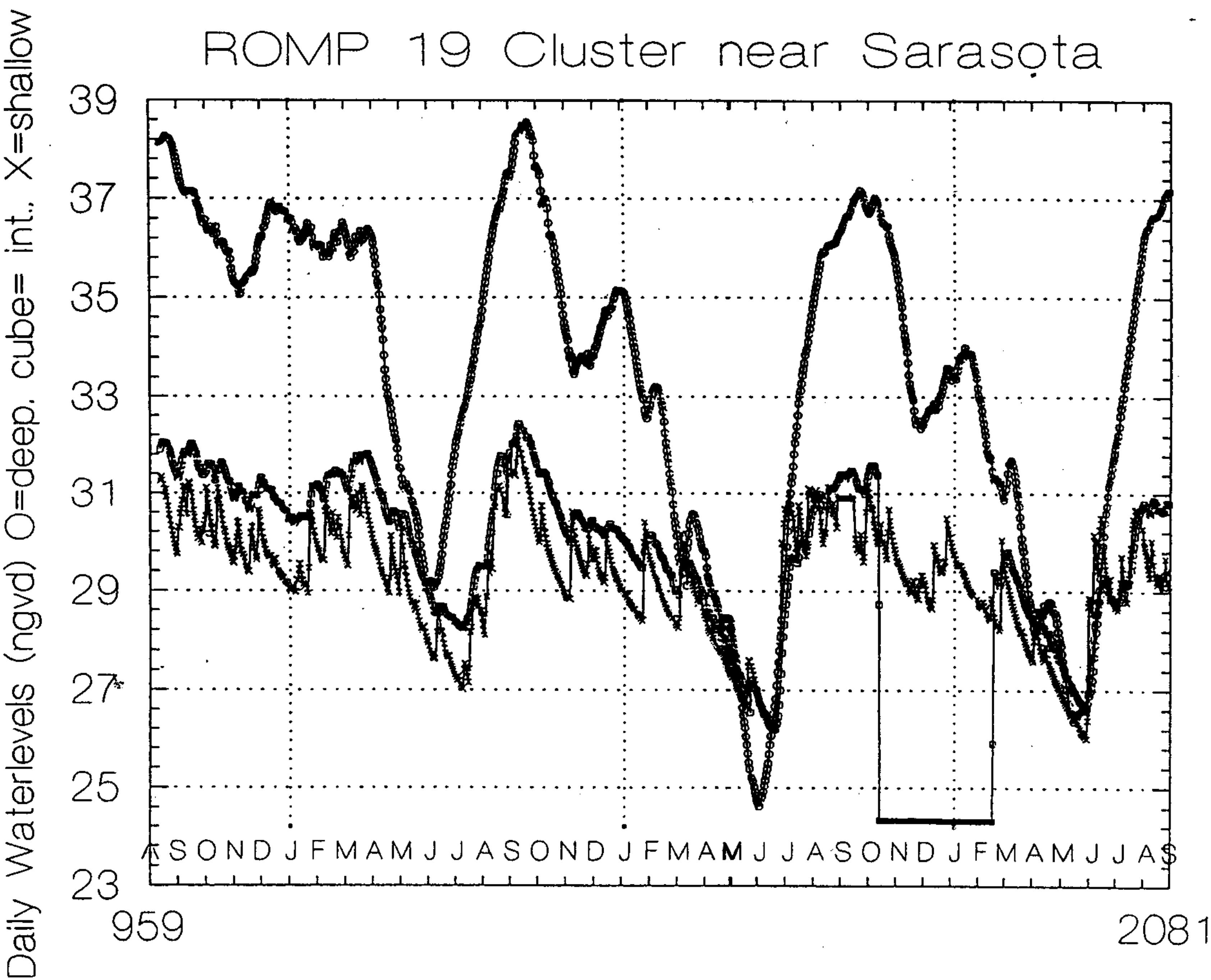



Figure 24. Groundwater hydrographs for the three aquifers monitored by the ROMP 19E well grid on the Carlton Reserve.

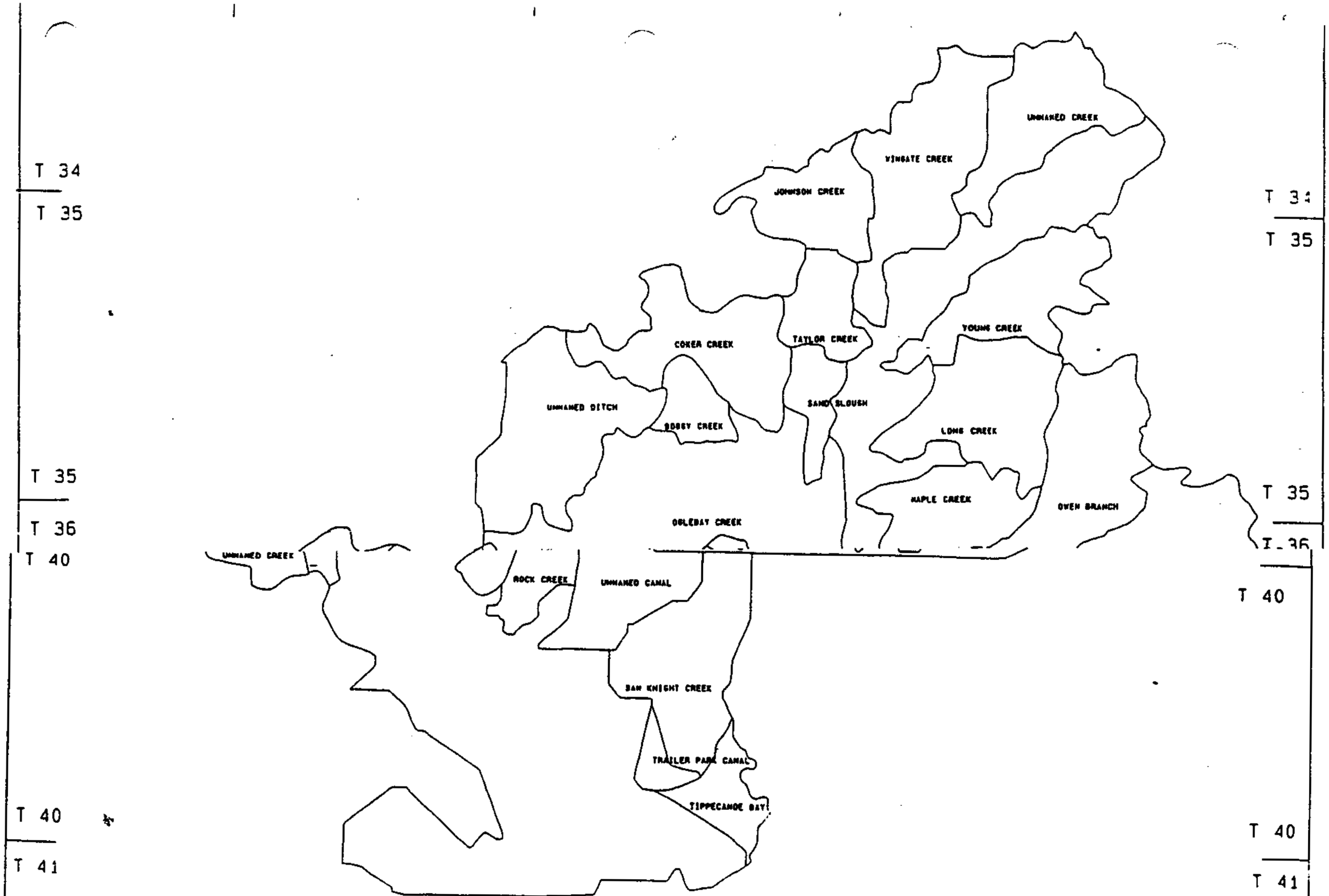
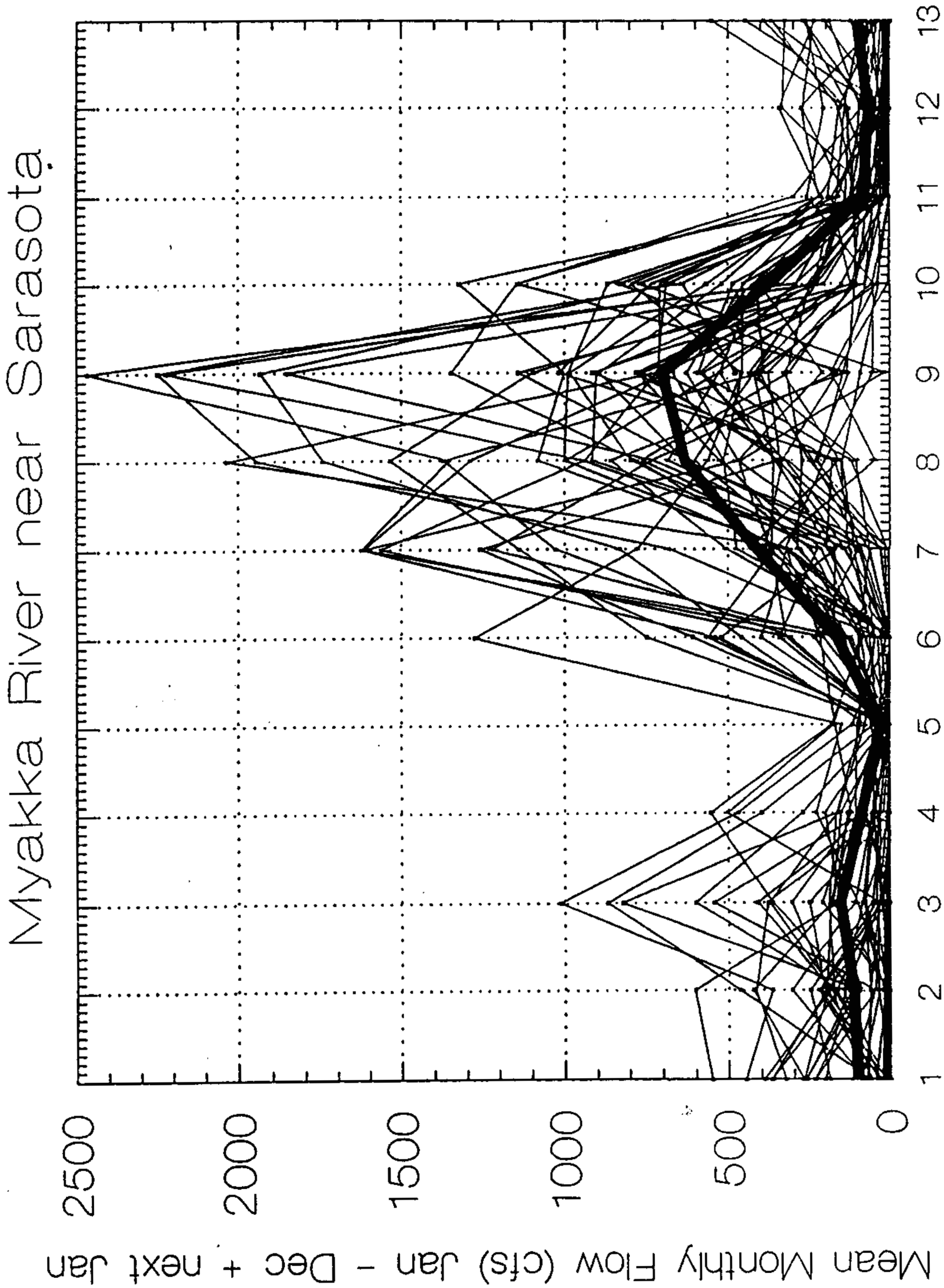



Figure 25. Sub-basins within the Myakka River watershed based on a Southwest Florida Water Management District GIS overlay of the area above and immediately below Myakka River State Park.

Figure 26. Mean monthly flow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park. Each year's data is plotted as an overlay. The heavy line is mean monthly flow for the period of record.



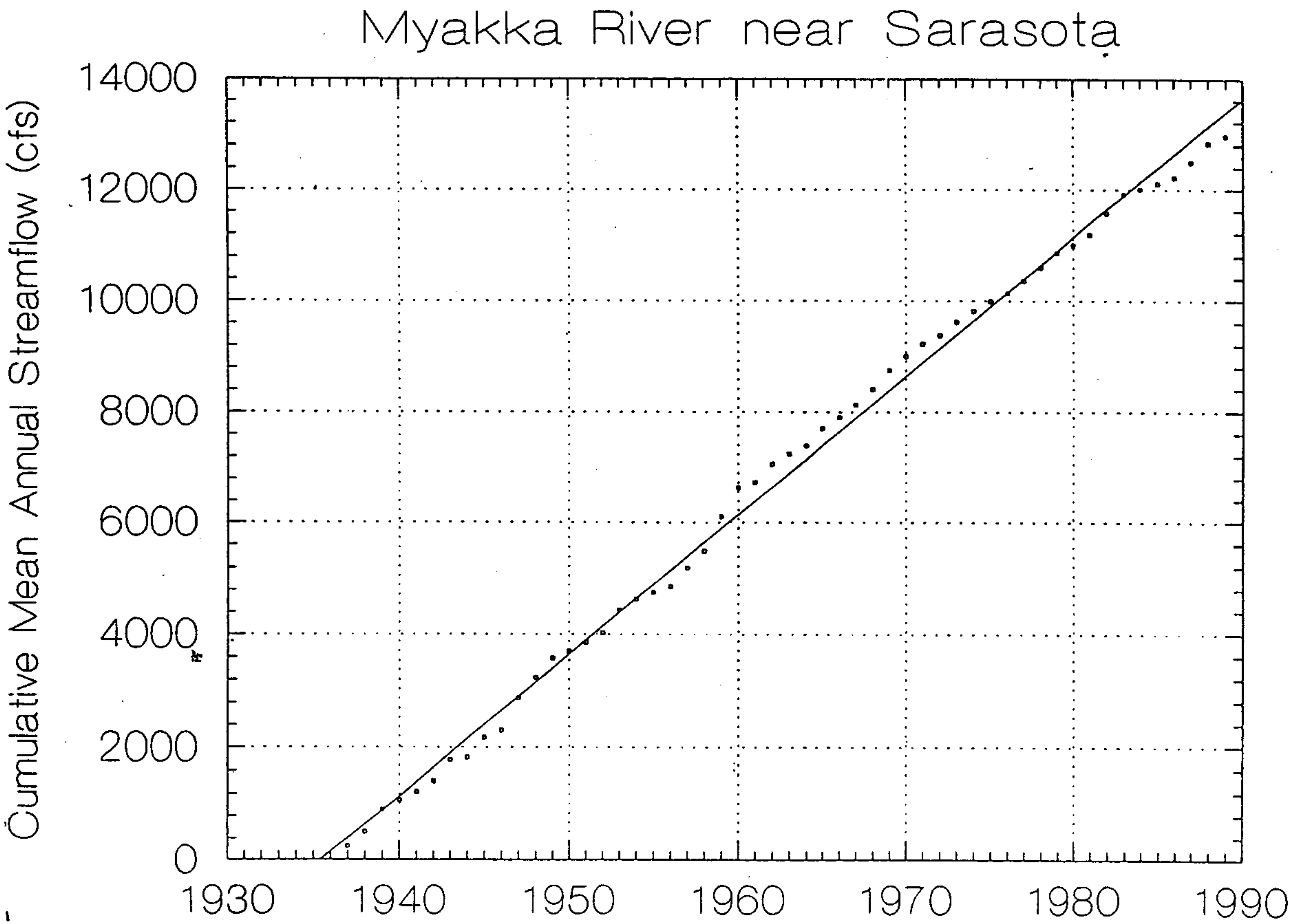



Figure 27. Cumulative mean annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park.

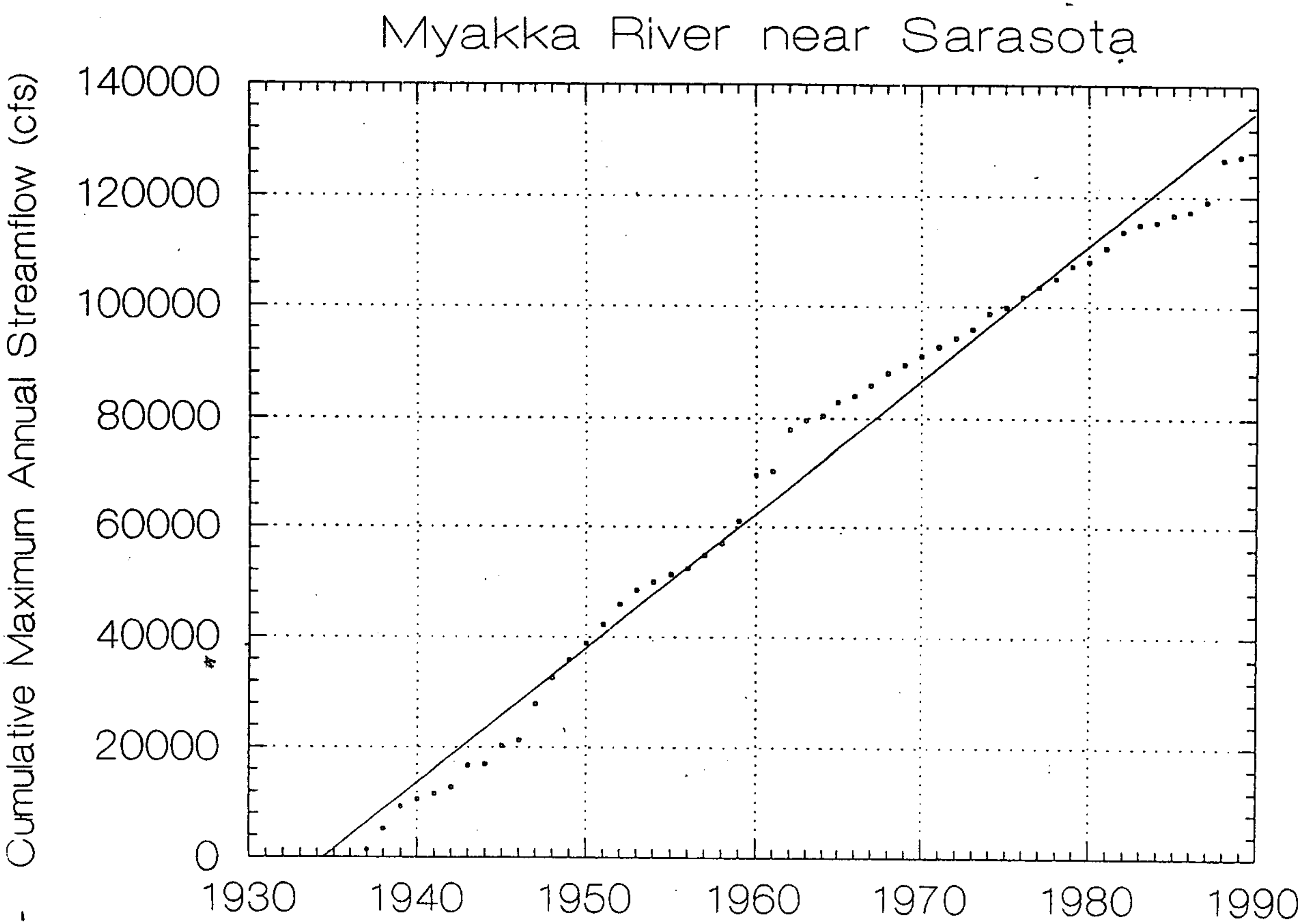



Figure 28. Cumulative maximum annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park.

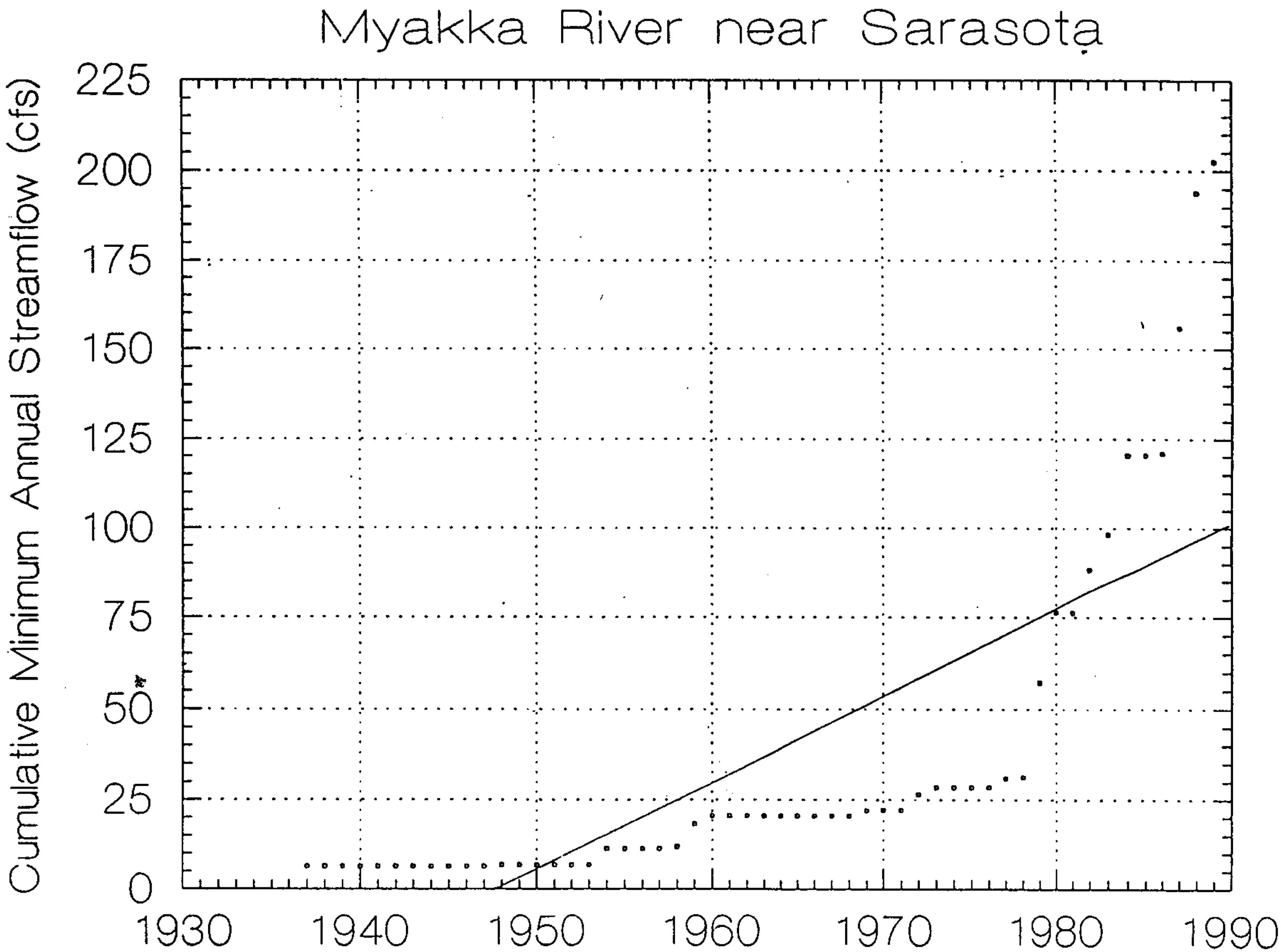



Figure 29. Cumulative minimum annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park.

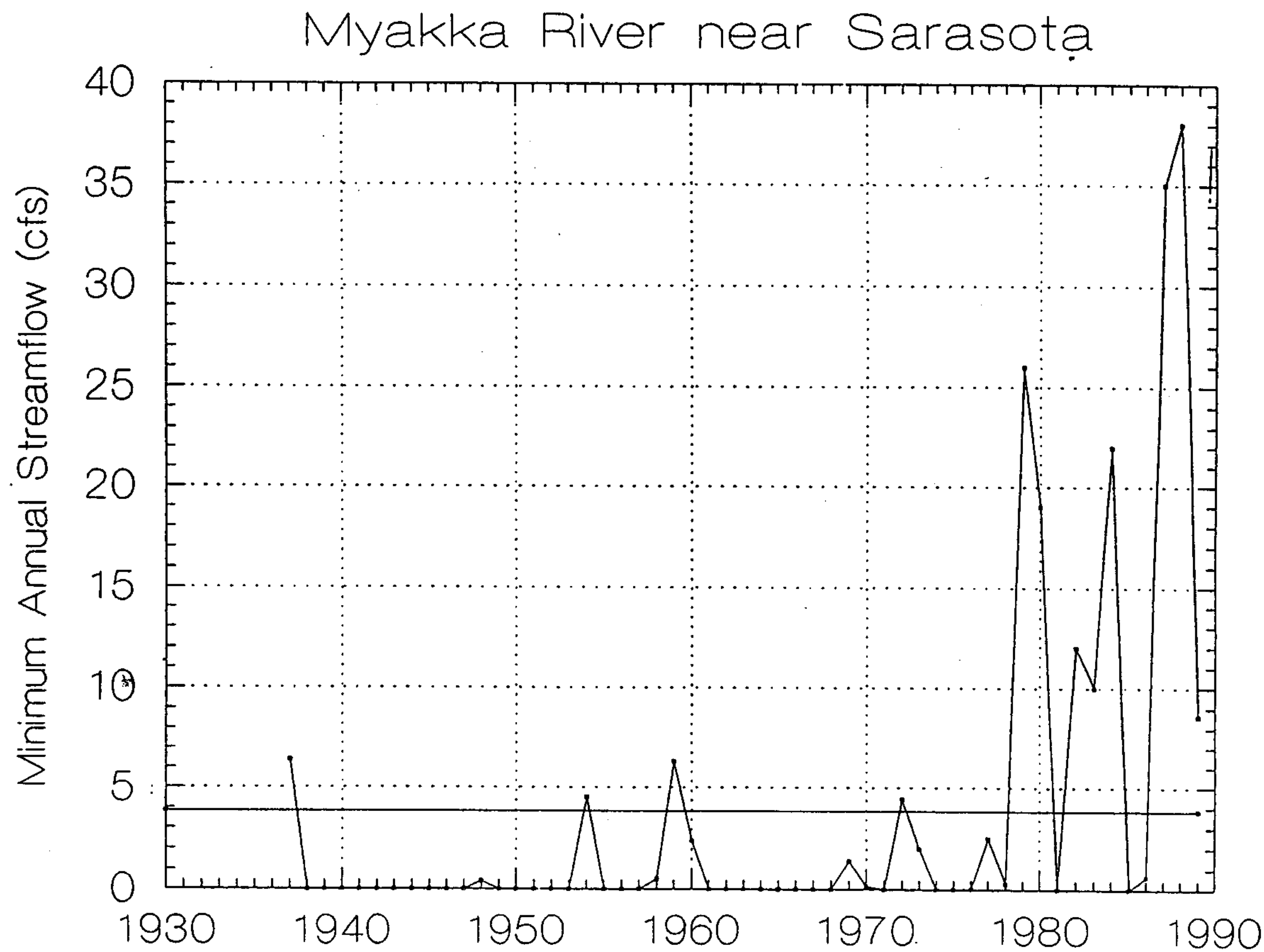



Figure 30. Minimum annual streamflow at the Myakka River near Sarasota water level monitoring station in Myakka River State Park. The horizontal line is the mean annual flow for the period of record.

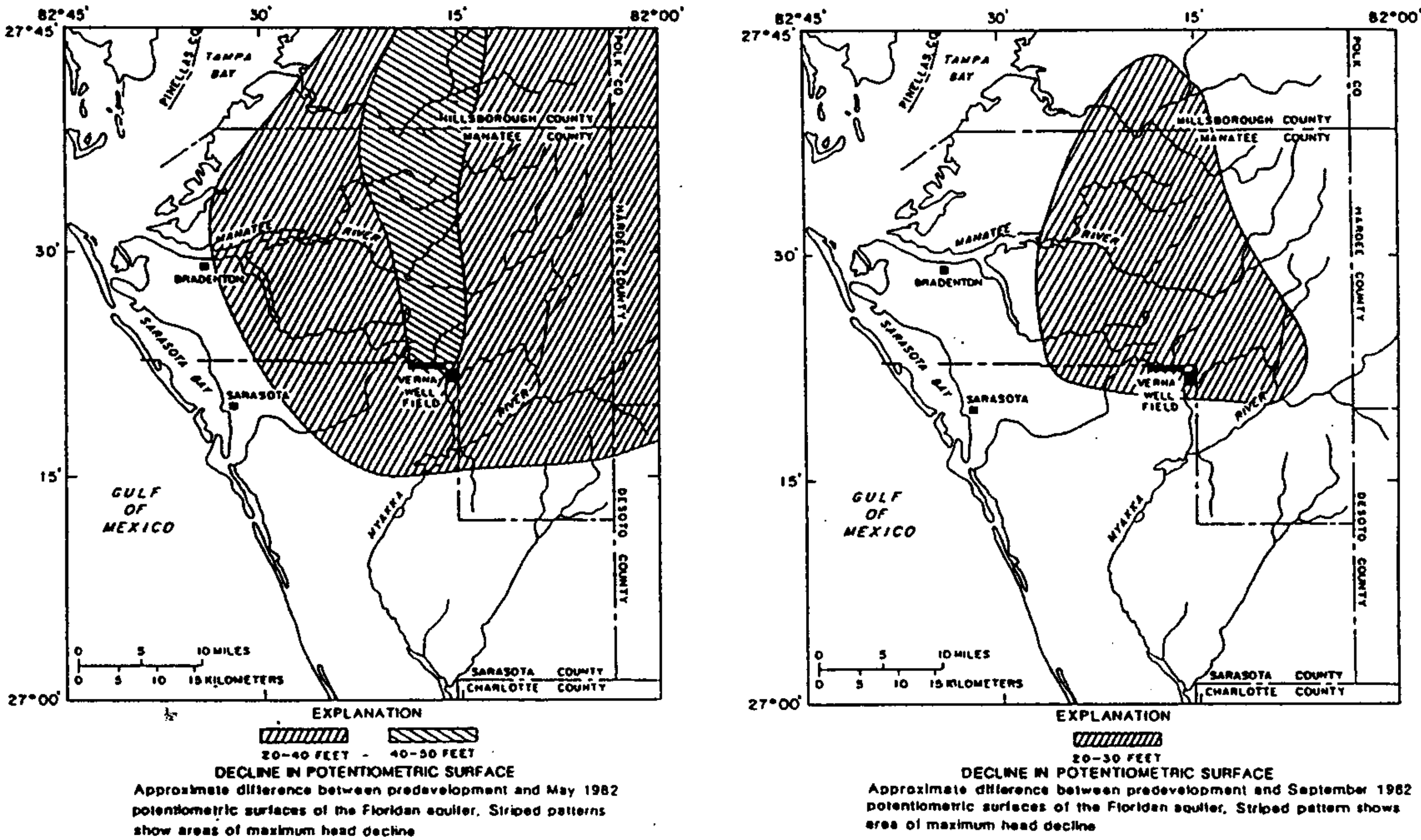



Figure 31. Estimated decline in the potentiometric surface of the Floridan Aquifer since predevelopment conditions (Hutchinson 1984).

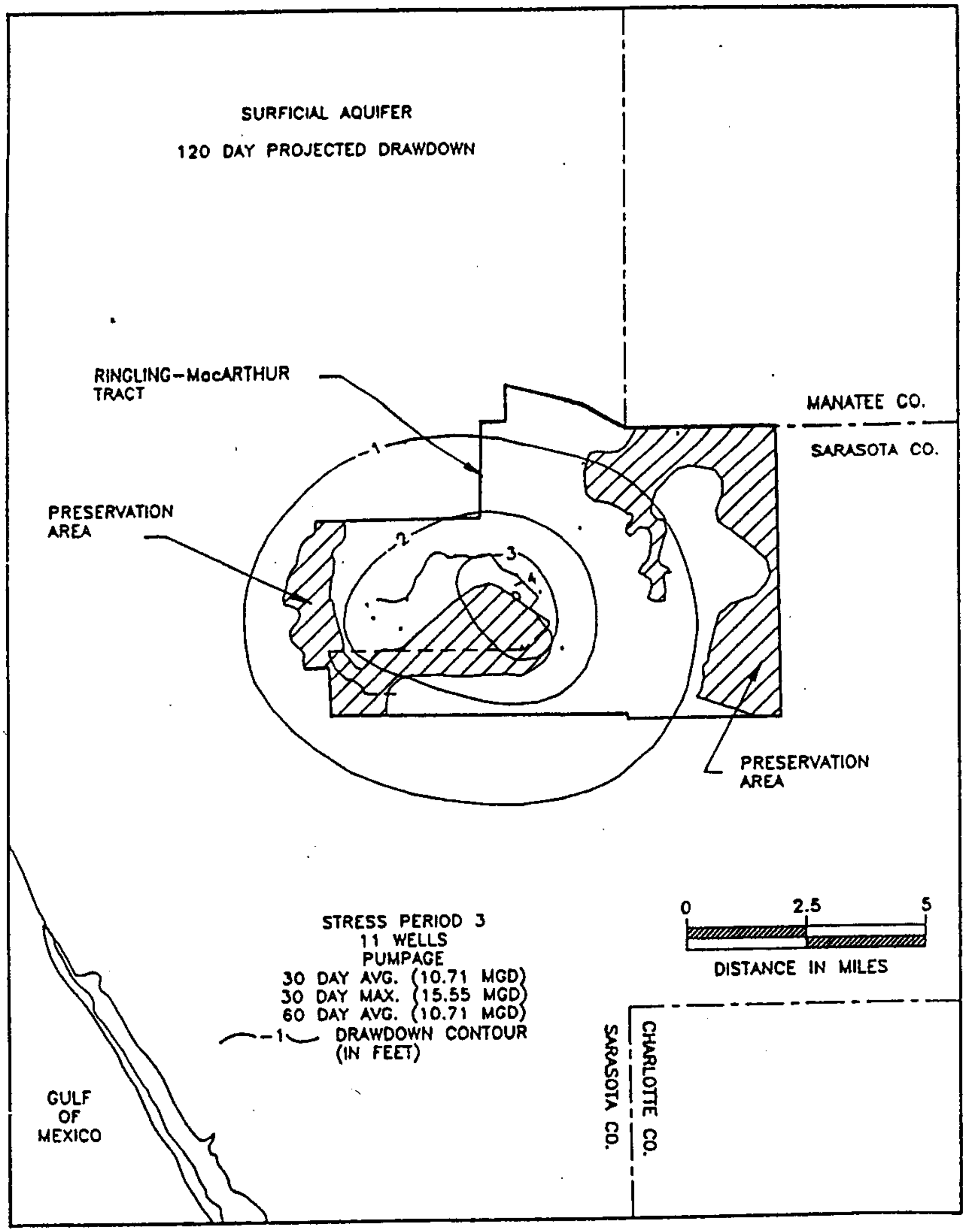



Figure 32. The projected drawdown in the Surficial Aquifer resulting from a 120-day stress test on pumping from the Floridan Aquifer on the Carlton Reserve (Dames and Moore 1988).

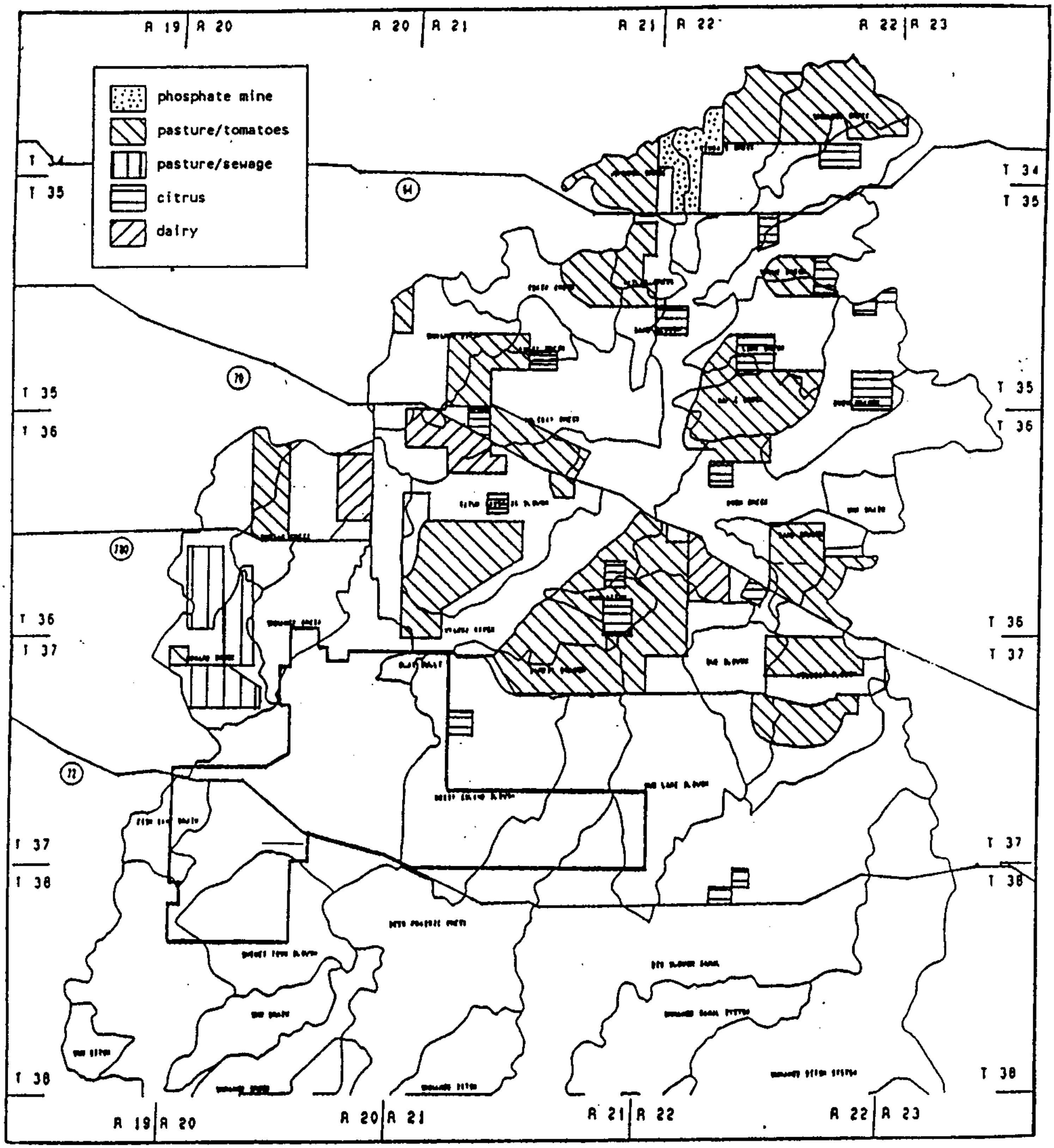



Figure 33. Land uses as of 1989 in the Myakka River watershed upstream of or near Myakka River State Park. It is overlaid on a reduced copy of Figure 25, which shows more clearly the location of Myakka River State Park and the names of the Myakka River sub-basins.

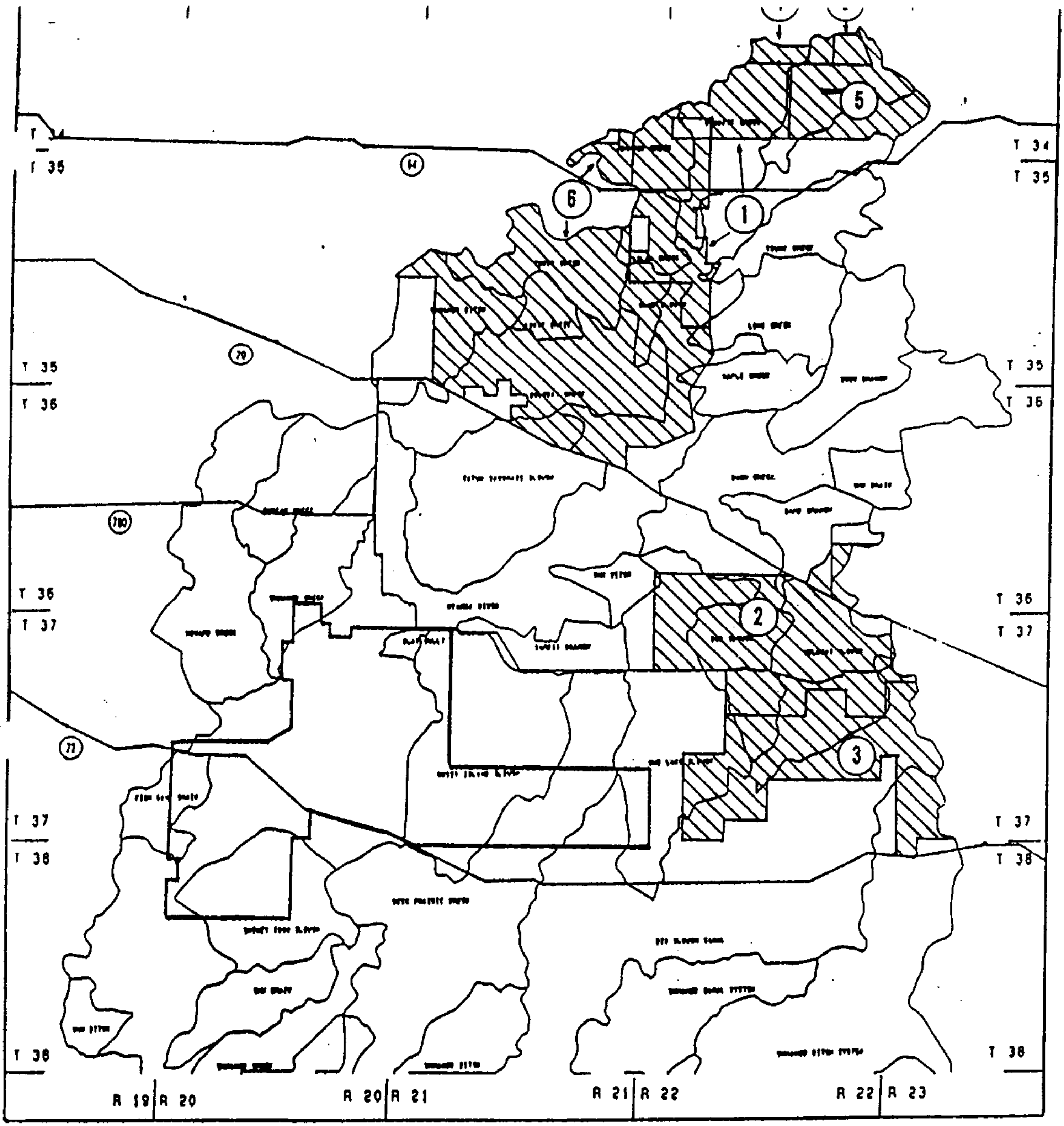



Figure 34. The hatched area indicates the location of lands owned by phosphate mining companies in the Myakka River watershed (Sarasota Herald Tribune 1976). Numbers refer to the company that owns the land: (1) Beker Phosphate Corporation, (2) International Minerals & Chemical Corporation, (3) Phillips Petroleum, (4) Swift Chemical Company, (5) Texaco, (6) WR Grace & Company. It is overlaid on a reduced copy of Figure 25, which shows more clearly the location of Myakka River State Park and the names of its watershed sub-basins.

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# ?PORT DOCUMENTATION PAGE

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**5. Supplementary Notes**

**6. Abstract (Limit: 200 words)**


The watershed above Myakka River State Park has gone from a virtually unaltered landscape in the 1940s to one with at least some degree of major alteration over most of its surface in the 1980s. Analysis of water flows at two sites on the Myakka River and three sites on rivers in adjacent watersheds has shown no major changes in mean, maximum, or minimum flows for the periods of record at each site. Another more subtle change in the park's hydrology, however, is the increasing use of groundwater in the region, which is showing significant affects on the aquifers that underlie the park and its upstream watershed. There is ample evidence that these aquifers are all interconnected with each other and with the surface water table, although the degree of connection is spatially quite variable. Because the affect will be felt on the water table throughout the park as well as on surface water flows, long term changes in the potentiometric surfaces of these aquifers may ultimately have more affect on the Myakka River State Park ecosystem than other types of changes in the watershed that affect only flows in the Myakka River itself.


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Natural area management.

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