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Fluctuations of the water table in Lee County, Florida, 1969-1973

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T. M. Missimer

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D. H. Boggess

OPEN FILE REPORT

FL 74019

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

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Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
FLORIDA DEPARTMENT OF NATURAL RESOURCES,
BUREAU OF GEOLOGY
and the
COUNTY COMMISSIONERS OF LEE COUNTY

Tallahassee, Florida

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ABSTRACT

The water table in Lee County generally ranges from near land surface to about 4 feet (1 metre) below land surface in June-October when recharge from rainfall is maximum. When recharge is limited by a deficiency of rainfall, the water table may range from 3 to 10 feet (1 to 3 metres) below the land surface.

Because of the nearness of the water table to land surface particularly during the wet season, extensive drainage networks have been constructed to make the land suitable for urban development.

INTRODUCTION

The rapid increase of population in Lee County from 23,404 in 1950 to an estimated 124,000 in 1972, has resulted in progressively greater demands on existing water supplies. Urbanization has at the same time increased the need for drainage of the land. This paradox emphasizes the need for more detailed information to facilitate effective management and conservation of the water resources of the area.

Lee County, comprising an area of 786 square miles (2036 square kilometres), is located on the southwest coast of Florida as shown on figure 1. The area is flat; land surface altitudes ranges from near sea level to about 32 feet (10 metres) above. The climate is subtropical; mean annual air temperature is 74° F (22° C). Tourism and agriculture remain major sources of income in the county, although the latter has declined as a result of increased urbanization.

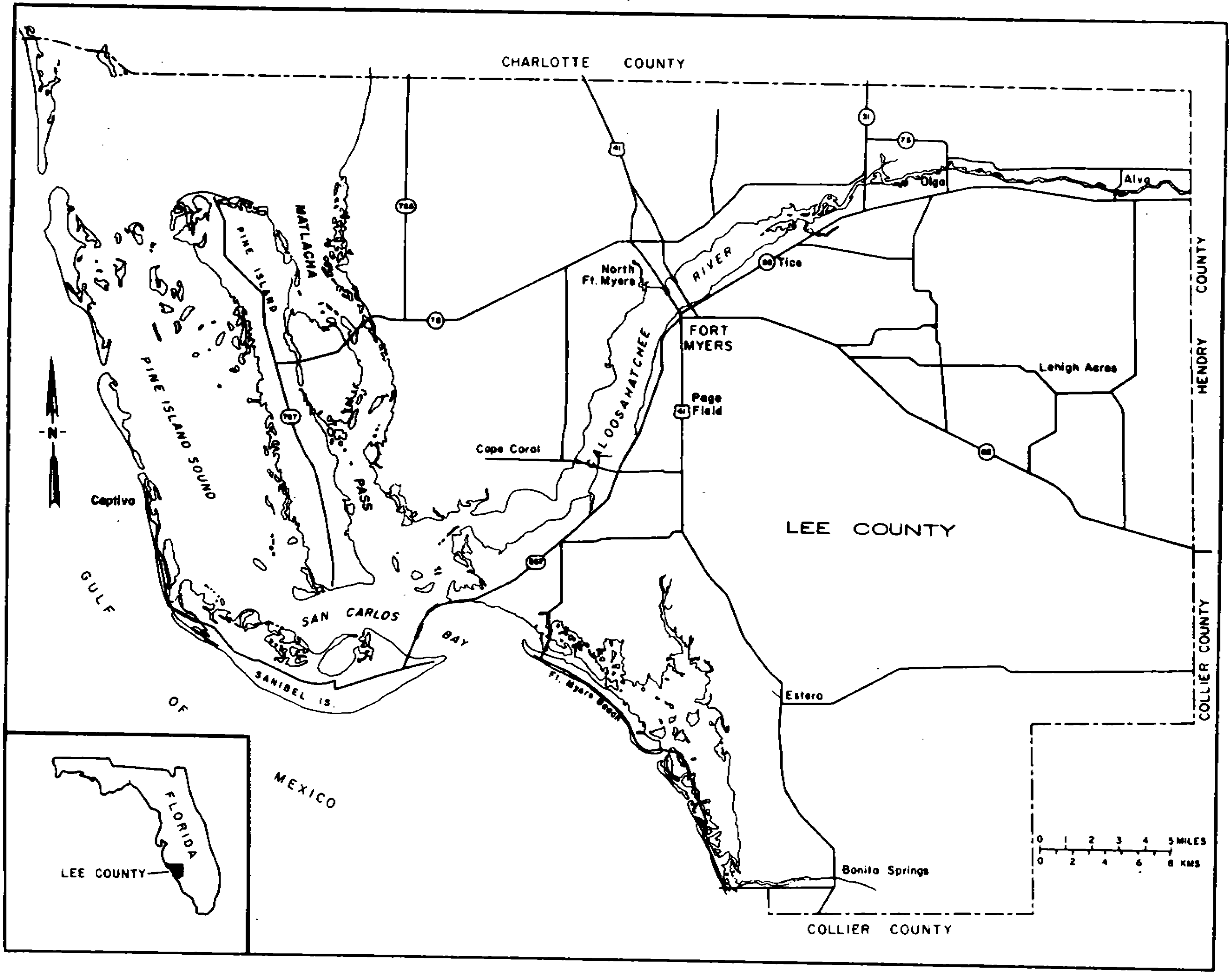

Figure 1.--Lee County, Florida showing names referred to in report.

Lee County is underlain by a series of water-bearing formations, the uppermost of which is termed the water-table aquifer. This aquifer, near land surface, is more readily affected by man's activities than are deeper aquifers. Drainage canals or ditches may permanently lower water levels in the aquifer; conversely, impoundments of surface water may permanently raise water levels. Pumping from the aquifer may temporarily lower water levels and thereby provide storage when water is available for recharge. High water levels in this aquifer, at or near land surface, may adversely affect the operation of septic tanks, may increase problems of road construction and maintenance, may adversely affect farming operations, and may result in numerous other problems related to man's activity. Low water levels in the aquifer may adversely affect most vegetation, including farm crops. Low ground-water levels will also result in decreased stream flow and lower water levels in lakes or ponds. Thus, establishing a balance wherein water levels in the aquifer are maintained at the highest practical level, according to the use of the land, is an important facet of efficient land management.

PURPOSE AND SCOPE

The purpose of this report is to provide records in concise and useable form of seasonal, annual, and long-term fluctuations of water levels in the water-table aquifer in Lee County. The effects on ground-water levels of natural recharge and discharge and factors related to man's activities are briefly described.

ACKNOWLEDGMENTS

This investigation was made as part of continuing program of monitoring ground-water levels in cooperation with the Florida Department of Natural Resources, Bureau of Geology, and the Board of County Commissioners of Lee County. The investigation is under the general supervision of Clyde S. Conover, District Chief and Thomas J. Buchanan, Subdistrict Chief of the Water Resources Division of the U. S. Geological Survey.

THE WATER-TABLE AQUIFER

Water at shallow depths beneath land surface is divided into 2 major zones: the unsaturated zone, in which water and air coexist in various proportions in the pore spaces between rock particles; and the saturated zone, in which the pores are filled with water. Water in the unsaturated zone is divided into three types; soil water, intermediate soil moisture, and capillary fringe water (fig. 2). Water that enters from the land surface, such as rainfall, must pass through the unsaturated zone before reaching the saturated zone.

The upper surface of the saturated zone, the water table, is "that surface in an unconfined water body at which the pressure is atmospheric" (Lohman and others, 1972, p. 14). This surface corresponds in general to the level at which water will stand in wells tapping the unconfined water body.

In Lee County, the water-table aquifer is made up of fine to medium quartz sand with some interbedded shell, calcareous sandstone, and sandy limestone. Where present, the aquifer may be less than 5 feet (2 metres) thick or it may be nearly 100 feet thick (31 metres) in some areas. Generally, the aquifer reaches a maximum thickness in the southeastern part of the county. In most of the county, the base of the aquifer consists of relatively impermeable gray and green carbonate clay.

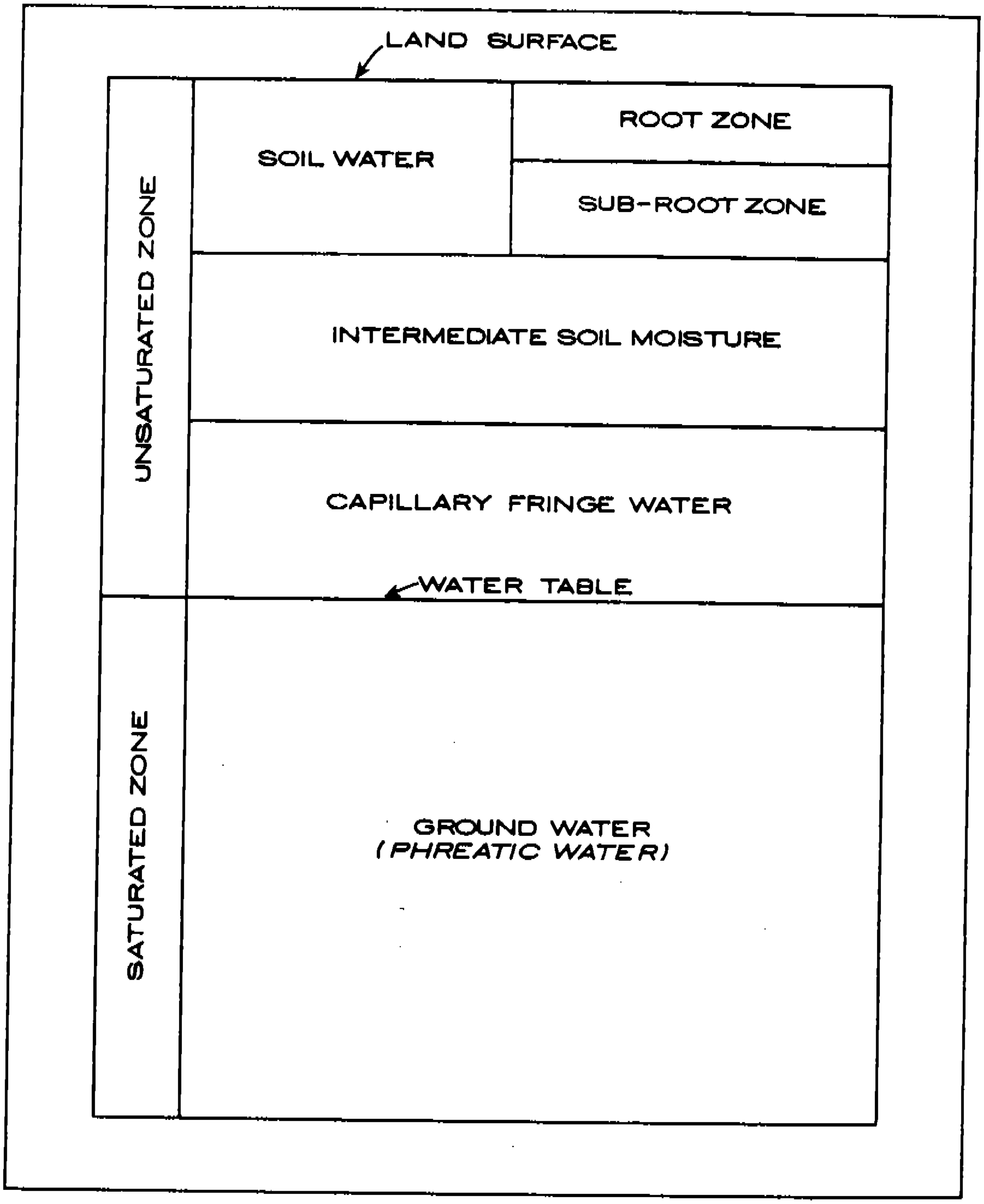

Figure 2.--Diagram showing divisions of subsurface water.

CAUSES OF WATER-TABLE FLUCTUATIONS

Climatic factors produce the greatest overall effect on fluctuations of the water table. The water table rises in response to recharge and declines as a result of discharge from the aquifer. The principal source of recharge is precipitation; natural discharge includes evaporation, transpiration, and discharge to streams or other surface-water bodies.

Fluctuations of the water table indicate changes in the volume of water in storage in the ground. Seasonal variations in rainfall, evaporation, and transpiration produce an imbalance between recharge and discharge so that the position of the water table is continuously changing. Seasonal fluctuations of the water table are repeated in an annual cycle. From year to year under natural conditions, recharge and discharge tend to balance such that little net change in ground-water storage occurs. Obviously, during very wet or very dry years, the water table may be at higher or lower positions than in previous years.

Water is recycled naturally between the atmosphere, the surface-water system, and the ground-water system. This continuous cycle of water interchange consisting of components of condensation, precipitation, infiltration, evaporation, and transpiration is termed the hydrologic cycle (fig. 3). Events of the hydrologic cycle produce fluctuations of the water table as previously described. Superimposed on the natural cycle of water-table fluctuations, are the effects of man's activities.

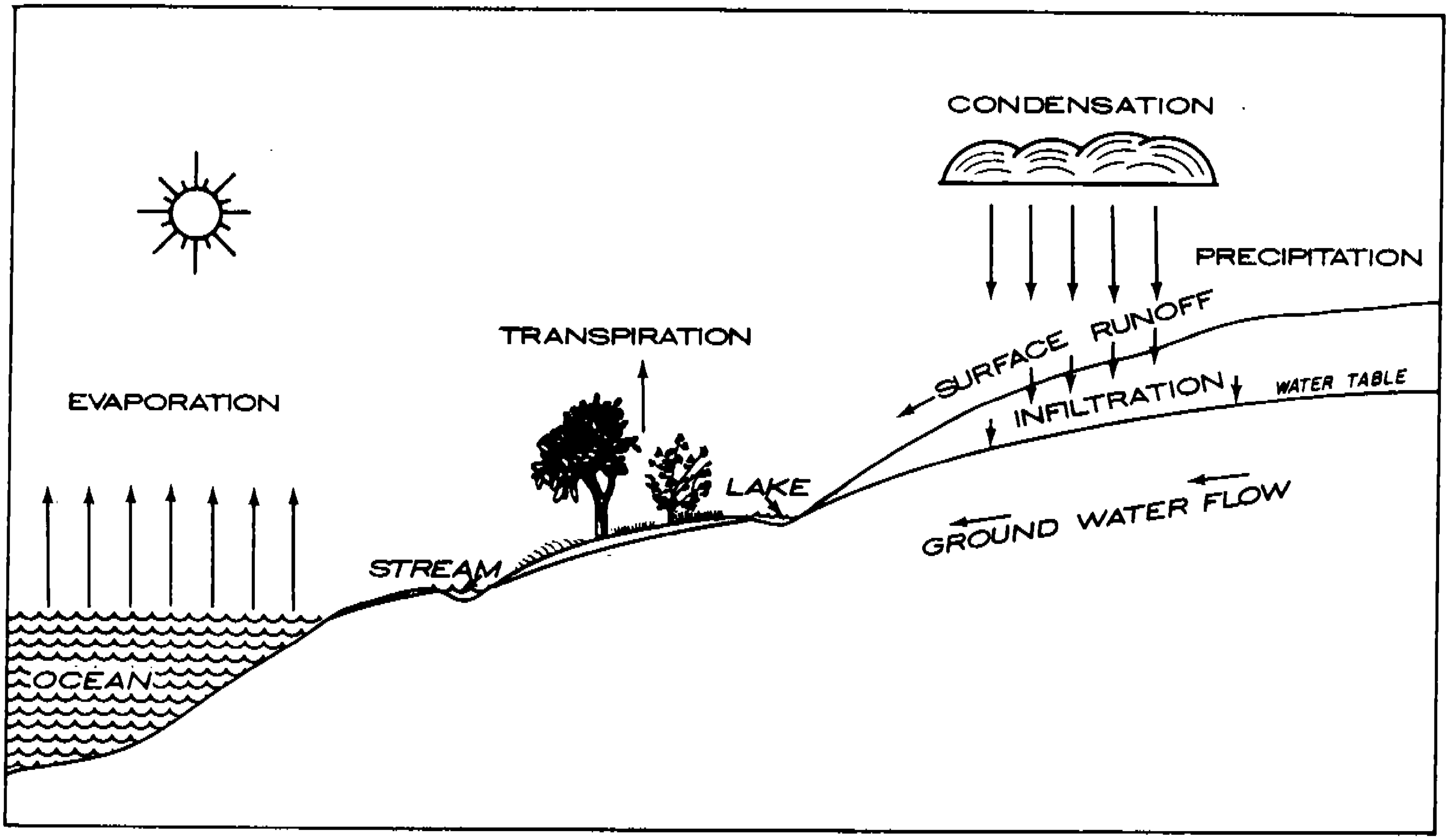

Figure 3.--Diagram showing the movement of water through the hydrologic cycle.

OBSERVATION WELLS

The location of the observation wells which tap the water-table aquifer in Lee County are shown on figure 4. The depth, casing diameter, and the year measurements were started on these wells are summarized in table 1.

Wells L-246, L-576, L-954, and L-1137 are equipped with recording instruments which provide a continuous record of water levels. In other wells, the water level is measured periodically, usually at 1-or 2-month intervals. Because of the time interval, these periodic measurements give some indication of the range of fluctuation of the water table, but often do not yield maximum or minimum levels. Where continuous records are obtained, the information presents a more detailed record of the range in fluctuations of the water table.

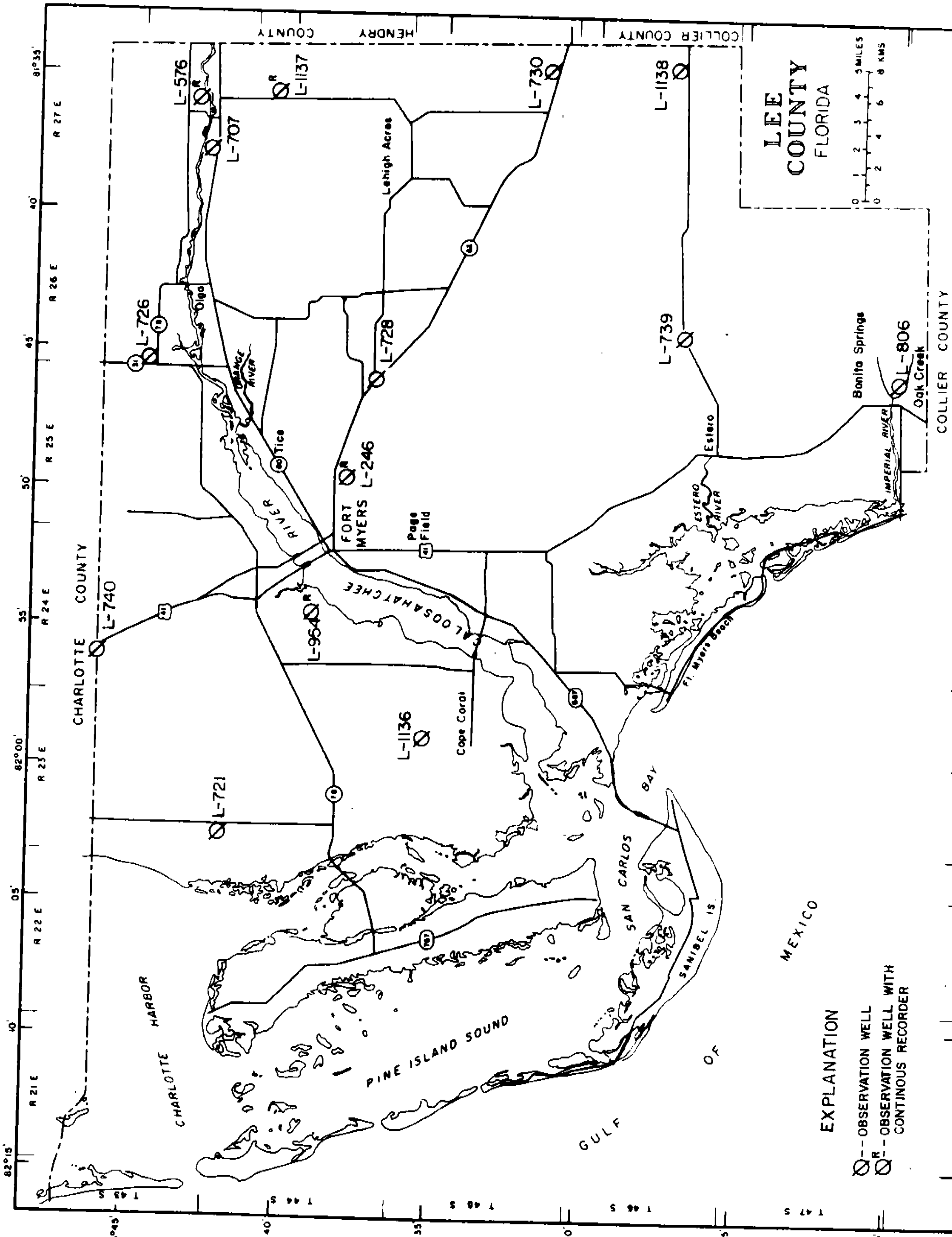

Figure 4.--Lee County showing the location of observation wells described in report.

Table 1.--Record of wells

Well no.	Latitude-longitude well number /1	Depth (ft.)	Diameter(in.)	Year record began
L-246	263802N0814934.1	27.7	8	1945
L-576	264253N0813654.1	10.7	6	1967
L-707	264235N0813753.1	20.6	4	1968
L-721	264153N0820223.1	18.4	4	1968
L-726	264425N0814540.1	19.0	4	1968
L-728	263712N0814612.1	19.3	4	1968
L-730	263127N0813516.1	19.0	4	1968
L-739	262657N0814435.1	20.3	4	1968
L-740	264611N0815554.1	18.0	4	1968
L-806	261958N0814602.1	32.7	6	1968
L-954	263903N0815504.1	14.2	8	1969
L-1136	263532N0815922.1	20.0	4	1970
L-1137	263950N0813553.1	20.0	4	1970
L-1138	262703N0813402.1	20.0	4	1970

/1 Refers to a nationwide numbering system adopted by the U.S. Geological Survey which locates the well according to the nearest second of latitude and longitude.

FLUCTUATIONS OF THE WATER-TABLE IN LEE COUNTY

Because rainfall is the principal source of recharge to the water-table aquifer and ground-water levels are directly related to recharge, the rainfall records from Page Field, the nearest weather station to the area of investigation, are given in table 2 for comparison with water-level data presented at various places in this report.

As indicated by the rainfall records for 1969-73 as well as by the 87-year average, the annual wet and dry seasons are well defined (table 2). About 70 per cent of the annual total falls during the wet season, June through October. Only 30 percent of the annual total falls during the dry season, November through May.

The highest and lowest water levels in each of 14 observation wells between 1969 and 1973 are listed in table 3. As indicated by most of the well data in table 3, the water table was highest in September and October 1969, when 27.9 inches (710 millimetres) of rainfall was recorded at Page Field. It was lowest in March, April, and May 1971 after an extended period of deficient rainfall. The seasonal, annual, and long-term average positions of the water table as determined from observation wells in Lee County are summarized in table 4.

Table 2.--Records of rainfall at Page Field, [1] 1969-73.
(Rainfall in inches)

Month	Average [2]	1969	1970	1971	1972	1973
Jan.	1.52	1.44	4.36	0.85	0.77	3.14
Feb.	2.21	2.87	2.20	1.55	2.14	2.23
Mar.	2.62	7.74	18.50	0.55	4.72	3.89
Apr.	2.64	0.15	0.00	0.70	0.27	1.71
May	3.85	4.71	6.36	3.77	5.20	0.78
Jun.	8.95	10.63	7.47	6.18	7.86	3.99
Jul.	9.08	7.11	4.74	9.50	9.72	9.57
Aug.	7.38	8.49	4.82	8.06	16.22	8.66
Sept.	8.50	16.60	8.29	9.21	2.33	8.38
Oct.	4.09	11.30	1.19	6.49	2.20	0.16
Nov.	1.20	0.22	0.46	0.16	3.85	0.10
Dec.	1.29	3.95	0.37	0.30	1.43	1.72
Total	53.34	71.94	58.84	47.32	56.71	44.33

1/ Records from Environmental Data Service, National Oceanic and Atmospheric Administration, U. S. Department of Commerce.

2/ Average of 87 years of record.

Table 3.--Highest and lowest position of the water table, 1969-73. (water levels in feet below land surface except where preceded by + which indicates above land surface)

Well	Highest level	Date	Lowest level	Date
L-246	0.00	8-31-72	3.47	4-30-71
L-576	3.27	9-27-73	5.38	3-31-71
L-707	0.94	10-31-69	3.92	12-30-70
L-721	+ 0.13	5-31-70	7.67	5-26-72
L-726	0.95	10-31-69	5.02	4-29-71
L-728	+0.81	10-31-69	4.13	4-29-71
L-730	0.97	10-30-69	7.27	5-28-71
L-739	+0.11	3-30-70	4.82	4-29-71
L-740	0.24	9-30-69	2.97	4-27-71
L-806	2.21	3-30-70	10.28	4-29-71
L-954	1.05	9-30-69	9.54	4-30-71
L-1136 1/	3.98	8-29-72	7.61	5-28-71
L-1137 1/	1.43	7-31-71	5.11	5-30-73
L-1138 1/	0.29	8-27-70	4.04	5-28-71

1/ Well established 1970

Table 4.--Seasonal, annual, and long term average water level of the water-table aquifer as determined from observation wells, 1969-73.

(water levels, in feet, below land surface)

Time period	Well L-246	Well L-576	Well L-707	Well L-721	Well L-726	Well L-728	Well L-730	Well L-739	Well L-740	Well L-806	Well L-954	Well L-1136	Well L-1137	Well L-1138
Wet season														
June-Oct. 1969	0.67	4.40	2.05	0.51	2.18	0.44	1.58	0.43	1.03	6.63	-	-	-	-
June-Oct. 1970	0.49	4.73	-	1.13	1.97	0.46	2.07	1.12	1.76	7.87	4.35	4.92	2.66	1.31
June-Oct. 1971	1.14	3.98	1.59	0.94	2.40	1.82	4.11	0.92	0.93	7.79	4.70	5.56	1.95	2.46
June-Oct. 1972	0.76	4.87	2.85	2.85	2.99	1.10	4.40	1.41	1.33	7.13	5.12	5.07	2.62	1.93
June-Oct. 1973	1.26	4.02	2.84	2.37	3.46	0.85	3.98	3.12	1.31	7.46	3.73	5.36	3.85	1.58
Dry season														
Nov. 1969-May 1970	0.95	4.35	2.52	1.63	2.45	0.95	1.85	1.02	1.51	6.59	3.92	-	-	-
Nov. 1970-May 1971	2.66	4.93	3.43	3.49	4.38	3.17	6.06	3.48	2.37	9.92	8.42	6.63	-	3.04
Nov. 1971-May 1972	2.08	4.89	2.67	5.18	3.87	2.17	5.66	2.62	2.07	9.33	7.38	5.61	3.93	2.63
Nov. 1972-May 1973	1.28	4.54	2.79	2.43	3.05	1.96	5.28	3.20	1.50	9.46	4.92	5.36	3.94	2.48
Annual														
June 1969-May 1970	0.83	4.37	2.32	1.16	2.33	0.73	1.74	0.78	1.31	6.60	-	-	-	-
June 1970-May 1971	1.75	4.85	-	2.37	3.37	2.04	4.40	2.50	2.12	9.07	6.73	6.01	-	2.32
June 1971-May 1972	1.69	4.51	2.22	3.41	3.25	2.02	5.02	1.91	1.60	8.69	6.27	5.60	3.11	2.56
June 1972-May 1973	1.06	4.68	2.81	2.60	3.02	1.60	4.91	2.46	1.43	8.49	5.01	5.25	3.39	2.25
Jan.-Dec. 1969	1.21	4.54	2.37	1.43	2.63	0.96	2.39	1.30	1.58	7.44	-	-	-	-
Jan.-Dec. 1970	0.93	4.56	-	1.58	2.51	1.12	2.70	1.53	1.81	7.62	4.54	-	-	-
Jan.-Dec. 1971	2.00	4.52	2.45	2.19	3.38	2.60	5.24	2.20	1.68	8.89	6.73	6.06	-	2.82
Jan.-Dec. 1972	1.35	4.83	2.95	4.14	3.50	1.65	5.08	2.34	1.67	8.54	6.17	5.41	3.41	2.36
Jan.-Dec. 1973	1.54	4.33	2.89	2.66	3.30	1.65	4.91	3.24	1.49	8.63	4.79	5.54	3.92	1.95
Long term														
Jan. 1969-Dec. 1973	1.41	4.56	-	2.40	3.06	1.60	4.06	2.12	1.65	8.22	-	-	-	-
Jan. 1970-Dec. 1973	-	-	2.66		-	-	-	-	-	-	5.56	-	-	-
Jan. 1971-Dec. 1973	-	-	-	-	-	-	-	-	-	-	-	5.67	-	2.38
Jan. 1972-Dec. 1973	-	-	-	-	-	-	-	-	-	-	-	-	3.67	-

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Comparison of the wet season average levels in individual wells (table 4) indicates some variation in the time periods when water levels were high. For example, during the wet season of 1971 well L-728 had an average water level of 1.82 feet (0.55 metre) below land surface, its lowest wet season average level. During the same time, well L-739 had an average water level of 0.92 foot (0.28 metre) below land surface, its second highest wet season average level. This difference apparently is largely the result of the non-uniform distribution of rainfall throughout the county. Boggess (1973, p. 21) reports that over a period of several days the amount of rain falling intermittently at stations only 2.5 miles (4.0 kilometres) apart may differ by as much as 3.5 inches (89 millimetres) and at greater distances apart the annual totals may differ by more than 15 inches (380 millimetres). Comparison of the dry season averages in table 4 shows that the lowest sustained positions of the water table occurred between November 1970 and May 1971. The annual and long-term averages also provide useful information for comparison purposes. For example, the annual averages (calendar year) for well L-739 show a continuous decline from the earliest period of record in 1969 through 1973.

Hydrographs of Wells Operating Under Natural Conditions

A hydrograph is a graphic record of the time related changes in the position of the water table as determined from water-level measurements in individual wells. All of the water levels in wells included in this report have been affected to some extent by modification of drainage patterns, pumping for water supply, changes in land use, or other related activities. In some cases, the change from preexisting natural conditions is so minor that it is negligible.

Rainfall is the major factor influencing fluctuations of water-levels. The hydrographs of wells L-728 and L-739 (fig. 5) indicate the general relation between rainfall and water levels in the water-table aquifer. Both wells show the effect of the extended period of deficient rainfall between October 1970 and April 1971, when water levels were the lowest of record. That the level in well L-739 did not recover during the wet season in 1973 is probably due to the erratic distribution of rainfall, although dewatering operations in rock pits about 2 miles (3 kilometres) north of the well may also have been a factor in preventing the recovery.

Hydrographs for wells L-1137 and L-1138 (fig. 6) in the eastern part of Lee County show a response to recharge from rainfall similar to wells L-728 and L-739, although the ranges in fluctuations are less. These 4 wells best illustrate response to recharge under natural conditions.

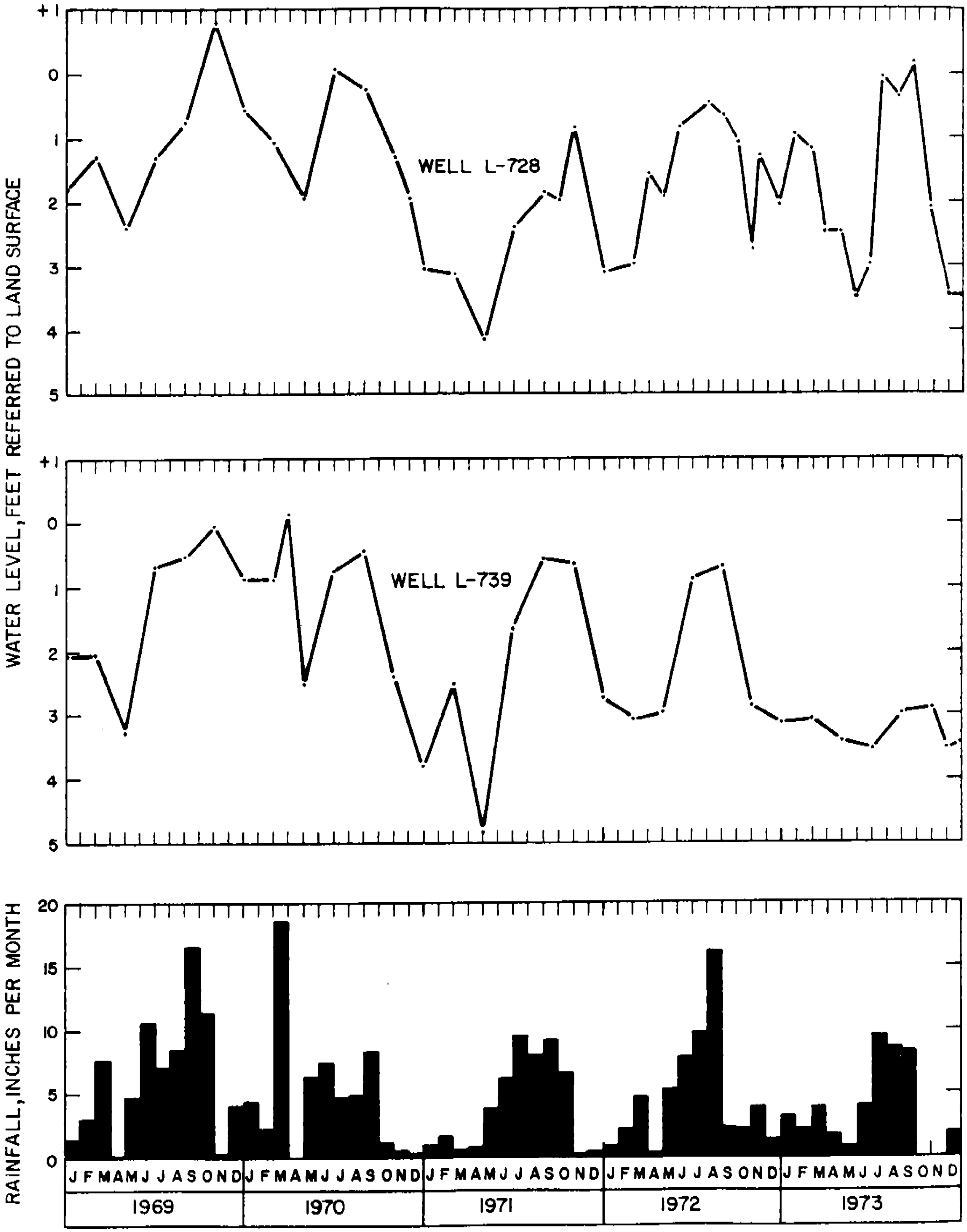


Figure 5.--Hydrograph of wells L-728 and L-739 and graph of monthly rainfall at Page Field, 1969-73.

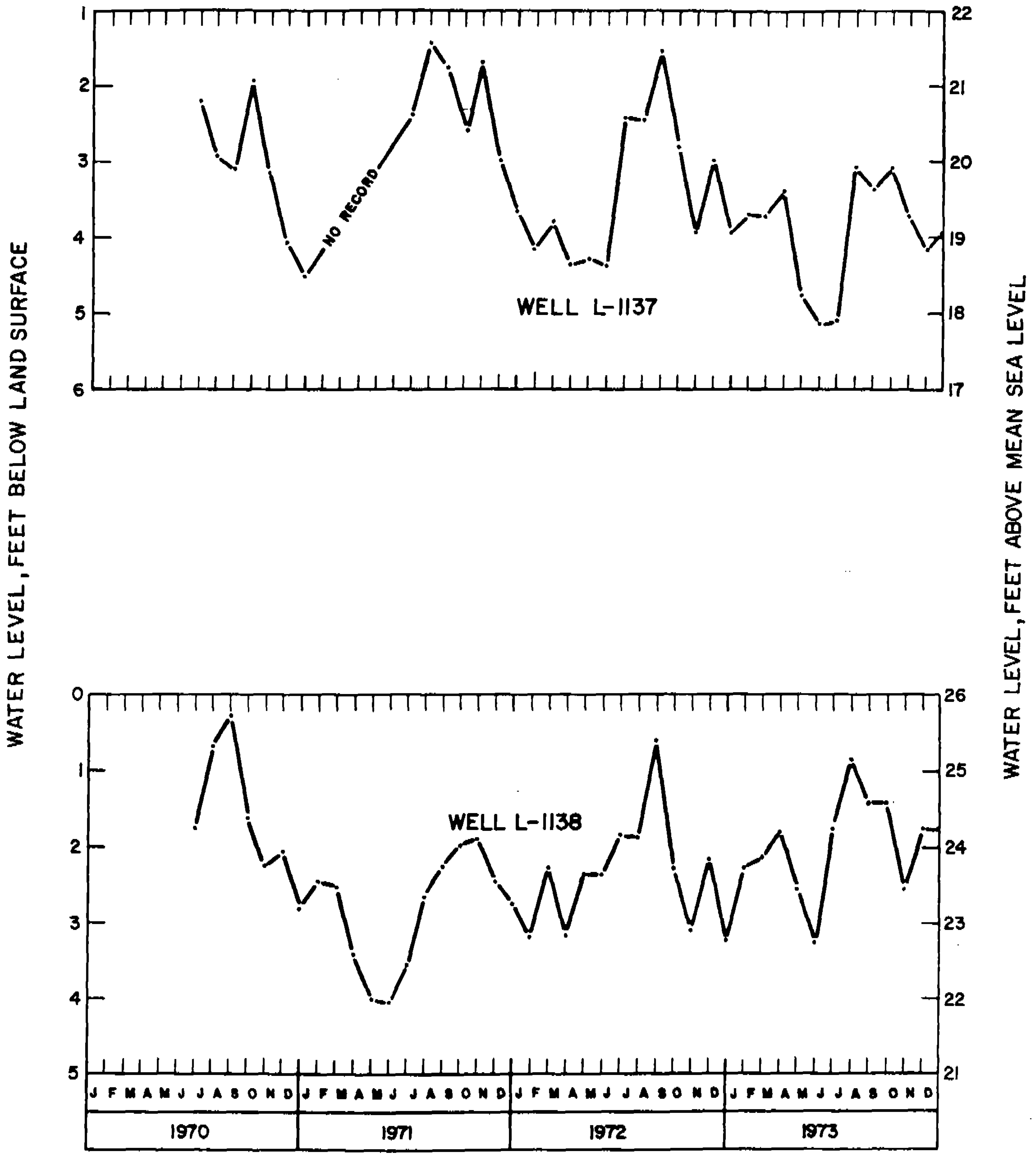


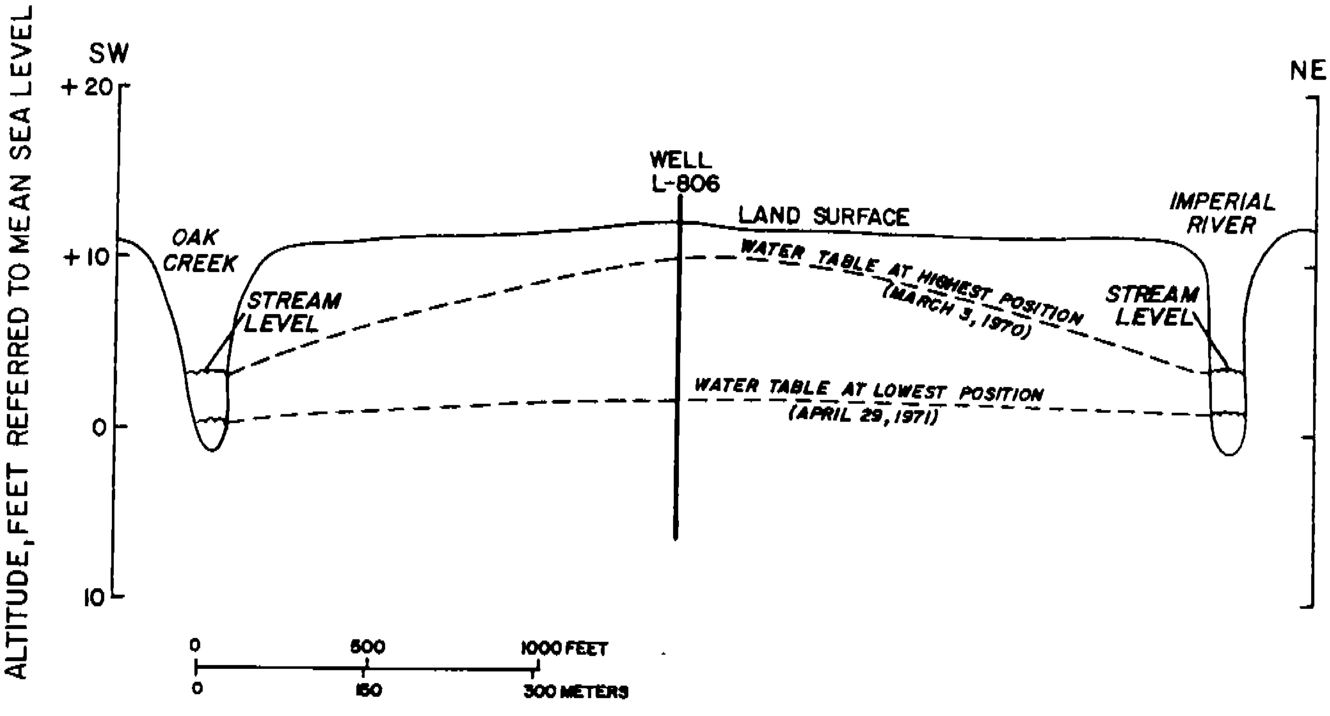
Figure 6.--Hydrographs of wells L-1137 and L-1138, June 1970-December 1973.

The water table tends to reflect the surface topography, occurring at higher altitudes where the land surface is higher and at lower altitudes where the land surface is lower. This is evident from the hydrographs on figures 5 and 6 where the altitude of the water table ranges from about 13 feet (4 metres) at its lowest position in well L-739 to about 25.7 feet (8.0 metres) above mean sea level at its highest position in well L-1138.

Under natural conditions, the stages in ponds and streams usually are related to water levels in the aquifer. Figure 7 illustrates the relation between stream levels and the water-table aquifer as determined in well L-806 near Bonita Springs.

During the wet season, recharge from rainfall results in a rise in both stream stage and ground-water levels. The major components of stream flow at that time consist of surface runoff from adjacent land areas and direct input of rainfall. Water contributed from the aquifer, although substantial, is less than the amount coming from the two other sources of recharge.

As stream levels decline during the dry season, discharge from the water-table aquifer becomes the major component of stream flow. As the water table declines, discharge to the stream decreases, resulting in diminished stream flow. Thus, during the dry season, both surface and ground-water levels reach their lowest positions in the annual cycle.



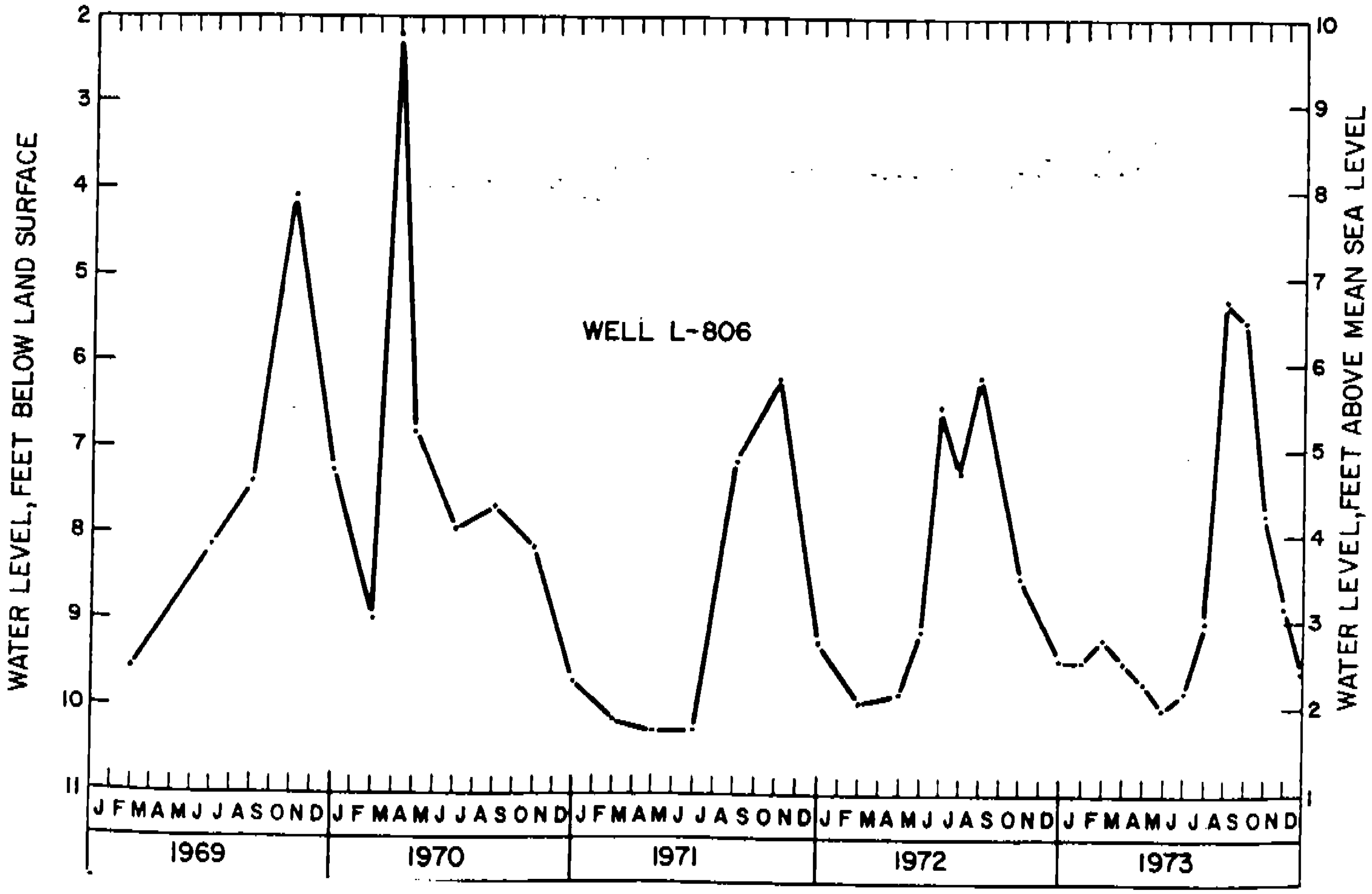


Figure 7.--Hydrograph of well L-806, 1969-73, and a diagram showing its relation to the Imperial River and Oak Creek.

Figure 7 also illustrates the effect of natural drainage on the water table. Well L-806 is in the divide area between two streams whose beds have been downcut several feet below mean sea level. The close proximity of the streams and the depth of the channels indicates a high potential for ground-water discharge from the area between the streams. This accounts for the wide range in fluctuation of the water table in well L-806, and the low altitude of the water table during the dry season.

In some parts of the county, discontinuous thin clay beds of low permeability occur near the land surface. Wells in these areas may exhibit pressure responses to compaction loading comparable to those of wells constructed to artesian aquifers. However, as shown by the hydrographs for wells L-726 and L-740 on figure 8, water levels follow the same seasonal pattern as other wells constructed to the water-table aquifer and hence, these wells are considered to tap the water-table aquifer.

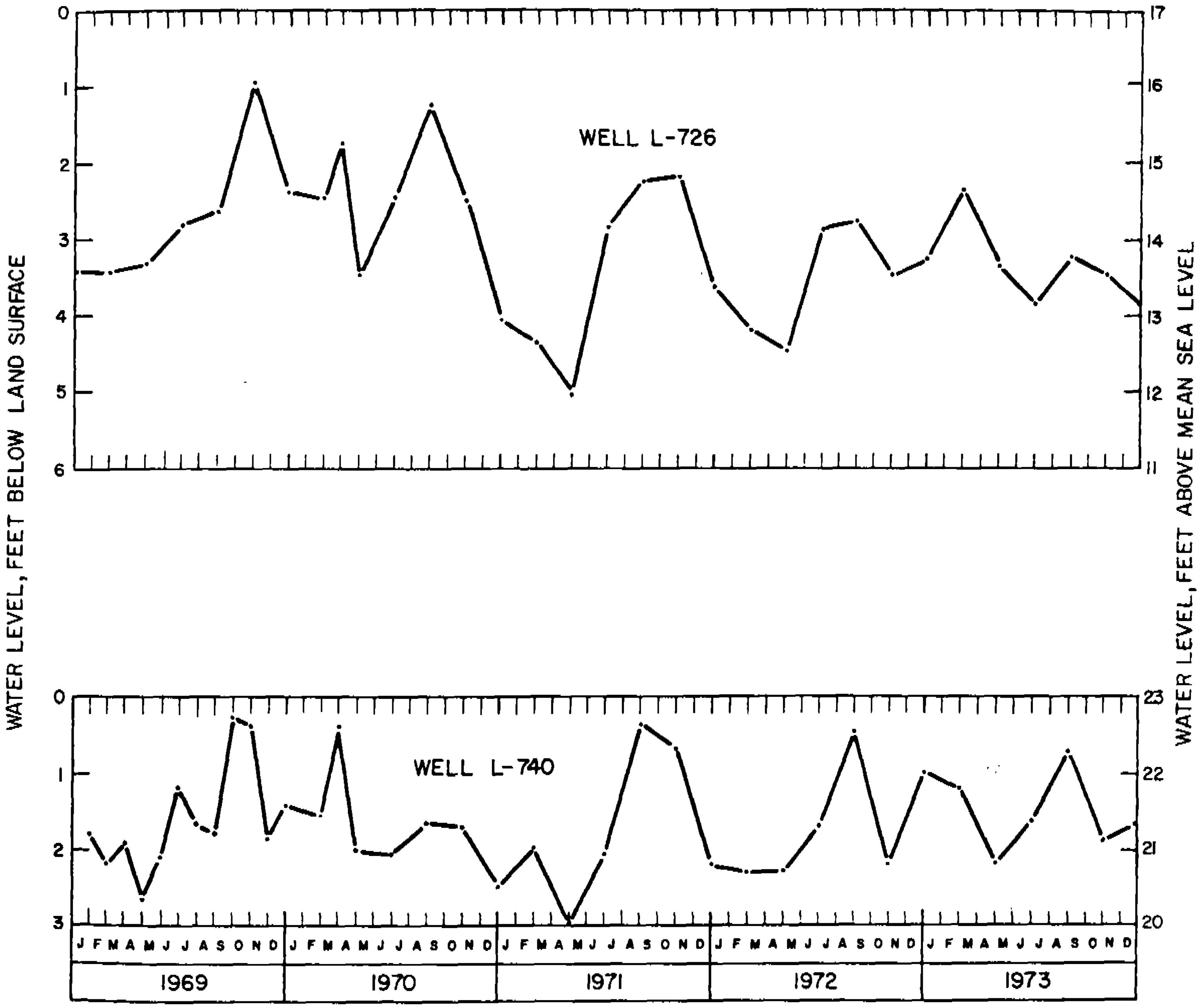


Figure 8.--Hydrographs of wells L-726 and L-740, 1969-73.

Hydrographs of Wells Affected By Water Control Operations

The low land relief and the high water table throughout most of Lee County requires that the land be given adequate surface and subsurface drainage prior to its development for urban housing or its being used for many other purposes. In most parts of the county, drainage is accomplished by the construction of canals or ditches which rapidly transport water to tidal water bodies. The canals or ditches discharge storm run-off thus allowing flood prevention and also lower the water table to a position where septic tanks may function properly. Where drainage canals are too deep or too closely spaced, excessive dewatering may result and large volumes of water may be lost to beneficial use.

Water-level declines in wells near a canal draining the aquifer tapped by the wells can be considerable. For example, when a deep canal was excavated along the Lee County-Hendry County line in 1971, well L-730, 1.5 miles (2.4 kilometres) west, declined markedly in level (fig. 9). Note, in figure 9, the lower positions of the water table in 1972 and 1973 as compared to the higher positions in 1969 and 1970 prior to the excavation of the canal. The lower position of the water table in the latter part of 1970 and the early part of 1971 is attributed largely to the effects of the deficiency of rainfall over that period, rather than to the construction of the canal.

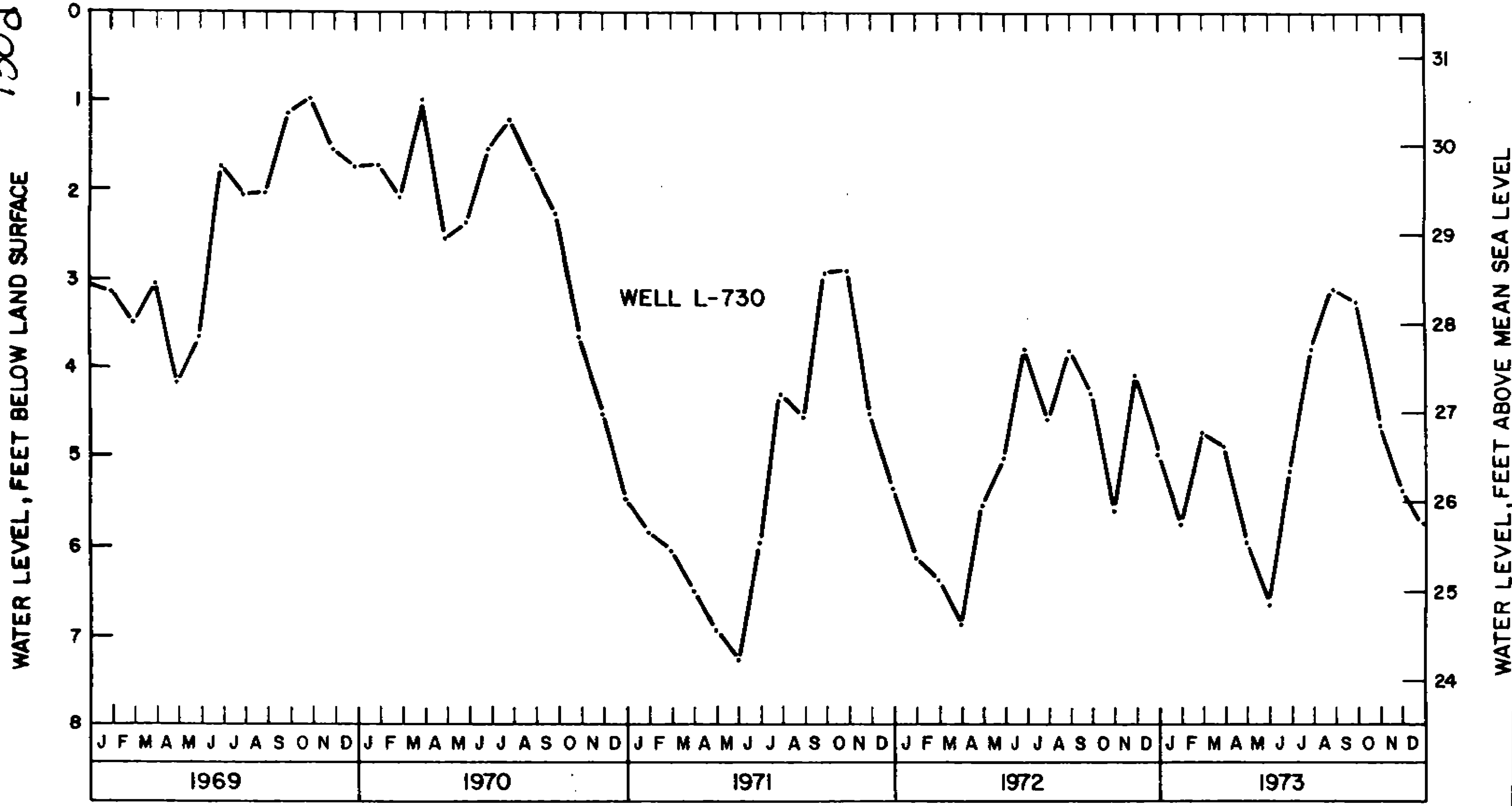


Figure 9.--Hydrograph of well L-730, 1969-73.

Well L-1136 in Cape Coral also is located near a canal. This well unlike well L-730, is only about 200 feet (60 metres) from the canal. As shown on figure 10, drainage to the canal limits the rise in the water table to a position about 4 or 5 feet (1 or 2 metres) below the land surface during the wet season. Prior to the construction of canals, the water table probably was near the land surface during the wet season. During extended dry periods such as that which occurred in 1970-71, both the water table and the water level in canals declines.

Because of the extensive network of canals, the hydrograph of well L-1136 probably is typical of the water table in many parts of Cape Coral, except near canals subject to tidal action.

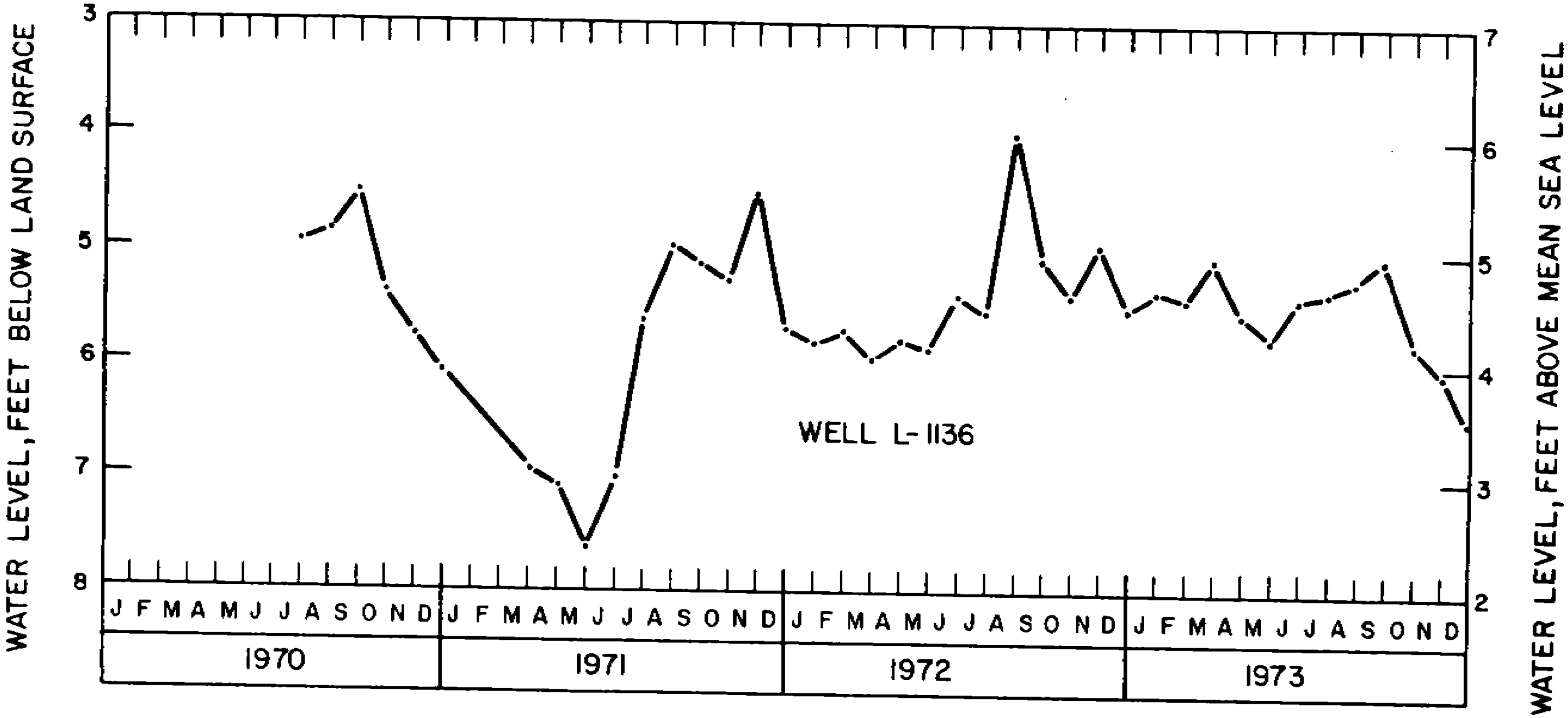


Figure 10.--Hydrograph of well L-1136, July 1970-December 1973.

As the water table may be permanently lowered by the excavation of drainage canals or ditches, it also may be permanently raised by the impoundment of water at the surface. The hydrograph for well L-576 (fig. 11), about 500 feet (150 metres) north of the Caloosahatchee River near Alva, is located in an area of surface-water impoundment. Prior to the construction of the W. P. Franklin Dam near Olga, water levels in this reach of the river fluctuated in response to discharge from the river and tides in the Gulf of Mexico. During the dry season, the mean river stage was slightly above mean sea level. The water table as determined from water-level measurements in well L-576, ranged from about 1 to 2 feet (0.3 to 0.6 metre) above mean sea level. After completion of the Franklin Dam in 1964, the river stage was raised and maintained at about 3 feet (0.9 metre) above mean sea level and, as shown on figure 11, the water table seldom declines below this level. Thus, the increase in altitude of the water table resulting from the impoundment of water in the river could have been as much as 2 feet (0.6 metre) during the dry season.

The increase in the altitude of the water table in the area adjacent to the river represents a substantial increase in the volume of water in storage in the water-table aquifer, particularly considering the length of the reach of river where ground-water levels were raised.

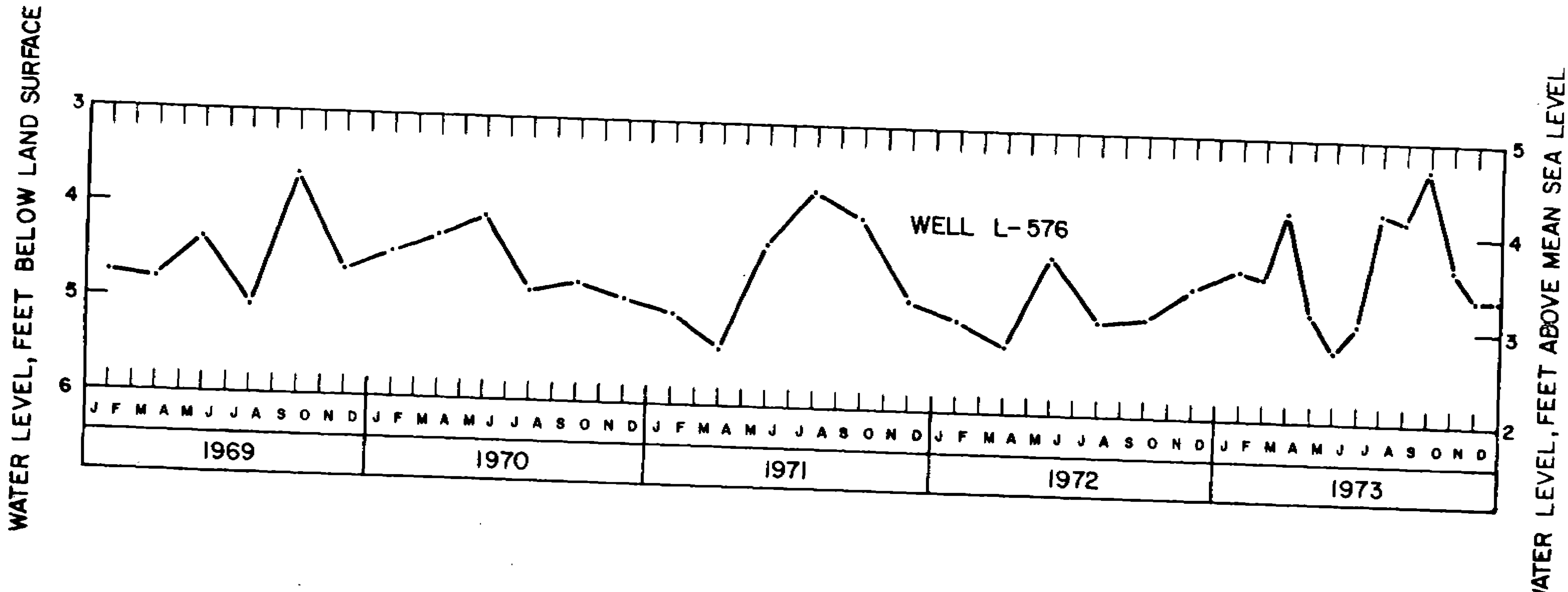


Figure 11.--Hydrograph of well L-576, 1969-73.

In many parts of Lee County, wells tapping the water-table aquifer provide water for domestic, agricultural, and municipal use. The effects of pumping these wells on water levels in the water-table aquifer are indicated by the hydrograph for well L-954 (fig. 12) located near a well field consisting of 6 wells tapping the water-table aquifer. Pumping of these wells during the 1971 drought caused the water level in well L-954 to decline to a position about 0.5 foot (0.1 metre) below mean sea level. Although pumping continued beyond termination of the drought, recharge from rainfall during the wet season caused the water level in well L-954 to recover about 6 feet (2 metres) above mean sea level by late August.

This illustrates an important function of the water-table aquifer as a source of water supply. When the water table is at or near land surface, the aquifer is full and further recharge is rejected. The removal of water from storage by pumping makes more space available for recharge. Thus, a continuous supply of water may be obtained from the aquifer provided sufficient storage is available to sustain pumping between periods of recharge.

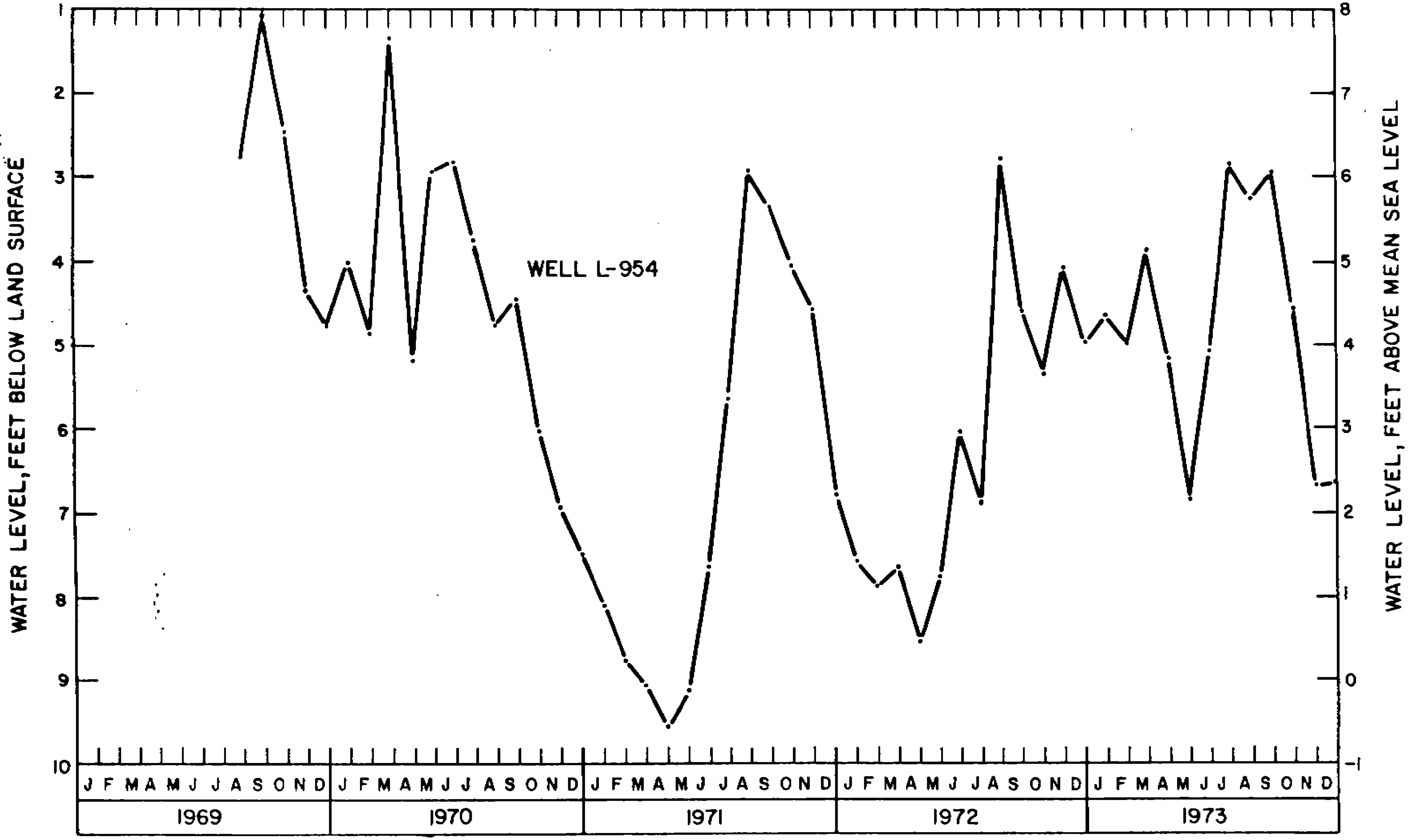


Figure 12.--Hydrograph of well L-954, August, 1969-December, 1973.

In places where the aquifer does not contain sufficient storage to supply the pumping demands between periods of limited natural recharge, artificial recharge may be used to maintain the water-supply system. Sustained heavy pumpage from the municipal well field for Fort Myers is made possible by the use of artificial recharge of water pumped 12 miles (19 kilometres) from the Caloosahatchee River above the W. P. Franklin Dam to the well field. Despite the progressive increase in pumpage from the city's wells, ground-water levels have remained consistently high at altitudes in excess of 16 feet (5 metres) above mean sea level, as shown on figure 13, where the hydrograph for well L-246, rainfall at Page Field, and pumpage are given. Prior to establishing the recharge system in 1967, water levels in well L-246 ranged from about 9 to 16 feet (3 to 5 metres) above mean sea level during the dry season (fig. 14). During the dry seasons before 1967, water production from some wells was curtailed and others failed to yield sufficient quantities because of low ground-water levels. This problem no longer exists as a result of the improved recharge system.

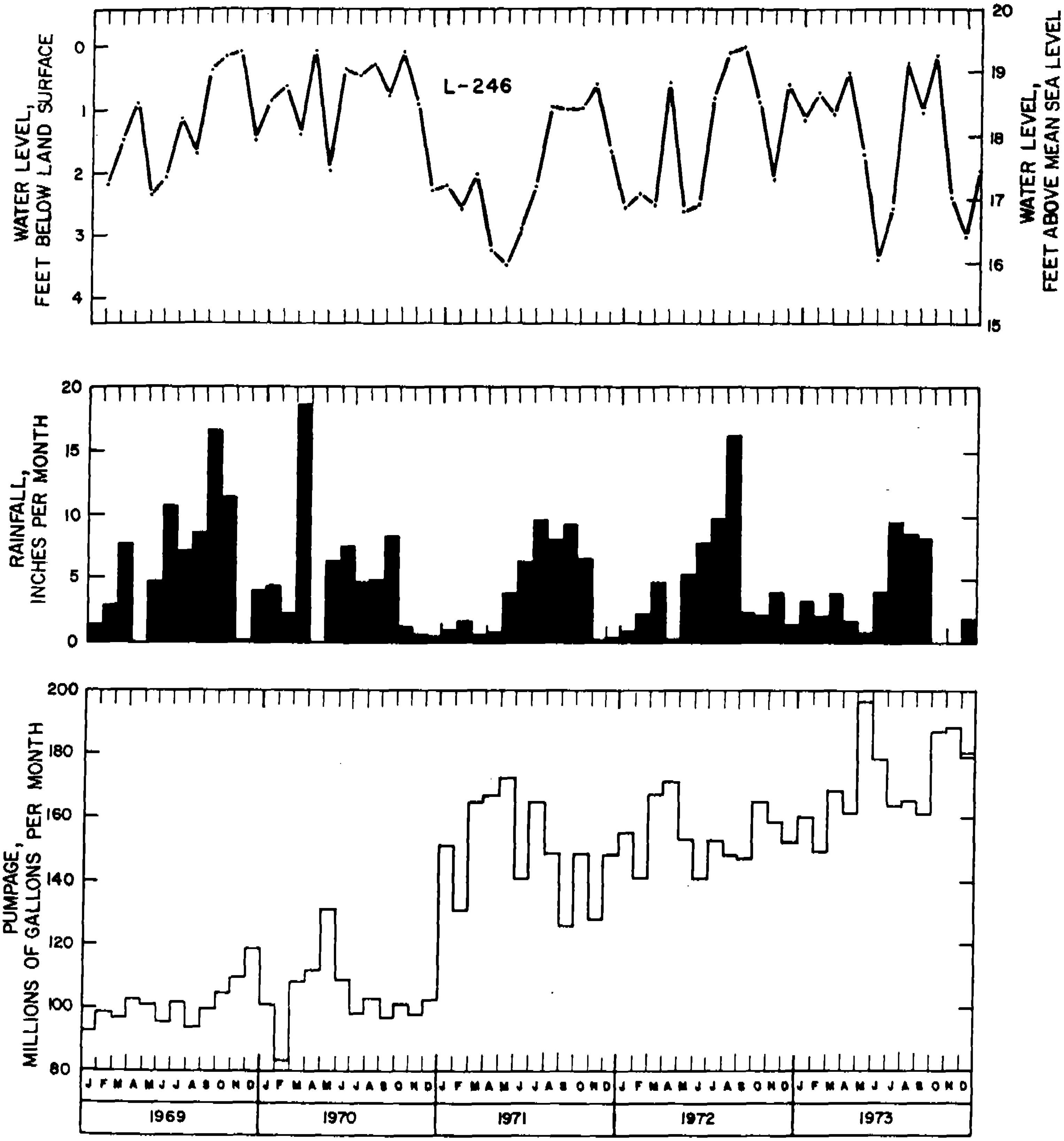


Figure 13.--Hydrograph of well L-246, and graph of rainfall at Page Field, and pumpage in the Fort Myers well field, 1969-73.

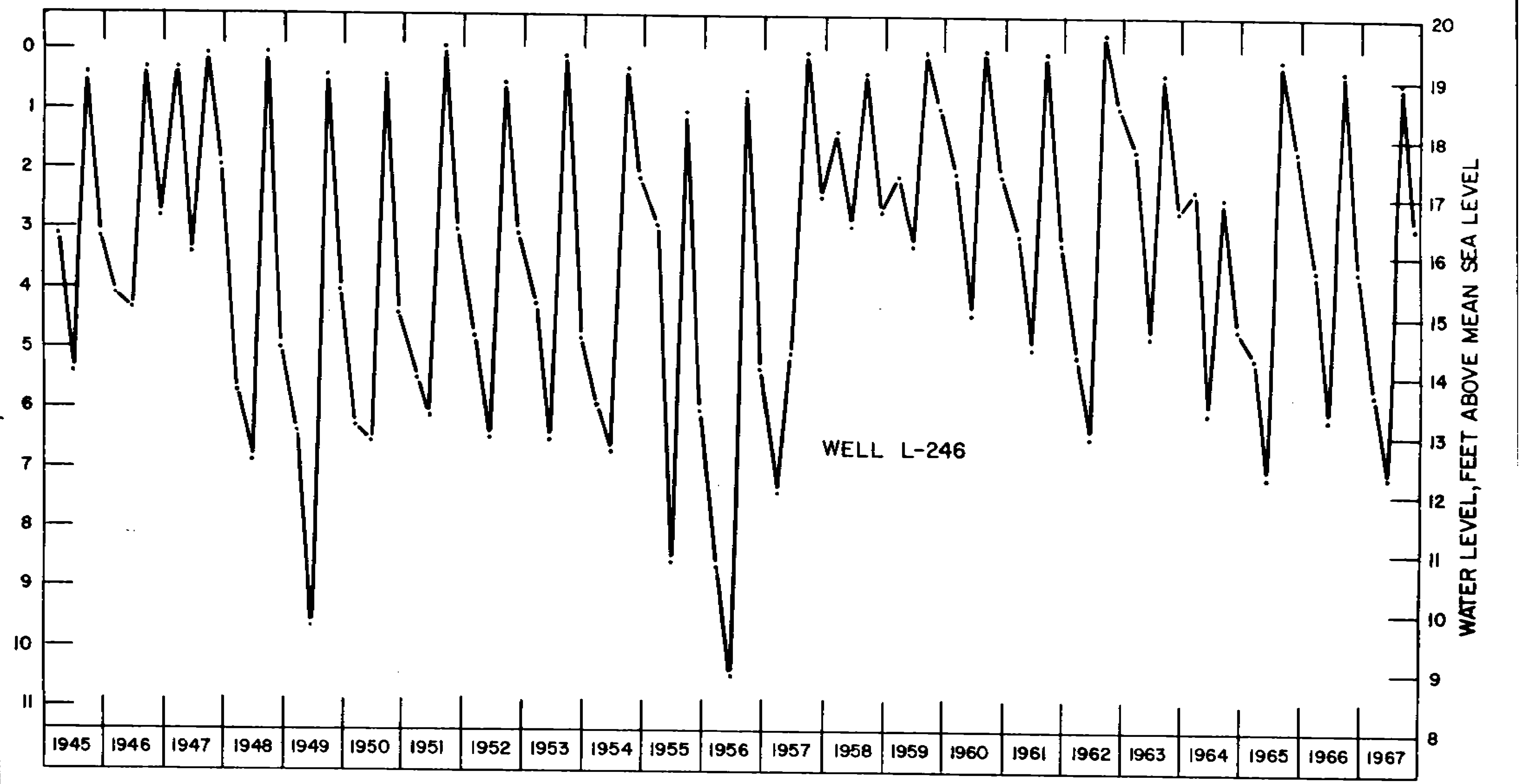


Figure 14.--Hydrograph of well L-246, 1945-67.

Well L-707 in the eastern part of Lee County is located in an area of controlled pumping from the water-table aquifer. Because pumping rate and spacing of wells are designed to prevent excessive lowering of the water table, the hydrograph of well L-707 indicates essentially natural conditions with no obvious pumpage effect (fig. 15).

The hydrograph for well L-721 on figure 16 shows a sharp decline in ground-water level, beginning in October 1971 and ending in May 1972. A part of this decline, from October to December 1971, is within the usual range of fluctuation of water levels for the short period of record shown. The remainder of the decline to 1.7 feet (0.5 metre) below sea level--3.7 feet (1.1 metre) below the previous lowest position of the water level which occurred in 1971 near the end of the drought--was contemporaneous with dewatering by pumping of a canal under construction about 1,500 feet (460 metres) south of well L-721. The cessation of canal dewatering in June 1972, combined with heavy rainfall of about 34 inches (860 millimetres) in June, July and August, allowed the water level in well L-721 to recover to about the same position as maintained prior to canal construction.

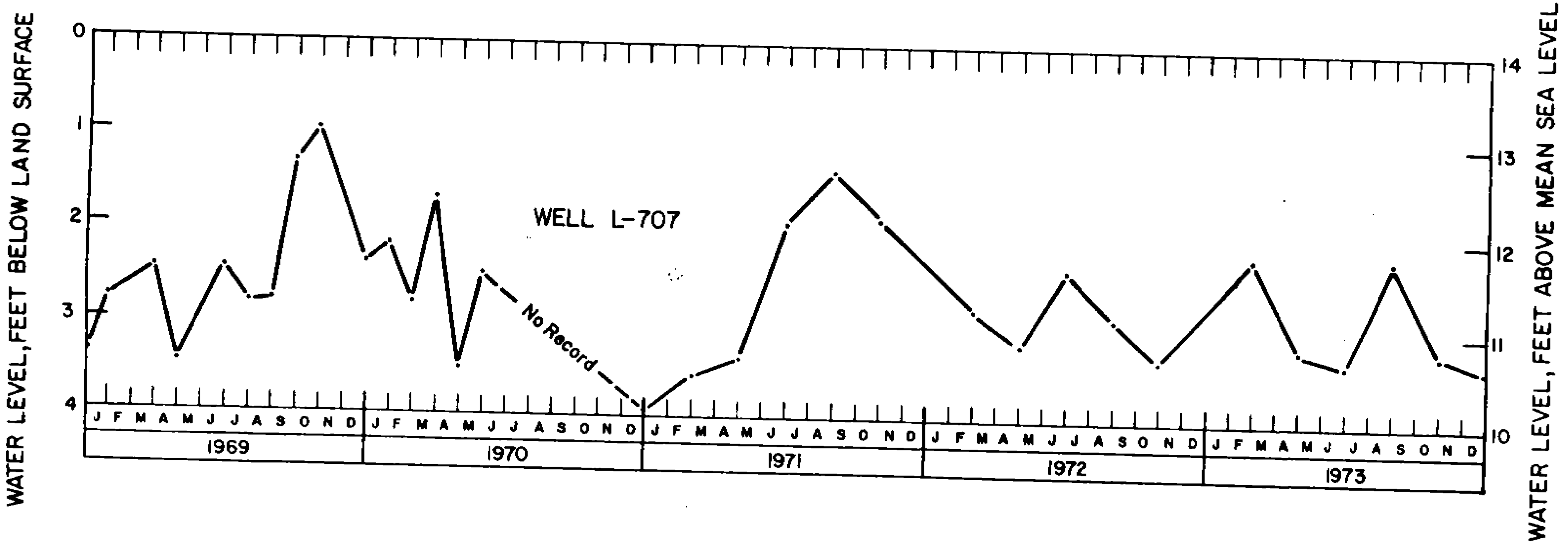


Figure 15.--Hydrograph of well L-707, 1969-73.

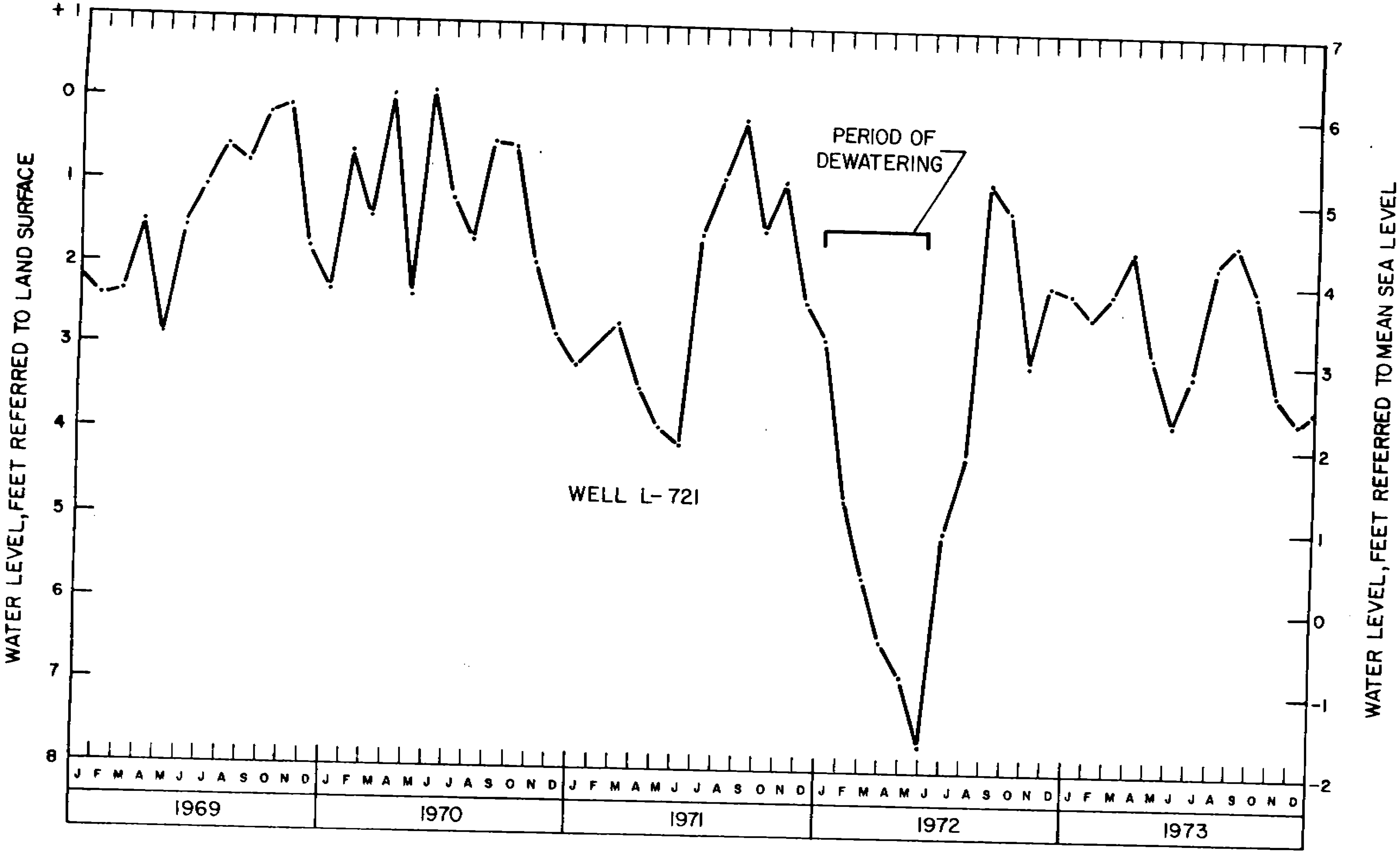


Figure 16.--hydrograph of well L-721, 1969-73.

SUMMARY AND CONCLUSIONS

Local rainfall is the principal source of recharge to the water-table aquifer in Lee County, Florida. The changes in volume of water in storage as indicated by the changing position of the water table, closely parallel the seasonal pattern of rainfall which annually averages about 53 inches (1350 millimetres). Most of the rain falls from June through October. During the wet season the water table generally ranges from near land surface to about 4 feet (1 metre) below land surface. During the dry season, November through May, the water table may range from 3 to 10 feet (1 to 3 metres) below the land surface.

Superimposed upon the fluctuations of the water table resulting from natural recharge and discharge are fluctuations resulting from man's activities. Several large canal networks have been excavated in the county to drain land for urban development. This has resulted in a general lowering of the water table. In some areas, a substantial increase in storage in the water-table aquifer has occurred as a result of impoundment of surface water. The construction of the W. P. Franklin Dam on the Caloosahatchee River near Olga, has resulted in higher sustained ground-water levels, particularly during the dry season. Considering the length of the river reach along which the aquifer has been favorably affected and the lateral extent of the affected area, this rise in level represents a substantial increase in ground-water storage.

The water-table aquifer is a source of water supply for domestic, agricultural, and municipal use. Pumping of wells lowers the water table in the surrounding area and provides storage space for additional recharge if and when available. A continuous supply of water may be obtained from the aquifer where sufficient storage is available to sustain pumping between periods of recharge. Artificial recharge such as the system operated by Fort Myers insures a continuous supply of water to the municipal wells by maintaining high ground-water levels during those periods when natural sources of recharge are inadequate to sustain the desired pumping rate.

Establishing a balance wherein the water table is maintained at the highest practical level commensurate with the use of the land will help to effectively conserve and manage the water-table aquifer. Adequate drainage is necessary for urban development, but excessive drainage should be avoided. Where drainage has been excessive, control structures which impound surface water may be used to reestablish higher ground-water levels.

The water-table aquifer is an integral part of the total water resources of Lee County. Because it is near land surface, the aquifer is readily subject to the effects of man's activities. A detailed analysis of these effects will help to preserve the shallow ground-water supply.

REFERENCES

Boggess, D.H., 1973, The shallow fresh-water system of Sanibel Island, Lee County, Florida, with emphasis on the sources and effects of saline water: U.S. Geol. Survey Open-file report 73029.

Lohman, S.W. and others 1972, Definitions of selected ground-water terms-revisions and conceptual refinements: U.S. Geol. Survey Water-Supply Paper 1968, 21 p.

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