

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

HYDROLOGIC CONDITIONS DURING 1966 IN DADE COUNTY, FLORIDA

By

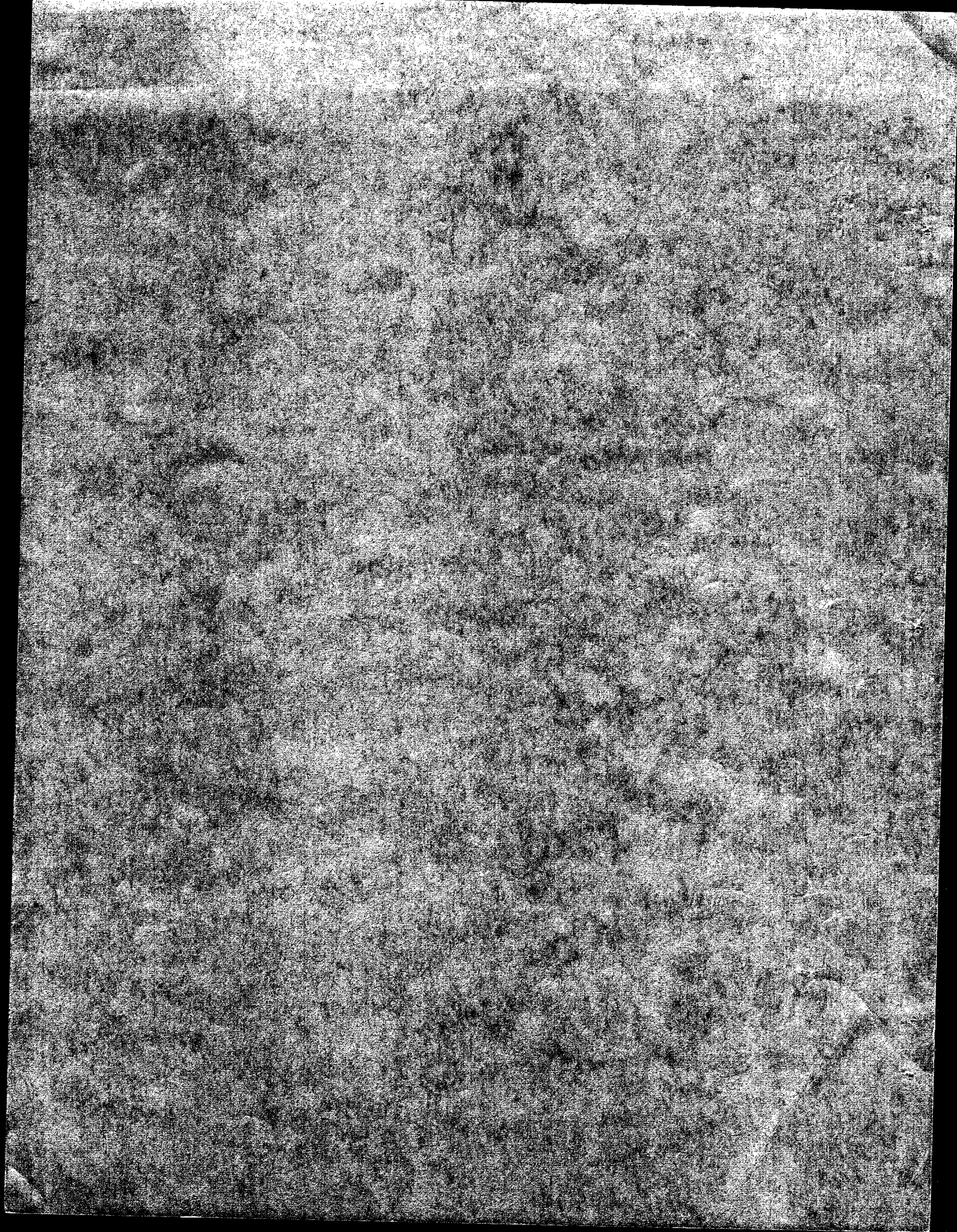
John E. Hull and Claiborne F. Galliher

OPEN-FILE REPORT

Prepared by the
U.S. GEOLOGICAL SURVEY
in cooperation with
DADE COUNTY, CITIES OF MIAMI AND MIAMI BEACH,
DIVISION OF GEOLOGY FLORIDA BOARD OF CONSERVATION,
CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT,
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and
CORPS OF ENGINEERS

Tallahassee, Florida
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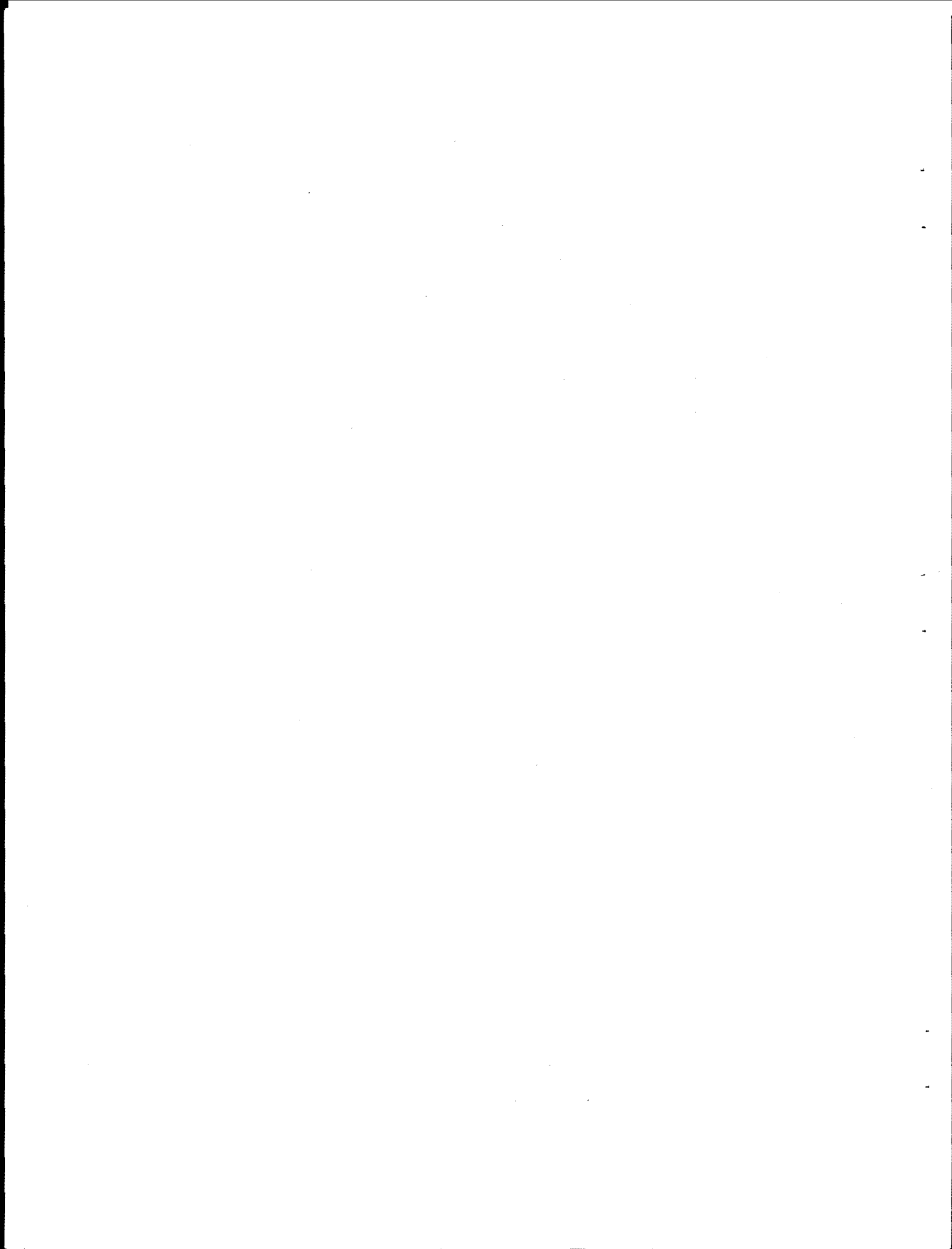
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HYDROLOGIC CONDITIONS DURING 1966 IN DADE COUNTY, FLORIDA

By John E. Hull and Claiborne F. Galliher

INTRODUCTION

This report is the first in a series designed to describe the annual hydrologic conditions in Dade County, Fla. A quantitative picture of the general hydrologic conditions which prevailed in Dade County for the period under consideration is summarized by use of tables, graphs, and maps. The locations and types of data-collection stations are shown in figures 1 and 2. Figure 1 indicates the location of ground-water stations and figure 2 indicates the location of rainfall and surface-water stations. To provide continuity of data supplied to cooperating agencies previously, the ground-water data in this report cover the 1966 calendar year and the surface-water data cover the 1966 water year (October 1, 1965 to September 30, 1966).

The water-level, discharge and rainfall data were obtained from an extensive network of ground-water observation wells, stream-gaging stations, and rainfall stations. The records from long-term installations (1940 to present) are of special value because those records span periods of hydrologic change and allow analysis of the hydrologic effects of some water-control practices.

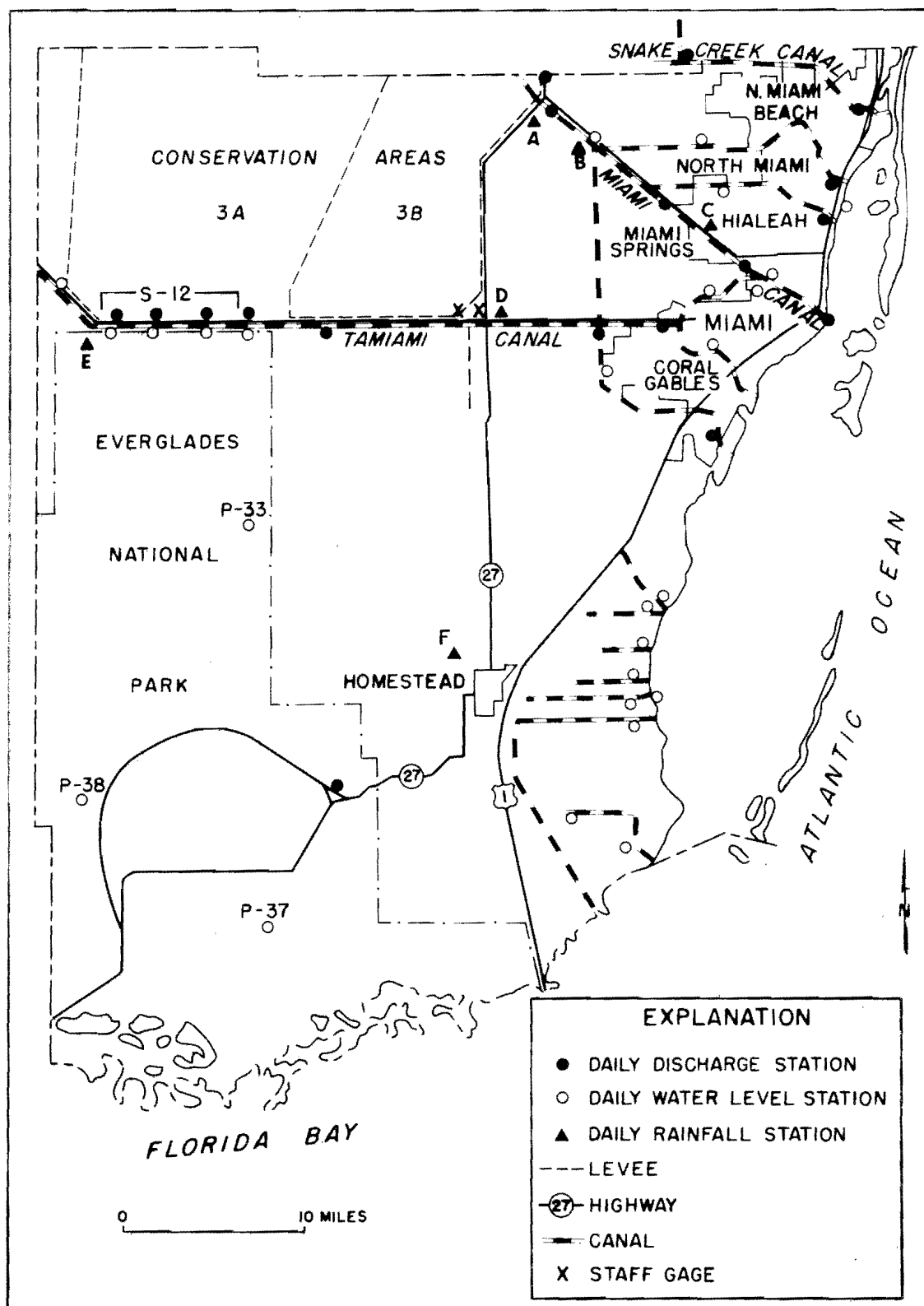


Figure 2.--Map of Dade County showing surface-water and selected rainfall stations.

This report was prepared by the U.S. Geological Survey in cooperation with Dade County; Cities of Miami and Miami Beach; Division of Geology, Florida Board of Conservation; Central and Southern Florida Flood Control District; National Park Service; and the Corps of Engineers.

CLIMATE

The climate of Dade County is essentially subtropical marine, characterized by long, warm, wet summers, followed by mild, dry winters.

Average temperature ranges from 67°F in January to 82°F in July and August.

The average annual rainfall for Dade County, based on 26 years of record (1941-66) at six locations, is 57 inches. During the 1966 water year the recorded rainfall averaged 68.34 inches; 11 inches above normal. The range between locations varied from a high of 81.40 inches at the Hialeah Water Plant to a low of 58.54 inches at Tamiami Canal at Forty-Mile Bend.

During the 1966 calendar year the recorded rainfall averaged 66.22 inches or about 9 inches above normal. The range between locations varied from a high of 79.44 inches at the Hialeah Water Plant to a low of 55.88 inches at Tamiami Canal at Forty-Mile Bend. Table 1 shows the distribution by stations (fig. 2).

Table 1.--Summary of precipitation data by stations.

<u>Location</u>	<u>Rainfall, inches</u>		
	<u>1965-66 Water Year</u>	<u>26-Year Average</u>	<u>1966 Calendar Year</u>
Miami Canal at Broken Dam (A)	77.67	60.74	75.89
Miami Canal at Pennsuco (B)	69.19	55.51	68.24
Hialeah Water Plant (C)	81.40	56.55	79.44
Tamiami Canal at Dade-Broward Levee (D)	59.41	52.70	60.13
Tamiami Canal at Forty-Mile Bend (E)	58.54	54.97	55.88
Homestead Experiment Station (F)	63.86	60.56	57.74

The total rainfall appears excessive when compared with the 26-year average. However, with the exception of June 1966, which averaged nine inches above normal, there was only a moderate deviation from the averages for all the other months (fig. 3).

GROUND WATER

The source of fresh ground water in Dade County is the Biscayne aquifer -- a highly permeable limestone and sandstone aquifer capable of yielding large quantities of water for municipal, industrial, and agricultural uses. It is 80 to 150 feet thick along the east coast and thins toward the Everglades.

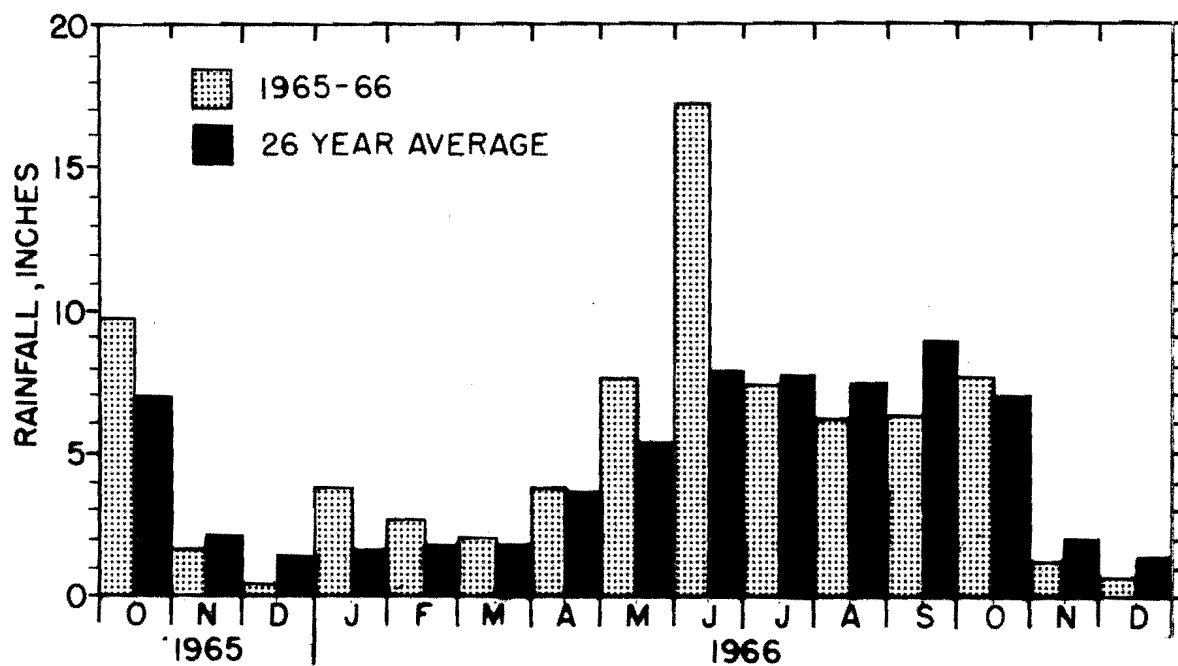


Figure 3.--Comparison of monthly rainfall for the period October 1965 to December 1966 with the normal (1941-1966) rainfall.

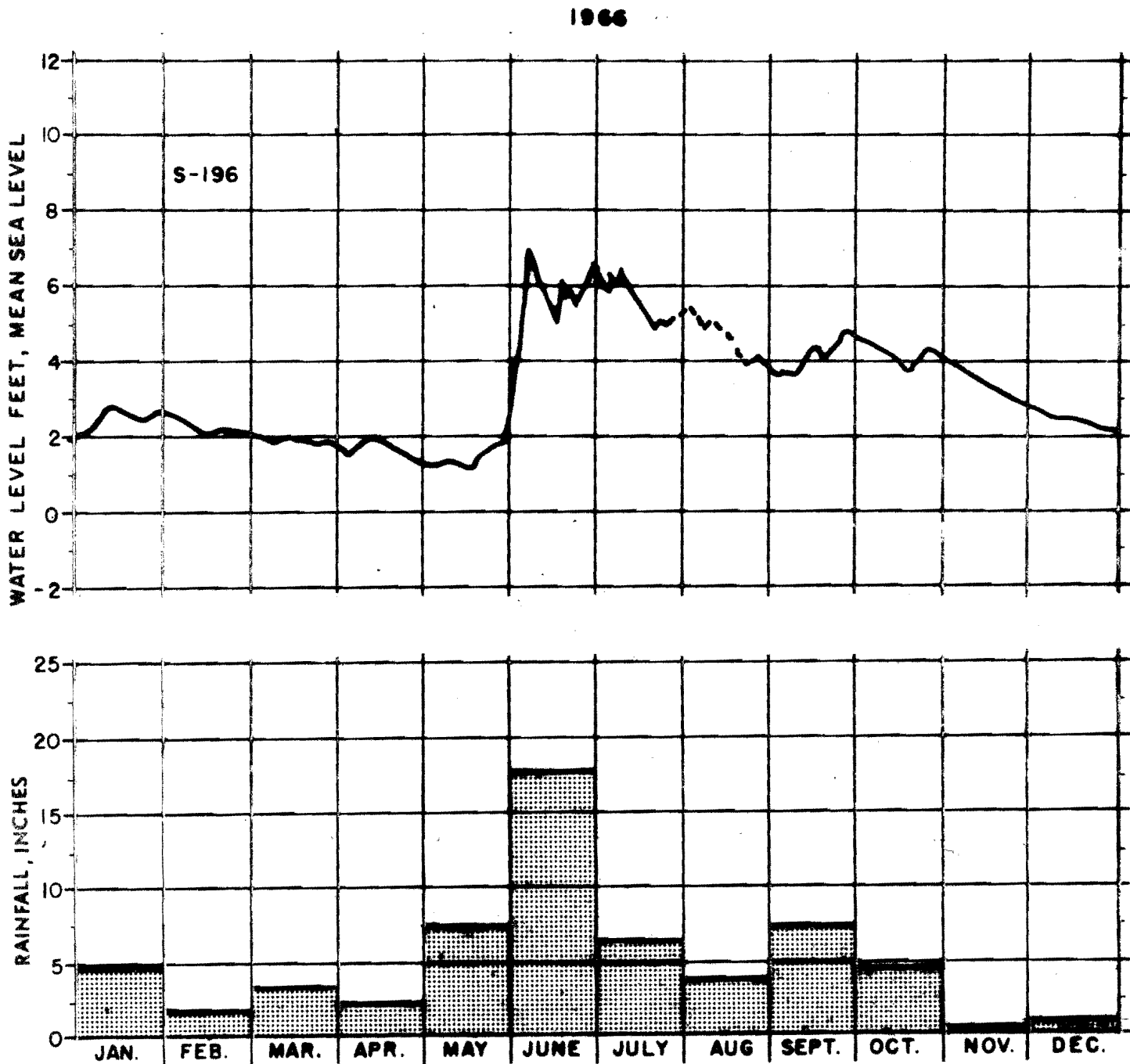


Figure 4.--Graphs comparing water levels in well S-196 and rainfall at Homestead Experiment Station (U.S. Weather Bureau).

Recharge to the aquifer is initially derived from rainfall, which percolates through the soil. The water table is the top of the zone of saturation and fluctuates in response to recharge by rainfall, seepage from conservation areas to the west, evaporation, transpiration, outflow into canals or bays, and pumping. Ground-water levels are higher in the western parts of the county and the areas more distant from drainage canals and they are lower near areas of discharge such as along the coast, adjacent to canals and large municipal well fields where heavy pumping occurs. The range of water-level fluctuation during a year may vary from 1 to 8 feet, depending upon the amount and distribution of rainfall and whether the area in question is near the coast or inland (fig. 4). The water-level peaks may result from heavy rainfall and are generally of short duration. The differences between the highest and lowest water levels during the period (1940-1966) based on graphic records obtained at wells equipped with continuous water-stage recorders ranged from 6 to 11 feet along the coastal ridge and from 7 to 8 feet in the Everglades.

The range between the highest and lowest average yearly water levels recorded for the period 1959-1966, the most recent period analyzed, was 7.0 to 7.5 feet in the Everglades and 1.5 to 2.5 feet along the coast. The lowest water levels recorded for the period 1959-1966 occurred during May and June 1962 and April and May 1965. Total rainfall during the 1965 calendar year was below average; as a result the recharge to the aquifer was below normal at the beginning of 1966.

The yearly average ground-water levels for 1966 ranged from 7.2 feet above msl (mean sea level) at well G-618 in the Everglades where levels are maintained by seepage from Conservation Area 3B to 0.7 foot below msl at well S-68 where levels are lowered by pumping in the Miami Springs well field. The water levels at G-618 and S-68 were 0.5 foot below and equal respectively to the 1959-66 average ground-water levels. (See figs. 5-22).

The highest ground-water levels in the network ranged from 8.3 feet above msl at well G-619 (fig. 10) in the Everglades to 2.2 feet above msl at well G-476 (fig. 8) on the coastal ridge. These levels were about equal to the 1959-1966 average of the yearly highest ground-water levels.

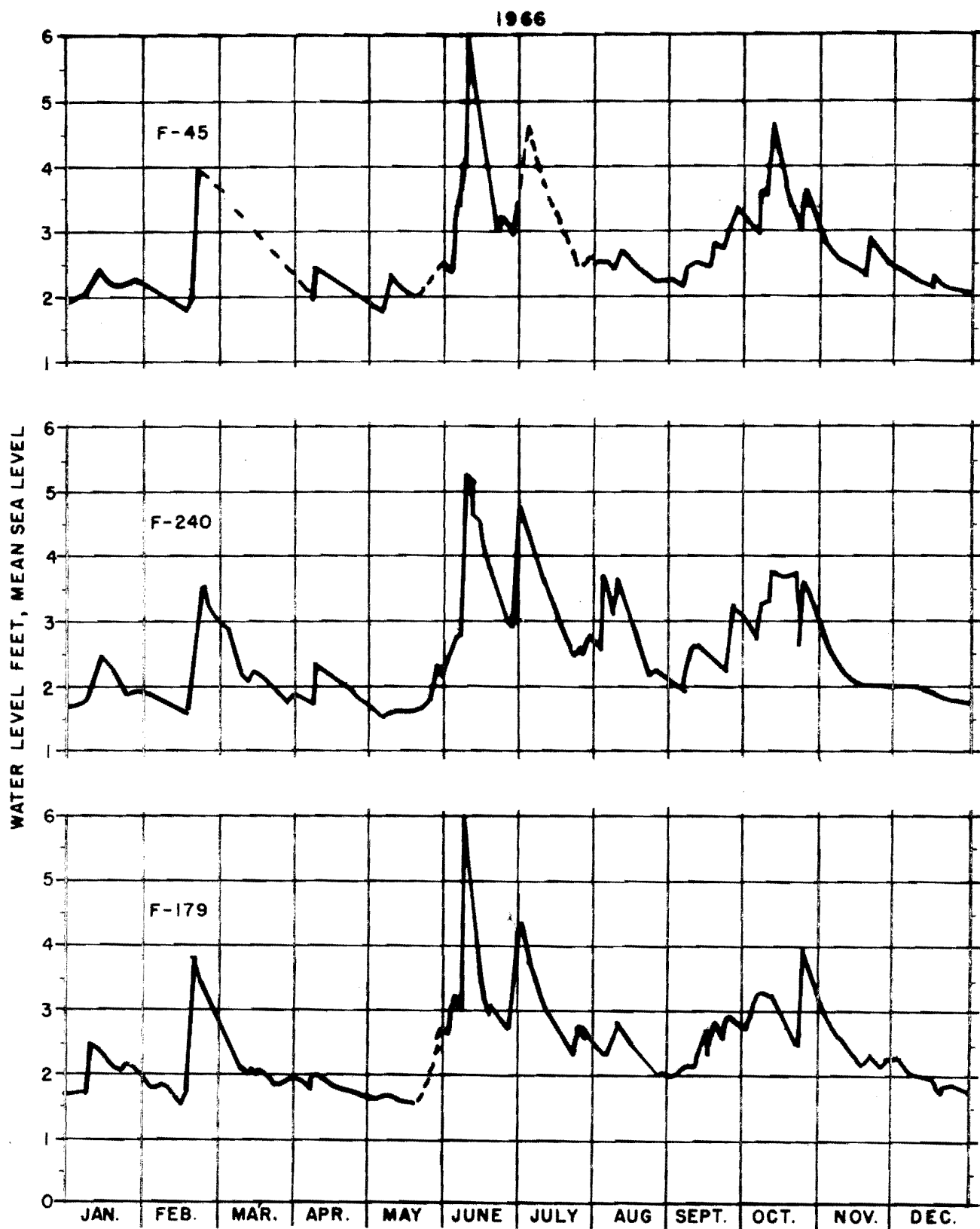


Figure 5.--Hydrographs of wells F-45, F-240, and F-179.

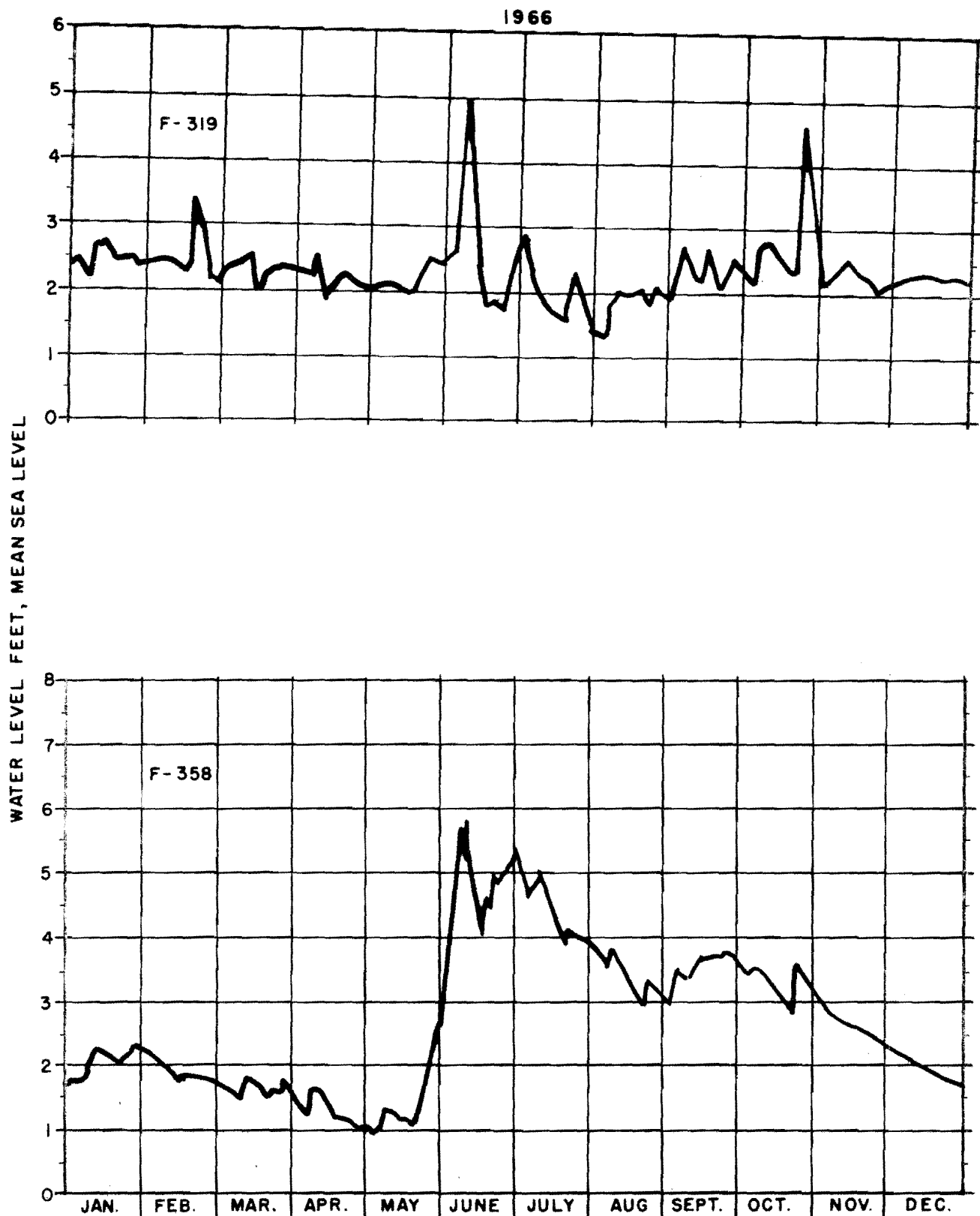


Figure 6.--Hydrographs of wells F-319 and F-358.

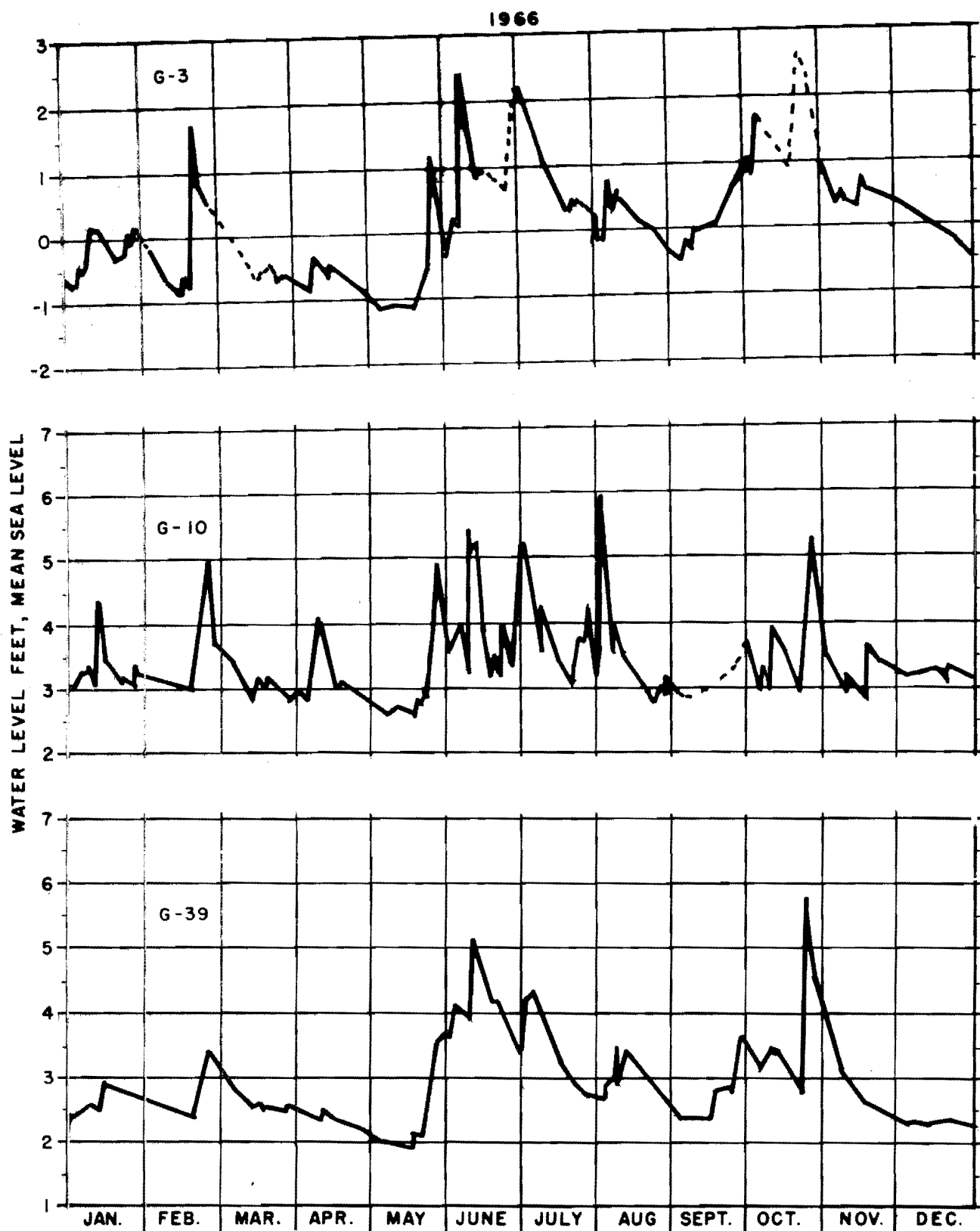


Figure 7.--Hydrographs of wells G-3, G-10, and G-39.
15b

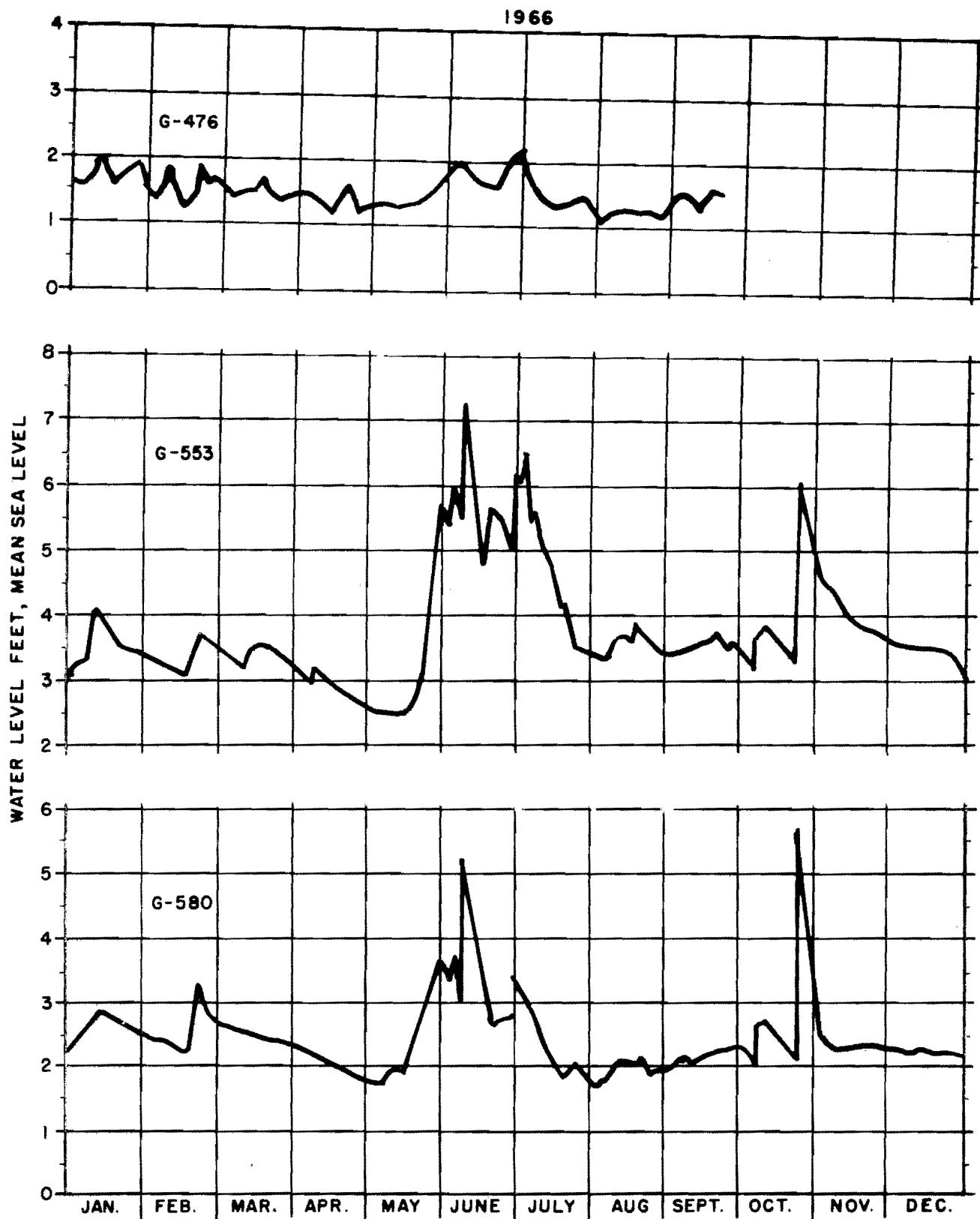


Figure 8.--Hydrographs of wells G-476, G-553, and G-580.

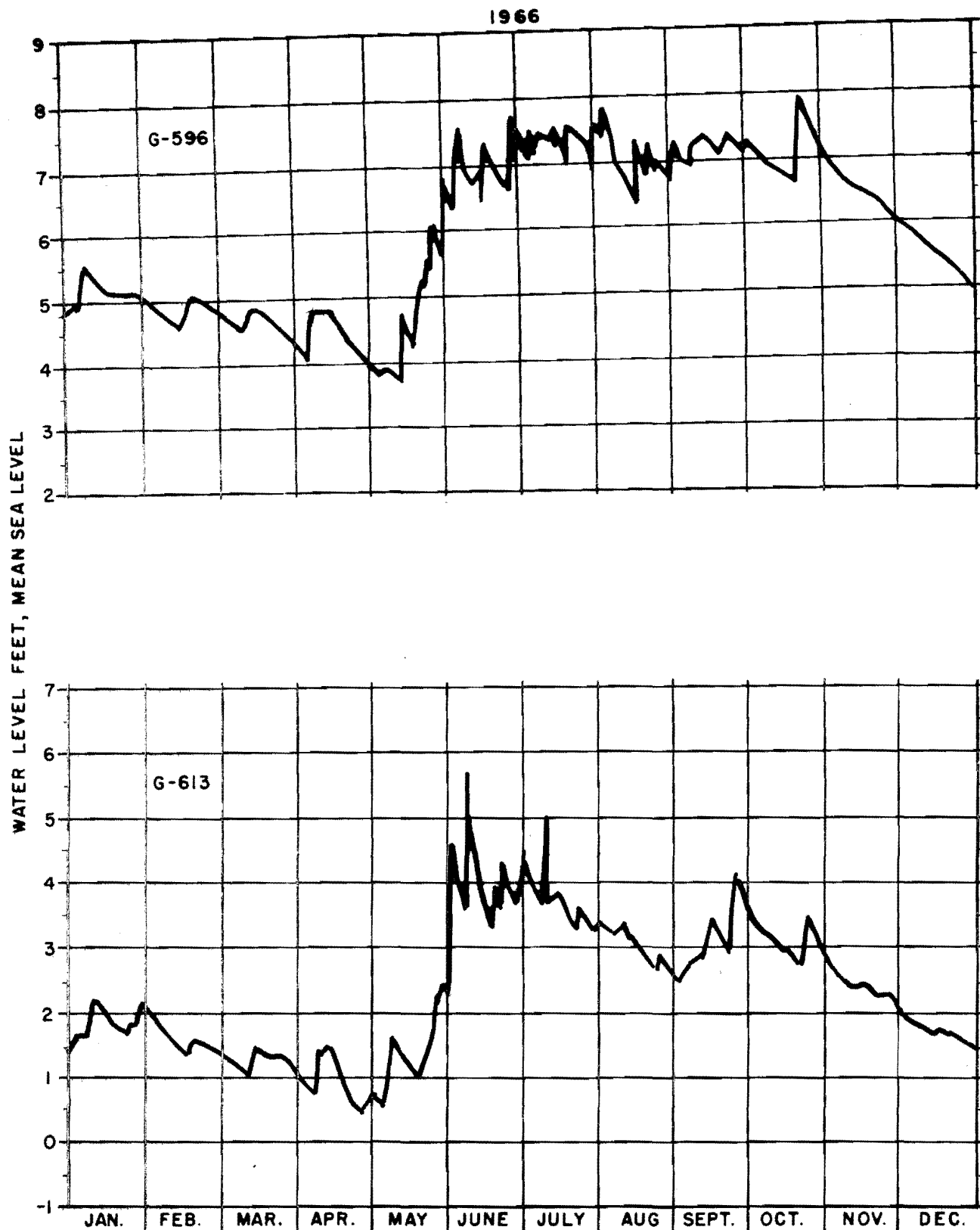


Figure 9.--Hydrographs of wells G-596 and G-613.

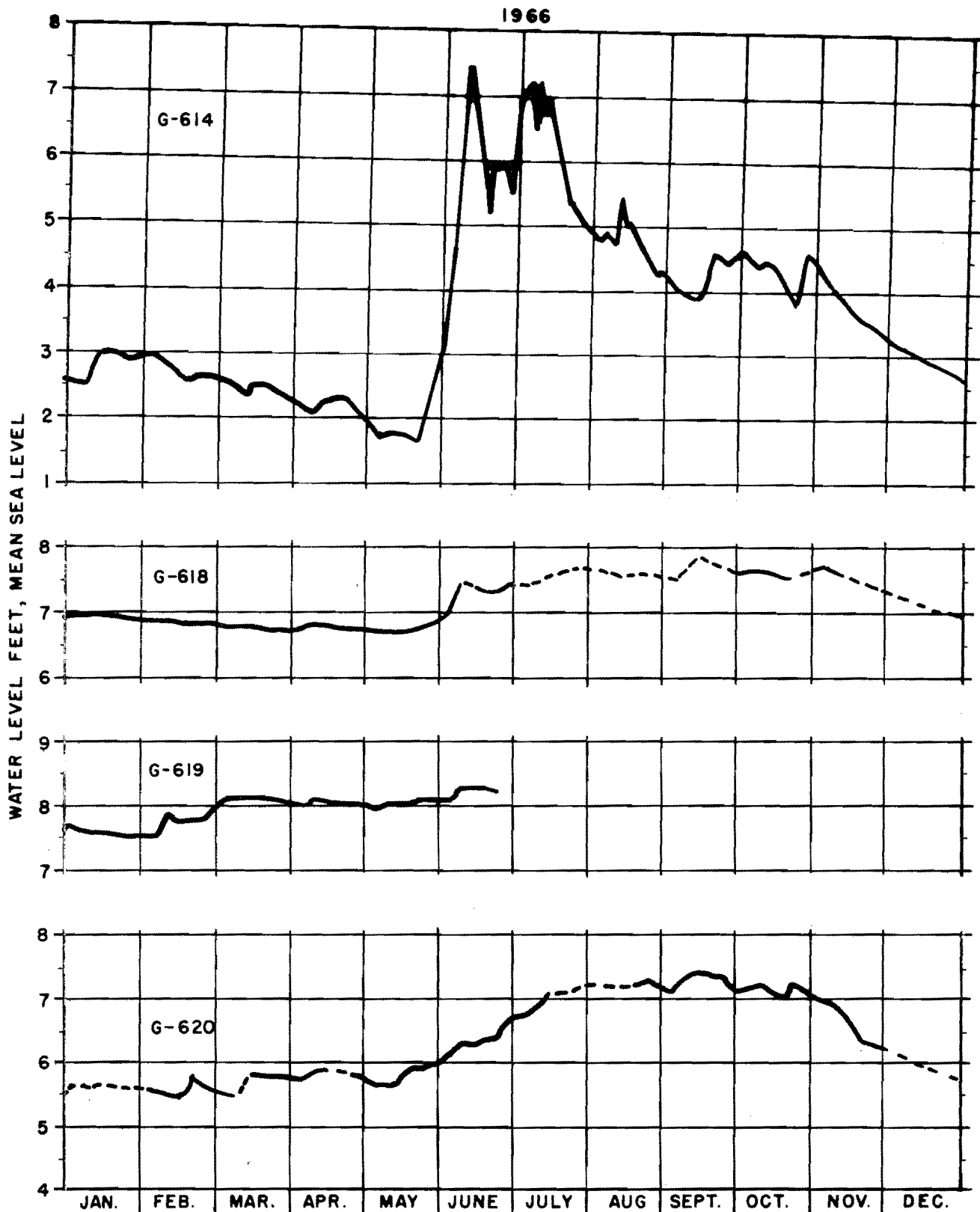


Figure 10.--Hydrographs of wells G-614, G-618, G-619, and G-620.

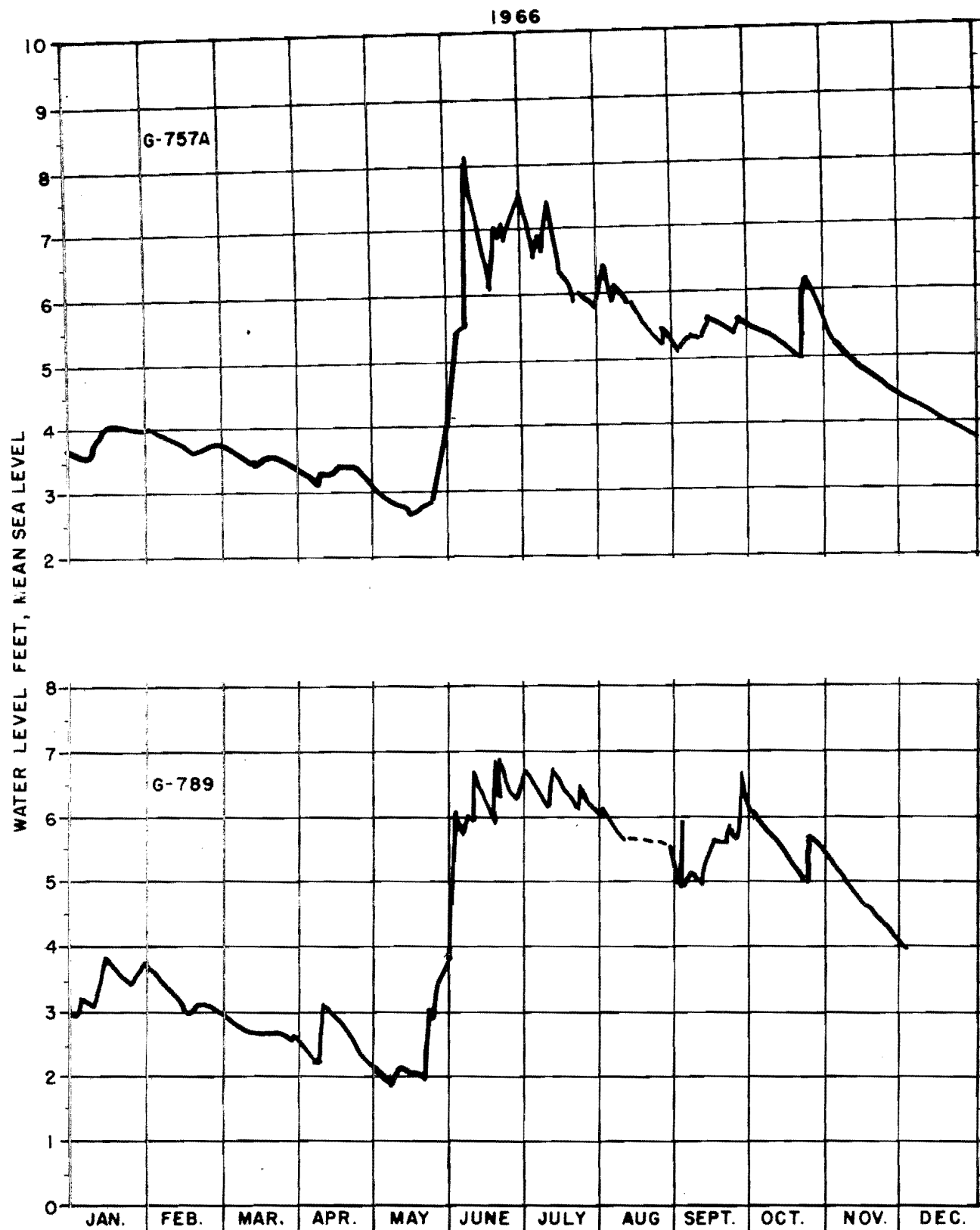


Figure 11.--Hydrographs of wells G-757A and G-789.

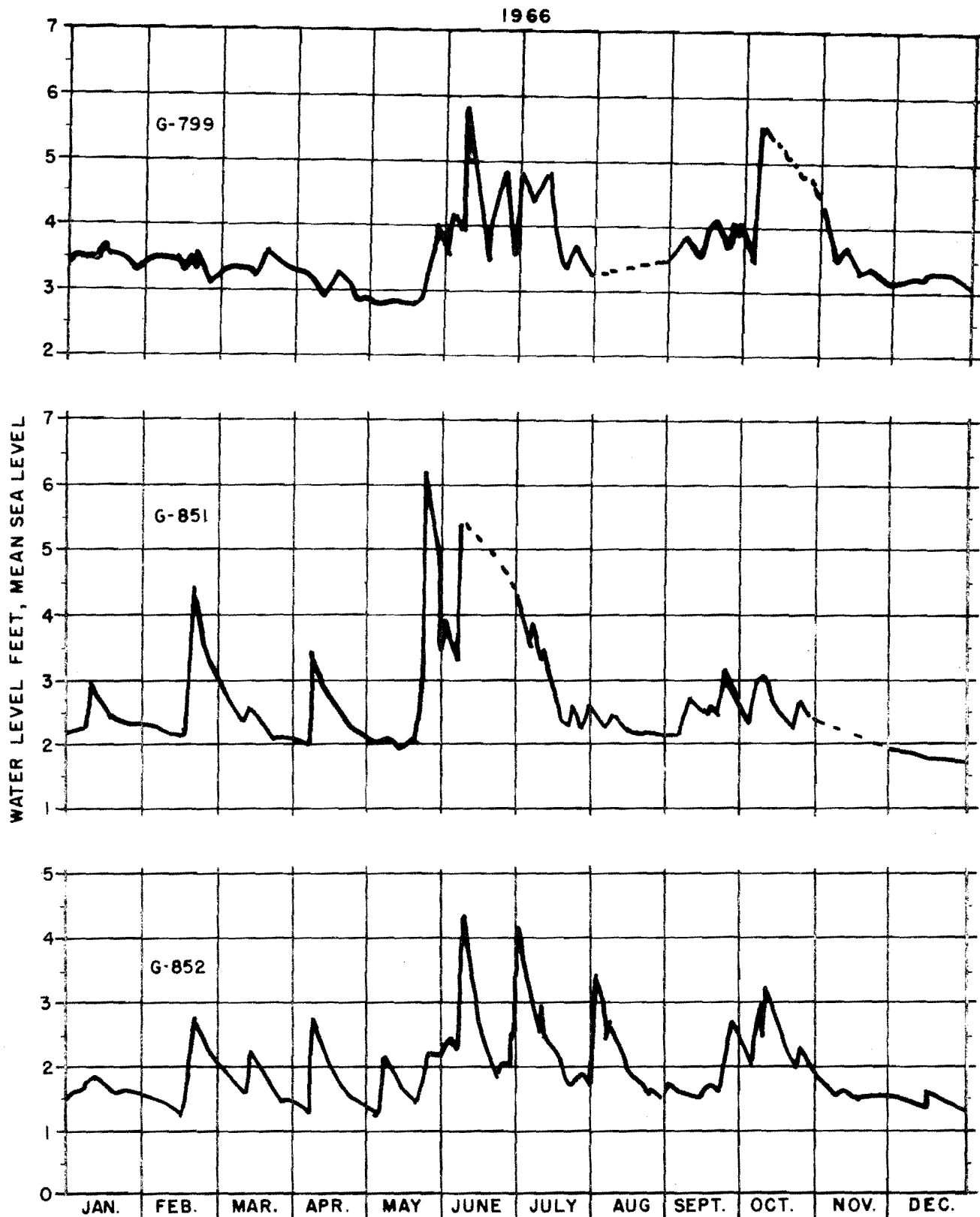


Figure 12.--Hydrographs of wells G-799, G-851, and G-852.

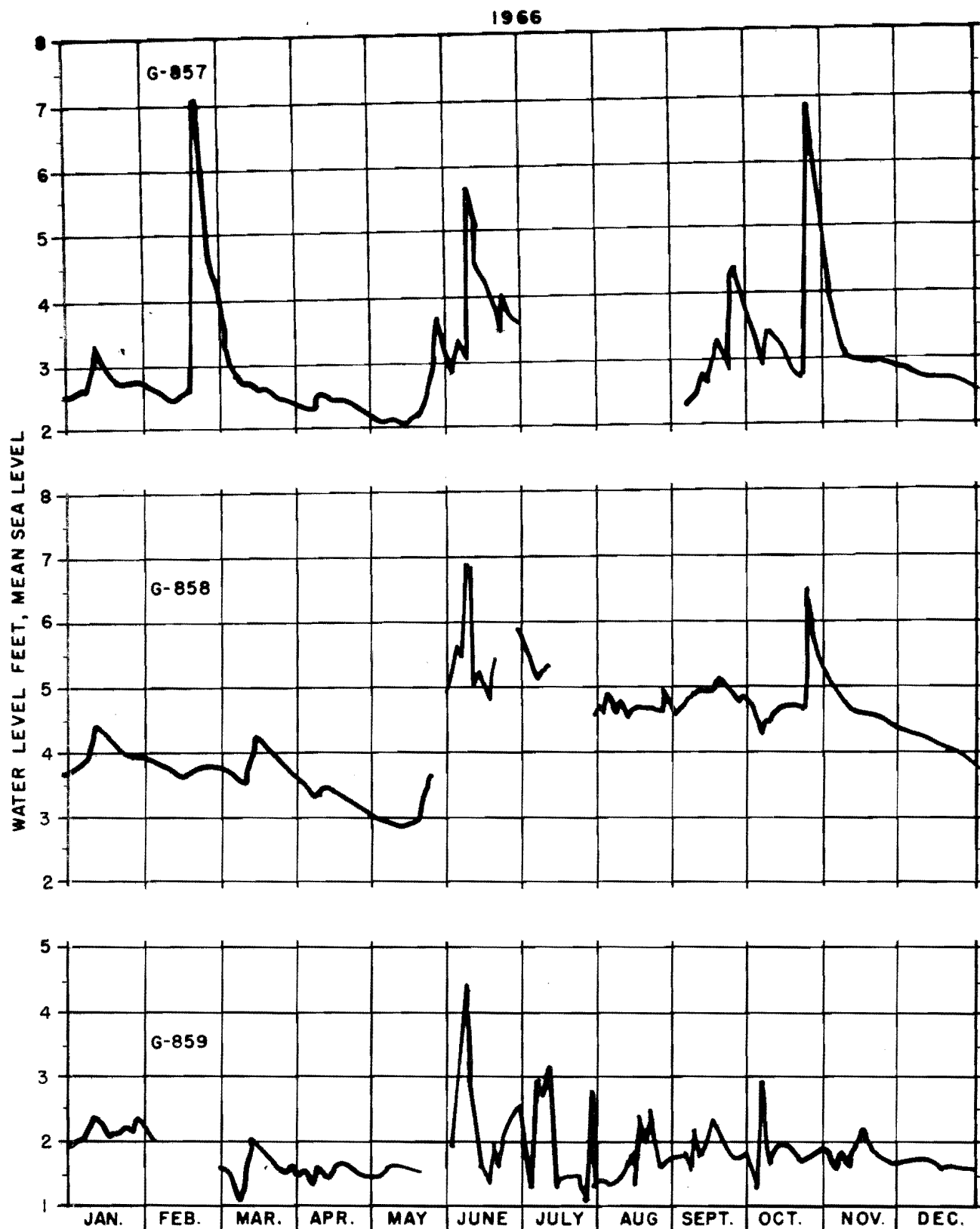


Figure 13.--Hydrographs of wells G-857, G-858, and G-859.

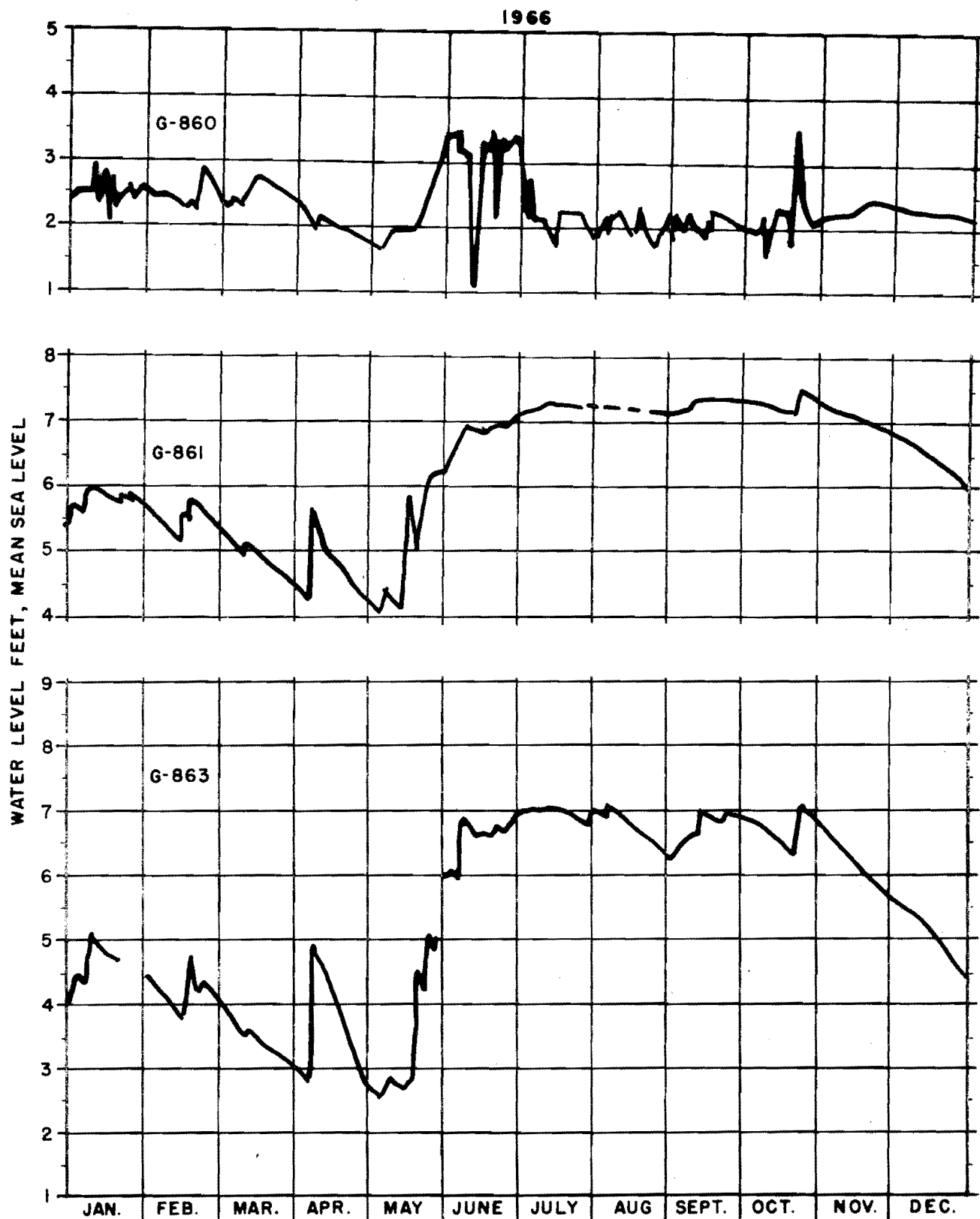


Figure 14.--Hydrographs of wells G-860, G-861, and G-863.

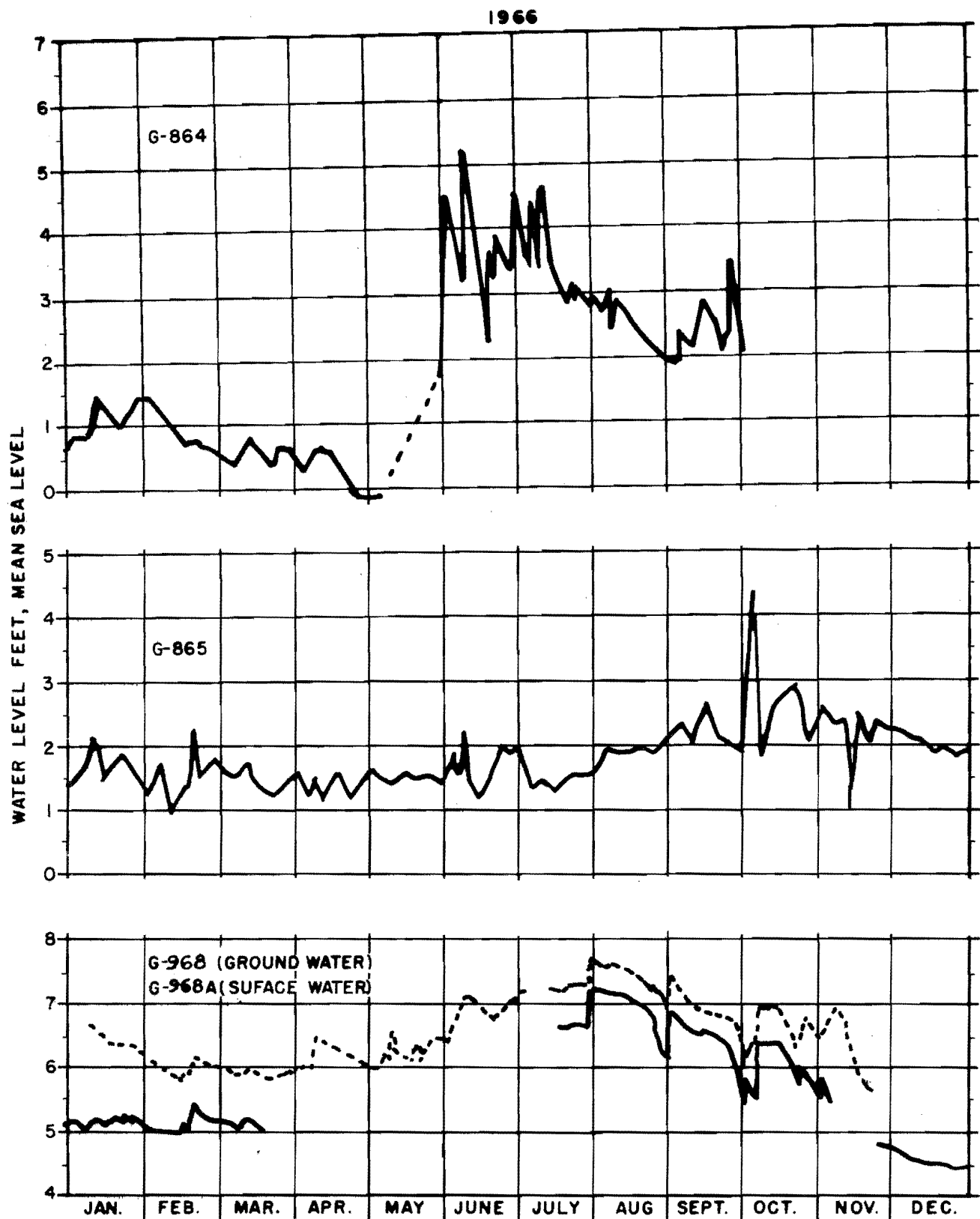


Figure 15.--Hydrographs of wells G-864, G-865, G-968, and G-968A.

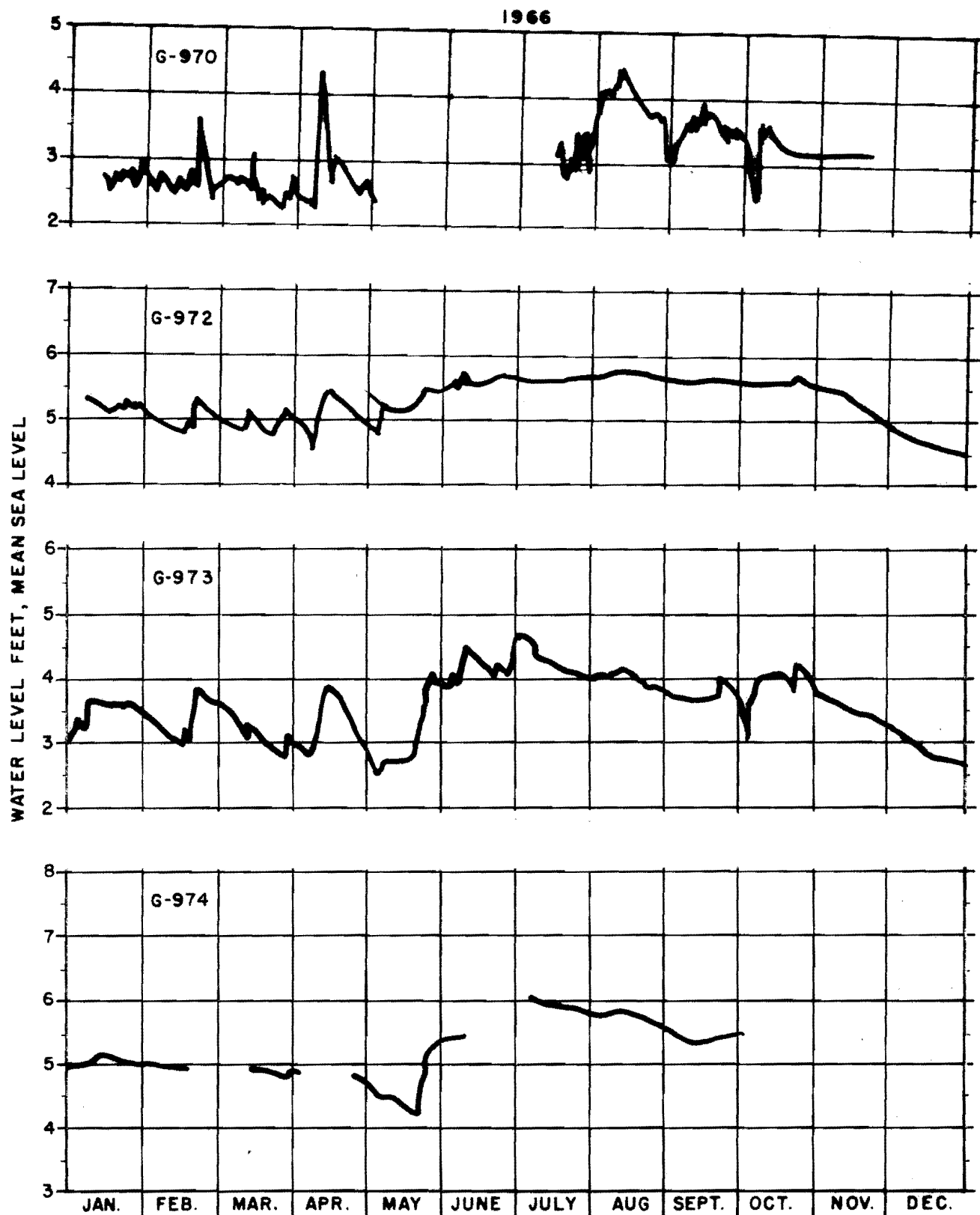


Figure 16.--Hydrographs of wells G-970, G-972, G-973, and G-974.

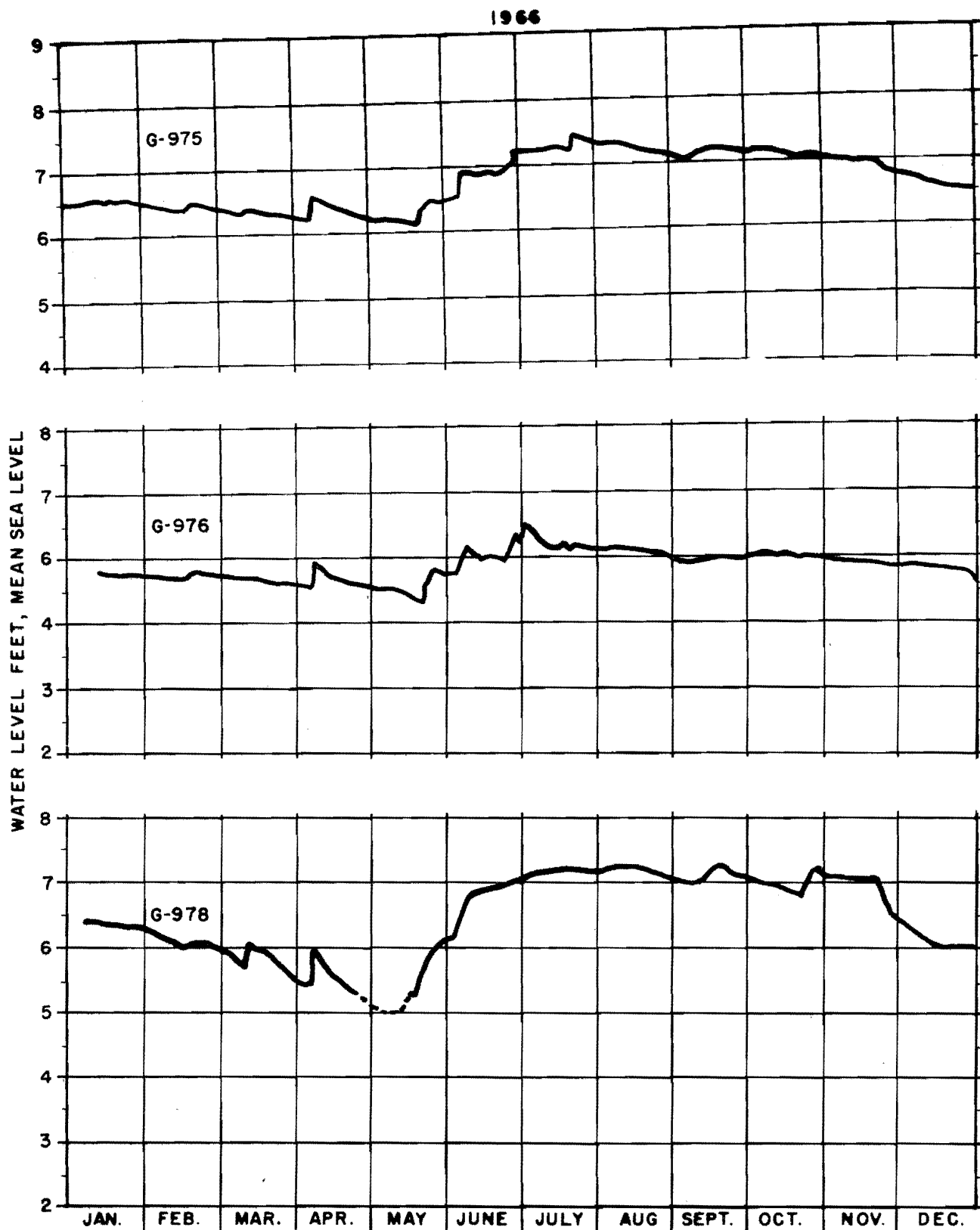


Figure 17.--Hydrographs of wells G-975, G-976, and G-978.

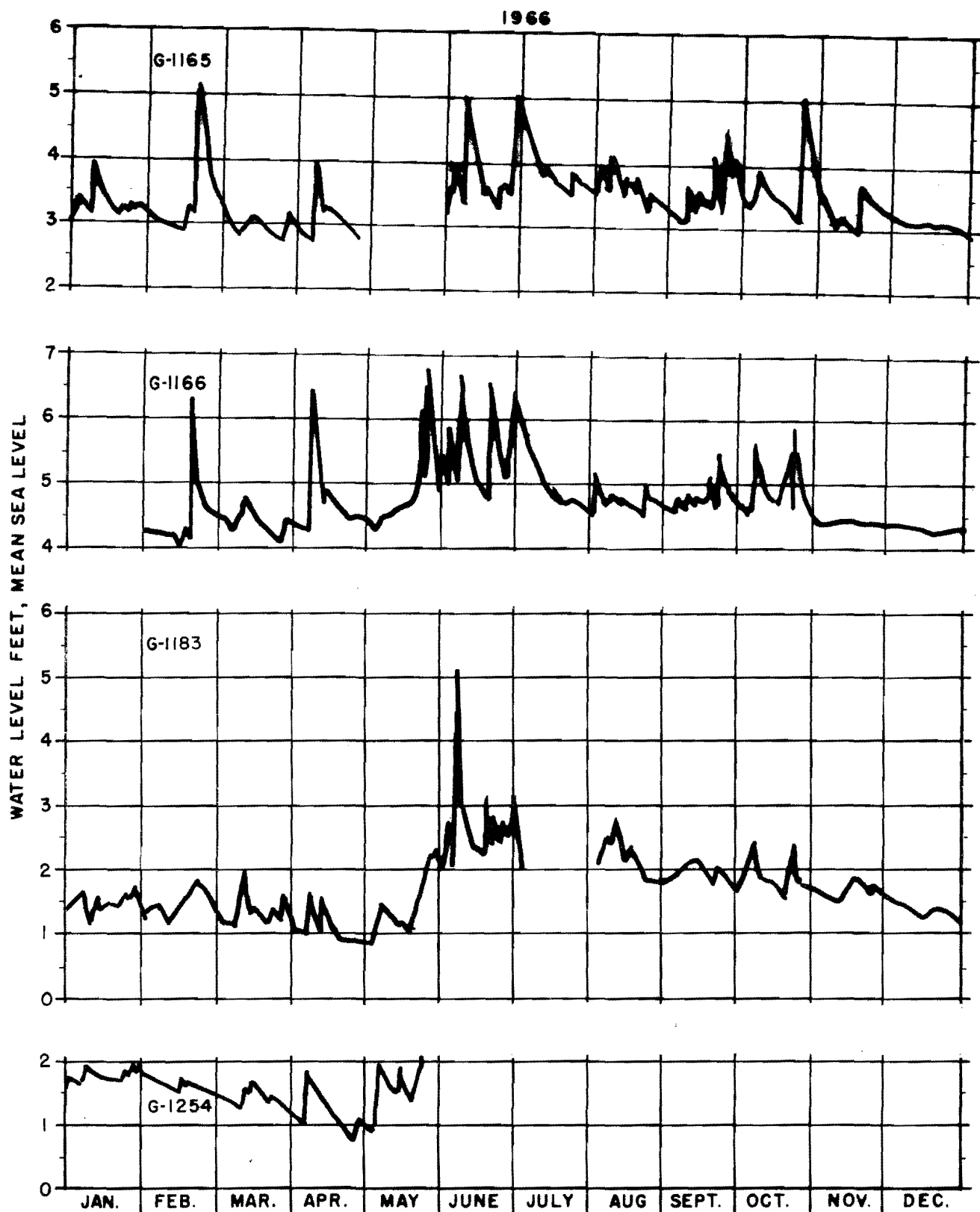


Figure 18.--Hydrographs of wells G-1165, G-1166, G-1183, and G-1254.

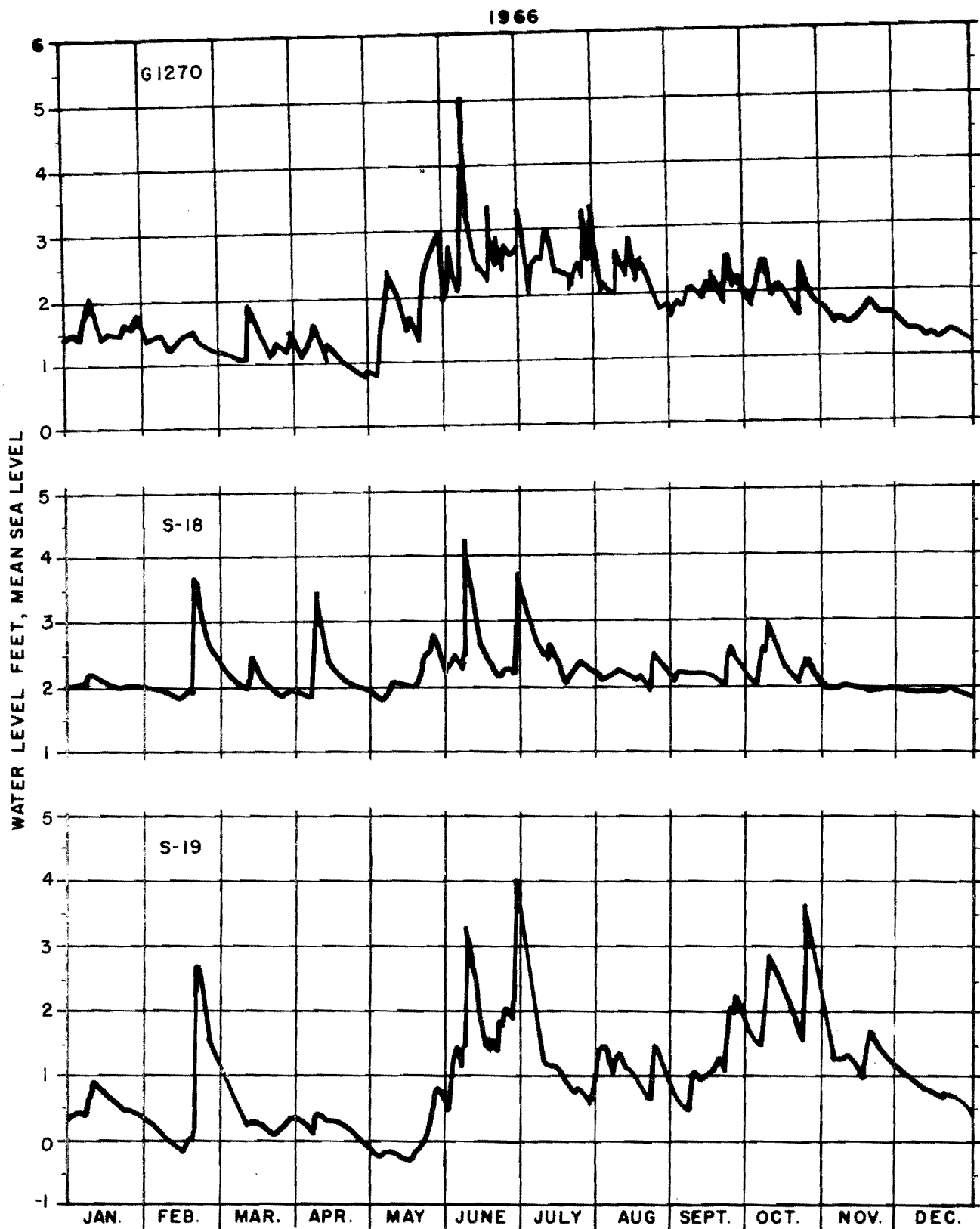


Figure 19.--Hydrographs of wells G-1270, S-18, and S-19.

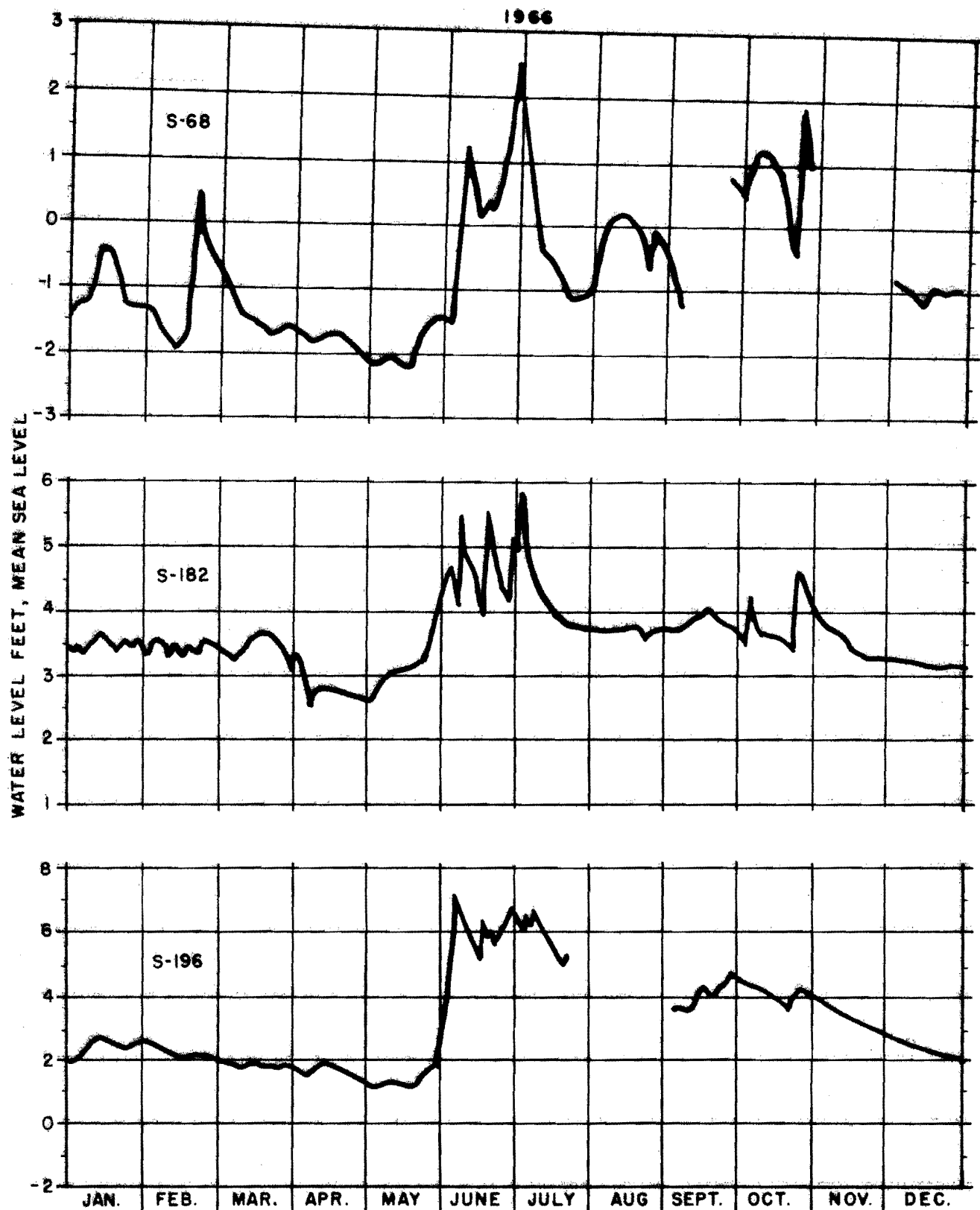


Figure 20.--Hydrographs of wells S-68, S-182, and S-196.

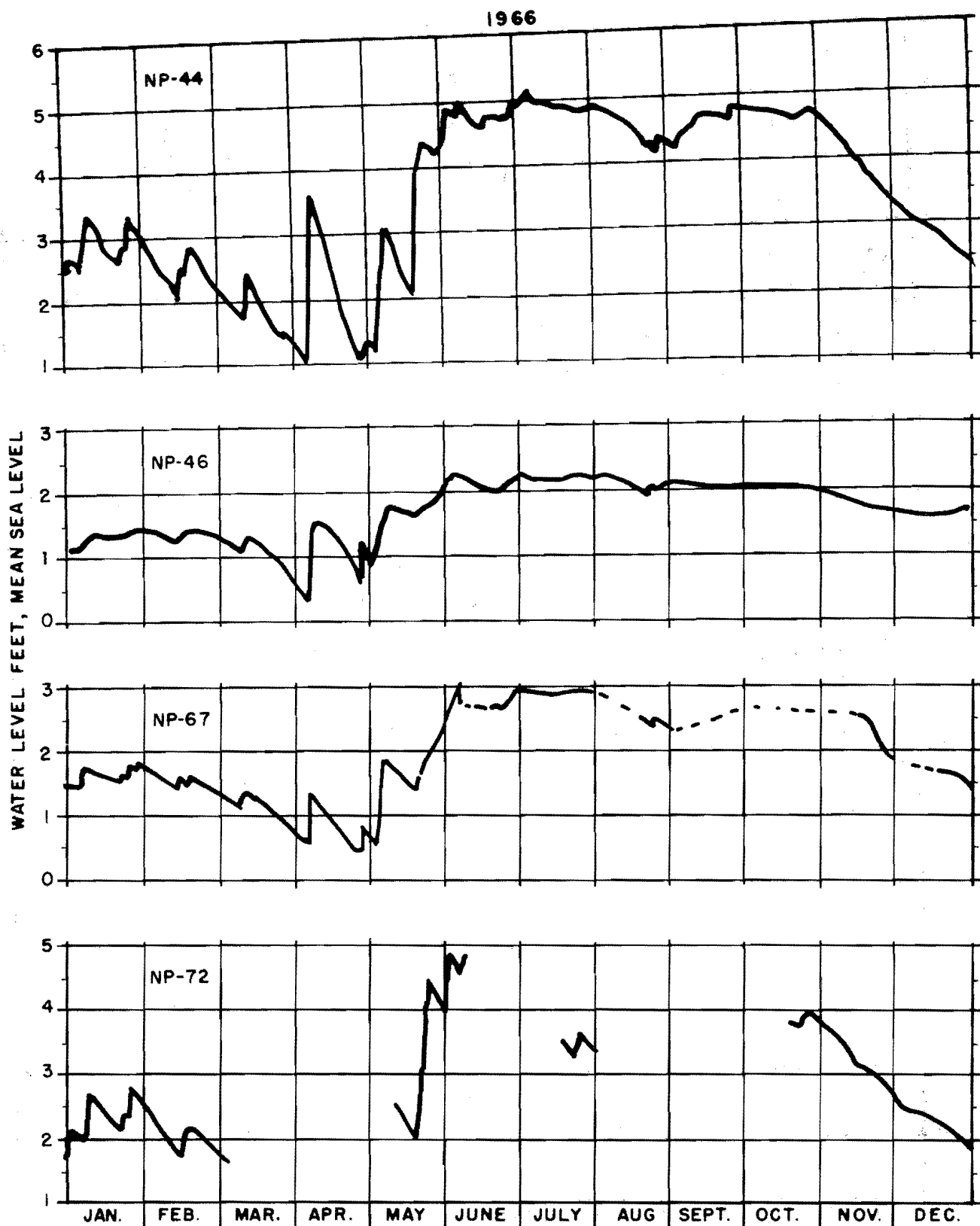


Figure 21.--Hydrographs of wells NP-44, NP-46, NP-67, and NP-72.

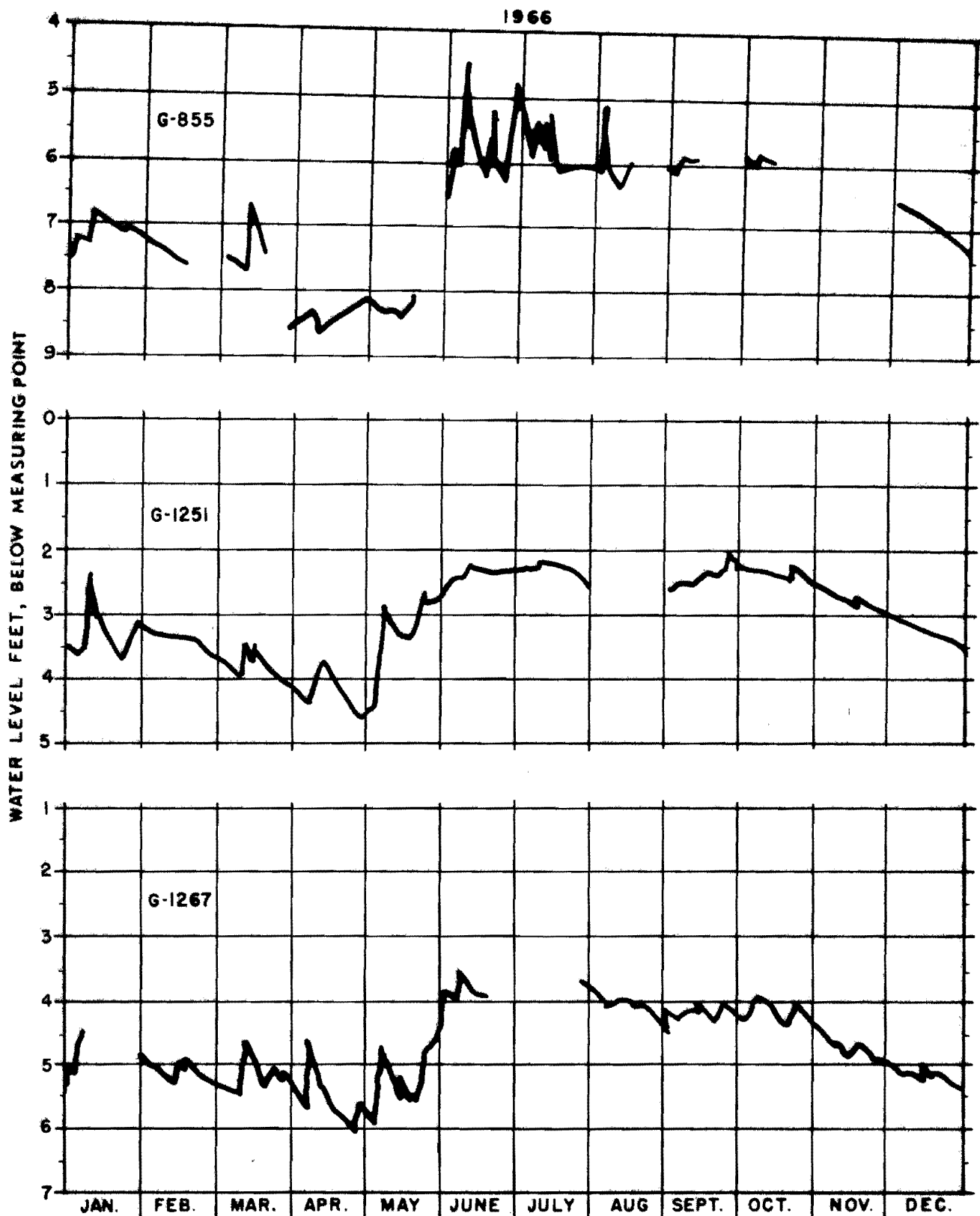


Figure 22.--Hydrographs of wells G-855, G-1251, and G-1267.

The lowest ground-water levels in the network ranged from 7.5 feet above msl at well G-619 (fig. 10) to 2.2 feet below msl at well S-68 (fig. 20). These levels were 1.6 feet above and 0.2 foot below the 1959-1966 average of the yearly lowest ground-water levels, respectively. The lowest ground-water stage for the year was reached during April and May and the highest stage occurred during June.

Water-table maps for May 6, 1966 (low water, fig. 23) and June 9, 1966 (high water, fig. 24) were prepared using data from the observation-well network, from measurements made by personnel of the Dade County Public Works Department, and from interpolation of miscellaneous measurements.

The measurement on May 6 was near the end of the dry season and coastal-control structures in canals had been closed or only partly open for several months. The highest water level in the county at that time was in the conservation areas and ground water was moving south from there, through the aquifer toward the ocean. Low flow in the canals was maintained principally by inflow of ground water from the zone of saturation. Canal-water levels near the coast were higher than the adjacent ground-water levels and it may be assumed that the aquifer was being replenished by seepage from these canals. In the south end of the county, levels were approaching sea level.

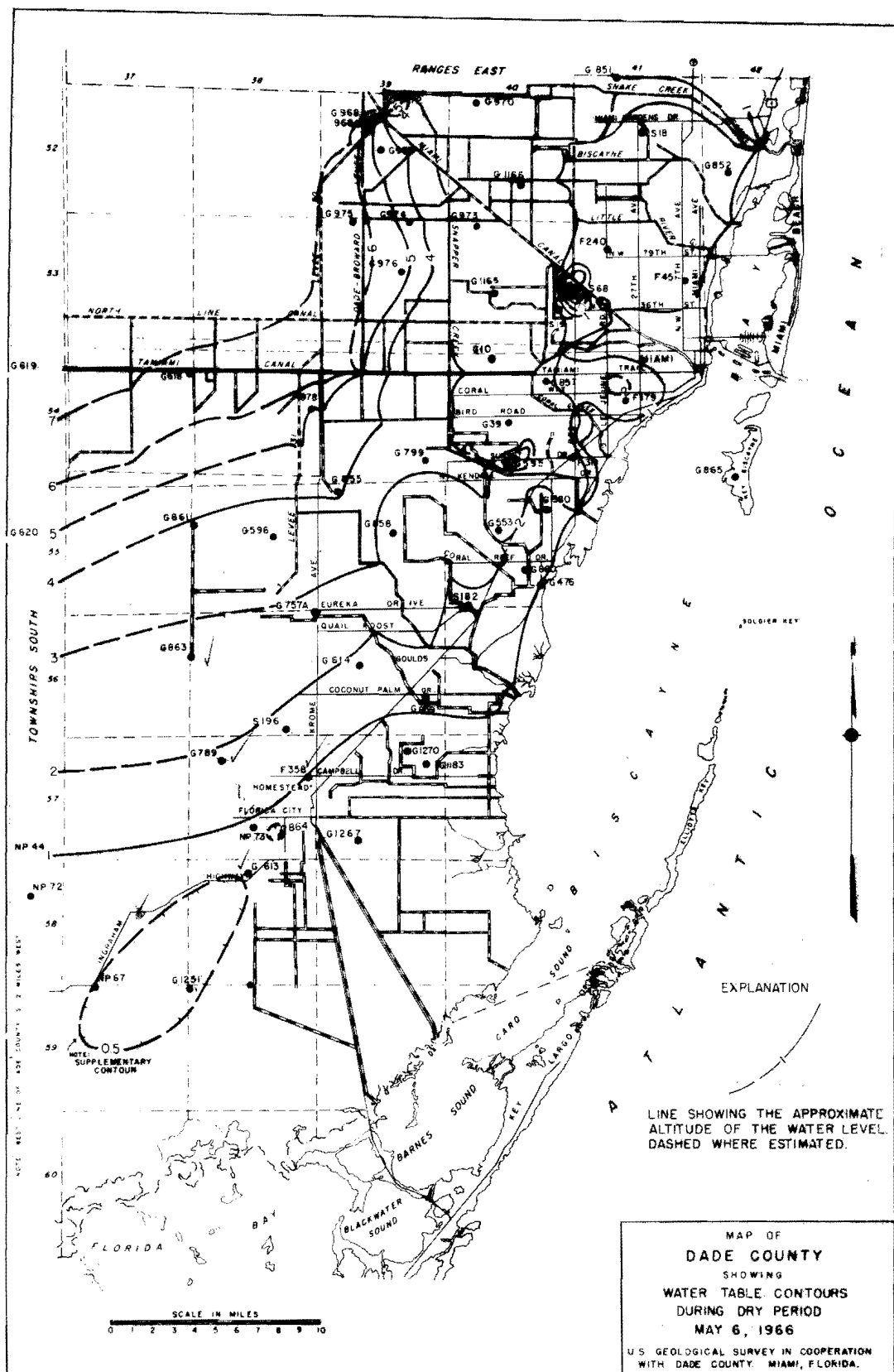


Figure 23.--Map of Dade County showing contours on the water table during dry period, May 6, 1966.

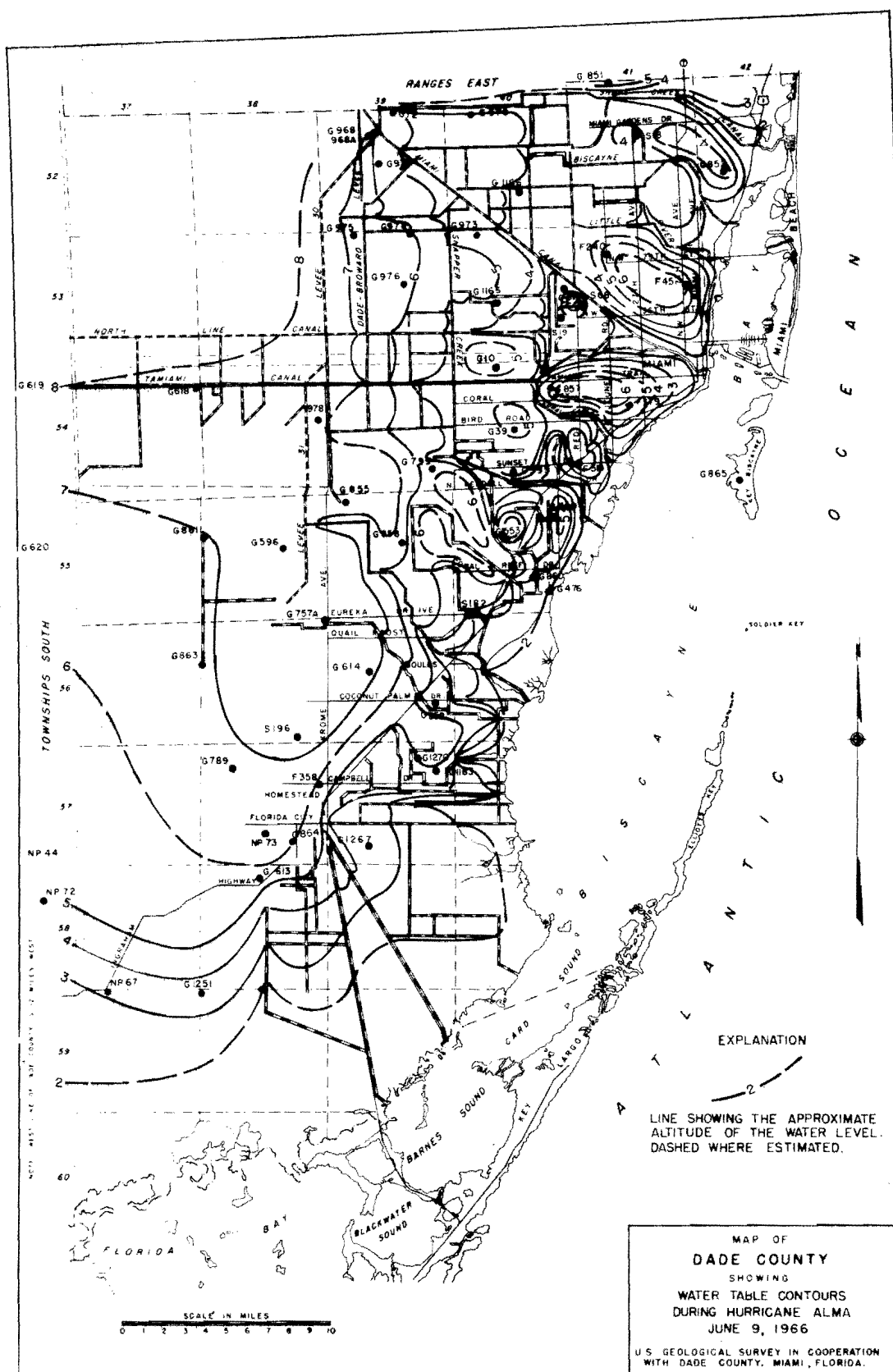


Figure 24.--Map of Dade County showing contours on the water table during Hurricane Alma, June 9, 1966.

High ground-water levels recorded in June 1966 were the result of recharge from rain from Hurricane Alma (U.S. Weather Bureau, 1966). Levels rose throughout the county and ground-water mounds were built up in the intercanal areas. However the high levels between canals were temporary because canal-control structures were opened, allowing the excess water to discharge to the ocean. The effect of Hurricane Alma on surface-water flows is discussed later in this report. Another hurricane, Inez, occurred on October 3-5, 1966.

The fluctuating water-table conditions are of economic importance in urban and rural areas. Excessively high water-table conditions may cause flooding in low areas resulting in the destruction of crops and endangering buildings. Excessively low water-table conditions may cause damage to non-irrigated crops, permit organic soil to shrink or burn, endanger wildlife in recreational areas, and increase the threat of sea-water intrusion along the coast.

Recharge and Discharge

Rainfall is the principal source of recharge to the Biscayne aquifer and the average is 57 inches annually. In general, lower amounts fall on the Everglades and higher amounts on the coastal ridge. A small amount of water moves into the aquifer from canals that extend northward into Broward County. In areas where canal flow is controlled by structures and where ground-water levels are lowered by pumping as in the Miami Springs and Alexander Orr well fields, canals are a source of recharge to the aquifer (figs. 25 and 26).

Of the 60 inches of average rainfall in the coastal ridge of Dade County, Parker (1955, p. 229) estimated that 22 inches is lost by evapotranspiration and surface runoff before reaching the water table. Of the 38 inches that infiltrates to the water table, 25 inches is discharged as ground-water flow and 13 inches is discharged by evapotranspiration and pumping. However, less evapotranspiration occurs in areas where heavy pumping has lowered the water table.

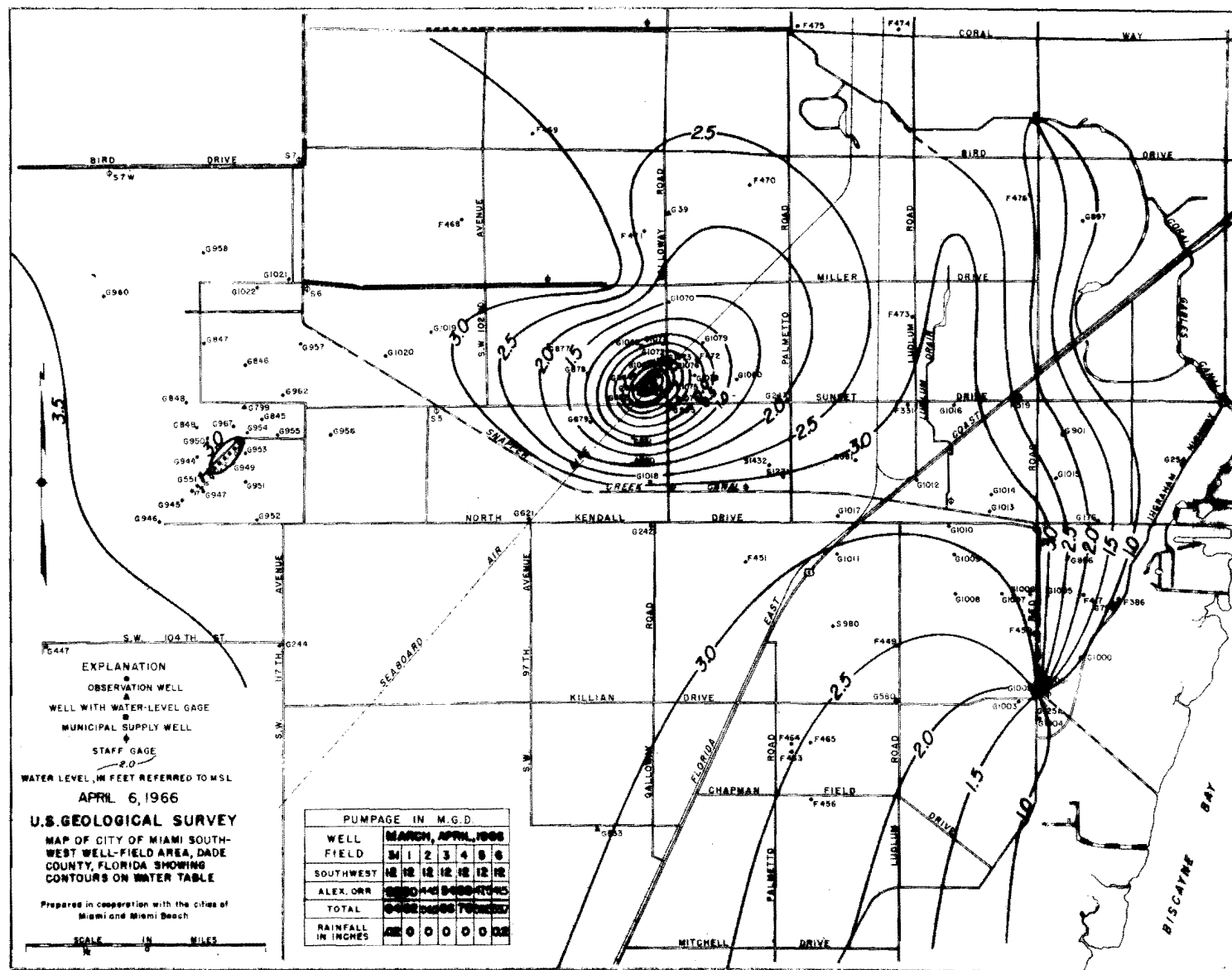


Figure 25.--Map of City of Miami southwest well-field area showing contours on the water table, April 6, 1966.

On April 6-7 water-level measurements were made in the southwest well field area and the Miami Springs well field to determine the effect of dry season pumping on water levels. Figure 25 shows the effect that pumping at the rate of 60 mgd (million gallons per day) in the southwest well field area had on water levels in the area. The contour map in figure 25 shows that the water level in the center of the field was drawn down to nearly 3 feet below msl, but the level in the Snapper Creek Canal was maintained above 3 feet above msl. The contour pattern shows that replenishment was occurring from the canal to the well field, thereby minimizing drawdown. The contour map of the Miami well field (fig. 26) shows the effect that pumping at the rate of about 80 mgd had on levels in that area. The pattern of the contours shows that replenishment was occurring from the Miami Canal and from the Florida East Coast Borrow Canal on the western perimeter of the well field. In both instances the coastal-control structure in each canal (Snapper Creek and Miami) was closed, permitting water in these canals to recharge the aquifer in areas of pumpage.

After the construction of Canal 102 in south Dade County in 1965, a significant change in the water levels occurred in the vicinity of Structure 165 near U.S. Highway 1. Records from observation well G-859, 5 miles inland from the Bay, showed tidal fluctuations during 1966 when S-165 and coastal structure 21-A were open. The lowering of water levels caused by control operations is readily discernible when comparing a dry year, 1965, with a wet year, 1966 (fig. 27). The

narrow range of fluctuations for a wet year (1966) with canals and controls constructed, contrasts greatly with the wide range shown in a dry year (1965) without canals.

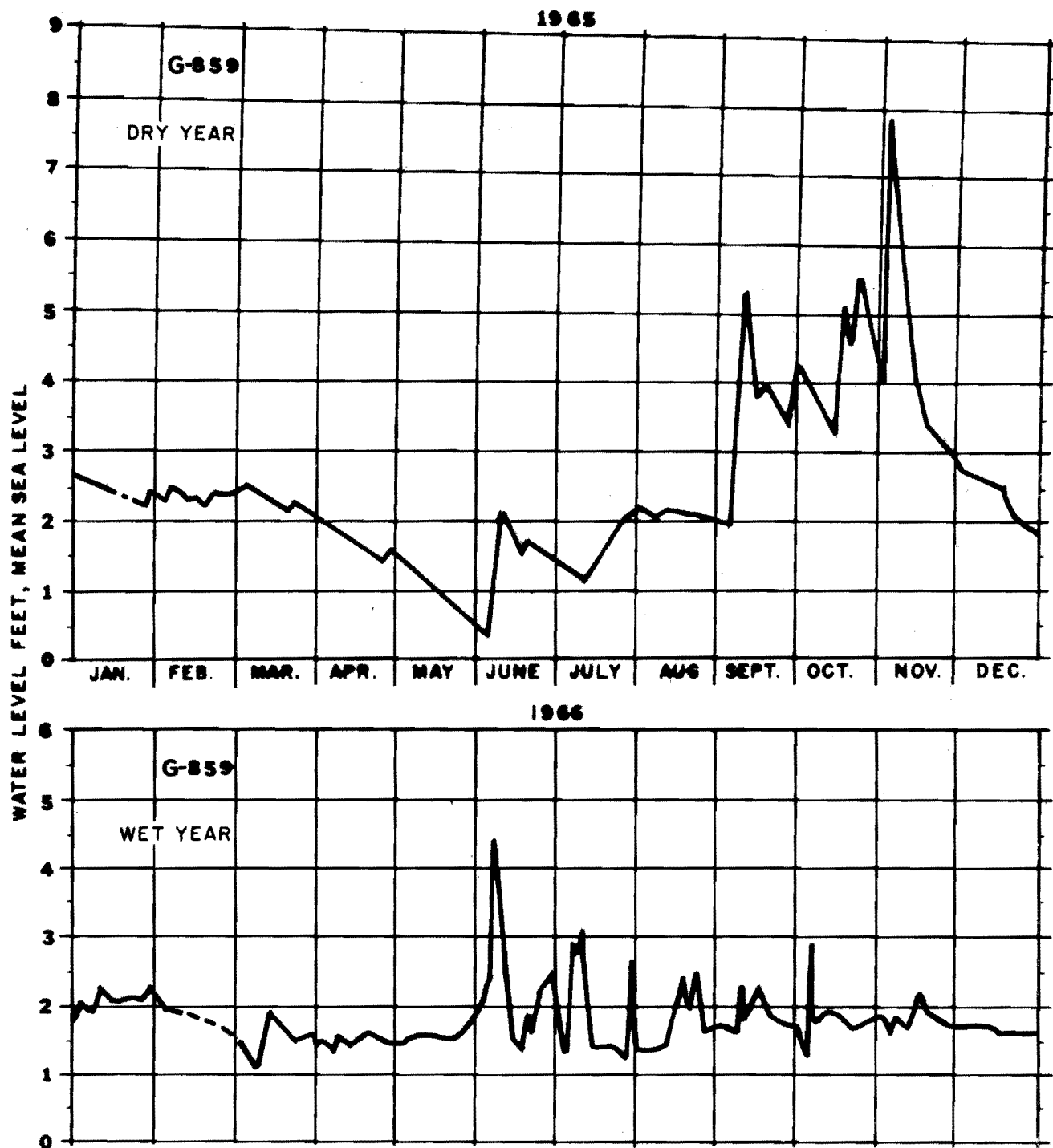


Figure 27.--Hydrographs of well G-859 for 1965 and 1966.

Water Use

Ground water in Dade County is used for municipal, industrial, domestic, and agricultural purposes. The total yearly pumpage at the Miami well fields increased from approximately 8.5 billion gallons in 1940 to 51 billion gallons in 1965 and dropped to 46 billion gallons in 1966 (fig. 28). The average daily pumpage at these well fields as shown in figure 29 indicates a steadily increasing trend in pumpage from 1930 through 1966. However the dropoff period during 1953 through 1966 reflects a population shift to the suburban areas. These areas are served by local water systems whose total average daily pumpage, if applied to the graph, would continue the 1930-1952 trend.

The monthly pumpage of the Miami well fields for 1966 as compared with monthly rainfall (fig. 30) shows the greater demand for water during a month of sparse rainfall (May). Conversely, during periods of peak rainfall water demands are reduced.

The estimated pumpage in Dade County for 1966 as compared to 1945 and 1950 in million gallons per day is given in table 2.

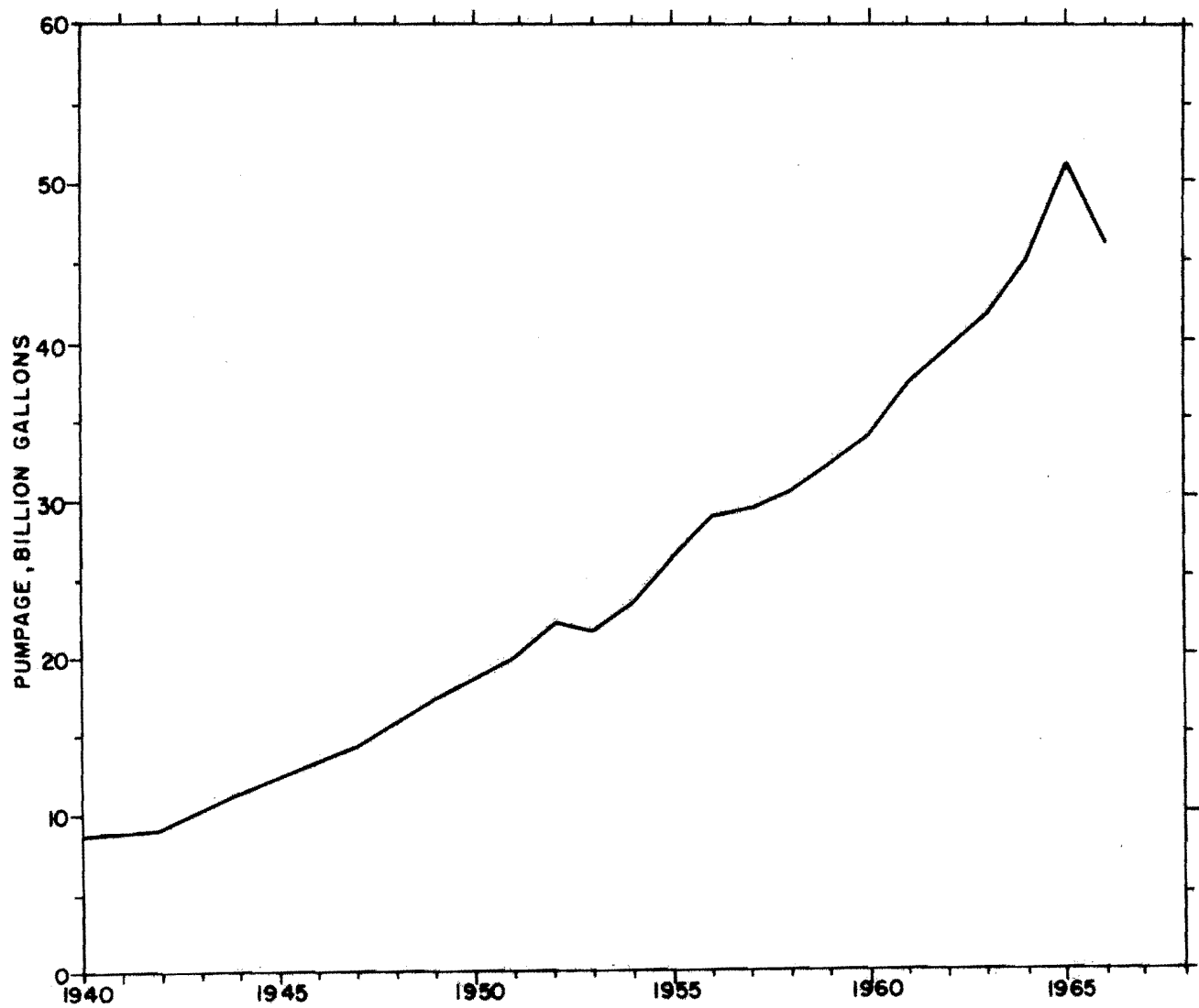


Figure 28.--Graph showing total yearly pumpage (1940-1966) at the Miami well fields.

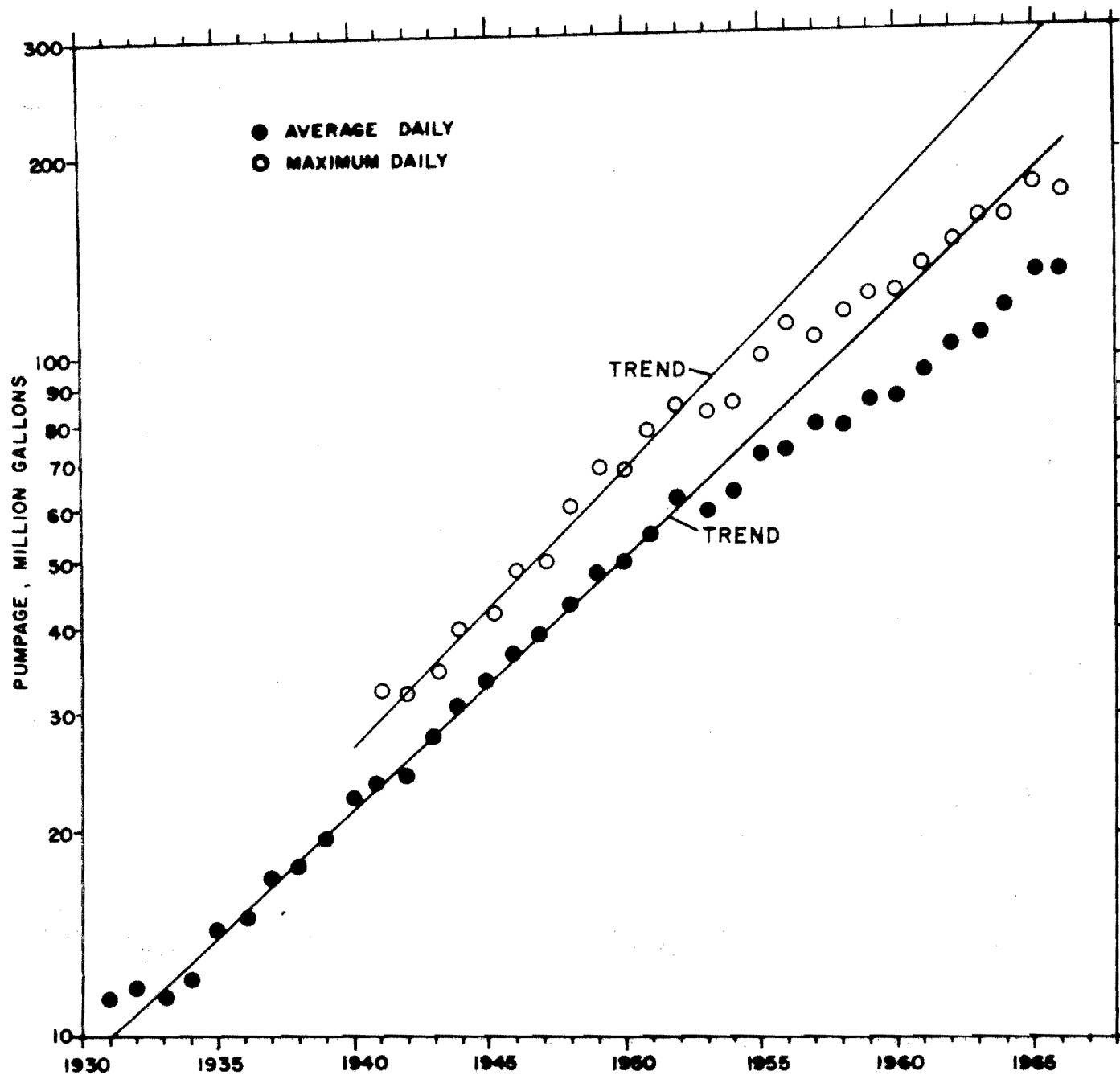


Figure 29.--Graphs showing average daily pumpage (1930-1966) and maximum daily pumpage (1940-1966) at Miami well fields.

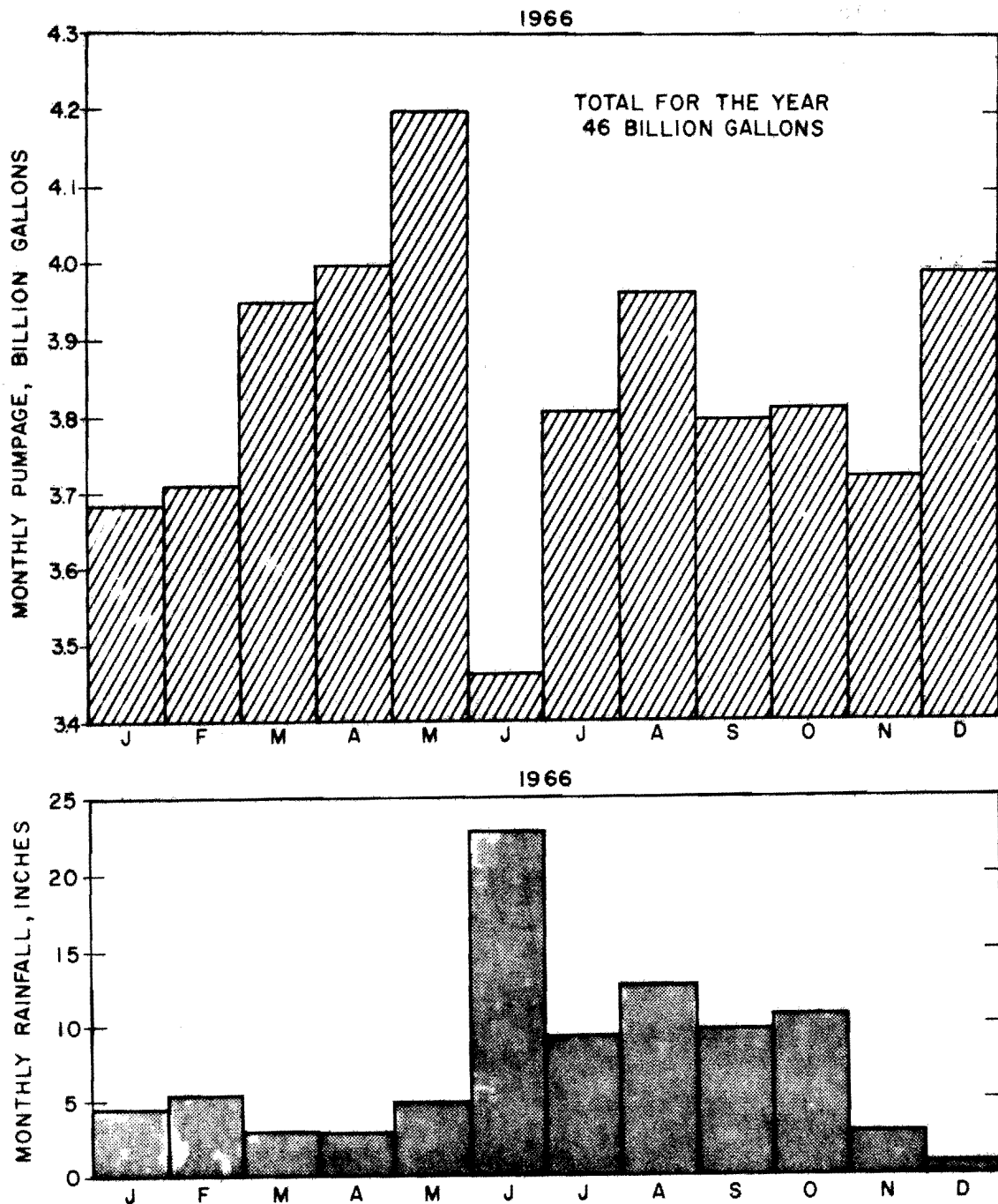


Figure 30. Graphs comparing monthly pumpage at Miami well fields, and monthly rainfall at Hialeah.

Table 2.--Estimated pumpage in Dade County for selected years.

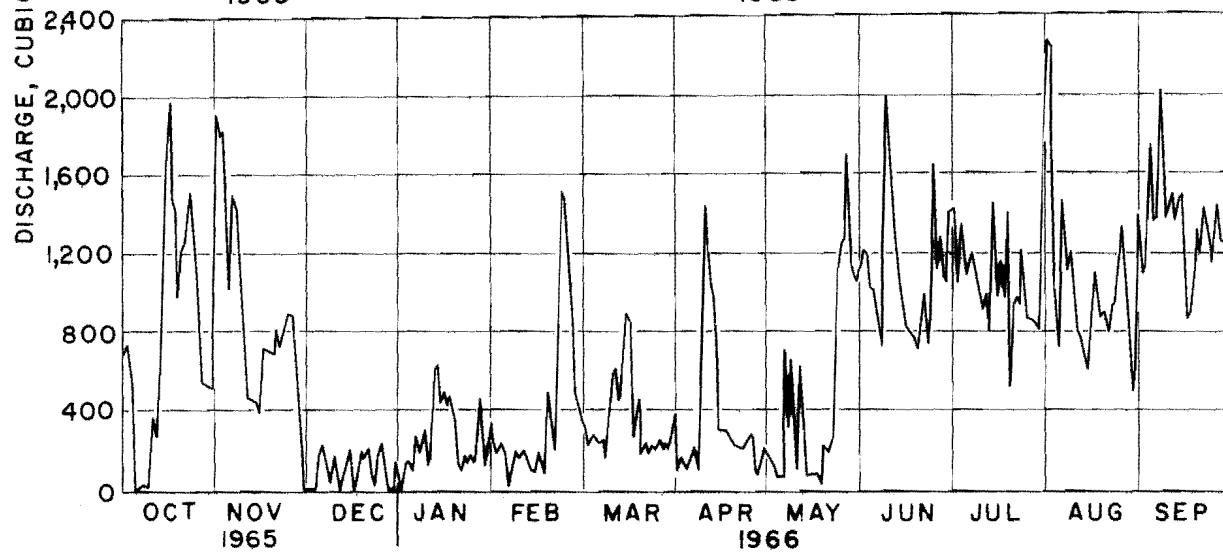
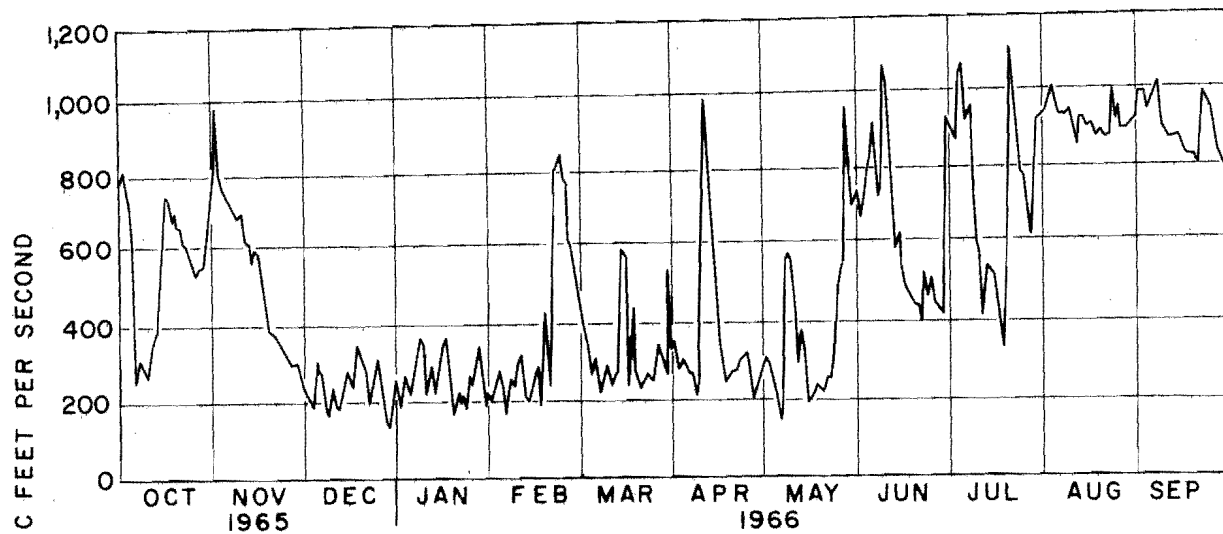
	<u>Pumpage, million gallons per day</u>		
	<u>1945</u>	<u>1950</u>	<u>1966</u>
Public supply	35	65	200
Industrial	12	20	10
Rural and irrigation	<u>11</u>	<u>15</u>	<u>40</u>
Total average daily pumpage	58	100	250

SURFACE WATER

During 1966 the U.S. Geological Survey maintained 48 surface-water gaging stations within the county to determine the annual runoff. Thirteen of these stations were located at coastal control structures, five were in estuarial reaches and in Biscayne Bay, and thirty were at inland locations. Records of daily flow were obtained at all major canals except the Black Creek Canal while periodic measurements of flow were made and daily water levels were recorded at canals of lesser importance. Discharge hydrographs for 12 of the stations are shown in figures 31 through 36. The affects of Hurricane Alma, June 8-10, may

be noted on these hydrographs.

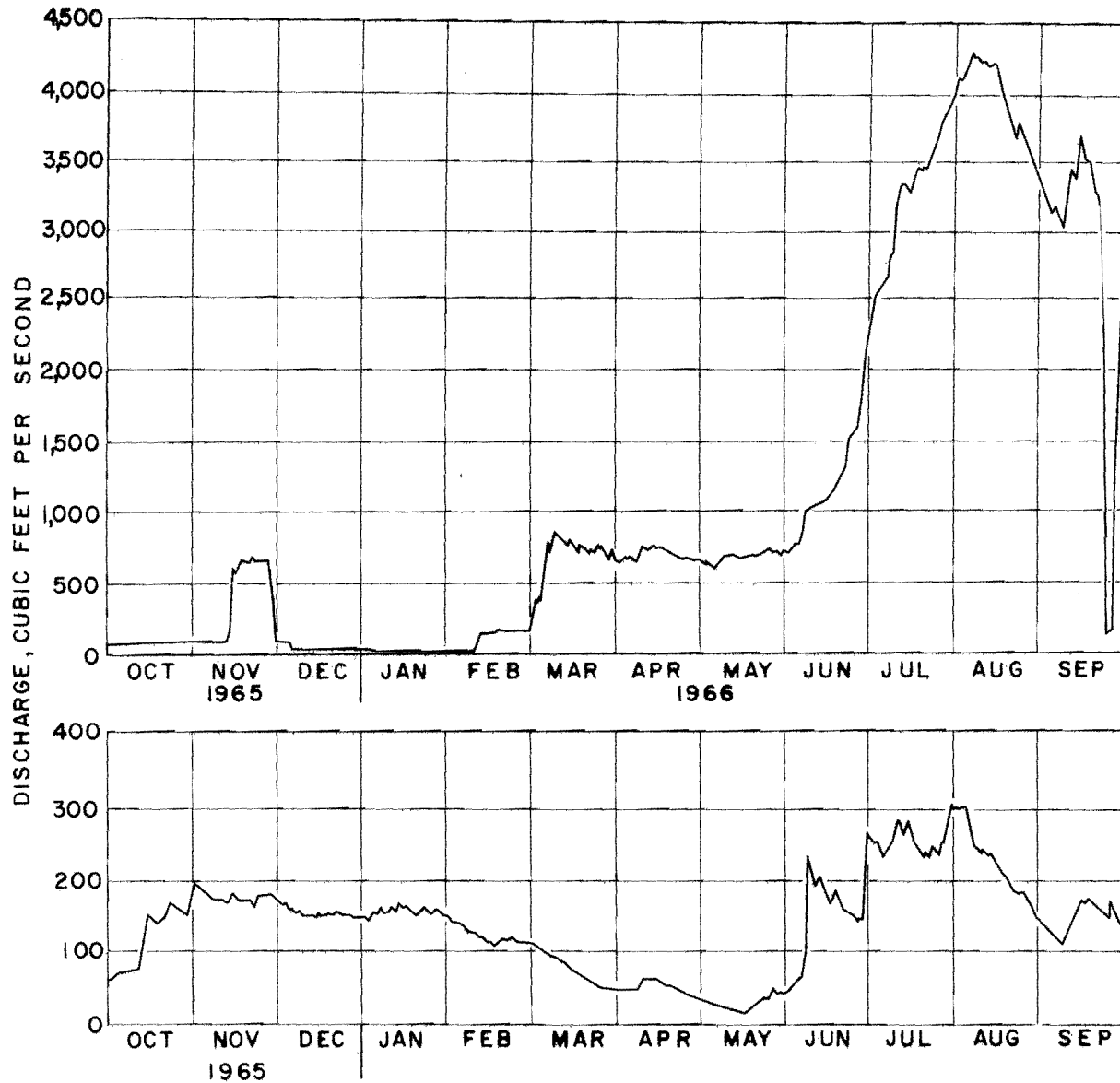
Snake Creek Canal at N.W. 67th Avenue, near Hialeah, Fla.



Snake Creek Canal at S-29, at North Miami Beach, Fla.

Figure 31. Discharge hydrographs for Snake Creek Canal.

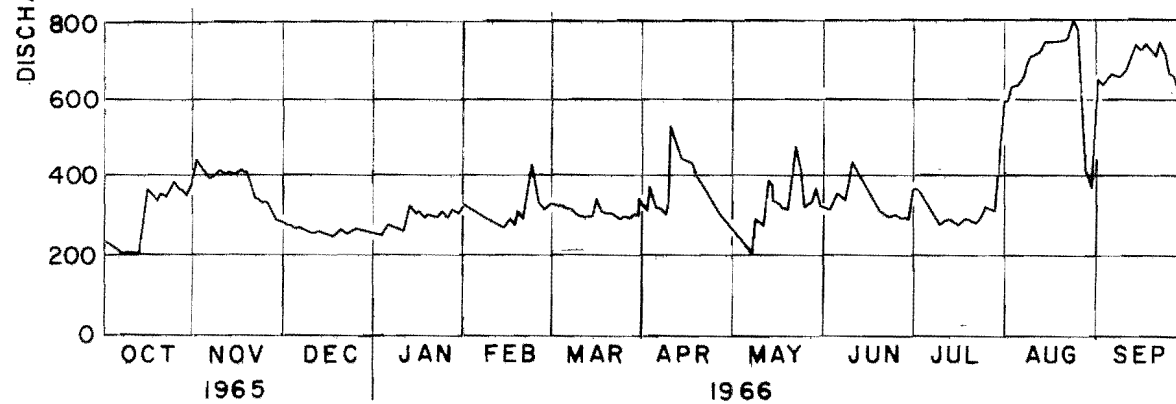
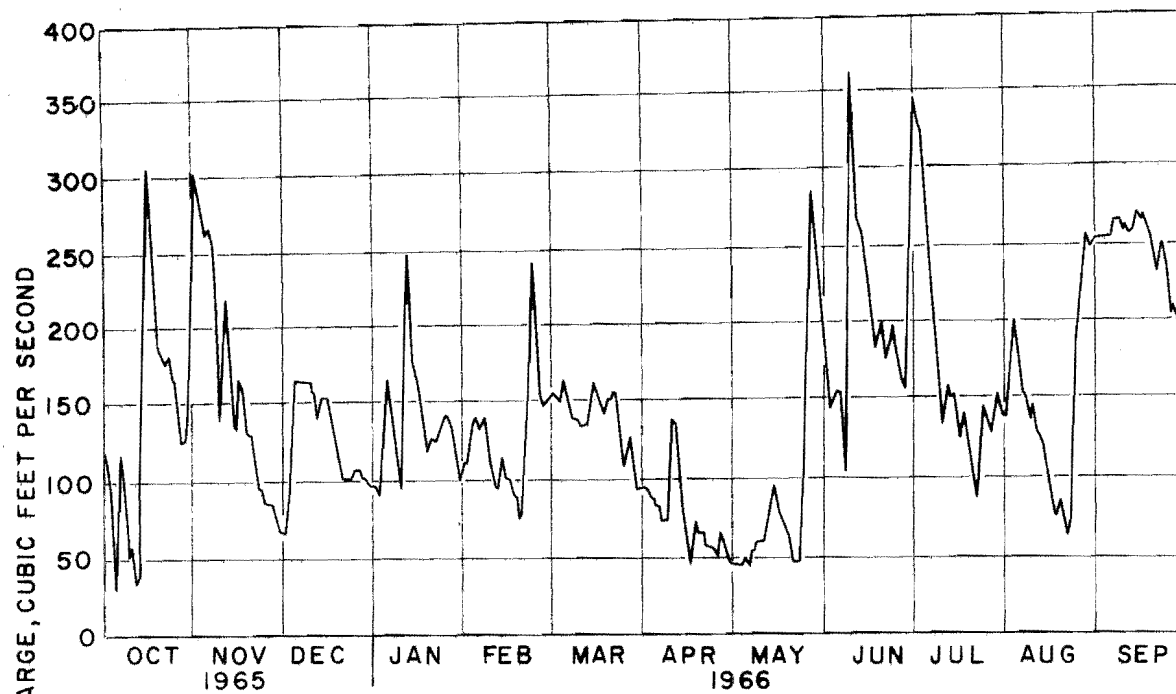
Tamiami Canal outlets, levee 67-A to 40-mile bend, near Miami, Fla.



Tamiami Canal outlets, levee 30 to levee 67-A, near Miami, Fla.

Figure 32. Discharge hydrographs for Tamiami Canal outlets.

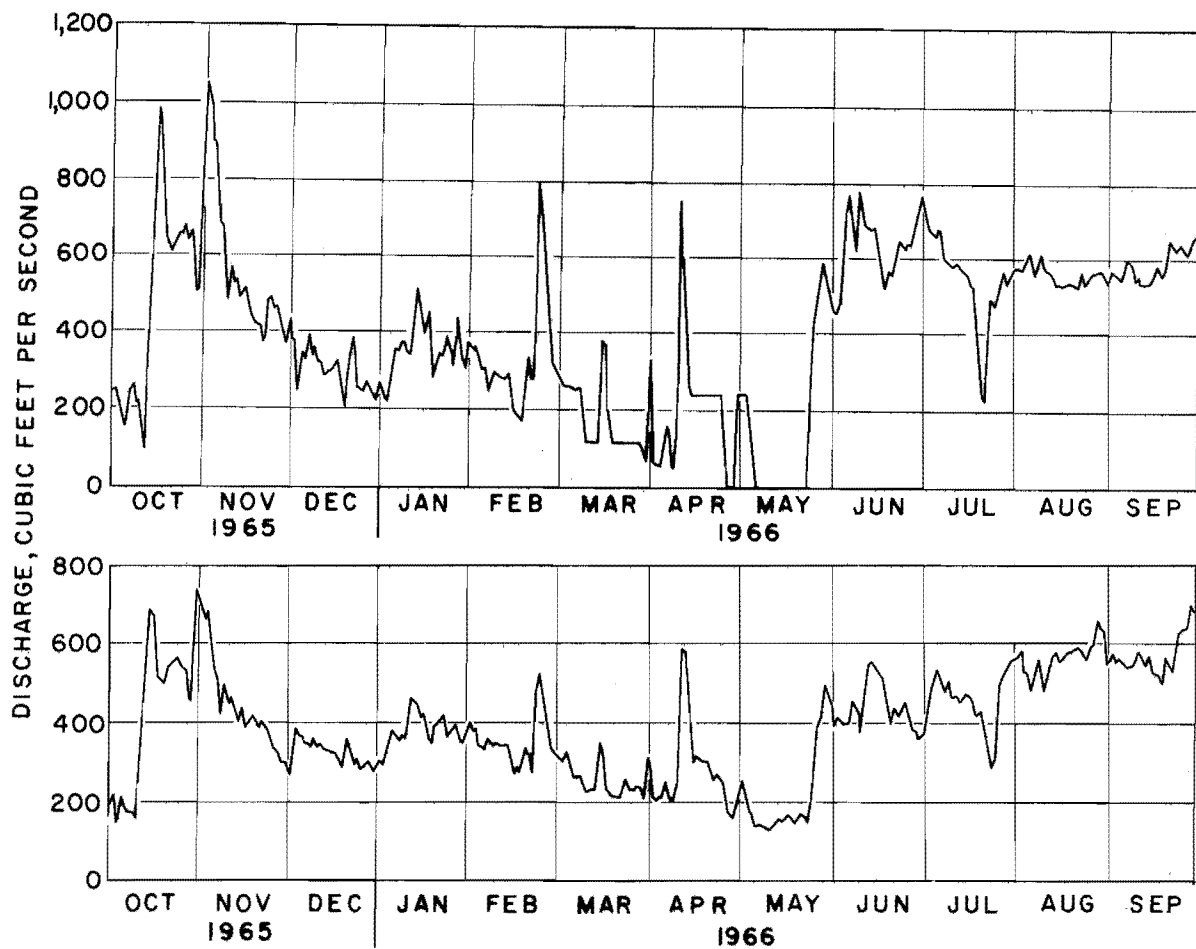
Tamiami Canal near Coral Gables, Fla.



Miami Canal at Broken Dam, near Miami, Fla.

Figure 33. Discharge hydrographs for Tamiami and Miami Canals.

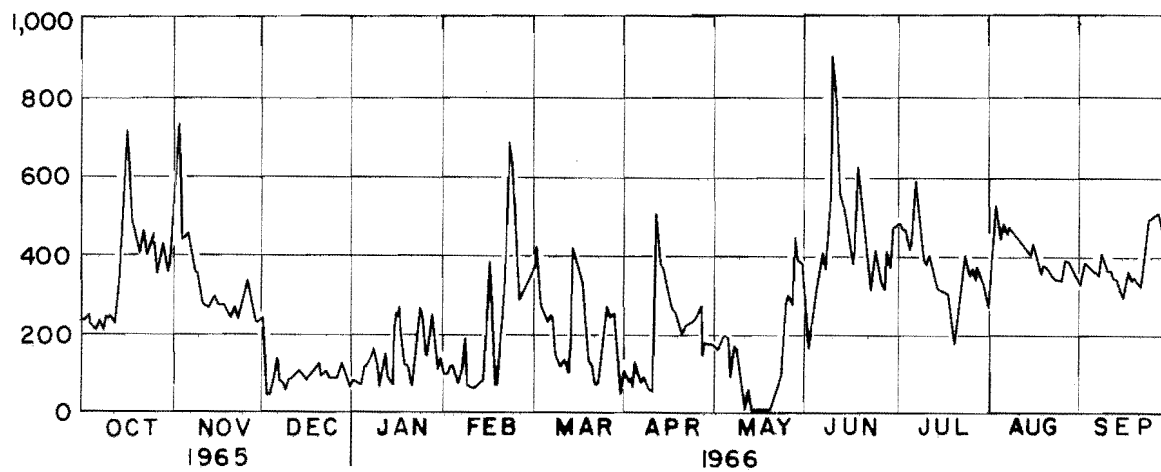
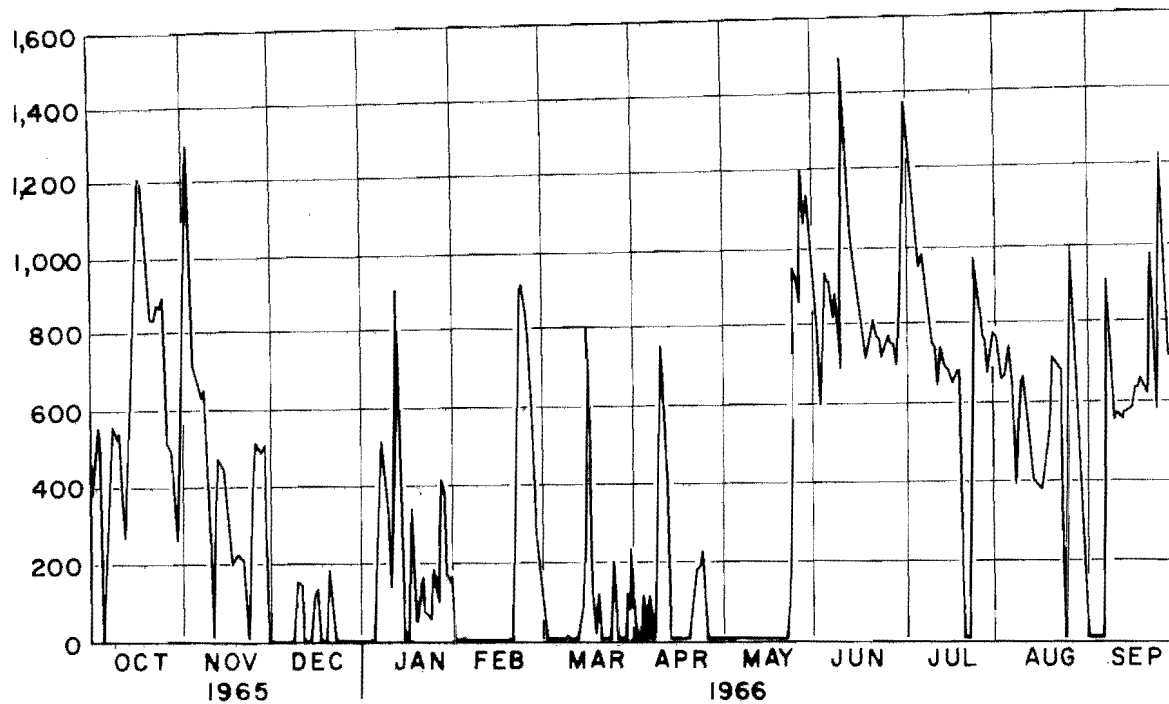
Miami Canal at N.W. 36th Street, Miami, Fla.



Miami Canal at Palmetto By-pass, near Hialeah, Fla.

Figure 34. Discharge hydrographs for Miami Canal.

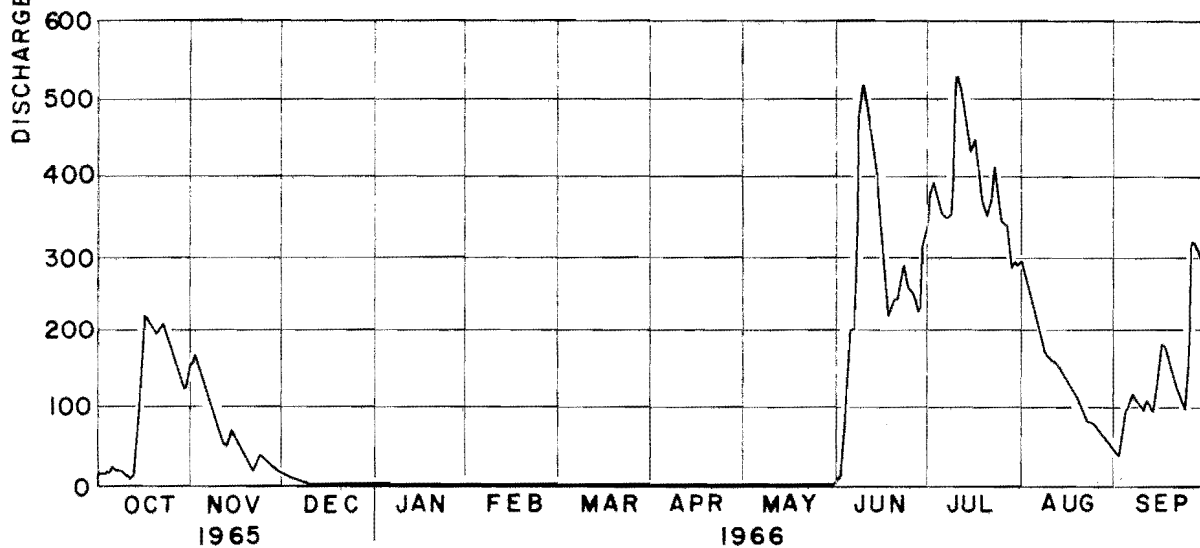
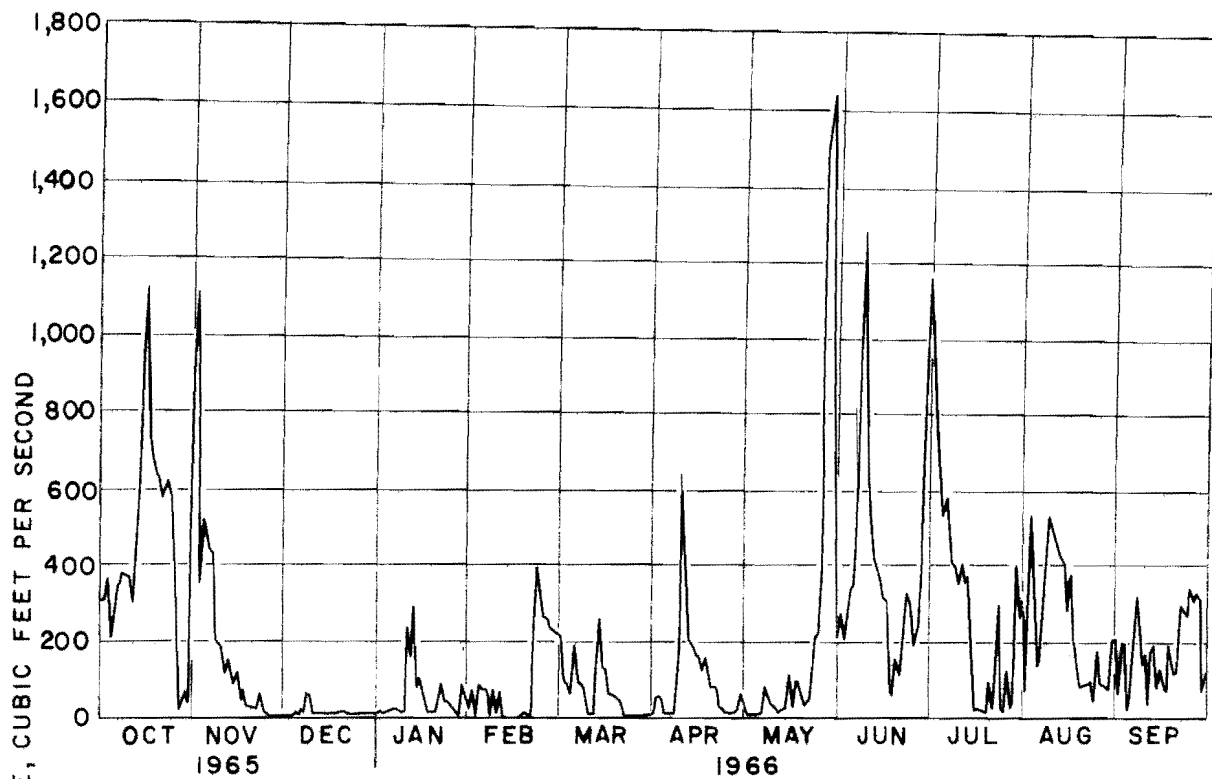
Snapper Creek Canal at S-22, near South Miami, Fla.



Little River Canal at S-27, at Miami, Fla.

Figure 35. Discharge hydrographs for Snapper Creek and Little River Canals.

Biscayne Canal at S-28, near Miami, Fla.



Taylor Slough near Homestead, Fla.

Figure 36. Discharge hydrographs for Taylor Slough and Biscayne Canal.

Determination of discharge

Each year the U.S. Geological Survey makes measurements of flow at all stations where daily records of discharge are kept (fig. 2). These measurements are made primarily as a check on existing ratings or to establish new relationships. During the 1965-66 Water Year, 180 such measurements were made at 16 different locations within the county. Many of the measurements were made difficult by the extremely low velocities and were further complicated at times by floating aquatic vegetation, and control structure regulations; however less than two percent were considered as having indefinite results.

Owing to flat gradients and complications resulting from control operations in the canals, stage-discharge relations to compute discharge are almost impossible to obtain. Deflection meters continued to be the most effective means of obtaining continuous records of flow. They were used at all but four locations where daily discharge was determined. The exceptions were Taylor Slough and the three Tamiami Canal outlet stations, where discharge is related to stage and adjusted for periodic shifts in control conditions.

Records of discharge

During the water year records of daily discharge were maintained at seventeen different locations on eight streams and canals within the county, a summary of which is given in table 3. Snake Creek, Biscayne,

Little River, Miami, Tamiami and Snapper Creek Canals, flow into the Atlantic Ocean, and their combined annual discharge represents an estimated seventy-five percent of the total eastward runoff from all Dade County canals.

In 1966 water year these canals had an average daily discharge of 2,100 cfs (cubic feet per second) or 1.36 billion gpd. This compares with a 7-year average of 1,420 cfs and 0.92 billion gpd. The total discharge of 2,100 cfs or 1.5 million acre-feet was nearly twice the discharge of the previous year and was 147 percent of the 7-year average.

Snake Creek Canal had the greatest discharge (494,100 acre-feet), and Tamiami Canal had the least discharge (106,700 acre-feet) of the six canals. All showed increases over last year and only Tamiami Canal discharged less than the average for the period of record. The maximum daily discharge of 2,280 cfs was recorded at Snake Creek Canal, while zero flow was recorded at all except Tamiami Canal where the minimum flow was 33 cfs. No net daily reverse flow was recorded at any of the six stations although partial day reverses did occur at all.

Table 3.--Summary of discharge data for gaging stations for the 1966 water year.

Gaging station	Maximum daily (cfs)	Minimum daily (cfs)	Number of days of zero flow	Mean (cfs)	Average for period of record (cfs)
Snake Creek Canal at S-30	818	0	305	118	42.8
Snake Creek Canal at N. W. 67 Avenue	1,100	145	---	520	311
Snake Creek Canal at S-29	2,280	0	1	683	380
Tamiami Canal outlets, 40 mile bend to Monroe	3,800	0	20	522	295
Tamiami Canal outlets, levee 67A to 40 mile bend	4,280	18	---	1,162	393
Tamiami Canal outlets, levee 30 to levee 67A	302	10	---	135	79.0
Tamiami Canal near Coral Gables	360	33	---	147	150
Miami Canal at broken dam	762	201	---	362	248
Miami Canal at Palmetto Bypass	717	133	---	395	332
Miami Canal at N.W. 36 St.	1,050	0	21	406	345
Snapper Creek Canal near Coral Gables	267	-14	---	70.8	44.9
Snapper Creek Canal at S-22	1,500	0	121	393	260
Little River Canal at S-27	912	0	8	275	134
Taylor Slough near Homestead	518	0	147	88.6	49.7
Biscayne Canal at S-28	1,640	0	5	194	156

Snake Creek Canal

In 1962, as part of the Central and Southern Florida Flood Control Project, Snake Creek Canal was widened, deepened, and extended westward some eight miles to Levee 33 canal. It now discharges more water than any other of Dade County's coastal canals. Flow in the canal is regulated by two gated control structures -- one located at the eastern edge of Conservation Area 3B and the other near the mouth.

During the 1966 water year the U.S. Geological Survey obtained daily stage and discharge records at three locations on the canal -- above each control and at the confluence of the north and west forks of the canal at N. W. 67 Avenue.

The upstream structure was kept closed from June 9, 1965 until July 29, 1966 and then remained open the balance of the water year except for four days in August. Discharge through the structure during the sixty days it was opened averaged 716 cfs. The immediate effect of opening the structure on the flow at N. W. 67 Avenue was an increase of about 300 cfs with a rise in stage of about 0.2 foot. The effect on the flow and stage at the downstream structure could not be determined because of tide affect. The increase in flow at N. W. 67 Avenue of only 300 cfs would indicate that about 60 percent of the discharge was being diverted into subsurface or channel storage, or was being discharged through other channels.

Flow for the three stations was the highest for the period of record. A total discharge of 85,240 acre-feet occurred at S-30 as compared to a previous high of 6,300 acre-feet. At N. W. 67 Avenue a total discharge of 376,200 acre-feet was recorded as compared to a previous high of 202,400 acre-feet. Structure 29 had a total discharge of 494,100 acre-feet as compared to a previous high of 291,100 acre-feet.

Miami Canal

Dade County's second largest coastal canal and the one most important to the county's economy, is the Miami Canal. The canal is 81 miles long and extends from Lake Okeechobee to Biscayne Bay. In recent years it has been divided into several independently controlled segments which have only limited hydrologic relationships.

That portion of the canal within the boundaries of Dade County is approximately 21 miles long, 15 miles of which lie upstream from the salinity-control dam at N. W. 36 Street in Miami. Flow in the northern part of this canal segment is derived principally from seepage from Conservation Area 3B. The seepage is supplemented at various times by storage releases from Area 3B.

Records of daily flow are obtained at four gaging stations along the canal at Broken Dam, Palmetto By-pass, N. W. 36 Street and Brickell Avenue (fig. 2). In addition daily records of stage are obtained from one station at Pennsuco.

Broken Dam is 1 mile southeast of Conservation Area 3B. As the flow moves along the reach downstream from Broken Dam there is generally some ground-water inflow and outflow, depending upon water levels of the surrounding aquifer and the status of the control structure at N. W. 36 Street. When water levels are high and the control is open the flow in the canal increases in a downstream direction as a result of inflow from the lateral canals and from pickup of ground water. When the control is closed the canal flow decreases in a downstream direction. During prolonged drought, the seepage from Conservation Area 3B supplies most of the flow in Miami Canal and is important because this seepage flow, plus ground-water inflow, provides recharge to the Miami Springs and Hialeah well fields in the reach between the Palmetto By-pass and the control structure.

Tamiami Canal Outlets Levee 67A to Forty-Mile Bend

During the 1965-66 water year the S-12 structures along the southern perimeter of Conservation Area 3A remained partly or fully open during the entire twelve months as compared to previous years when the control gates remained closed for most of each year. Flow to the south through the four control structures, 12-A, 12-B, 12-C and 12-D, was the highest of record both as to total volume (841,200 acre-feet); maximum daily (4,280 cfs) and mean (1,162 cfs). In addition, the total discharge was greater than at any other station in the county. Daily records of stage and discharge were obtained by the Geological Survey from eight gaging stations (fig. 2), one above and below each control. Maximum gage height north of S-12-C for 1966 was 10.26 feet above msl on September 28 and the minimum was 8.30 feet msl on May 6.

Water Levels

During the 1966 water year the Geological Survey obtained daily water-level records from 41 gaging stations and 2 twice-monthly staff-gage observations at 43 different locations within the county. There was no major flooding or extended periods of drought during the year. Water levels in the Everglades were moderately high while most coastal areas were about normal. Most of the maximum gage heights occurred in the four months June, July, September and October, while most of the minimums occurred in the four months February, April, May, and July. A summary of all the maximum and minimum gage heights for the water year and for the periods of record is given in table 4.

Table 4.--Summary of Dade County surface-water levels
for the 1966 water year.

Station	Water level, feet, mean sea level			
	1966 water year		Period of record	
	Maximum	Minimum	Maximum	Minimum
Snake Creek Canal at S-30	7.20	4.49	7.20	3.15
Snake Creek Canal at N. W. 67 Avenue	4.27	1.49	4.27	1.18
Snake Creek Canal at S-29	3.87	-.60	3.88	-.69
Biscayne Canal at Red Rd.	4.03	1.45	8.12	.57
Biscayne Canal at S-28	4.24	.36	4.24	-.34
Biscayne Bay at North Miami	2.51	-1.50	5.52	-1.77
Little River at Palm Ave.	3.65	1.23	4.15	.69
Little River at S-27	3.36	-.01	4.49	-.18
Miami Canal at Broken Dam	6.21	3.37	6.21	1.40
Miami Canal at Pennsuco	4.61	2.72	9.07	.05
Miami Canal at Palmetto Bypass	3.88	2.19	4.74	.99
Miami Canal at N. W. 36 St.	3.25	.15	5.14	-.44
Tamiami Canal at Forty-Mile Bend	9.22	7.52	10.3 est	1.46
above Tamiami Canal / S-12-C	10.26	8.30	10.26	5.34
below Tamiami Canal / S-12-C	10.12	7.52	10.12	5.37

Table 4.--Summary of Dade County surface-water levels
for the 1966 water year - continued.

Station	Water level, feet, mean sea level			
	1966 water year		Period of record	
	Maximum	Minimum	Maximum	Minimum
above Tamiami Canal / S-12-B	10.26	8.30	10.26	5.31
below Tamiami Canal / S-12-B	10.18	7.65	10.18	5.35
lower				
Tamiami Canal at Bridge 45	8.04	6.70	9.76	1.96
Tamiami Canal east of Levee 30	7.66	6.29	9.37	2.57
Tamiami Canal west of Levee 30	8.07	6.60	10.02	2.72
Tamiami Canal near Coral Gables	4.87	2.03	8.49	1.08
Tamiami Canal at Red Rd.	3.00	-.01	6.00	-.52
Miami Canal at N.W. 27 Ave.	2.62	-1.08	5.38	-1.54
S. Fork Miami River at at N. W. 29 Avenue	3.12	.33	5.01	-.92
Miami River at Brickell Avenue	2.59	-1.54	5.85	-1.57
Biscayne Bay at Coconut Grove	2.60	-1.63	9.9	-1.94
Coral Gables Canal at Red Rd.	3.93	.50	6.58	-.82
Coral Gables Canal near S. Miami Avenue	2.70	-1.55	7.51	-1.58
Snapper Creek near Coral Gables	5.63	3.02	6.74	1.30

Table 4.--Summary of Dade County surface-water levels
for the 1966 water year - continued.

Station	Water level, feet, mean sea level			
	1966 water year		Period of record	
	Maximum	Minimum	Maximum	Minimum
Snapper Creek near Miller Drive	4.88	2.42	6.93	1.32
Snapper Creek at S-22	4.19	-.39	6.02	-.59
Black Creek above S-21	3.50	-.57	6.41	-.57
Goulds Canal above control	3.30	-.32	8.90	-1.40
Military Canal above control	4.30	-.30	9.17	-.76
North Canal above control	2.81	-.27	9.12	-.58
Biscayne Bay near Homestead	2.77	-1.03	9.82	-1.56
Florida City Canal above control	2.80	-.35	9.56	-.77
Model Land 5.2 mile upstream from control	3.00 est	.32	8.0 est	-1.41
Model Land below control	2.02	-.30	10.0 est	-.68
Taylor Slough	4.93	.76	5.28	-1.30 est
Everglades P-37	2.23	.01	3.05	-1.85
Everglades P-33	7.13	5.45	7.69	2.20
Everglades P-38	2.38	-.03	2.92	-1.43

REFERENCES

- Klein, Howard, and Sherwood, C. B., 1961, Hydrologic conditions in the vicinity of Levee 30, northern Dade County, Florida: Fla. Geol. Survey Rept. Inv. no. 24, Part I.
- Kohout, F. A., and Leach, S. D., 1964, Salt-water movement caused by control-dam operation in the Snake Creek Canal, Miami, Florida: Fla. Geol. Survey Rept. Inv. no. 24, Part IV.
- Leach, S. D., and Sherwood, C. B., 1963, Hydrologic studies in the Snake Creek Canal area, Dade County, Florida: Fla. Geol. Survey Rept. Inv. no. 24, Part III.
- Parker, G. G., Ferguson, G. E., and Love, S. K., 1955, Water resources of southeastern Florida, with special reference to the geology and ground water of the Miami area: U.S. Geol. Survey Water-Supply Paper 1255, 935 p.
- Schroeder, Melvin C., Klein, Howard, and Hoy, Nevin D., 1958, Biscayne aquifer of Dade and Broward Counties, Florida: Fla. Geol. Survey Rept. Inv. no. 17.
- Sherwood, C. B., and Leach, S. D., 1962, Hydrologic studies in the Snapper Creek Canal area, Dade County, Florida: Fla. Geol. Survey Rept. Inv. no. 24, Part II.
- U.S. Weather Bureau, 1966, Climatological Data, Florida: v. 70, no. 6, June 1966.

