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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

# WATER-RESOURCES DATA COLLECTED IN THE DEVILS HOLE AREA, NYE COUNTY, NEVADA 1976-77

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Open-File Report 79-742

Prepared in cooperation with
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Carson City, Nevada
1979

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## CONVERSION FACTORS

Factors for converting Inch-pound units to metric units shown to four significant figures.

| Inch-pound units | Multiply by | Metric |
|---|---|---|
| acre | 4,047 | $m^2$ (square meter) |
| $ft^3/s$ (cubic foot per second) | 0.02832 | $m^3/s$ (cubic meter per second) |
| ft (foot) | 0.3048 | m (meter) |
| gal/min (gallon per minute) | 0.06308 | L/s (liter per second) |
| mi (mile) | 1.609 | km (kilometer) |

# WATER-RESOURCES DATA COLLECTED IN THE DEVILS HOLE AREA, NYE COUNTY NEVADA, 1976-77

By R. L. Carson

## ABSTRACT

This report presents water data collected in Devils Hole and vicinity from July 1976 through June 1977 for the purpose of observing the effects of irrigation pumping on the pool level in Devils Hole, Nye County, Nevada. The pool contains the endangered species of pupfish, Cyprinodon diabolis. The report presents changes in water level and springflow in graphic form and tabulates electric energy consumed by irrigation wells as an index of the pumpage.

The U.S. Geological Survey has collected comprehensive water-resources data in the Devils Hole area since July 1972. Devils Hole, a collapsed depression in limestone hills northeast of Ash Meadows, Nye County, Nevada (fig. 1), is the sole natural habitat of the Devils Hole Pupfish (Cyprinoden diabolis), an endangered species. This species feeds and reproduces on a slightly submerged rock ledge in Devils Hole. Past irrigation pumping, however, nearly exposed this ledge (Dudley and Larson, 1976). In this regard, the purpose of the Geological Survey's data-collection activities, which are being conducted in cooperation with the National Park Service, is to monitor the effects of ground-water pumping from specified irrigation wells in the Ash Meadows area on the water level in Devils Hole.

The monitoring program includes the collection of three types of water-resources data. Data are collected on water-level fluctuations in Devils Hole and in observation wells, discharge fluctuations of major springs, and electrical power consumption by pumps in irrigation wells. Data collected on the water-level fluctuations in Devils Hole are of direct and obvious importance to the monitoring program. Other data, however, are of indirect importance to the program. These data provide information upon which insights into the causes of water-level fluctuations in Devils Hole can be developed. The scope of the current program does not include the development of cause-and-effect relations. The collected data, however, provides a base for such an analysis.

This report, which is the fourth open file report in an annual series, presents water-resource data collected for July 1976 through June 1977. Data for earlier periods were presented by Larson (1974, 1975) and Hanes (1976). Additionally, interpretive information on the Devils Hole was given by Dudley and Larson (1976).

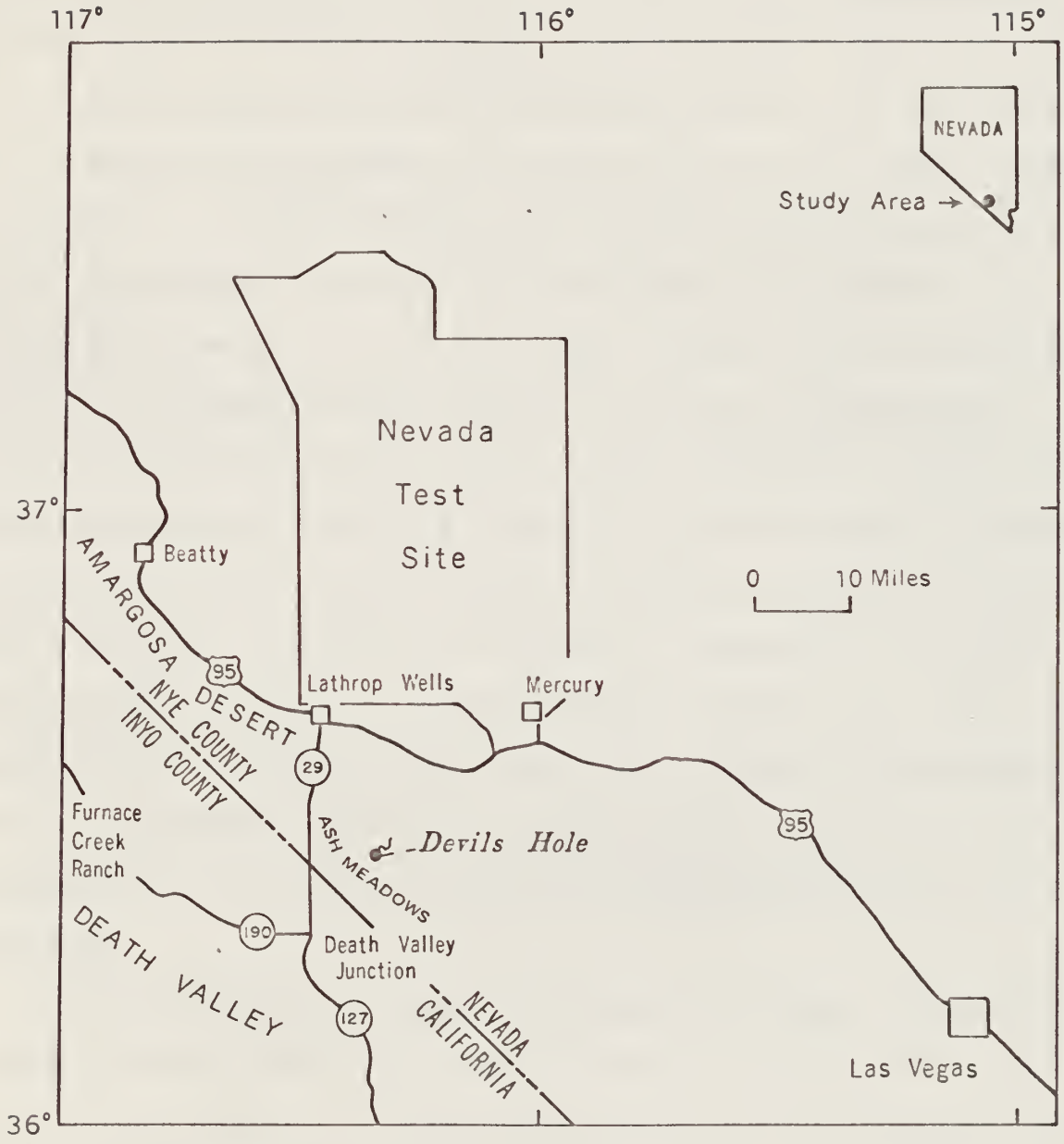


Figure 1.--Location of Ash Meadows and Devils Hole.

## NUMBERING SYSTEM FOR WELLS AND SPRINGS

The numbering system used in this report is based on an index of hydrographic areas in Nevada (Rush, 1968) and on the rectangular subdivision of the public lands referenced to the Mount Diablo base line and meridian. Each number consists of five units separated by spaces: The first unit is the hydrographic area number; the second unit is the township, preceded by an N or S to indicate location north or south of the base line. The third unit, preceded by an E, is the range east of the meridian. The fourth unit consists of the section number. Quarter sections are designated in the fifth segment counterclockwise "A" through "D", beginning with "A" for the northeast quarter section. Where field maps are sufficiently accurate, additional letters "A" through "D" are also assigned in counterclockwise sequence to further subdivide the quarter sections into 40- or 10- acre tracts. The letters are followed by a number indicating the order in which the well was recorded in that particular tract. For example, well 230 S18 E51 4DAC1 is the Devils Hole area of the Amargosa Desert (hydrographic area 230). It is the first well recorded in the SW¼NE¼SE¼ sec. 4, T. 18 S., R. 51 E., of the Mount Diablo base line and meridian.

Other well-numbering systems have been used in Nevada. In particular, Dudley and Larson (1976) used a sequence number to identify well sites in the Devils Hole area. Table 1 cross references the well numbers used by Dudley and Larson (1976).

Table 1.--Site inventory data for selected wells in the Devils Hole area 1/

| Local well identification | Well identification used by Dudley and Larson (1976) | Land surface altitude (feet) | Casing Depth (feet) | Perforated zone (feet) |
|---|---|---|---|---|
| 230 S17 E50 36DD1 | -- | 2,405 | 248 | 48-248 |
| 230 S18 E51 7BBB1 | 5 | 2,320 | 500 | 139-500 |
| 230 S18 E51 7BDB1 | 13 | 2,340 | 467 | 132-467 |
| 230 S18 E51 7CA1 | 4 | 2,295 | 500 | 100-500 |
| 230 S18 E51 7DAA1 | 1 | 2,320 | 395 | 155-395 |
| 230 S18 E51 7DAC1 | 2 | 2,315 | 300 | 60-300 |
| 230 S18 E51 7DAD1 | 3 | 2,315 | 780 | 10-780 |
| 230 S18 E51 7DB2 | -- | 2,315 | 282 | 40-282 |
| 230 S18 E51 8CBB1 | 17 | 2,320 | 500 | -- |

1. Additional site inventory data are given by Dudley and Larson (1976, table 3).

## LOCATION OF DEVILS HOLE

Devils Hole is in a 40-acre tract of Death Valley National Monument that is geographically separated from the main part of the Monument. Devils Hole is about 65 miles west of Las Vegas, Nev., and about 12 miles northeast of Death Valley Junction, Calif. (fig. 1).

Considering the local physiographic setting, Devils Hole is on the northeast boundary of Ash Meadows, a northwest-trending linear area of many oases and salt meadows watered by numerous springs. Ash Meadows, at an altitude of approximately 2,200 feet, is bordered on the northeast by a segmented group of low hills ranging from 500 to 900 feet in height. Devils Hole is between these low hills and Ash Meadows (fig. 2).

The Ash Meadows area discharges ground water collected from several thousand square miles of a regional aquifer system that is developed in carbonate rocks of Paleozoic age (Dudley and Larson, 1976). The rocks exposed in the hills on the east side of Ash Meadows, and those in which Devils Hole is formed, are part of the carbonate aquifer system. Faults near the eastern edge of Ash Meadows define the boundary between the carbonate rocks and clastic sediments of Ash Meadows. Ground water moves westward across the fault contacts from the carbonate aquifer system into the clastic aquifer system and then is discharged by the springs in Ash Meadows.

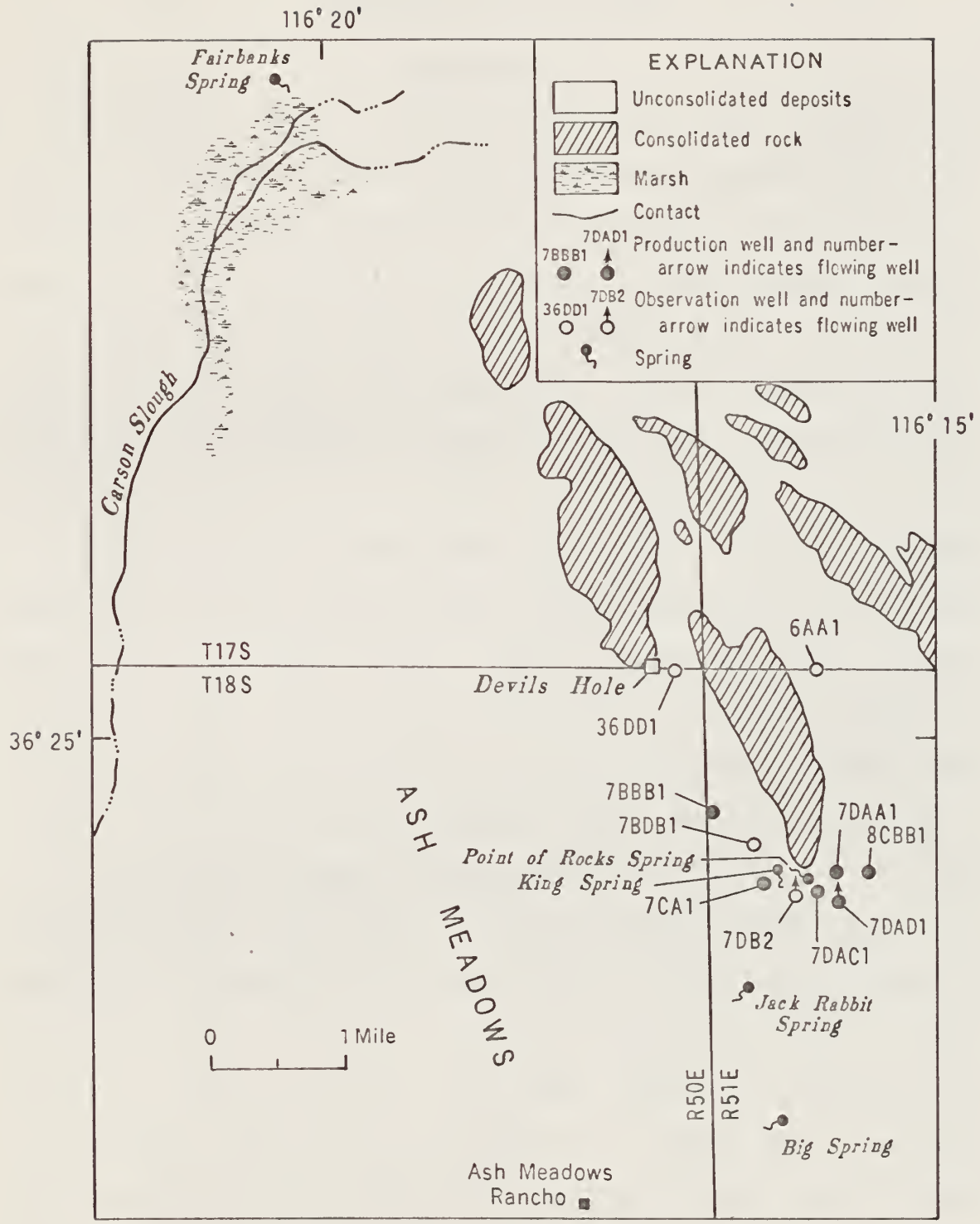


Figure 2.--Location of Devils Hole and of the wells and springs monitored in Ash Meadows, Nye County.

## WATER-LEVEL FLUCTUATIONS

### Devils Hole

Two recorders are used to monitor the water level in Devils Hole: one is a conventional recorder using a float and stilling well, while the other is a remote recorder which operates from a pressure transducer. The remote recorder was installed so that interested parties could monitor the water level without having to enter the fenced enclosure of Devils Hole. The water-level records produced by these recorders are referenced to a copper nail and washer in the south wall of the hole.

Ground water in the Devils Hole area is used to irrigate crops for cattle feed. This use of ground water affects the water level in Devils Hole (Dudley and Larson, 1976). Figure 3 shows the monthly instantaneous low water level in Devils Hole for January 1968, prior to the start of pumping, through June 1977. Beginning in 1969, the water level declined from about 1.4 feet below the copper washer to a maximum of 3.87 feet below the washer in September 1972. Since that time and continuing through the period of record covered by this report, the monthly instantaneous lows have shown an upward trend, corresponding to decreased pumping from production wells (Dudley and Larson, 1976). Injection of water into well S17 E50 36DD1, beginning in July 1976, may also partially explain the water-level trend in Devils Hole. For July 1976 through June 1977, the range of monthly low water level was from 2.89 to 3.23 feet below the copper washer.

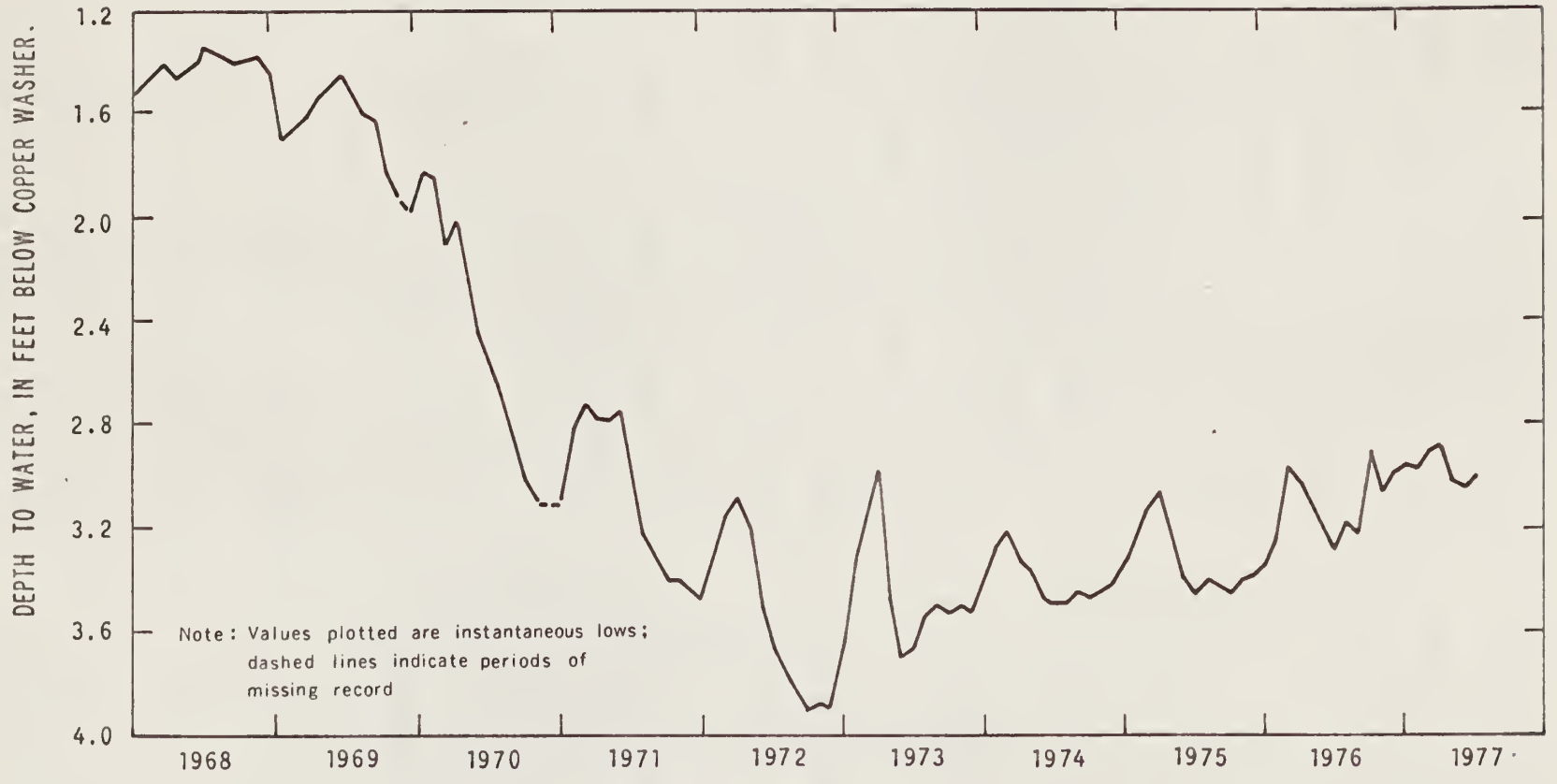


Figure 3.--Monthly low water levels in Devils Hole.

Superimposed on the long-term trend of water levels in Devils Hole, are short-term fluctuations of water levels resulting from several stimuli (Dudley and Larson, 1976). An important stimulus of these fluctuations is seasonal and daily changes in the rate and location of pumping. Tidal deformation of the carbonate aquifer causes diurnal and semidiurnal fluctuations in water levels. Additionally, changes in barometric pressure and seismic events, including natural earthquakes and nuclear explosion at the Nevada Test Site north of Devils Hole (fig. 1), cause water-level fluctuations.

Figure 4 shows the daily mean water level and the 5-day moving average of the daily instantaneous low and high water level in Devils Hole for July 1976 through June 1977. The 5-day moving average of daily low water level for a particular day is obtained by averaging the low on that day with the lows on the four preceding days. A similar computational procedure is used to obtain the 5-day moving average of daily high water level. The 5-day moving average reflects mostly the effects of pumping on water levels. The tidal, barometric, and seismic effects have a principal periodicity or duration of much less than 5 days, and these effects tend to be filtered out by the averaging procedure. The differential, however, between the 5-day averages of daily low and daily high water level is a measure of the average of tidal, barometric, and seismic effects.

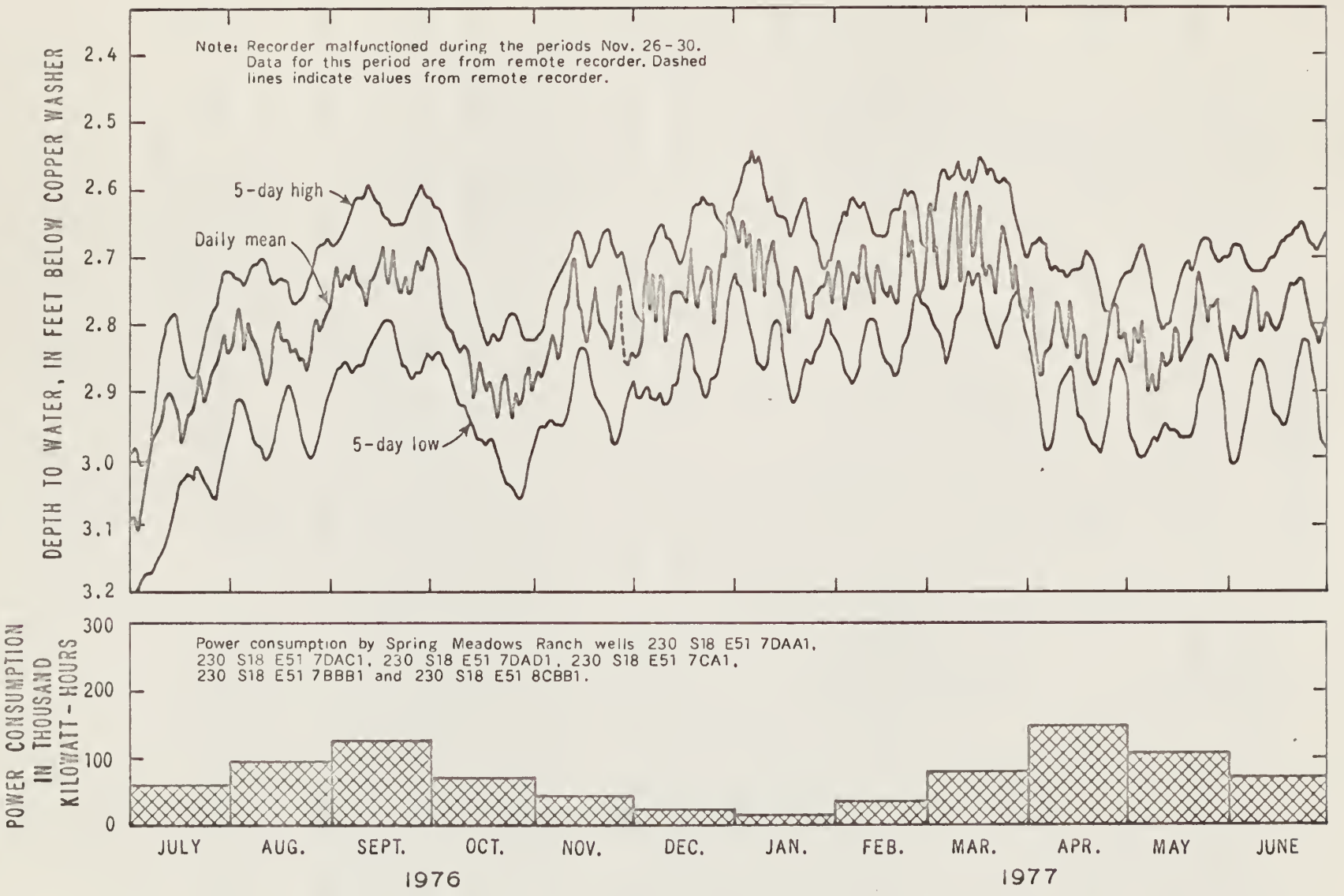


Figure 4.--Water-level fluctuations in Devils Hole and power consumption by irrigation wells.

## Observation Wells

In addition to monitoring water level in Devils Hole, the Geological Survey also monitors water level in six observation wells in the Devils Hole area. These are wells 230 S17 E50 36DD1, 230 S18 E51 6AA1, 7BBB1, 7BDB1, and 7DB2. The locations of these wells are shown in figure 2.

Continuous water-level records are obtained for well 230 S17 E50 36DD1, which is about 900 feet east of Devils Hole. This well has been used for artificial recharge of the carbonate aquifer near Devils Hole since July 1973. The recharge, which is supplied from King Spring at a rate of about 400 gal/min, was begun in an attempt to counteract the effects of nearby pumping on the water level in Devils Hole. Figure 5 shows the daily mean water level in well 230 S17 E50 36DD1. For July 1976 through June 1977, the daily mean water level fluctuated between 18.3 and 49.3 feet below land surface (fig. 5), owing mostly to periodic recharge through the well.

Monthly water-level measurements were made in wells 230 S18 E51 6AA1 and 7BBB1. Well 230 S18 E51 6AA1 is about 1.0 mile east of Devils Hole and about 1.5 miles north of the major well field in Ash Meadows, near Point of Rocks Spring (fig. 2). The monthly water-level measurements varied 2.1 feet from July 1976 through June 1977 (fig. 6). Well 230 S18 E51 7BBB1 is 1.0 mile south of Devils Hole and 1.0 mile northwest of the well field. The monthly water-level measurements in this well varied 1.6 feet from July 1976 through June 1977 (fig. 6).

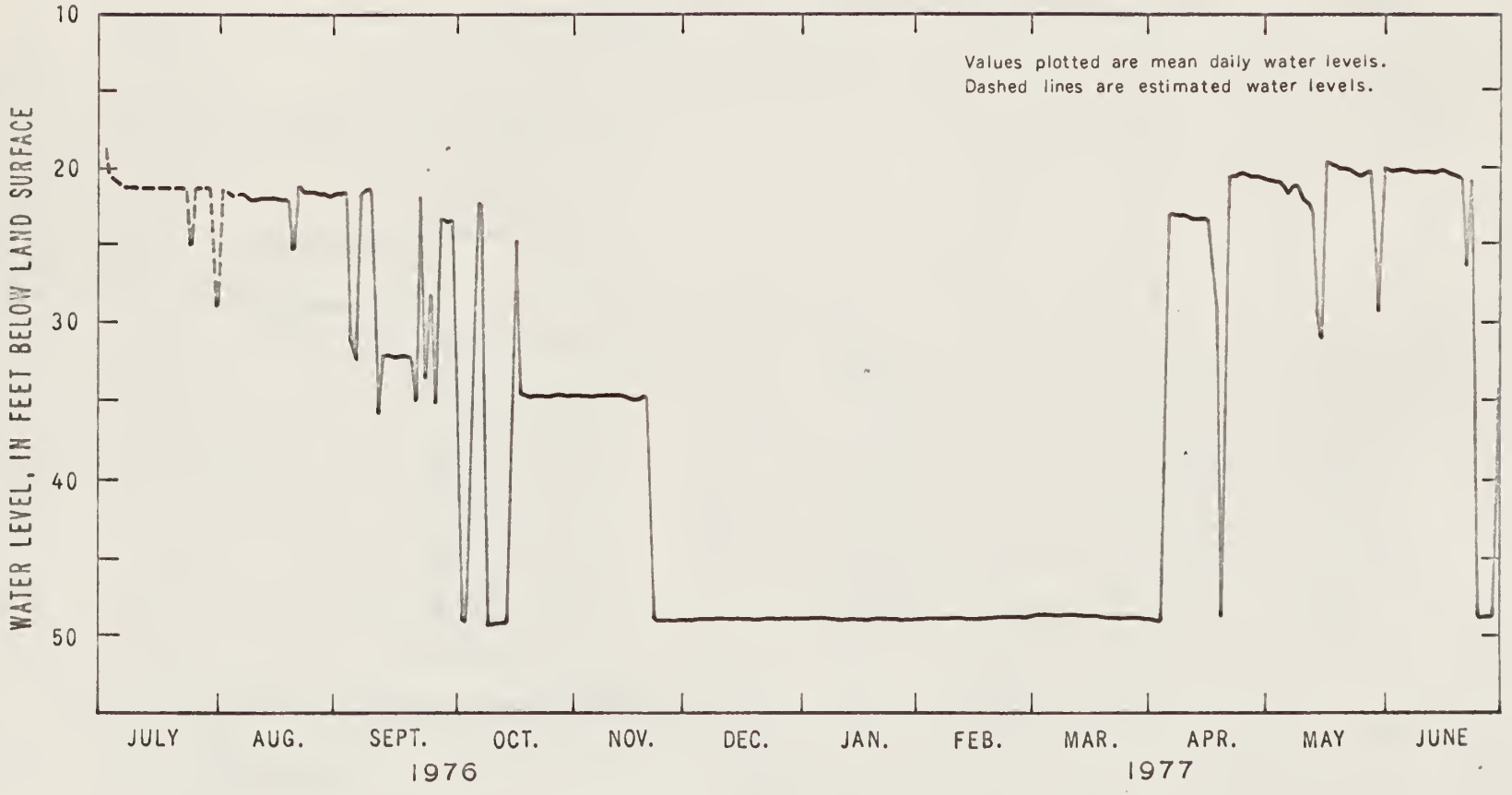


Figure 5.--Water-level fluctuations owing to periodic injection in well S17 E50 36DDD1.

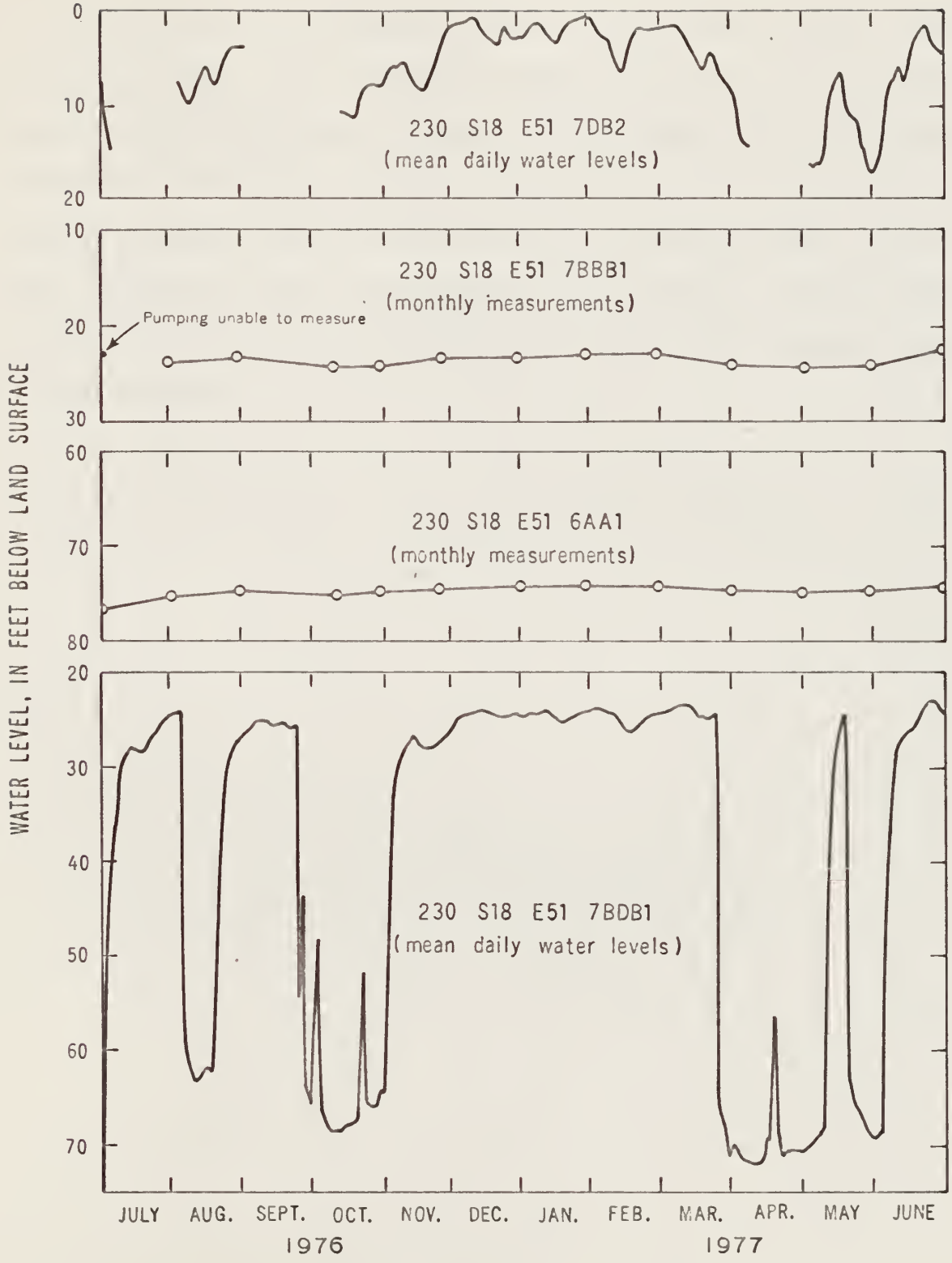


Figure 6.--Water-level fluctuations in observation wells.

Wells 230 S18 E51 7BDB1 and 7DB2 are in the well field near Point of Rocks Spring. Well 230 S18 E51 7BDB1, which is about 1.5 miles southeast of Devils Hole, is near the north edge of the well field. Continuous water-level measurements are recorded for this well, and from July 1976 through June 1977 water levels fluctuated 52.8 feet (fig. 6). Well 230 S18 E51 7DB2, which is about 2 miles southeast of Devils Hole, is near the center of the well field, and water levels fluctuated about 17 feet (fig 6).

## SPRING-DISCHARGE FLUCTUATIONS

The discharge of four springs in the Ash Meadows area is monitored by the Geological Survey. The monitored springs, which cumulatively represent about one-third the total spring discharge in Ash Meadows, are Fairbanks, Big, Point of Rocks, and Jack Rabbit Springs. The locations of these springs are shown in figure 2. They are generally alined in a northwest-trending direction and are structurally controlled by faulting.

The discharge of the monitored springs for July 1976 through June 1977 is shown in figures 7 and 8. Fairbanks and Big Springs, which respectively, are in the extreme northern and southern parts of Ash Meadows, exhibit little variability in discharge. The discharge of Fairbanks Spring averaged 3.23 $ft^3/s$ and fluctuated between 2.96 and 3.41 $ft^3/s$ and the discharge of Big Spring averaged 1.99 $ft^3/s$ and fluctuated between 1.93 and 2.05 $ft^3/s$.

In contrast, the discharges of Point of Rock and Jack Rabbit Springs, which are near the major well field in Ash Meadows, are highly variable. The discharge of Point of Rock Spring averaged 0.66 $ft^3/s$ and fluctuated between 0.45 and 0.97 $ft^3/s$ and that of Jack Rabbit Spring averaged 0.29 $ft^3/s$ and fluctuated between 0 and 1.87 $ft^3/s$.

Prior to July 1976, the discharge of Big Spring was computed by using a theoretical stage-discharge relation for the flume installed at the spring. In an effort to refine this theoretical stage-discharge relation, periodic direct measurements of discharge, using a current meter, were made during the period July 1976 through June 1977. Results of these direct discharge measurements did not warrant any change from the theoretical stage-discharge relation for the Big Spring flume.

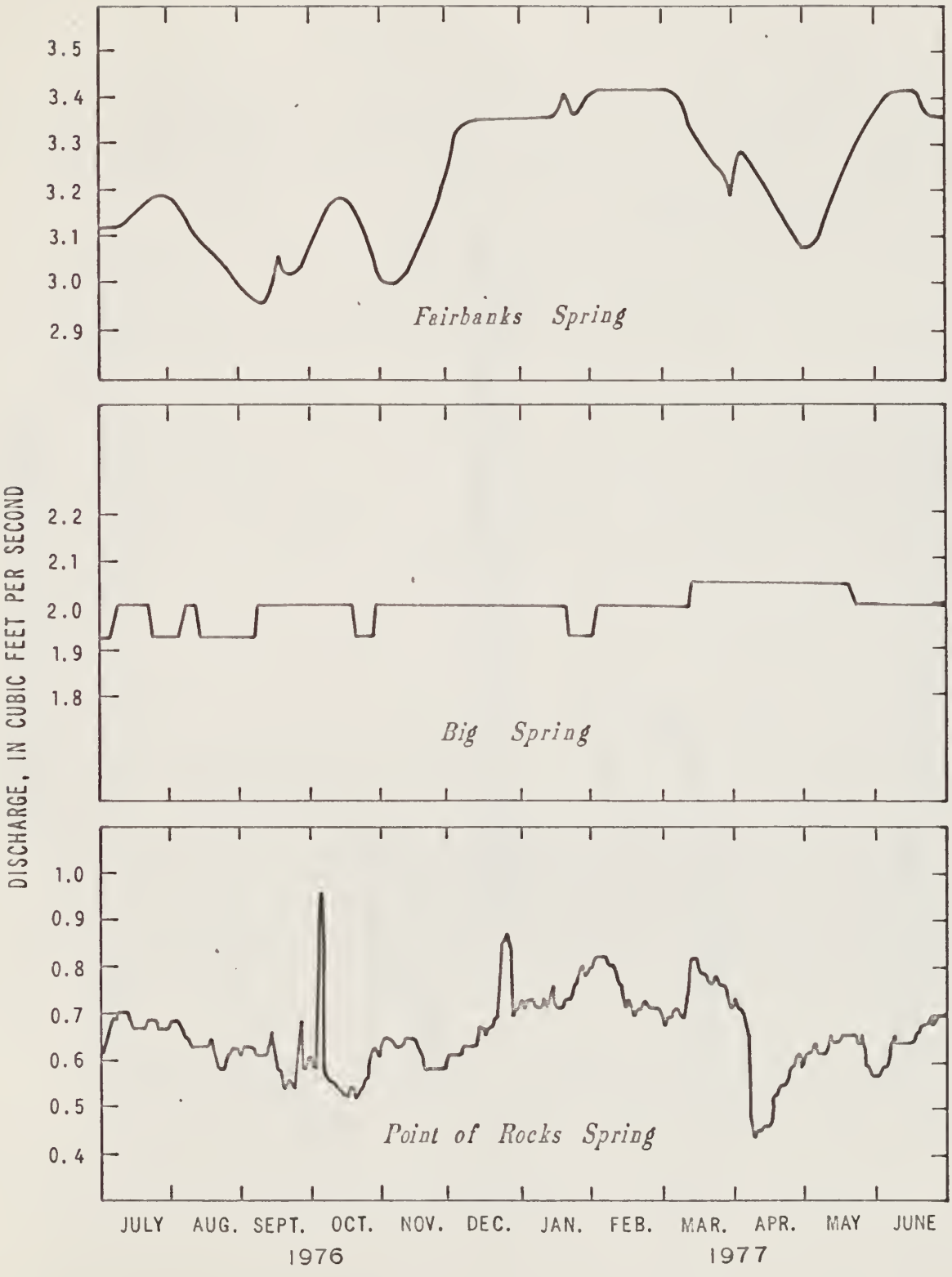


Figure 7.--Average daily discharges of Fairbanks, Big, and Point of Rocks Springs.

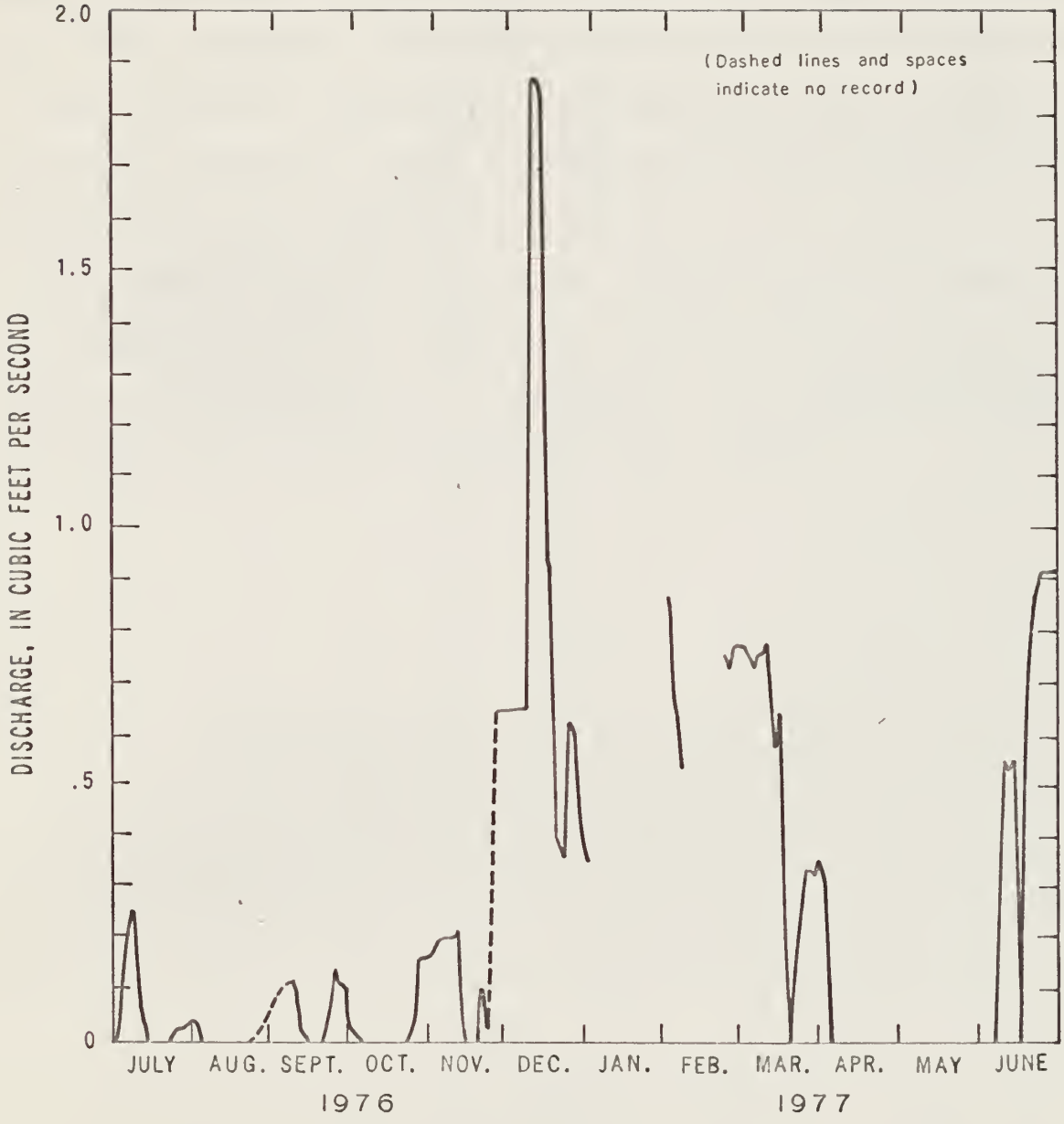


Figure 8.--Average daily discharge of Jack Rabbit Spring.

## ELECTRICAL-POWER CONSUMPTION

Power consumption data are collected for the pumps in six irrigation wells in Ash Meadows. These are wells 230 S18 E51 7DAA1, 7DAC1, 7DAD1, 7CA1, 7BBB1, and 8CBB1. The locations of these wells are given in figure 2. Table 2 lists the monthly power consumption in kilowatt-hours for these six wells. Additionally, figure 9 indicates the periods during which water was being pumped from the wells.

The power consumption data can be used to estimate the quantity of water pumped from a well. The scope of the monitoring program does not include estimating pumpage, but correlation of power consumption and well discharge has been estimated (Dudley and Larson, 1976).

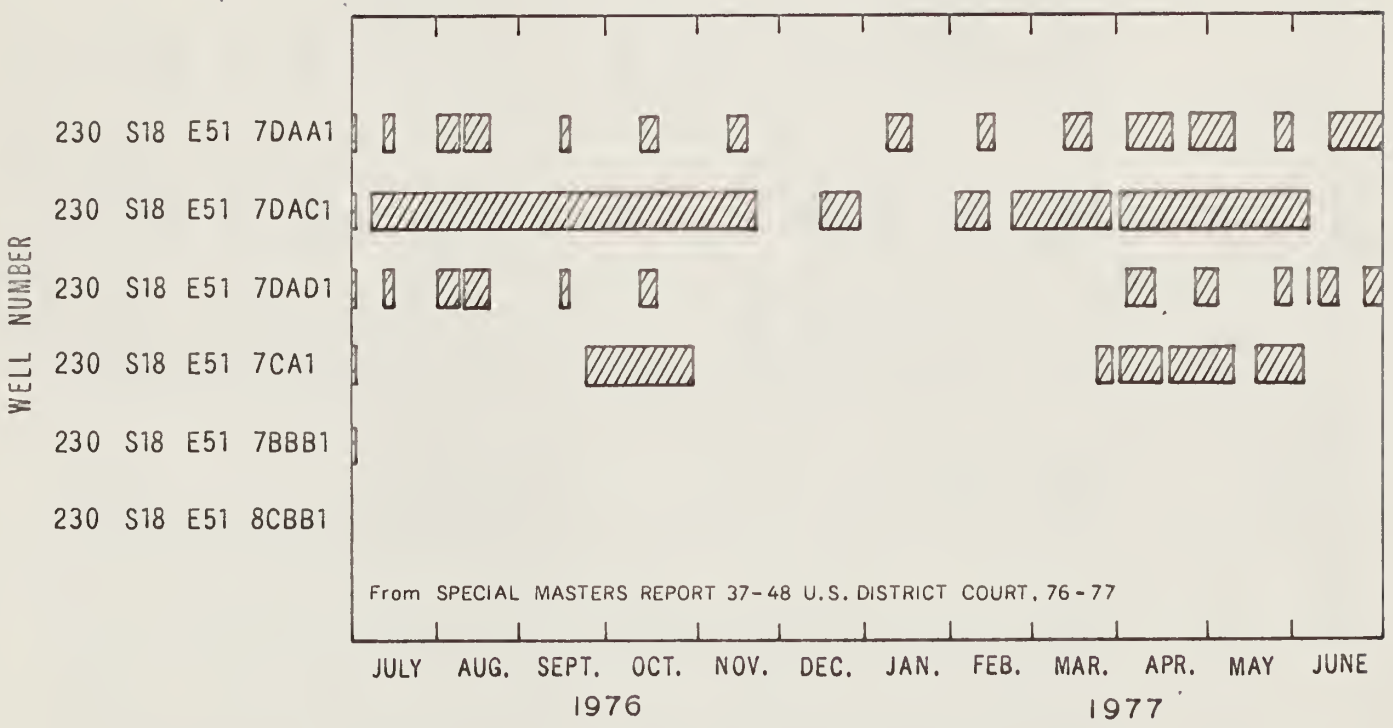


Figure 9.--Periods during which water was being pumped from the wells.

Table 2.--Power consumption, in kilowatt-hours, for irrigation wells in Ash Meadows

| Month | Well number 230 S18 E51 - 7DAA1 | 7DAC1 | 7DAD1 | 7CA1 | 7BBB1 | 8CBB1 | Total |
|---|---|---|---|---|---|---|---|
| 1976 | | | | | | | |
| July | 12,700 | 36,600 | 9,040 | 3,080 | 680 | 0 | 62,100 |
| Aug. | 19,700 | 40,000 | 13,800 | 22,400 | 0 | 0 | 96,000 |
| Sept. | 41,600 | 55,300 | 4,320 | 29,700 | 0 | 0 | 131,000 |
| Oct. | 9,850 | 25,700 | 8,600 | 29,600 | 0 | 0 | 73,800 |
| Nov. | 15,000 | 27,300 | 0 | 0 | 0 | 0 | 42,300 |
| Dec. | 90 | 21,200 | 960 | 0 | 0 | 0 | 22,300 |
| 1977 | | | | | | | |
| Jan. | 14,600 | 20 | 0 | 0 | 0 | 0 | 14,600 |
| Feb. | 12,500 | 22,300 | 0 | 0 | 0 | 0 | 34,800 |
| Mar. | 18,300 | 36,700 | 3,040 | 22,300 | 0 | 0 | 80,300 |
| Apr. | 41,200 | 38,700 | 24,400 | 46,600 | 0 | 0 | 151,000 |
| May | 23,400 | 39,000 | 14,100 | 33,400 | 0 | 0 | 110,000 |
| June | 30,400 | 8,740 | 29,300 | 6,120 | 0 | 0 | 74,600 |
| Total 1/ | 239,000 | 352,000 | 108,000 | 193,000 | 680 | 0 | 893,000 |

1. Rounded to three significant figures

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