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OBED M. LASSEN, COMMISSIONER

ANNUAL REPORT ON GROUND WATER IN ARIZONA SPRING 1968 TO SPRING 1969

PREPARED UNDER THE DIRECTION OF
H.M. BABCOCK, DISTRICT CHIEF
ARIZONA DISTRICT, WATER RESOURCES DIVISION

COMPILED BY THE GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR

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ANNUAL REPORT ON GROUND WATER IN ARIZONA, SPRING 1968 TO SPRING 1969

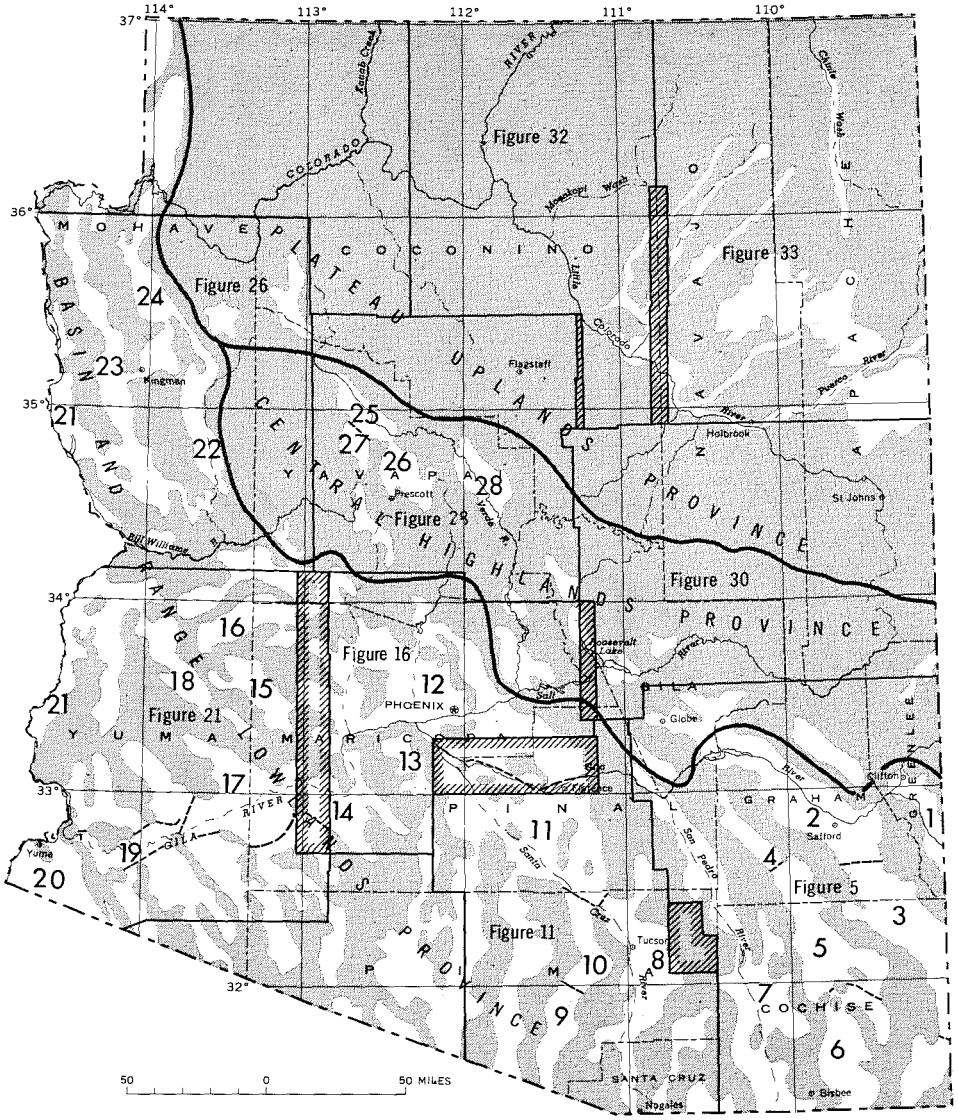
Prepared under the direction of H. M. Babcock,
District Chief, Arizona District, Water Resources Division

INTRODUCTION

The availability of adequate potable water supplies has great influence on the continuing development of Arizona. Some surface water is available in a few places in the State, but the amount is not sufficient to meet the constantly increasing demand. For many years, nearly two-thirds of Arizona's water supply has been withdrawn from the ground-water reservoirs; the principal use of the ground water is for the irrigation of crops. It is of prime importance to protect the water supplies through effective management, which requires a comprehensive knowledge of the storage capacity of the aquifers and of the factors that control the transmission of water through them.

Since 1939, a planned program of ground-water studies has been conducted by the U.S. Geological Survey in cooperation with the State of Arizona. The State has been represented by the State Land Department since 1942. The program, which includes the collection and analysis of the geologic and hydrologic data necessary to evaluate the ground-water resources of the State, is under the immediate supervision of H. M. Babcock, district chief of the Water Resources Division of the U. S. Geological Survey in Arizona.

This report is a result of the cooperative program between the U. S. Geological Survey and the State of Arizona. The report contains graphs showing water levels in selected wells and estimated annual ground-water pumpage in most of the developed areas in the State and maps showing (1) depth to water in selected wells in spring 1969, (2) change in water levels in selected wells from 1964 to 1969, and (3) potential well production by areas. Figure 1 shows the areas for which ground-water data are given. The well-numbering system used in Arizona is explained and illustrated in figure 2. Figure 3 is a pictorial summary of the status of current ground-water work in Arizona.



EXPLANATION

BASIN AND RANGE LOWLANDS PROVINCE

Ground water mostly from alluvial deposits; small amounts from fractures in consolidated rocks

1. DUNCAN BASIN
2. SAFFORD BASIN
3. SAN SIMON BASIN
4. ARAVAIPA VALLEY
5. WILLCOX BASIN
6. DOUGLAS BASIN
7. SAN PEDRO RIVER VALLEY
8. UPPER SANTA CRUZ BASIN
9. ALTAR VALLEY
10. AVRA VALLEY
11. LOWER SANTA CRUZ BASIN
12. SALT RIVER VALLEY
13. WATERMAN WASH AREA
14. GILA BEND BASIN
15. HARQUAHALA PLAINS AREA
16. McMULLEN VALLEY
17. GILA RIVER DRAINAGE FROM PAINTED ROCK DAM TO TEXAS HILL
18. RANEGRAS PLAIN AREA
19. WELLTON-MOHAWK AREA
20. YUMA AREA
21. COLORADO RIVER FLOOD PLAIN FROM DAVIS DAM TO IMPERIAL DAM
22. BIG SANDY VALLEY
23. SACRAMENTO VALLEY
24. HUALAPAI VALLEY

CENTRAL HIGHLANDS PROVINCE

Ground water from alluvial deposits in a few small valleys and from fractures and joints in consolidated rocks; many springs issue from fractures

25. BIG CHINO VALLEY
26. LITTLE CHINO VALLEY
27. WILLIAMSON VALLEY
28. VERDE VALLEY

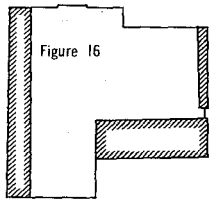
PLATEAU UPLANDS PROVINCE

Ground water mostly from fine-grained sandstone units in consolidated rocks; siltstone and claystone layers act as aquicludes; moderate amounts of ground water from narrow alluvial deposits

ALLUVIAL DEPOSITS

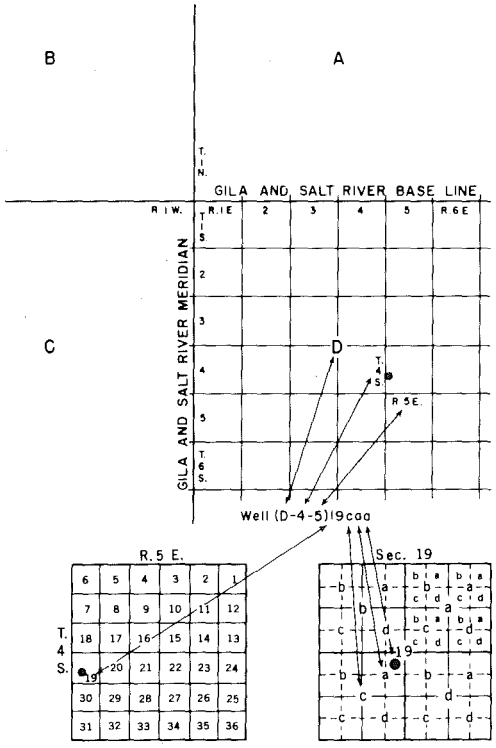
CONSOLIDATED ROCKS

AREA BOUNDARIES NOT DEFINED BY CONTACT BETWEEN ALLUVIAL DEPOSITS AND CONSOLIDATED ROCKS



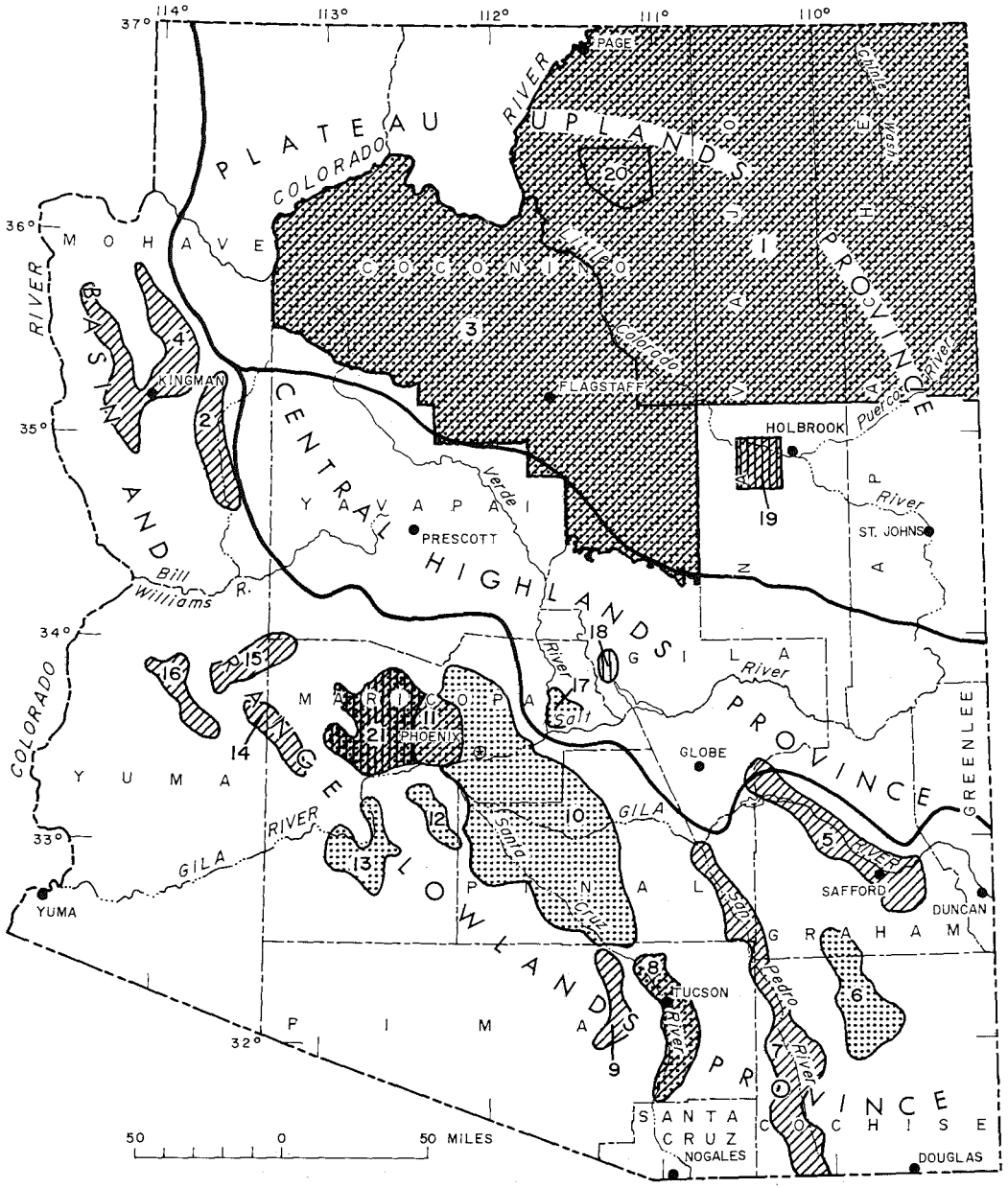
GROUND-WATER DATA FOR AREA OUTLINED SHOWN ON INDICATED FIGURE; HACHURES INDICATE MAP OVERLAP AREA

FIGURE 1.--AREAS FOR WHICH GROUND-WATER DATA ARE GIVEN.



The well numbers used by the Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants. These quadrants are designated counterclockwise by the capital letters A, B, C, and D. All land north and east of the point of origin is in A quadrant, that north and west in B quadrant, that south and west in C quadrant, and that south and east in D quadrant. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters also are assigned in a counterclockwise direction, beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. In the example shown, well number (D-4-5)19caa designates the well as being in the $NE\frac{1}{4}NE\frac{1}{4}SW\frac{1}{4}$ sec. 19, T. 4 S., R. 5 E. Where there is more than one well within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes.

FIGURE 2. --WELL-NUMBERING SYSTEM IN ARIZONA.



EXPLANATION

SUMMARY OF GROUND-WATER PROGRAMS

1. Navajo-Hopi Indian Reservations
2. Big Sandy Valley
3. Southern Coconino County
4. Sacramento and Hualapai Valleys (Kingman area)
5. Arid-lands study (Safford basin)
6. Willcox basin
7. San Pedro River valley
8. Tucson basin
9. Avra Valley (electrical-analog analysis
10. Part of central Arizona (electrical-analog analysis)
11. Western part of Salt River Valley (Beardsley area)
12. Waterman Wash area
13. Gila Bend basin
14. Harquahala Plains area
15. McMullen Valley
16. Ranegras Plain area
17. Sycamore Creek
18. Lower Tonto Creek basin
19. Joseph City area
20. Tuba City area (electrical-analog analysis)
21. Lower Hassayampa area

Area where field investigation is in progress (As of June 1969)

Area for which a report is in preparation (As of June 1969)

Area for which a report was released (July 1968-June 1969)

A multiple pattern indicates that, although a report was released in the prescribed period, further work and (or) reports are in progress

FIGURE 3. --SUMMARY OF CURRENT GROUND-WATER PROGRAMS.

Scope of the Federal-State Cooperative Ground-Water Program

The Federal-State cooperative ground-water program in Arizona consists of three major parts—(1) the collection and analysis of basic hydrologic data under the statewide ground-water survey, (2) comprehensive areal ground-water investigations, and (3) research studies related to specific hydrologic problems. The three parts of the program are related closely and to a large extent are interdependent.

Collection and analysis of basic hydrologic data.--The statewide ground-water survey provides for the collection of the basic hydrologic and geologic data that are necessary to study and analyze the ground-water resources of the State. The work includes well inventories, periodic water-level measurements, collection of water samples for chemical analysis, and collection and cataloging of drill cuttings from wells. The "Annual Report on Ground Water in Arizona" is a result of this part of the cooperative program. The report is published by the State Land Department, and copies are available to the public. Another phase of the present program is designed to give the developed basins in the State periodic intensive study. Although the basins will receive only cursory examination in the years between the intensive studies, the data collection in the intervening years will be sufficient to monitor any significant changes in the ground-water regimen. The number of water-level and discharge measurements made and the amount of other data collected in any given year depend to some extent on the basin or basins selected for intensive study. Water-level measurements, however, are made in about 860 wells each year under the general program, and the water-level measurements made in the basin selected for intensive treatment are in addition to these measurements. The discharge from several hundred wells is measured each year. Reports are in preparation for the following: Harquahala Plains area, San Pedro River valley, lower Hassayampa area, Joseph City area, Ranegras Plain area, and McMullen Valley. Reports for the Waterman Wash area and the Gila Bend basin were published during the year (see section entitled "Current Publications of the Arizona District").

Samples of ground water for chemical-quality determinations are obtained on an annual basis from about 35 wells and from many other wells on an intermittent schedule. The temperature of the ground water is obtained coincident with the sampling.

Comprehensive areal ground-water investigations.--Areal studies are undertaken to develop the information and understanding required for the management of water in specific problem areas. These are areas where conditions are critical due to overdevelopment of the water supply, where development

of the water supply is beginning, or where there is some special problem or interest.

Areal studies were in various stages of completion for four projects under the Federal-State cooperative program in 1968-69. A report on the geohydrology of Sacramento and Hualapai Valleys is in the Government Printing Office for publication. Reports are in preparation for the following projects: (1) Ground-water resources of the western part of the Salt River Valley (Beardsley area); (2) Water resources in southern Coconino County; and (3) Hydrology of alluvial basins.

Research programs.--The research studies of the Water Resources Division in Arizona are directed toward the hydrology of arid lands. The national programs, which are supported by Federal funds, include basic research in hydrology and applied research in instrumentation and techniques; these programs directly benefit the State program. Projects being supported by the Federal-State cooperative program are: (1) Effects of vegetation manipulation on surface runoff—Sycamore Creek; and (2) Electrical-analog analysis of Avra Valley.

Programs in Cooperation with Other Agencies

In 1968-69 ground-water studies were being conducted in cooperation with the following agencies:

City of Flagstaff
City of Tucson
Navajo Tribe
Salt River Valley Water Users' Association
University of Arizona
U.S. Army
U.S. Bureau of Indian Affairs
U.S. Bureau of Reclamation
U.S. National Park Service

Current Publications of the Arizona District

The following reports on the water resources and geology of Arizona were published or released to the open file from July 1, 1968, through June 30, 1969.

Water-resources data for Arizona, 1966—Part 2: Water-quality records, by U.S. Geological Survey: U.S. Geol. Survey open-file report, 1966. 85 p., 1 fig.

Water-resources data for Arizona, 1967—Part 2: Water-quality records, by U.S. Geological Survey: U.S. Geol. Survey open-file report, 1967. 85 p., 1 fig.

Canyon cutting in the Colorado River system, by M. E. Cooley and Alfonso Wilson, in The encyclopedia of geomorphology, R. W. Fairbridge, ed.: New York, Reinhold, 1968. p. 99-102, 5 figs., 1 table.

Electrical-analog analysis of ground-water depletion in central Arizona, by T. W. Anderson: U.S. Geol. Survey Water-Supply Paper 1860, 1968. 21 p., 4 pls., 4 figs.

Electrical-analog analysis of the hydrologic system in Tucson basin, Arizona, U.S.A., by T. W. Anderson, in The use of analog and digital computers in hydrology: Internat. Assoc. Scientific Hydrology, v. 1, no. 80, December 1968. p. 15-24, 5 figs.

Floods of August 14-22 in central Arizona, by B. N. Aldridge, in Summary of floods in the United States during 1963, by J. O. Rostvedt and others: U.S. Geol. Survey Water-Supply Paper 1830-B, 1968. p. 98-106, 3 figs., 4 tables.

Ground-water conditions in the Waterman Wash area, Maricopa and Pinal Counties, Arizona, by E. E. Denis: Arizona State Land Dept. Water-Resources Rept. 37, August 1968. 23 p., 9 figs., 3 tables.

Investigation of the geochemistry of water in a semiarid basin in Arizona, U.S.A., by R. L. Laney: Internat. Assoc. Hydrogeologists Memoires, Congress of Istanbul, 1967, 1968. p. 559-565, 3 figs., 1 table.

The phreatophyte problem in Arizona, by H. M. Babcock: Arizona State Land Dept., Proceedings 12th Annual Watershed Symposium, September 1968. p. 34-36, 3 figs., 1 table.

Water resources of the Sycamore Creek watershed, Maricopa County, Arizona, by B. W. Thomsen and H. H. Schumann: U.S. Geol. Survey Water-Supply Paper 1861, 1968. 53 p., 1 pl., 31 figs., 7 tables.

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Water-resources data for Arizona, 1967—Part 1: Surface-water records, by U.S. Geological Survey: U.S. Geol. Survey open-file report, 1968. 237 p., 4 figs.

Activities of Water Resources Division in Arizona, by U.S. Geological Survey: U.S. Geol. Survey open-file report, 1969. 15 p., 1 fig.

Annual report on ground water in Arizona, spring 1967 to spring 1968, prepared under the direction of H. M. Babcock, District Chief, Arizona District, Water Resources Division, U. S. Geological Survey: Arizona State Land Dept. Water-Resources Rept. 38, February 1969. 54 p., 32 figs., 1 table.

Carbonate cementation of Tertiary and Quaternary nonmarine clastic deposits by ground water, Tucson basin, Arizona [abs.], by R. L. Laney: Geol. Soc. America Abstracts with programs for 1969, pt. 5, May 1969.

Geohydrology and water utilization in the Willcox basin, Graham and Cochise Counties, Arizona, by S. G. Brown and H. H. Schumann: U.S. Geol. Survey Water-Supply Paper 1859-F, 1969. 32 p., 3 pls., 7 figs., 2 tables.

Hydrologic conditions in the Gila Bend basin, Maricopa County, Arizona, by R. S. Stulik and Otto Moosburner: Arizona State Land Dept. Water-Resources Rept. 39, March 1969. 63 p., 10 figs., 4 tables.

Infiltration of streamflow in the main arroyos in the Tucson basin, Arizona [abs.], by D. E. Burkham, in Abstracts of contributed papers, An international conference on Arid lands in a changing world: Tucson, Am. Assoc. for the Adv. Sci., June 1969. 2 p.

Regional hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, by M. E. Cooley, J. W. Harshbarger, J. P. Akers, and W. F. Hardt, with a section on Vegetation, by O. N. Hicks: U.S. Geol. Survey Prof. Paper 521-A, 1969. 61 p., 5 pls., 20 figs., 8 tables.

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SUMMARY OF GROUND-WATER CONDITIONS

The principal use of water in Arizona is for the irrigation of crops, and the ground-water reservoirs furnish nearly two-thirds of the water supply. For the last 16 years, the withdrawal of ground water has been more than 4 million acre-feet per year. In 1968, slightly more than 4.4 million acre-feet was withdrawn, but this amount is considerably less than the record high of nearly 5.2 million acre-feet in 1967. Figure 4 shows the estimated annual ground-water pumpage and the irrigated acreage in Arizona since 1940, and table 1 shows the amount of water pumped in each of the major developed areas in 1968 and the accumulated total since the beginning of record. Through 1968, more than 125 million acre-feet of ground water has been withdrawn in the State.

Ground water occurs under different conditions in each of the three water provinces in Arizona (fig. 1)—the Basin and Range lowlands province, the Central highlands province, and the Plateau uplands province. The use of ground water and current ground-water conditions in each of the three provinces are discussed separately in the following sections.

Basin and Range Lowlands Province

In the Basin and Range lowlands province (fig. 1) the unconsolidated or weakly consolidated deposits in the basins store large amounts of water and yield the water readily to wells. Although the province comprises only about 45 percent of the State, it contains more than 90 percent of the cultivated land and more than 80 percent of the population; therefore, it is the most highly developed of the three provinces from the standpoint of ground-water use. The extensive development of the ground-water supply has resulted in a decline in water levels in a large part of the province.

The Salt River Valley and the lower Santa Cruz basin are the largest agricultural areas in the State. Through 1968, more than 60 million acre-feet of ground water had been pumped from the aquifers in the Salt River Valley, and more than 32 million acre-feet had been pumped from the lower Santa Cruz basin. It is in these two areas that the largest water-level declines have taken place; however, the rate of water-level decline was less in 1968 than in previous years, and in parts of the area water levels rose during the year. The rises apparently were due to the availability of more surface water for irrigation, which resulted in less withdrawal of ground water. Other areas in the Basin and Range lowlands province where withdrawals have caused large declines in water levels are the Willcox basin, upper Santa Cruz basin, Avra Valley, Gila Bend basin, and McMullen Valley.

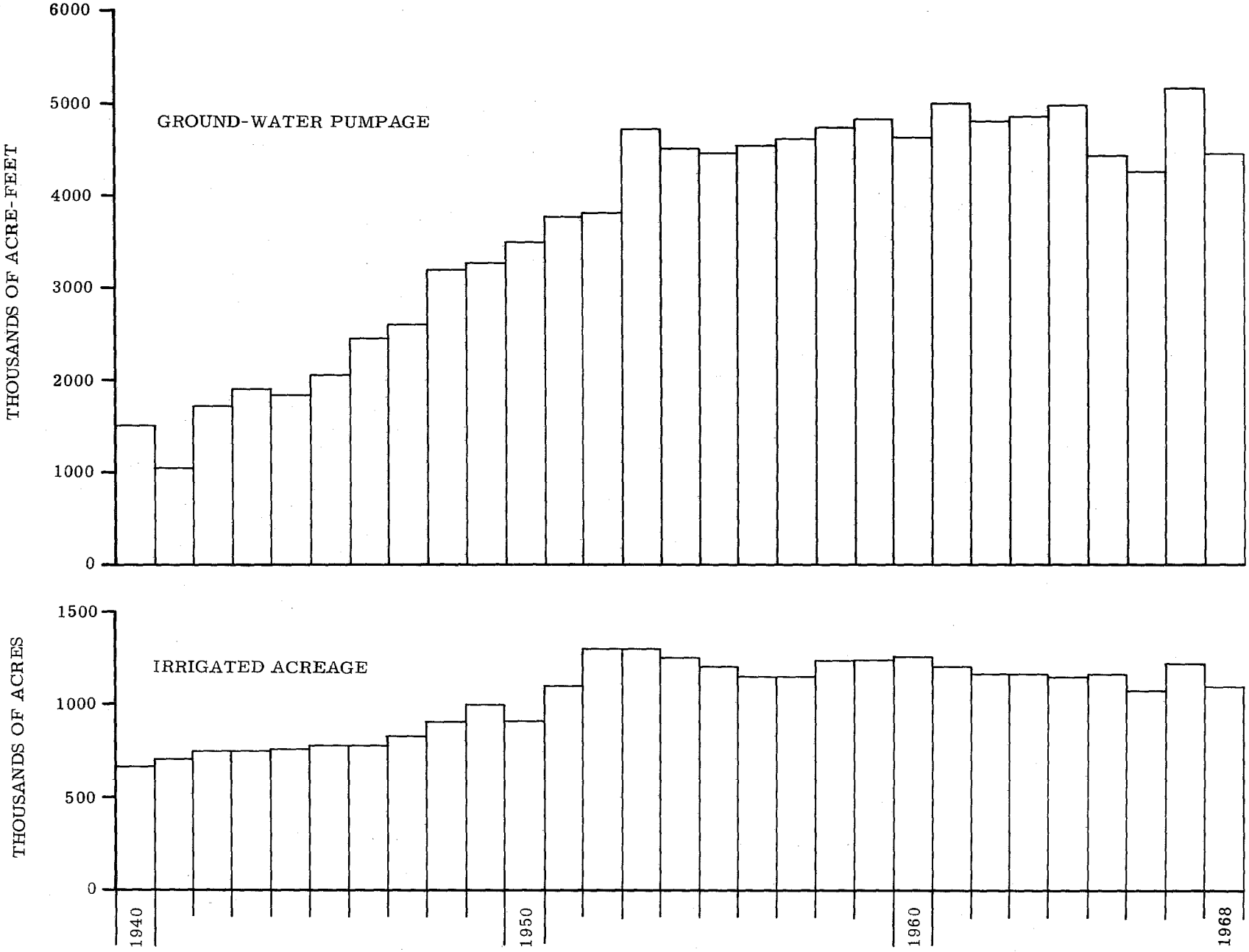


FIGURE 4. --ESTIMATED ANNUAL GROUND-WATER PUMPAGE AND IRRIGATED ACREAGE IN ARIZONA.

Table 1.--Estimated ground-water pumpage in Arizona, by areas

[Numbers rounded to nearest thousand acre-feet. Area: See figure 1 for location. Other areas: Aravaipa Valley, Big Sandy Valley, Date Creek area, Peeples Valley, Skull Valley, Verde Valley, Little Colorado River basin, areas in the Plateau uplands, and small areas not identifiable with any particular basin]

Area	Pumpage, in thousands of acre-feet	
	1968	Accumulated total through 1968
Duncan basin	25	568
Safford basin	78	2,508
San Simon basin	81	1,109
Willcox basin	290	3,193
Douglas basin	120	1,361
San Pedro River valley	71	1/ 199
Upper Santa Cruz basin	210	5,417
Avra Valley	134	2,312
Lower Santa Cruz basin	910	32,112
Salt River Valley	1,264	60,081
Waterman Wash area	54	778
Gila Bend basin	153	3,336
Harquahala Plains area	176	1,891
McMullen Valley	107	925
Gila River drainage from Painted Rock Dam to Texas Hill	126	1,017
Ranegras Plain area	15	226
Wellton-Mohawk area	2/ 220	2,470
Yuma area 3/	265	2,979
Colorado River flood plain from Davis Dam to Imperial Dam	17	132

See footnotes at end of table.

Table 1.--Estimated ground-water pumpage in Arizona, by areas—Continued

Area	Pumpage, in thousands of acre-feet	
	1968	Accumulated total through 1968
Sacramento Valley	6	18
Hualapai Valley	4	18
Big Chino Valley	9	358
Little Chino Valley	12	337
Williamson Valley	2	38
Other areas	100	4/ 1,815
Total	4,449	125,198

1/ Pumpage for San Pedro River valley was not computed prior to 1966. Thus, accumulated total is for 1966-68 only. Estimated pumpage before 1966 is included under other areas.

2/ Withdrawal for drainage purposes only.

3/ Yuma area includes South Gila Valley, Yuma Mesa, and Yuma Valley. Beginning in 1947 in Yuma Valley and in 1961 in South Gila Valley, part of the pumpage was for drainage of waterlogged lands.

4/ Total through 1967 is 1,715 (figure published in previous report was in error).

Figures 5, 11, 16, 21, and 26 show the depth to water in spring 1969 and the change in water levels from 1964 to 1969 in selected wells in the province, and figure 15 shows the depth to water in the lower Santa Cruz basin in spring 1969. Graphs (figs. 6, 7, 8, 9, 10, 12, 13, 19, 20, 22, 23, 24, 25, and 27) showing the depth to water in wells and estimated annual pumpage are included for most areas in the province. Graphs showing the cumulative average change in water levels for areas in the lower Santa Cruz basin and the Salt River Valley and estimated annual pumpage are given in figures 14, 17, and 18.

Central Highlands Province

In the Central highlands province the igneous and metamorphic rocks and the well-consolidated sedimentary rocks that constitute most of the area contain only small amounts of space for the storage of ground water. A few small valleys between the mountains contain varying thicknesses of alluvial deposits that store some ground water; these deposits yield sufficient water to irrigation wells.

The Central highlands province is the smallest of the three water provinces in Arizona; only a few thousand acres of land is under cultivation, and the amount of ground water pumped is small. The cultivated acreage is concentrated mainly in the Chino and Verde Valleys. Figures 28 and 30 show the depth to water in spring 1969 and the change in water levels from 1964 to 1969 in selected wells; graphs showing depth to water in selected wells and estimated annual pumpage for several areas in the province are given in figure 29.

Plateau Uplands Province

In the Plateau uplands province, water-bearing sandstone constitutes a large storage reservoir for ground water, but well yields generally are small. Ground-water development in the province is small compared to that in the Basin and Range lowlands, but it is somewhat greater than that in the Central highlands. Only about 35,000 acres of land is under cultivation in the Plateau uplands province. Except for the few population centers, such as Flagstaff, Holbrook, and the White Mountains recreational areas, the use of ground water is confined to scattered farms and homesites. The Navajo and Hopi Indian Reservations make up a large part of the province.

Figures 28, 30, 32, and 33 show the depth to water in spring 1969 and the change in water levels from 1964 to 1969 in selected wells in the province. Graphs showing water levels in selected wells are given in figure 31.

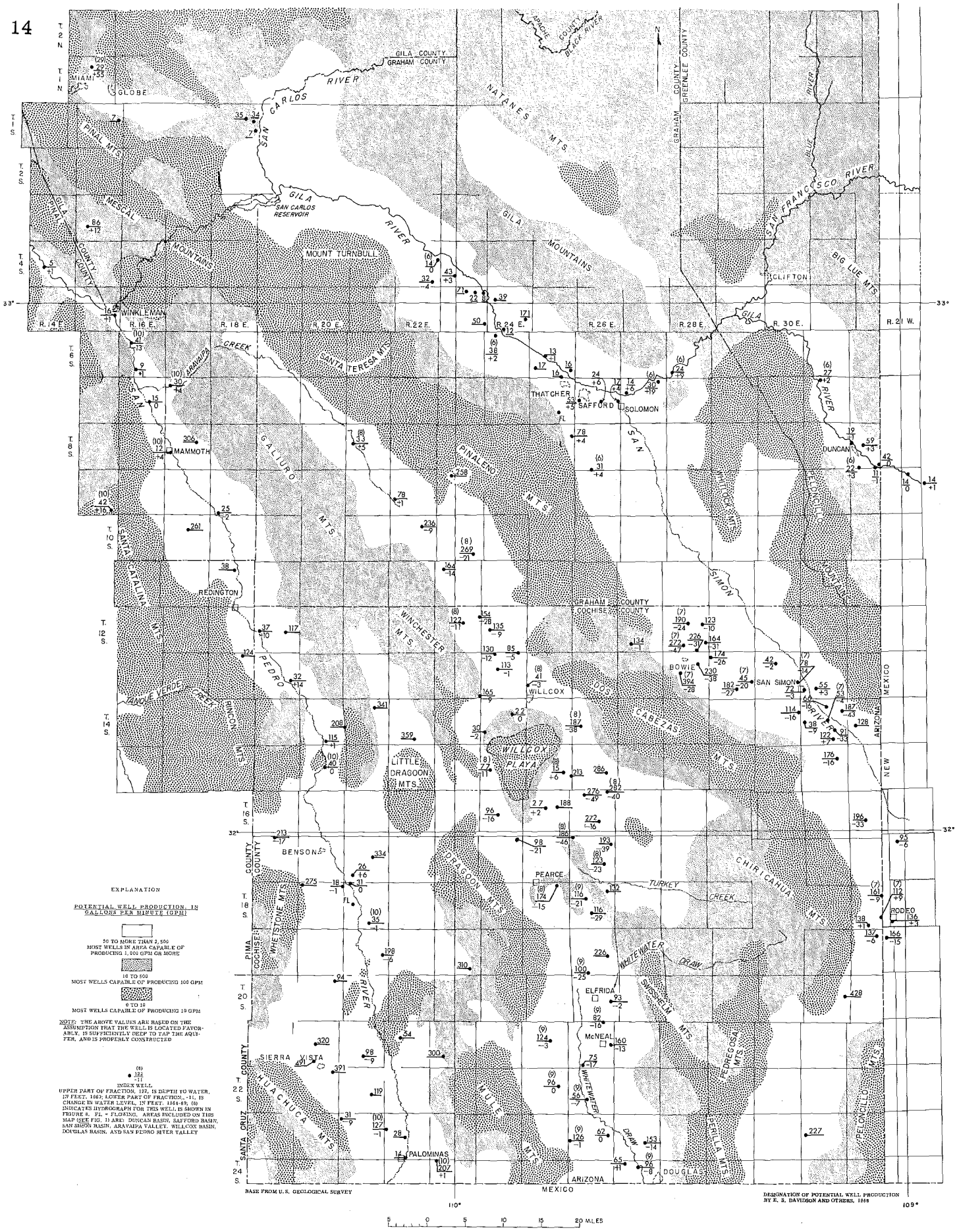


FIGURE 5.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE SOUTHEAST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

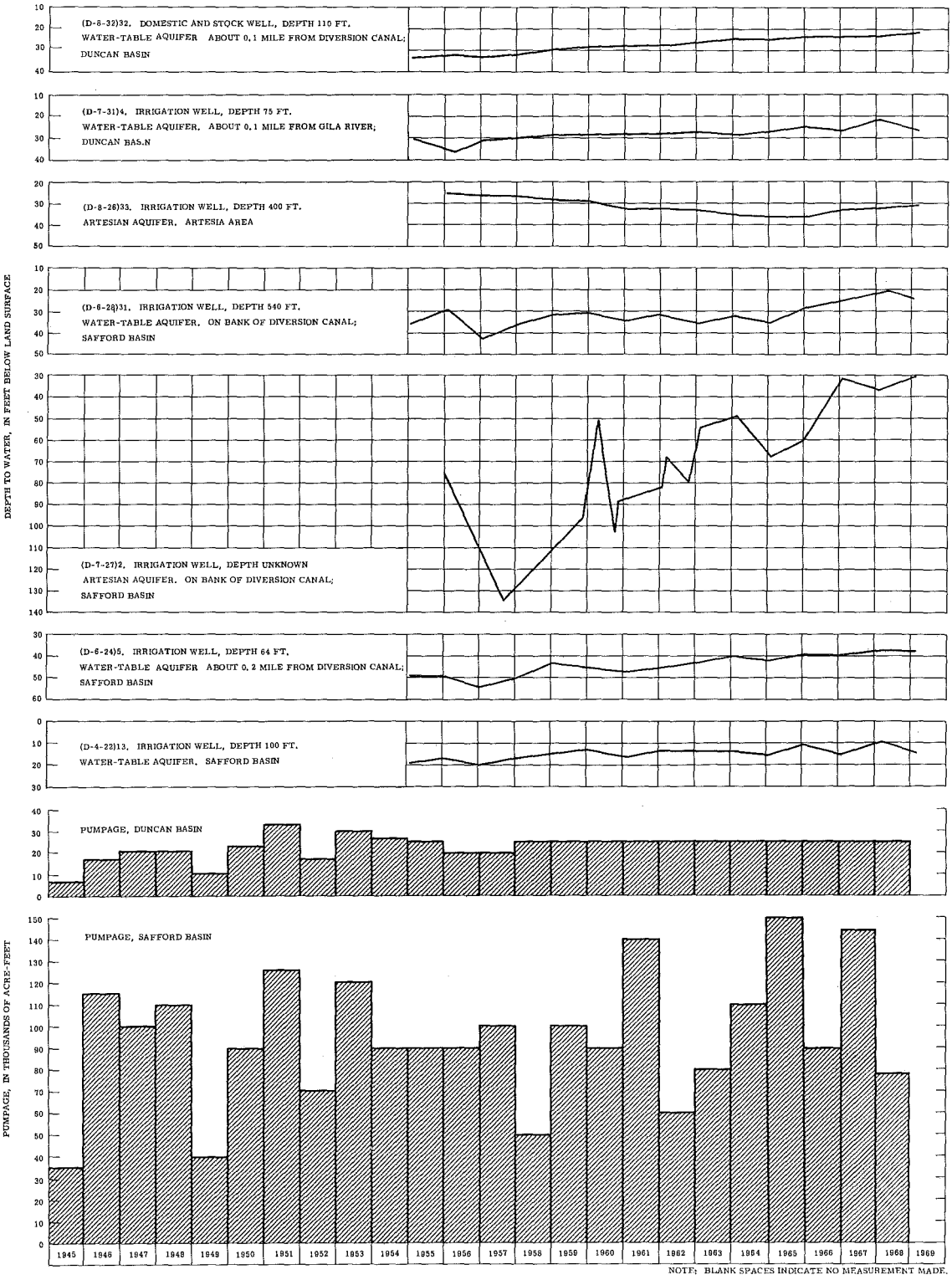


FIGURE 6. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE DUNCAN AND SAFFORD BASINS.

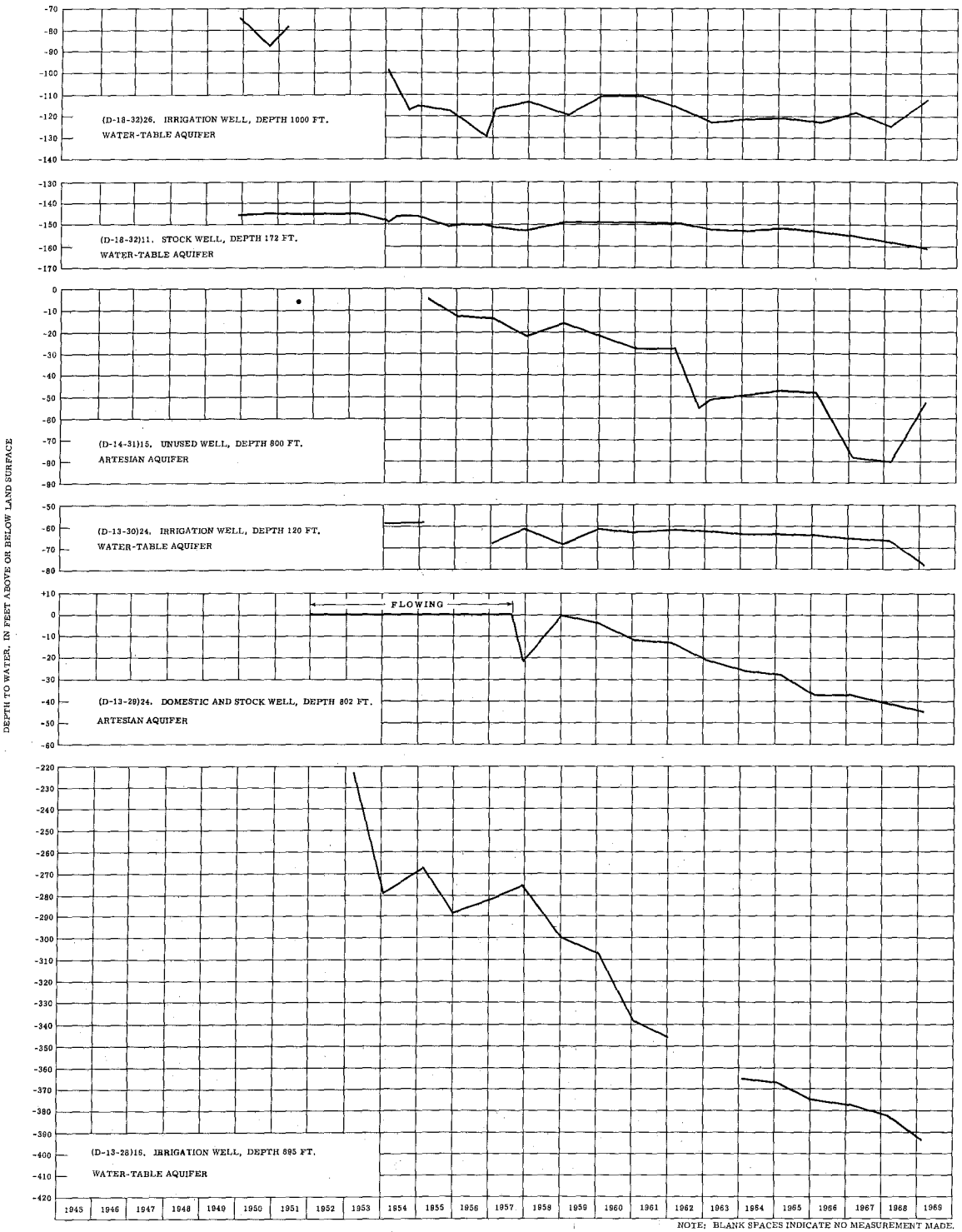


FIGURE 7.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SAN SIMON BASIN. (IN TWO SHEETS.)
SHEET 1 OF FIGURE 7

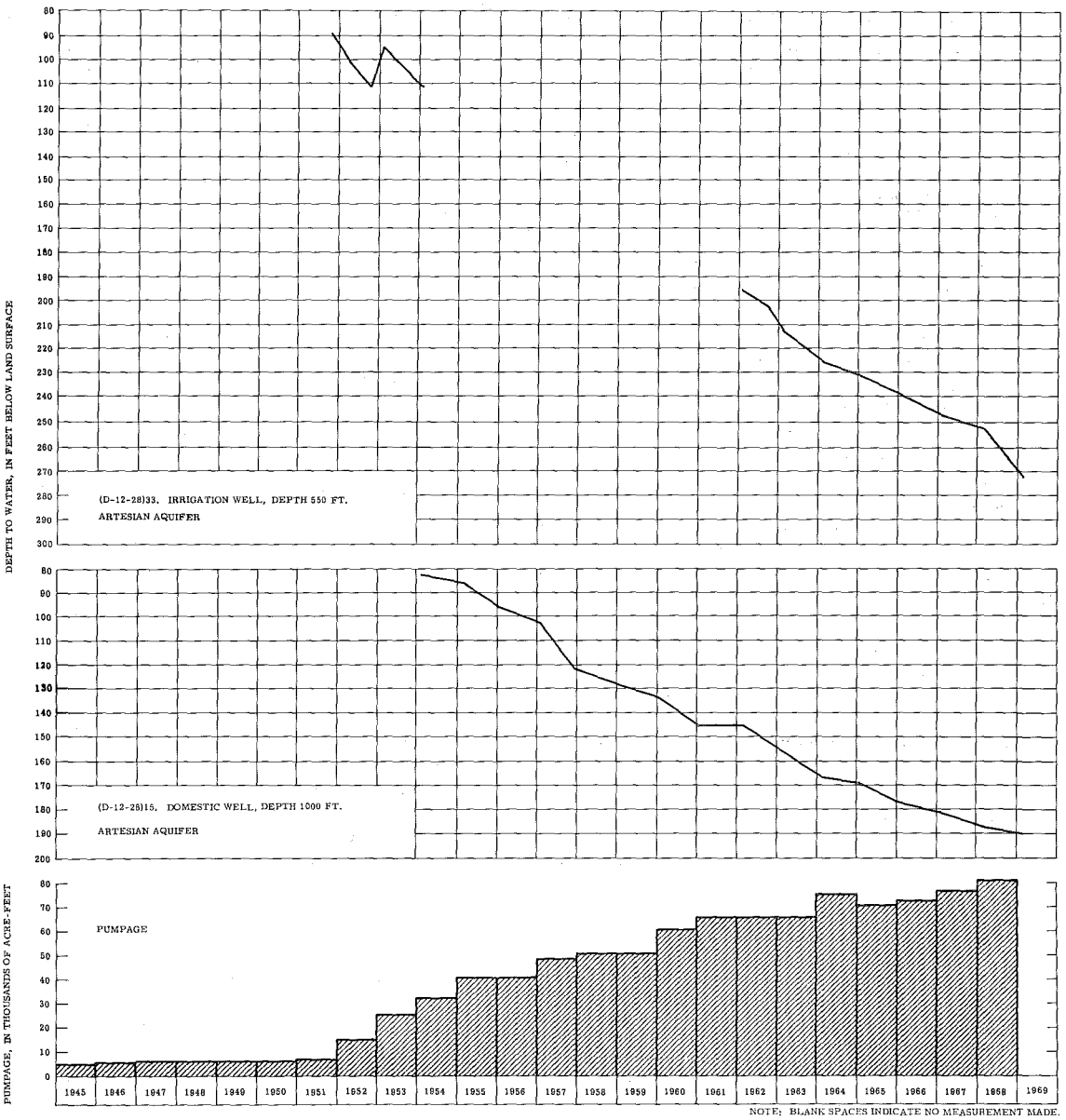
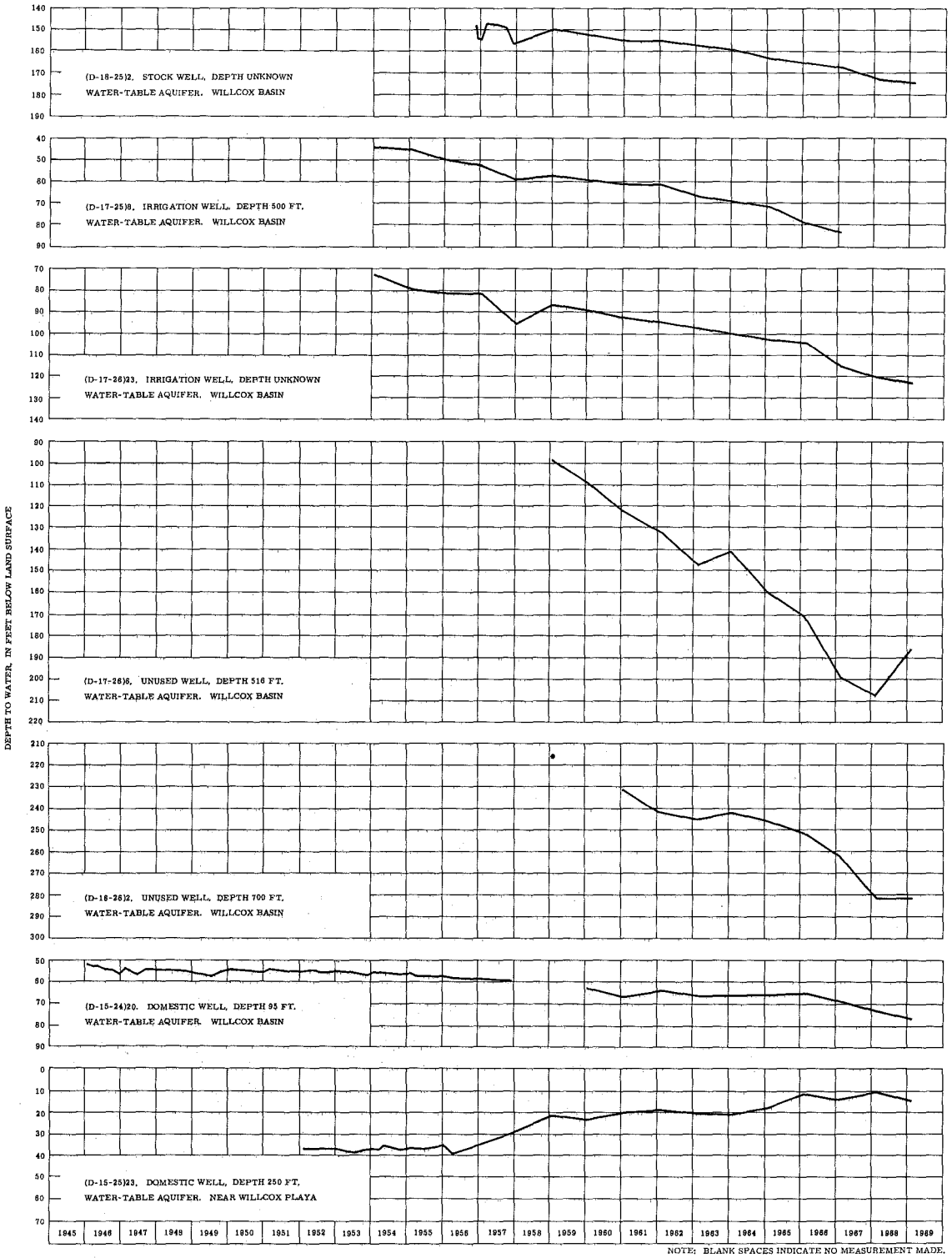


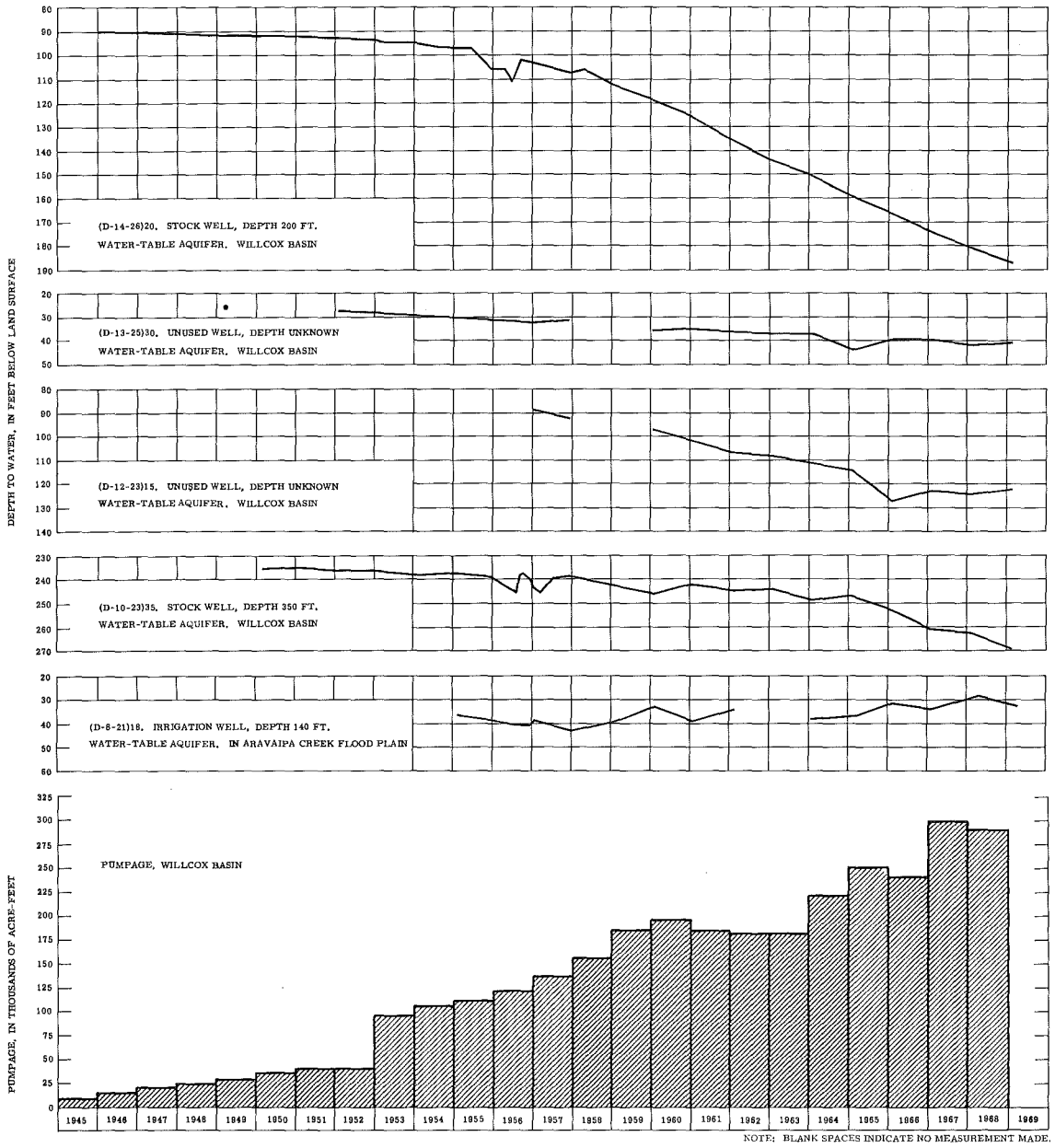
FIGURE 7.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SAN SIMON BASIN, (IN TWO SHEETS.)
SHEET 2 OF FIGURE 7



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 8, --DEPTH TO WATER IN SELECTED WELLS IN WILLCOX BASIN AND ARAVAIPA VALLEY AND ESTIMATED ANNUAL PUMPAGE IN WILLCOX BASIN.
(IN TWO SHEETS,)

SHEET 1 OF FIGURE 8,



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 8.--DEPTH TO WATER IN SELECTED WELLS IN WILLCOX BASIN AND ARAVAIPA VALLEY AND ESTIMATED ANNUAL PUMPAGE IN WILLCOX BASIN.
(IN TWO SHEETS.)

SHEET 2 OF FIGURE 8.

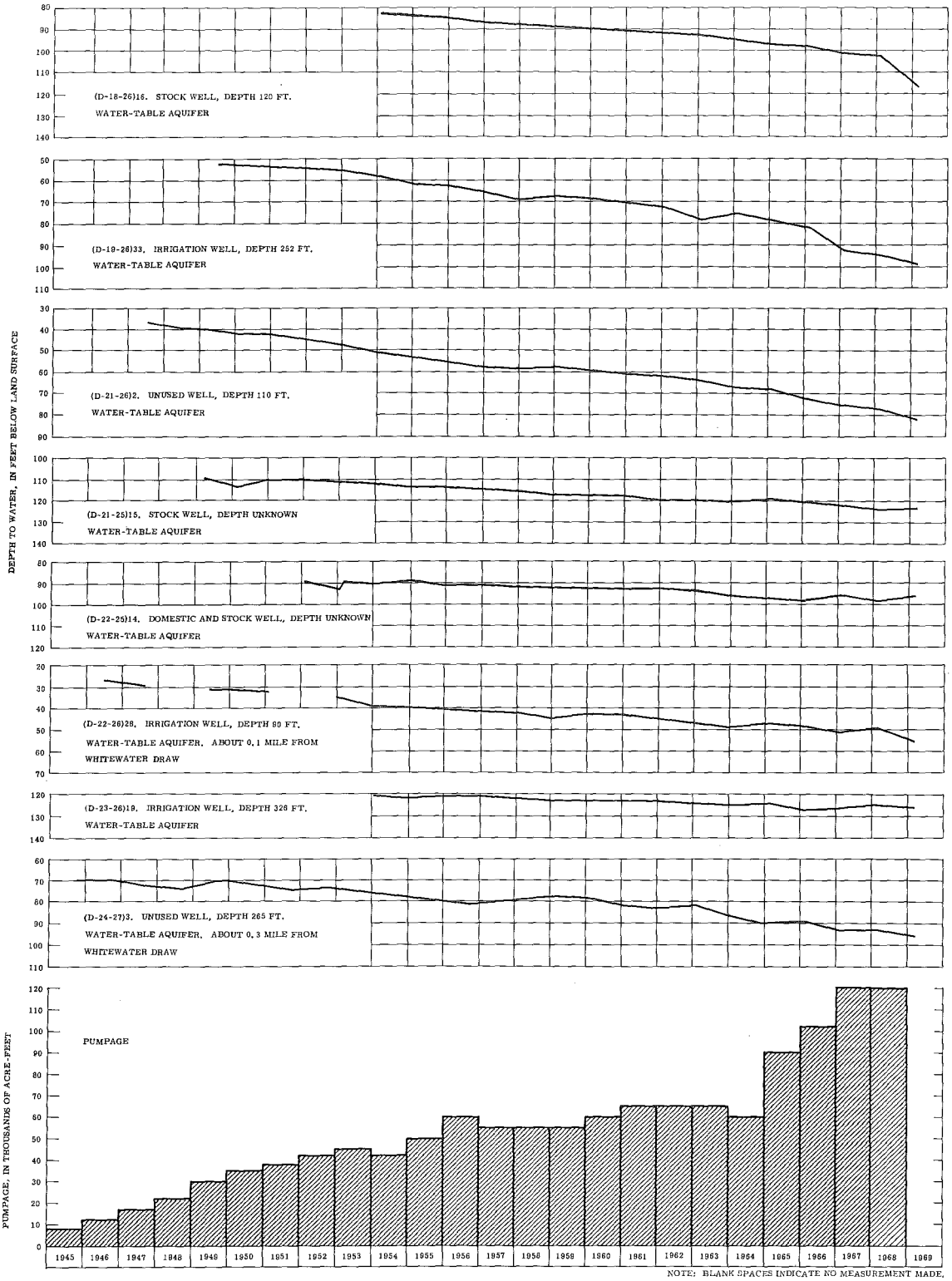
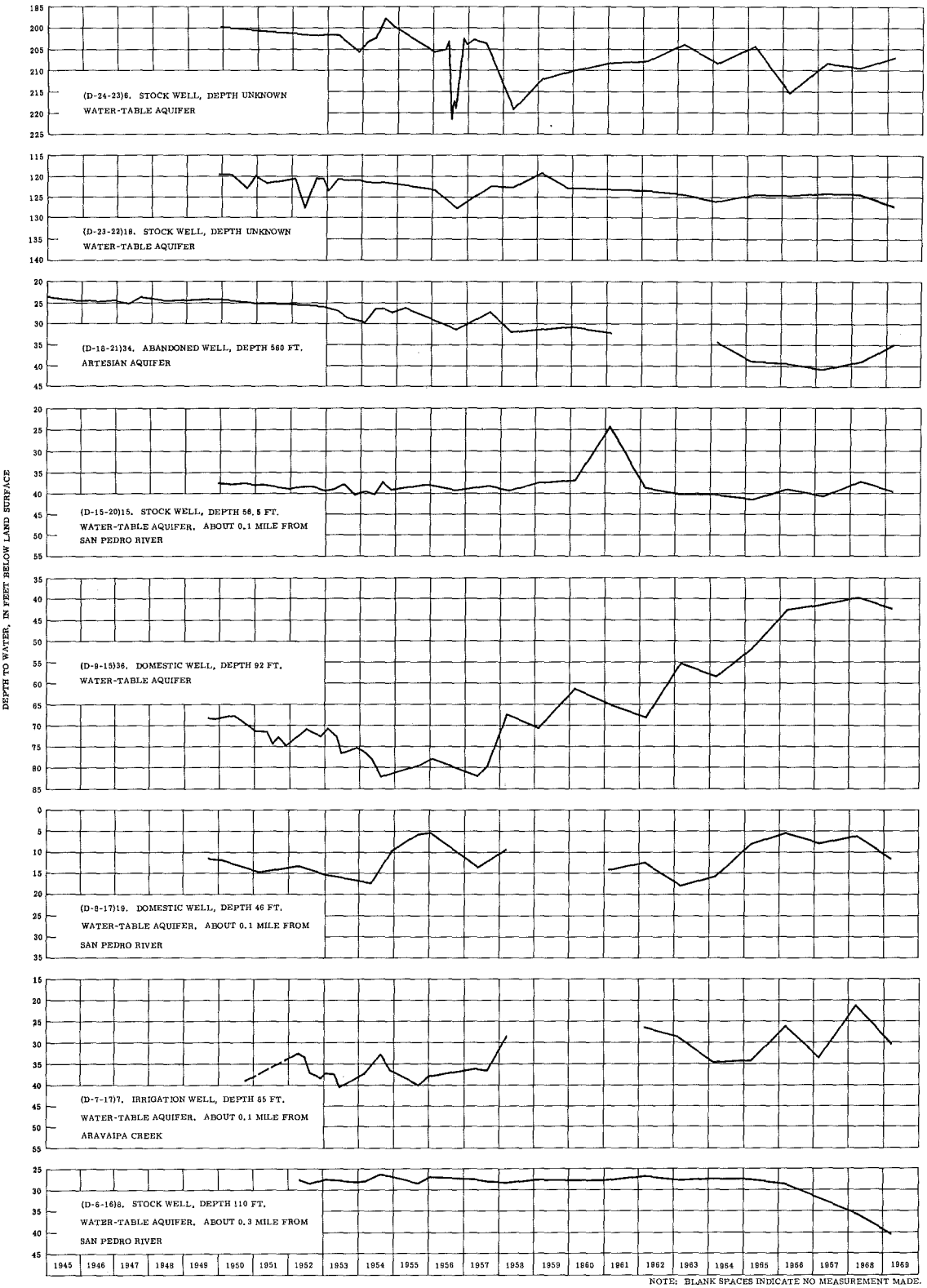


FIGURE 9 --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN DOUGLAS BASIN.



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 10.--DEPTH TO WATER IN SELECTED WELLS IN THE SAN PEDRO RIVER VALLEY.

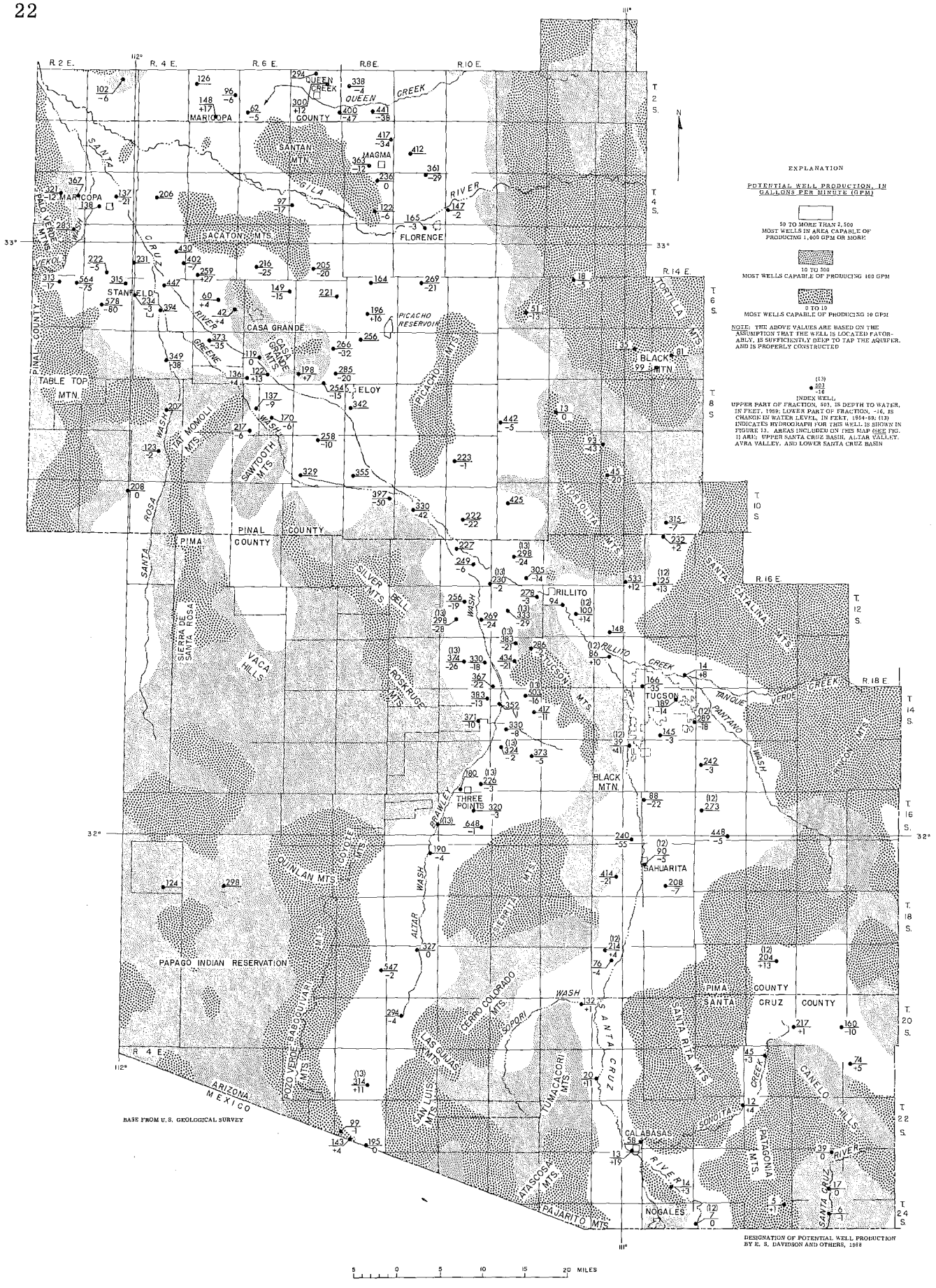
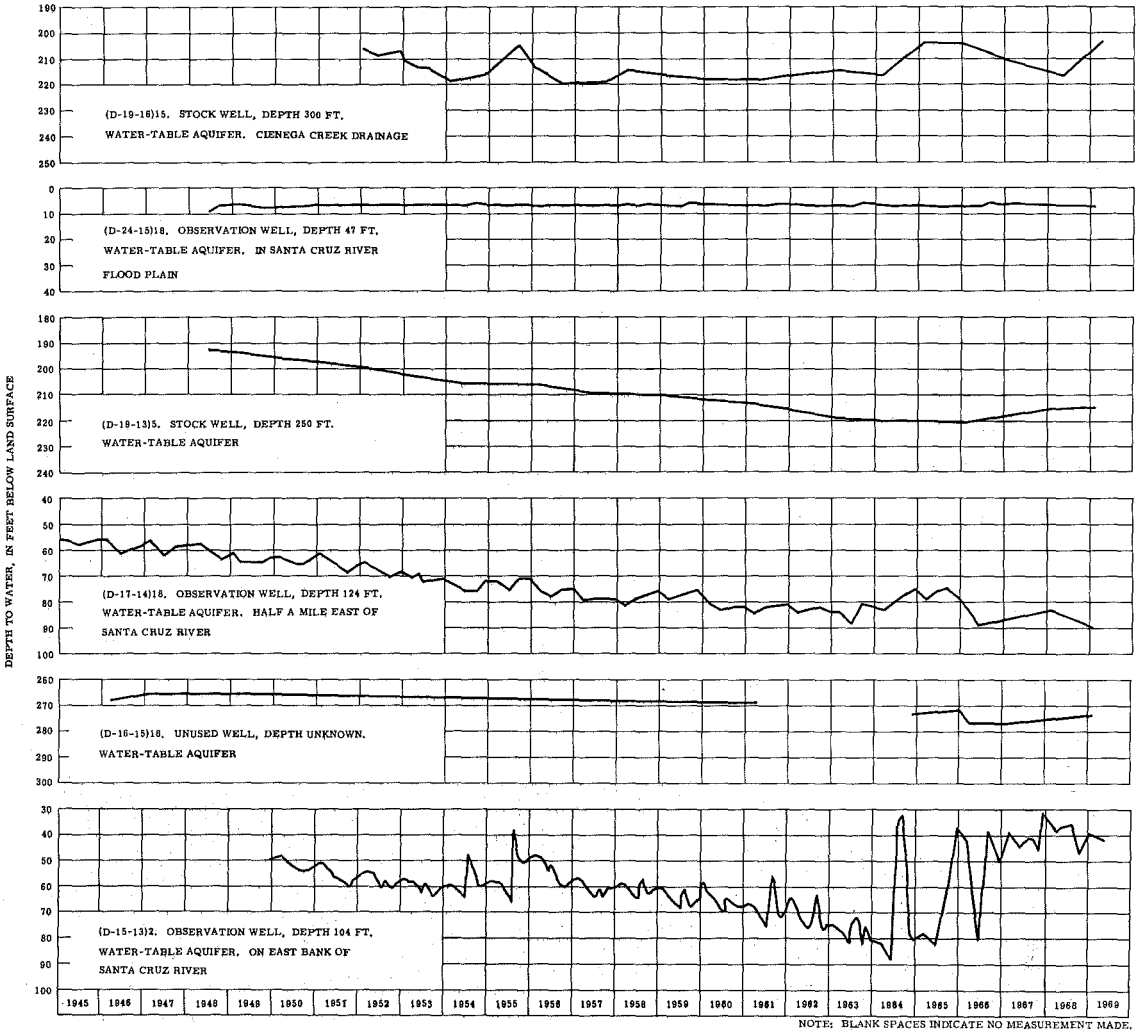
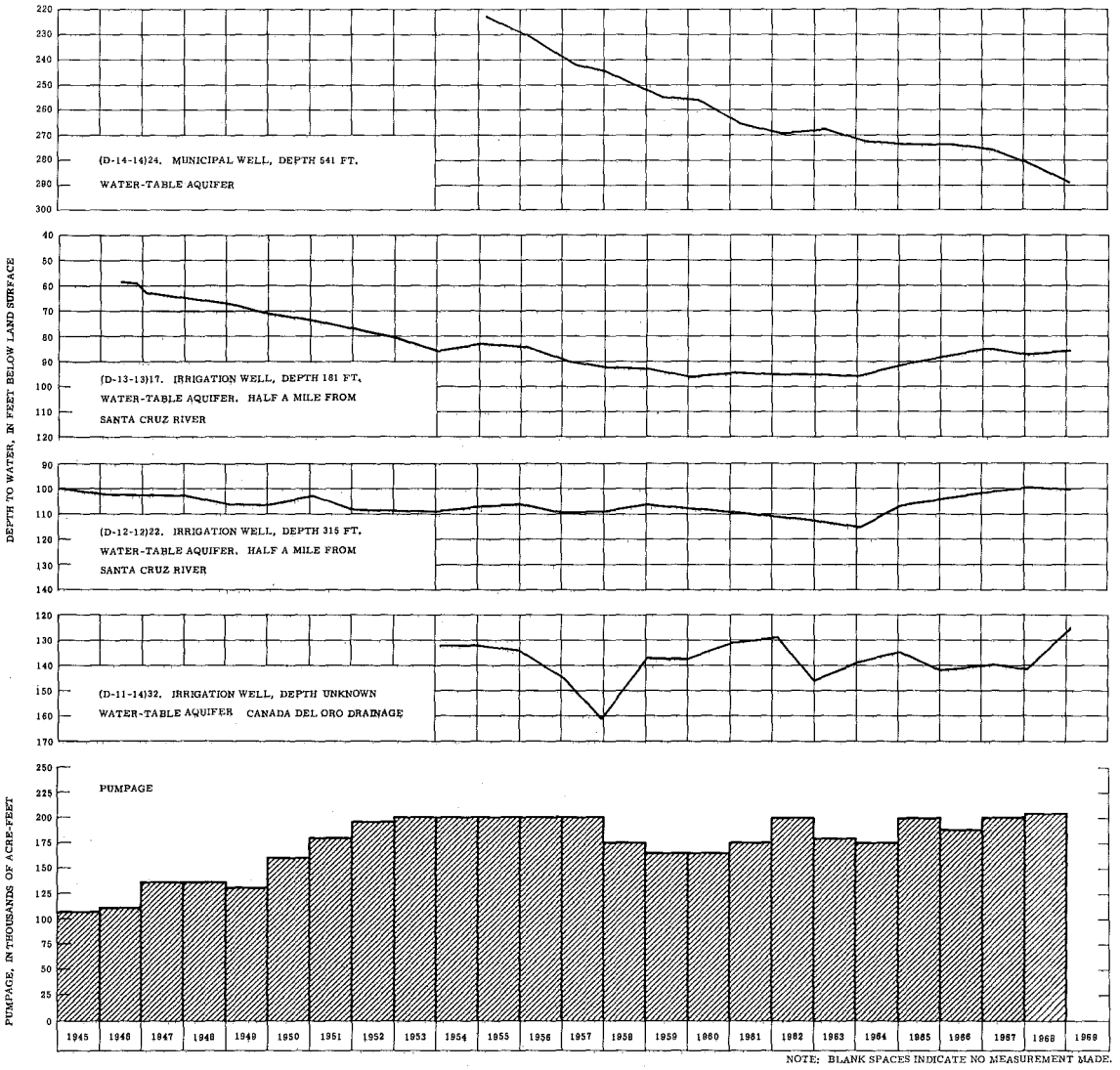


FIGURE 11.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE SOUTH-CENTRAL PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.



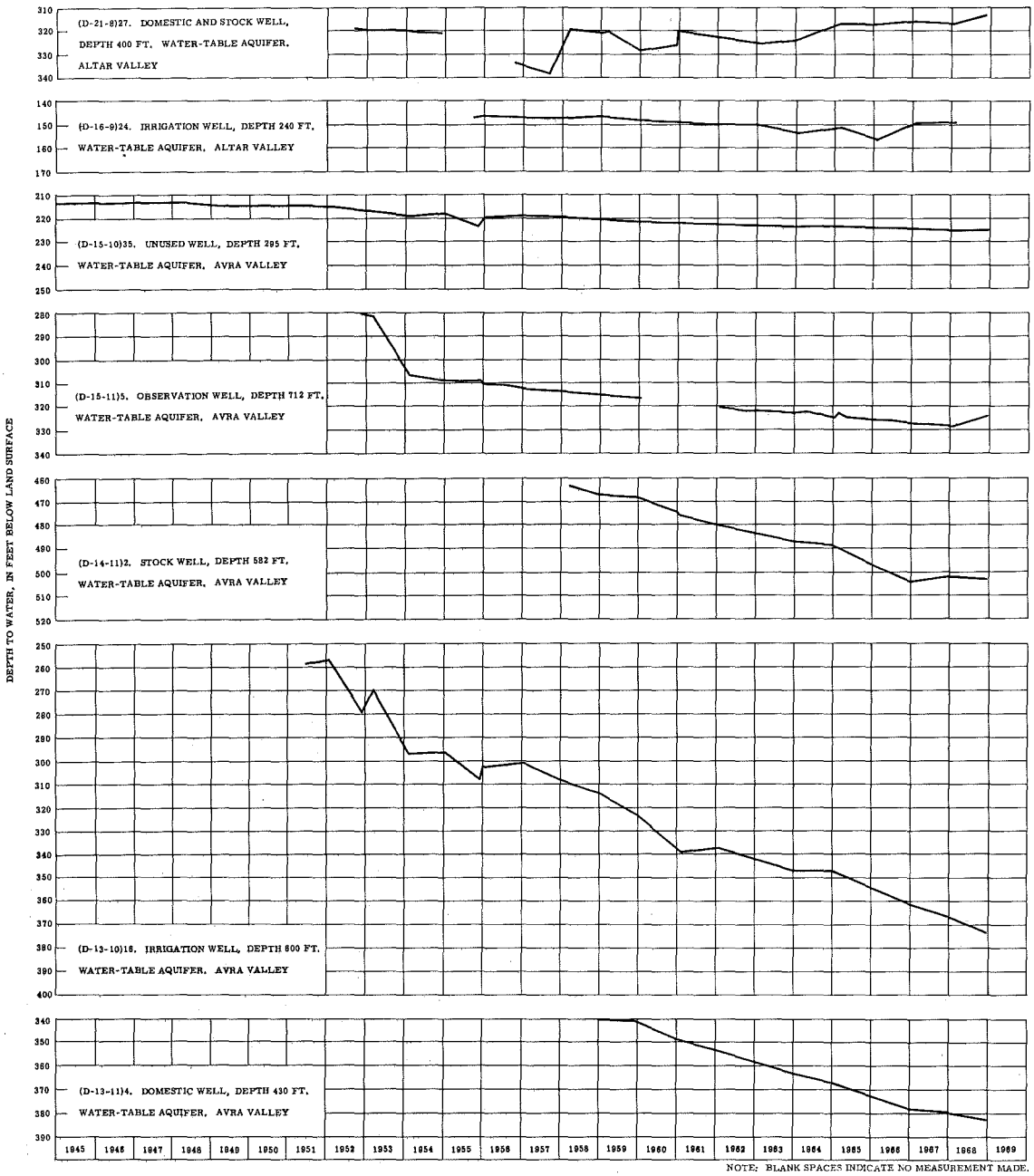
NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 12.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE UPPER SANTA CRUZ BASIN. (IN TWO SHEETS.)
SHEET 1 OF FIGURE 12



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 12.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE UPPER SANTA CRUZ BASIN. (IN TWO SHEETS.)
SHEET 2 OF FIGURE 12



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 13.--DEPTH TO WATER IN SELECTED WELLS IN ALTAR AND AVRA VALLEYS AND ESTIMATED ANNUAL PUMPAGE IN AVRA VALLEY. (IN TWO SHEETS.)

SHEET 1 OF FIGURE 13

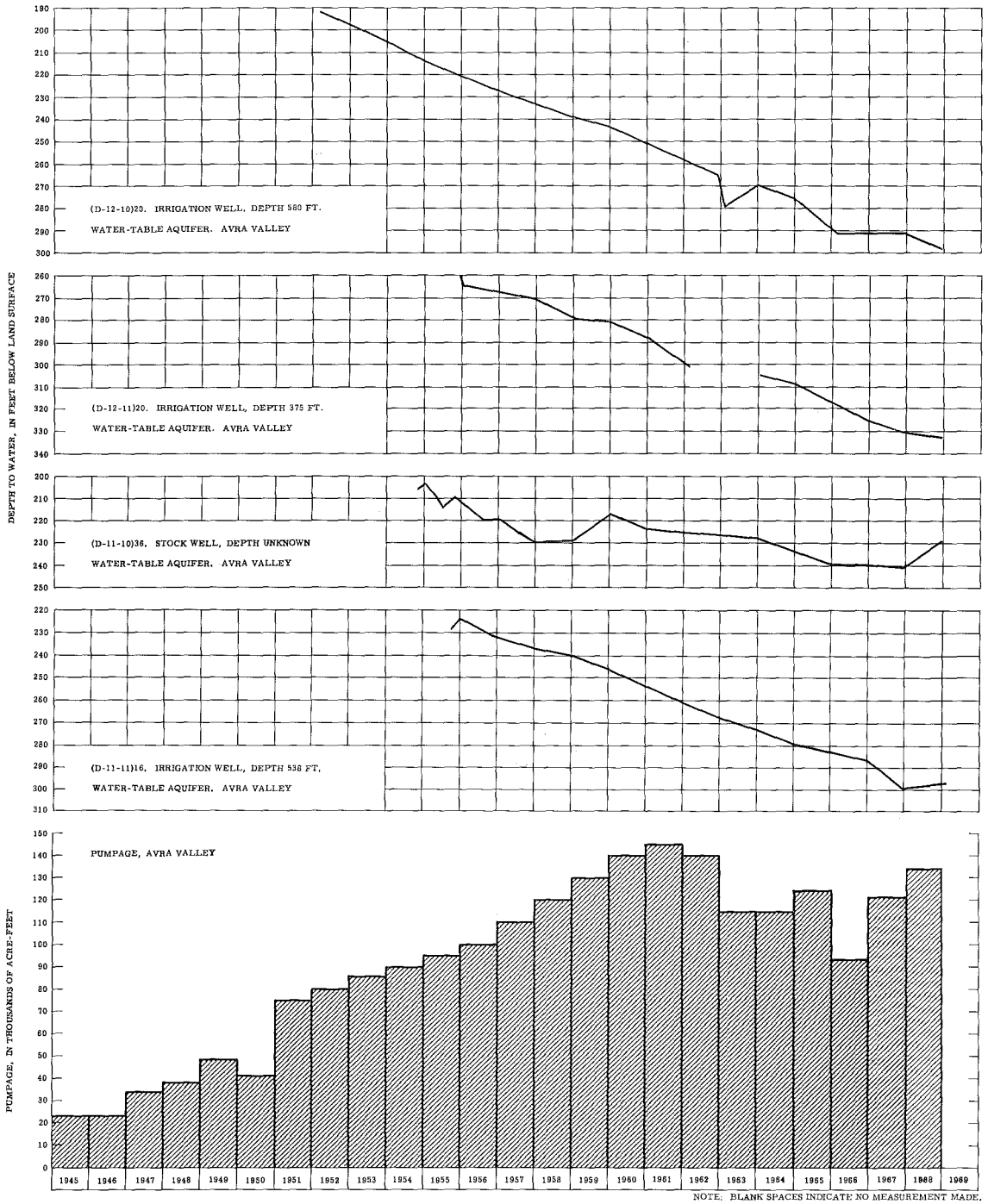


FIGURE 13.--DEPTH TO WATER IN SELECTED WELLS IN ALTAR AND AVRA VALLEYS AND ESTIMATED ANNUAL PUMPAGE IN AVRA VALLEY.
(IN TWO SHEETS.)

SHEET 2 OF FIGURE 13

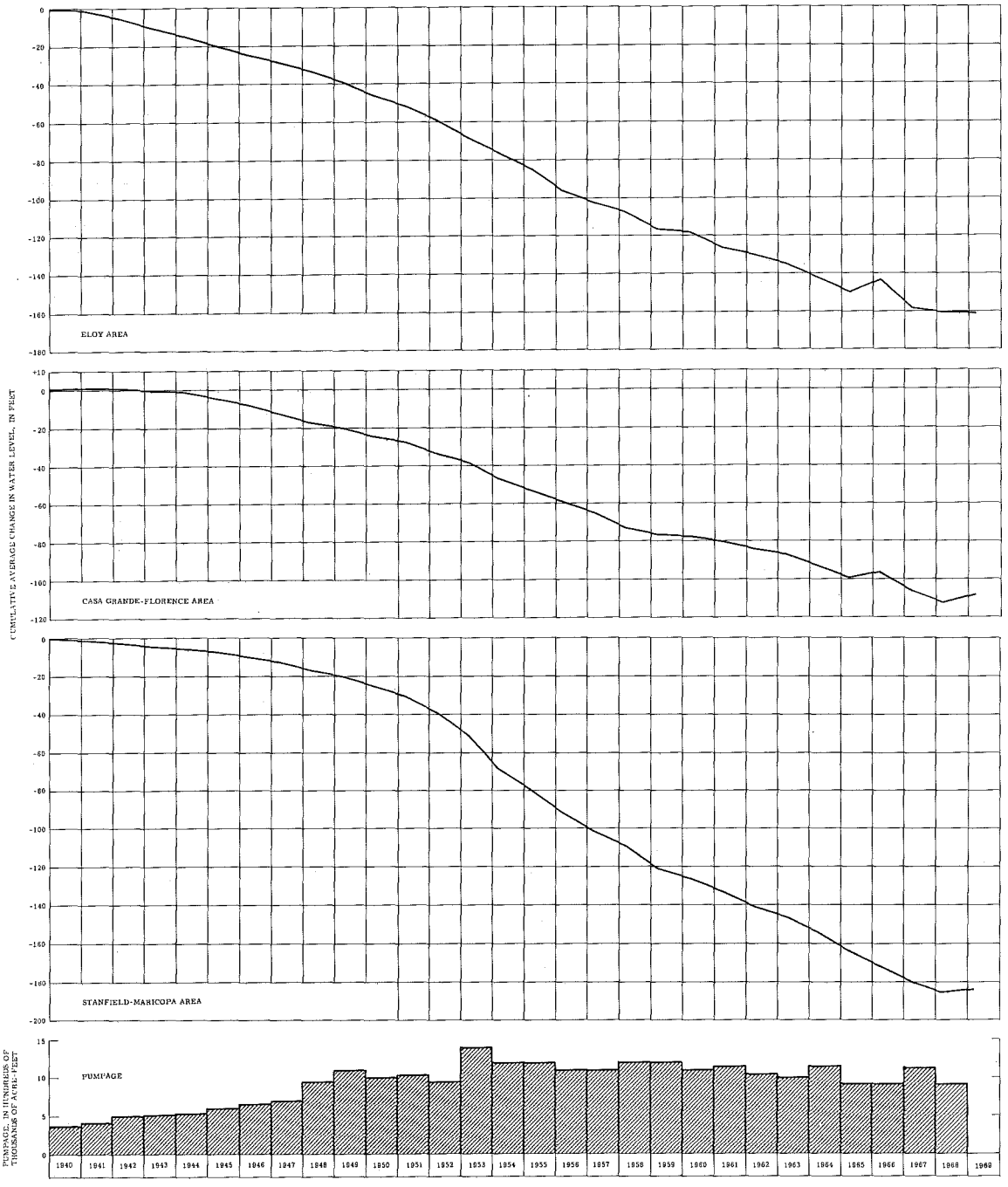


FIGURE 14.--CUMULATIVE AVERAGE CHANGE IN WATER LEVEL BY AREAS AND ESTIMATED ANNUAL PUMPAGE IN THE LOWER SANTA CRUZ BASIN.

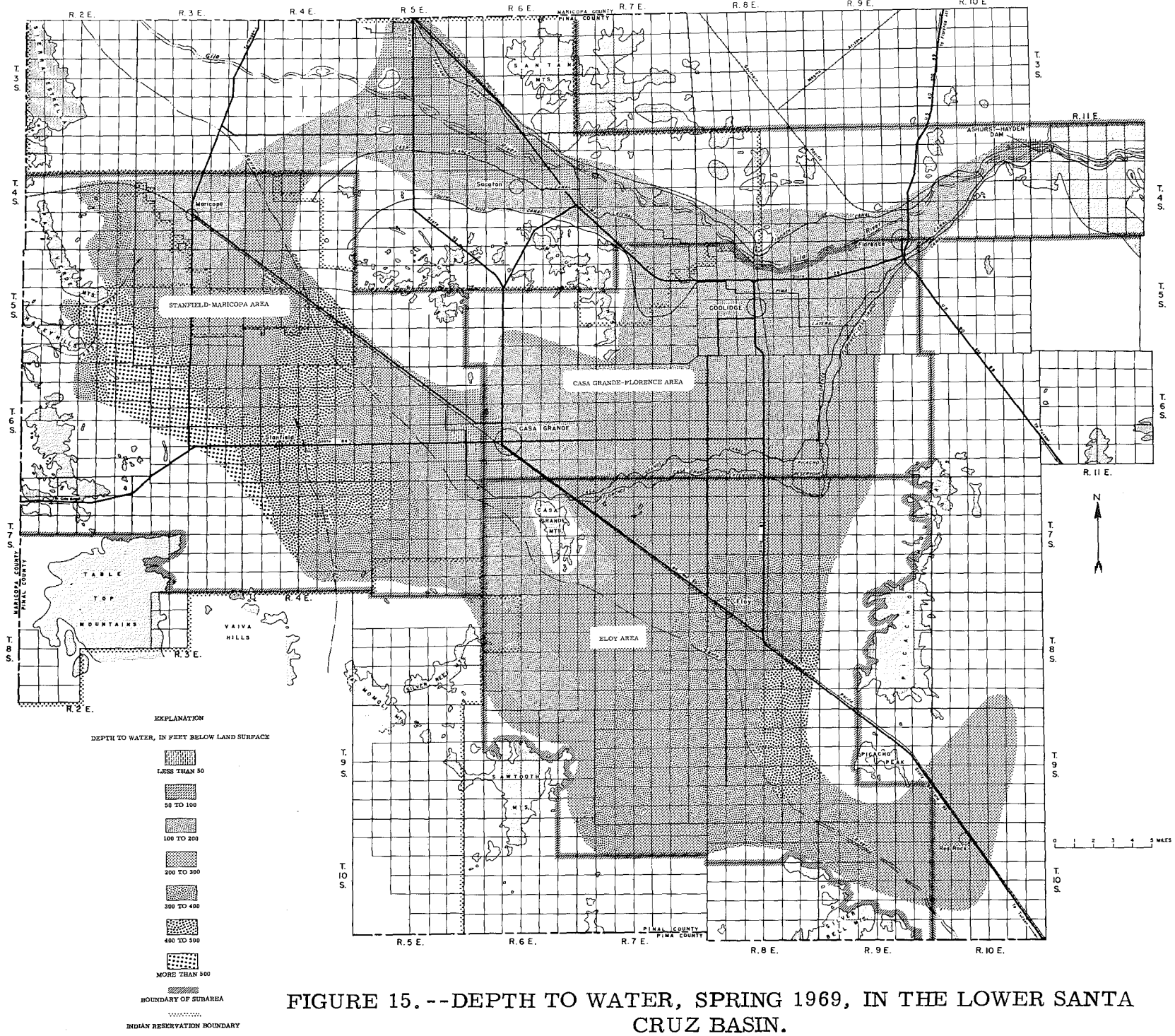


FIGURE 15.--DEPTH TO WATER, SPRING 1969, IN THE LOWER SANTA CRUZ BASIN.

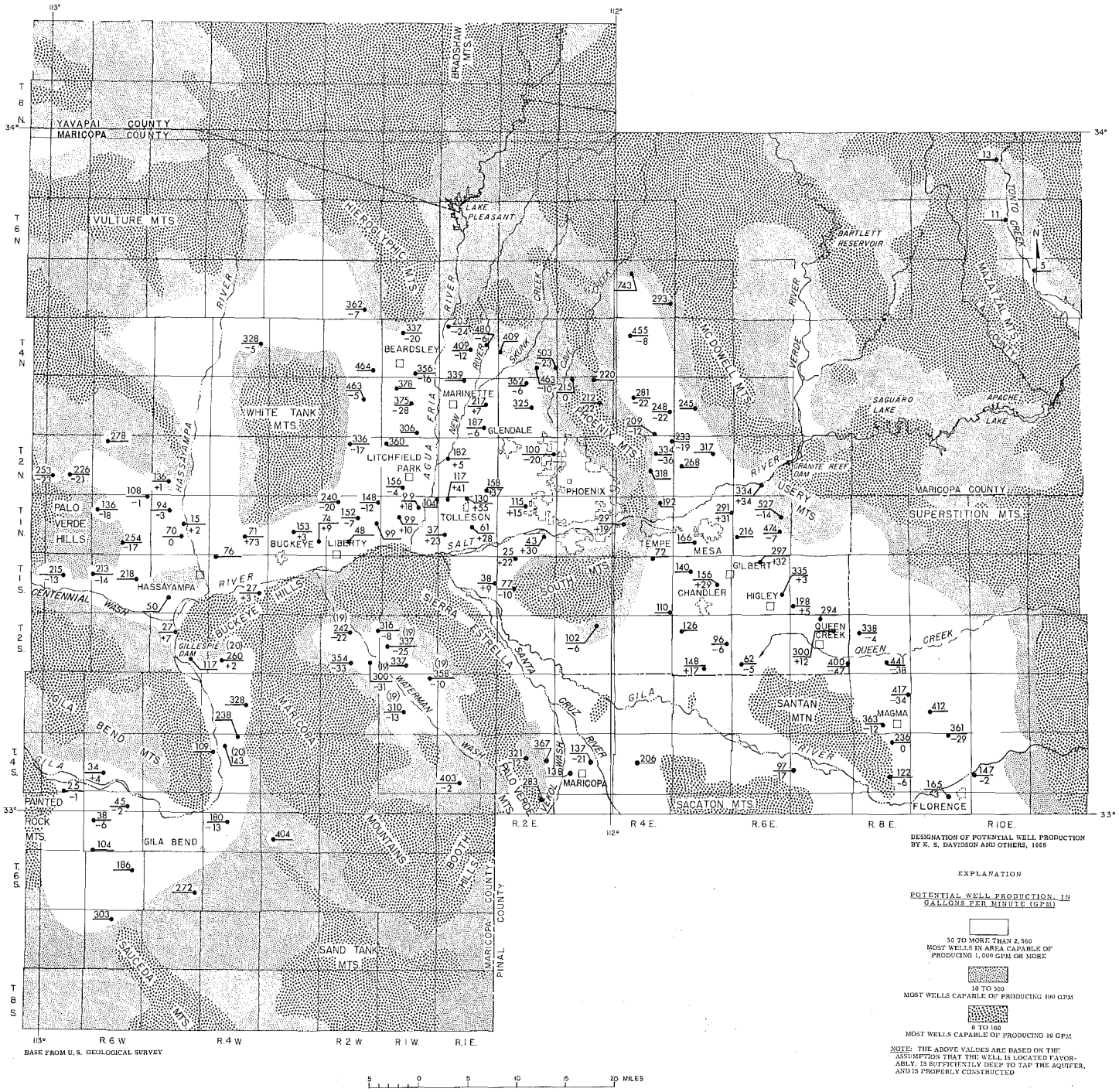


FIGURE 16.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE CENTRAL PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

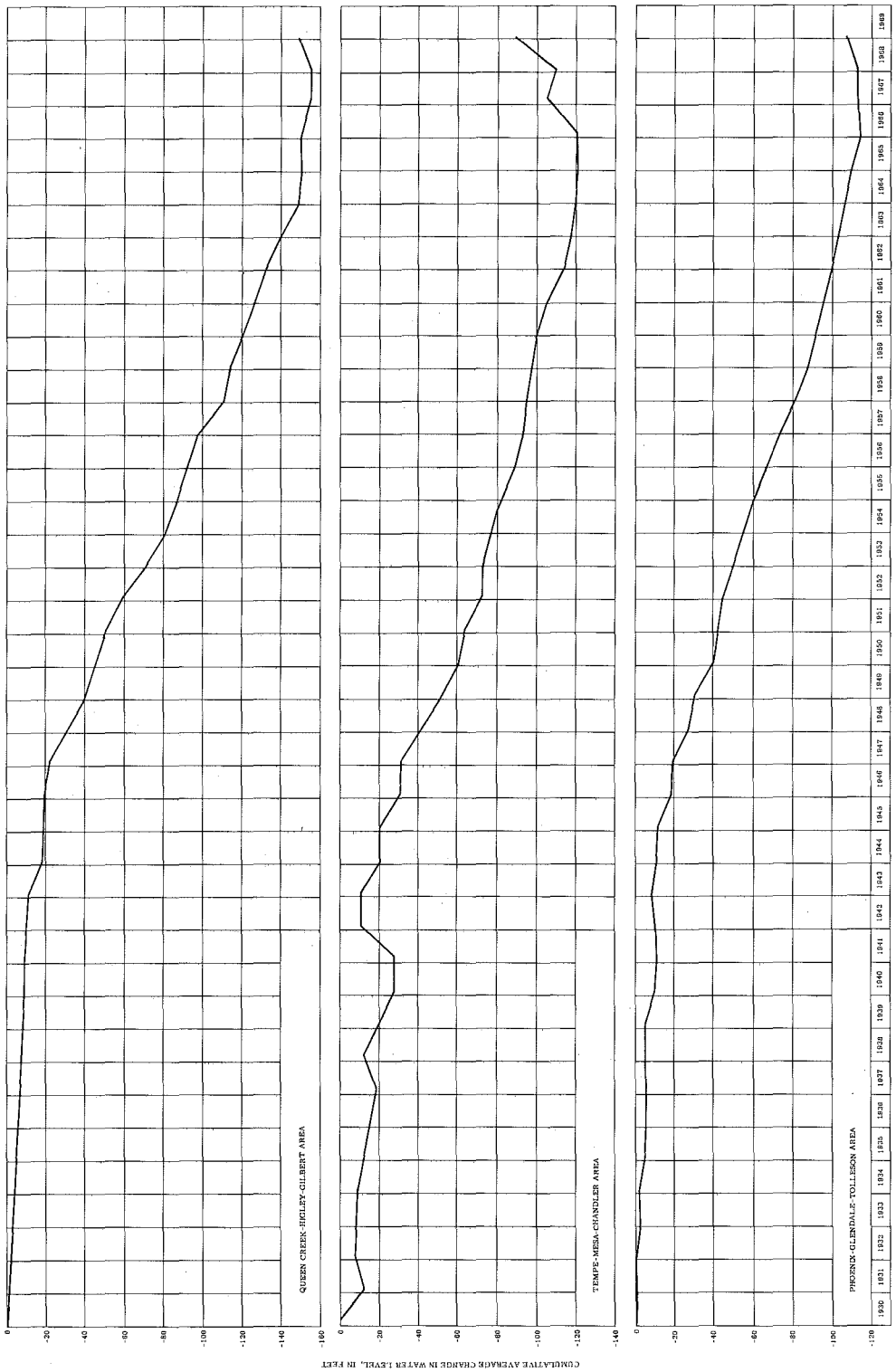


FIGURE 17.--CUMULATIVE AVERAGE CHANGE IN WATER LEVEL IN THE QUEEN CREEK-HIGLEY-GILBERT, TEMPE-MESA-CHANDLER, AND PHOENIX-GLENDALE-TOLLESON AREAS OF THE SALT RIVER VALLEY.

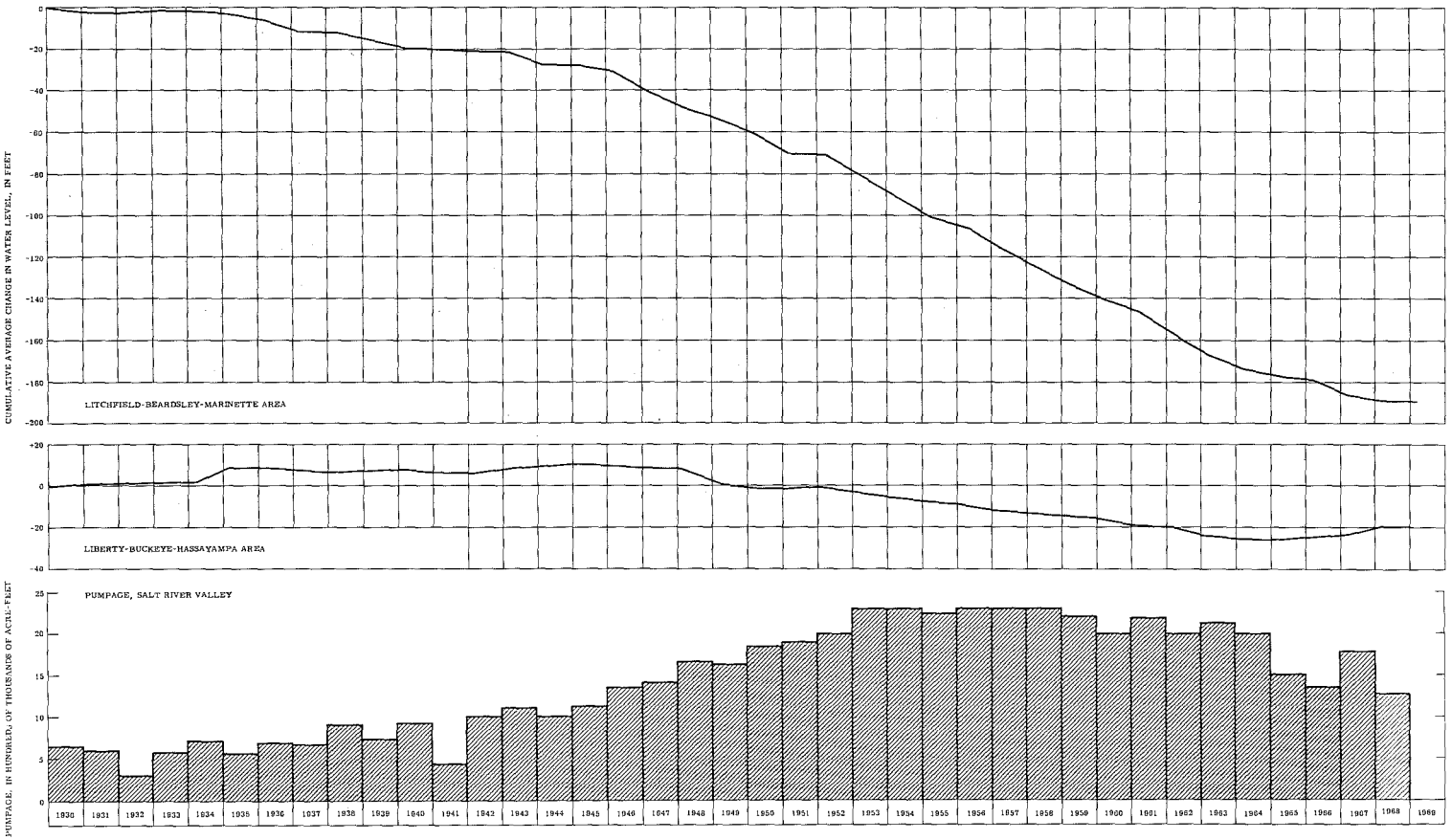


FIGURE 10.--CUMULATIVE AVERAGE CHANGE IN WATER LEVEL IN THE LITCHFIELD-BEARDSLEY-MARINETTE AND LIBERTY-BUCKEYE-HASSAYAMPA AREAS AND ESTIMATED ANNUAL PUMPAGE IN THE SALT RIVER VALLEY.

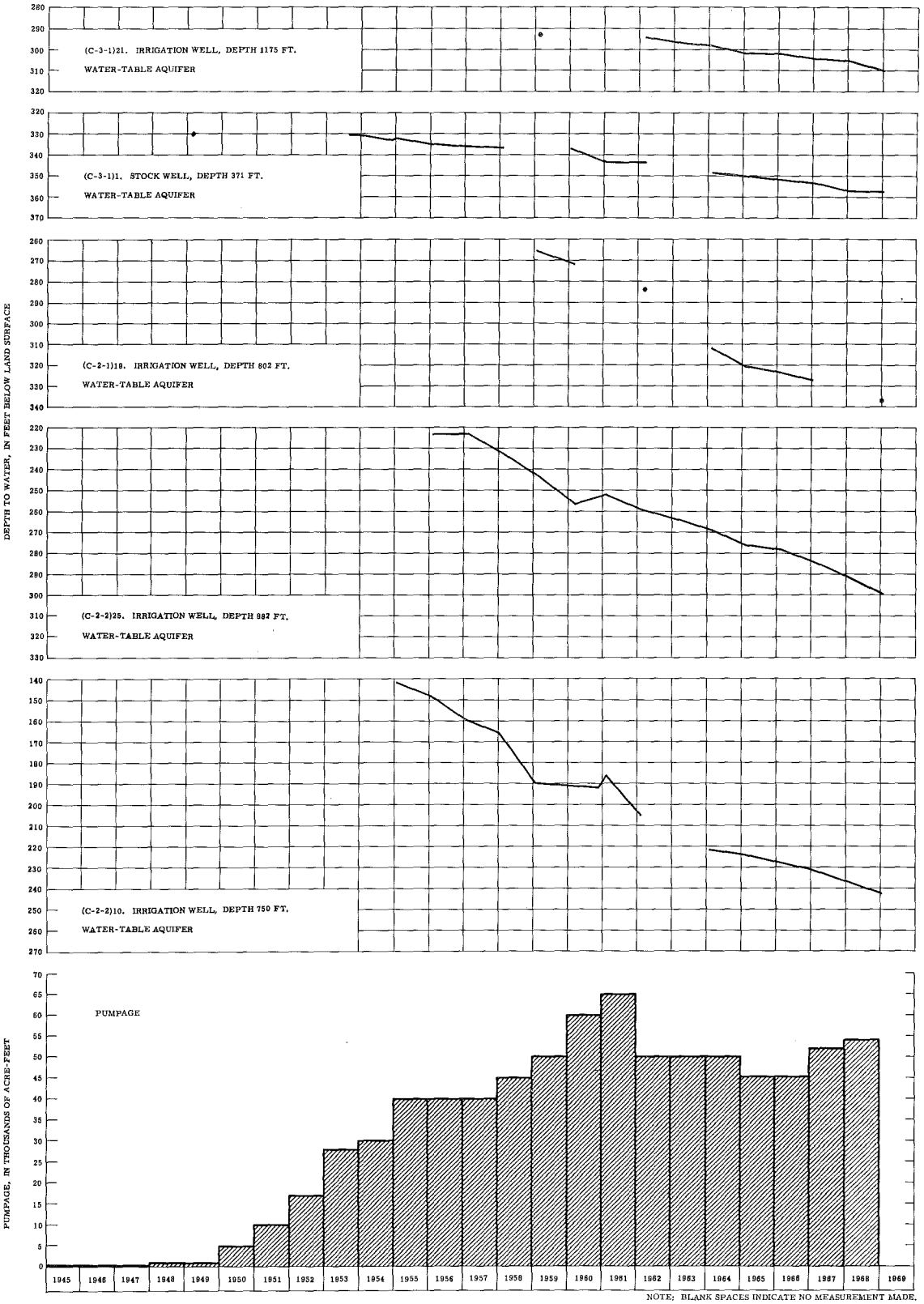
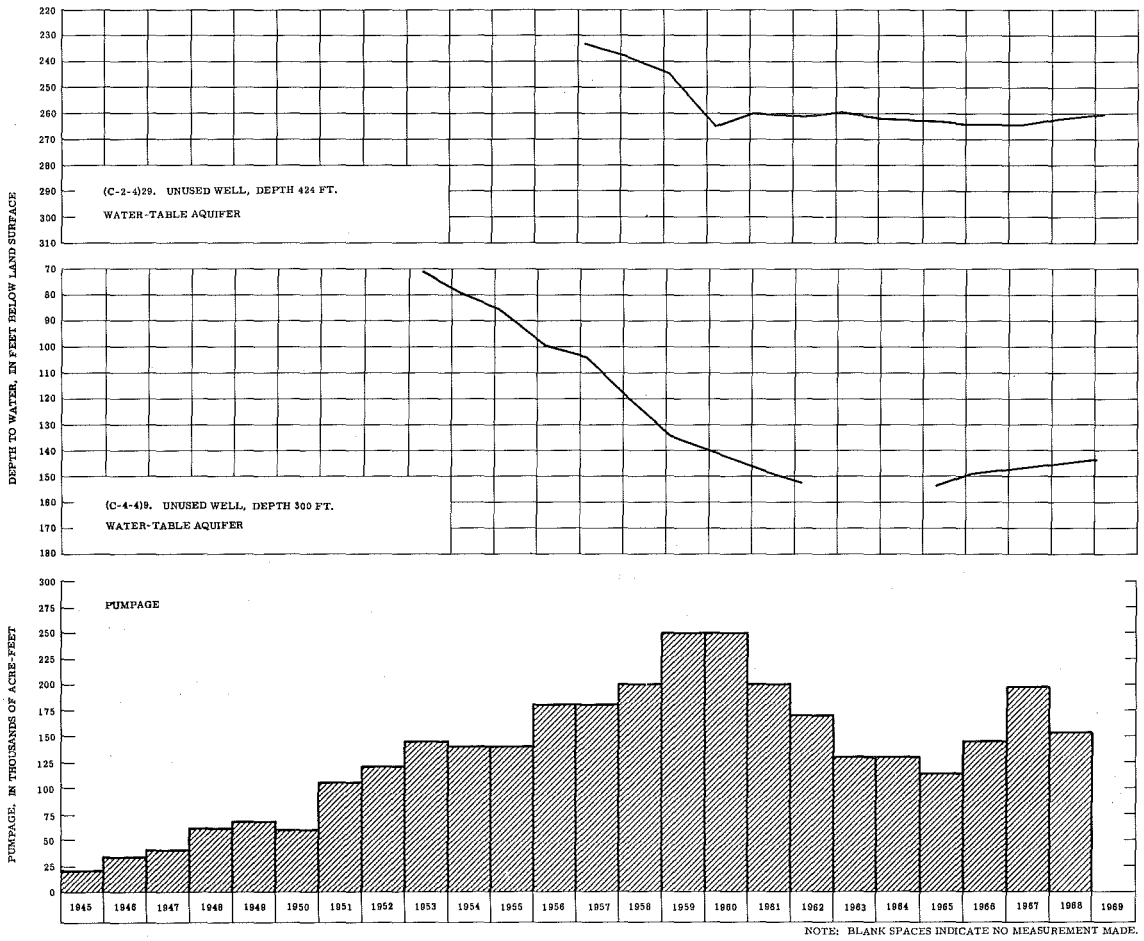


FIGURE 19.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE WATERMAN WASH AREA.



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 20.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE GILA BEND BASIN.

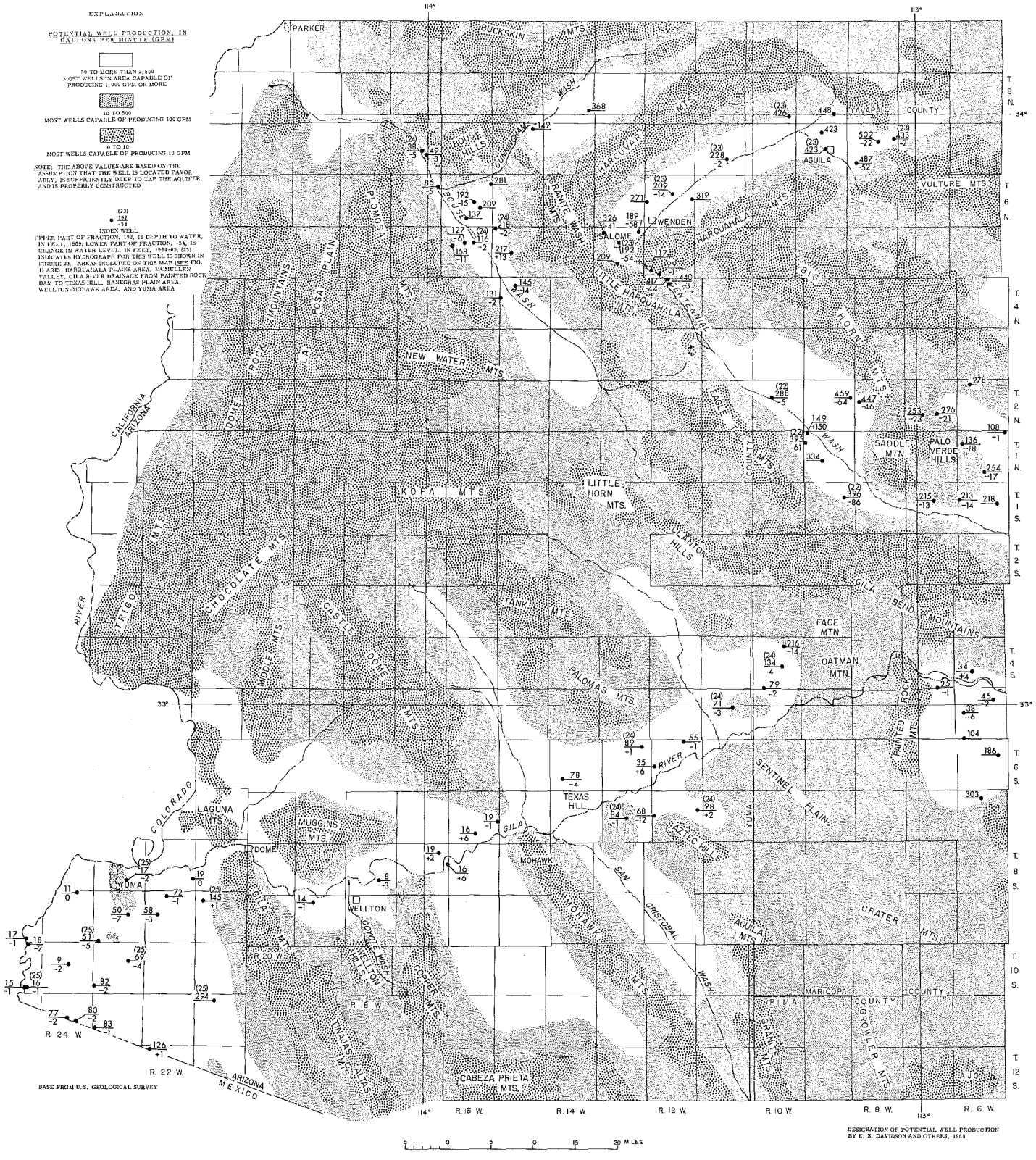


FIGURE 21.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE SOUTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

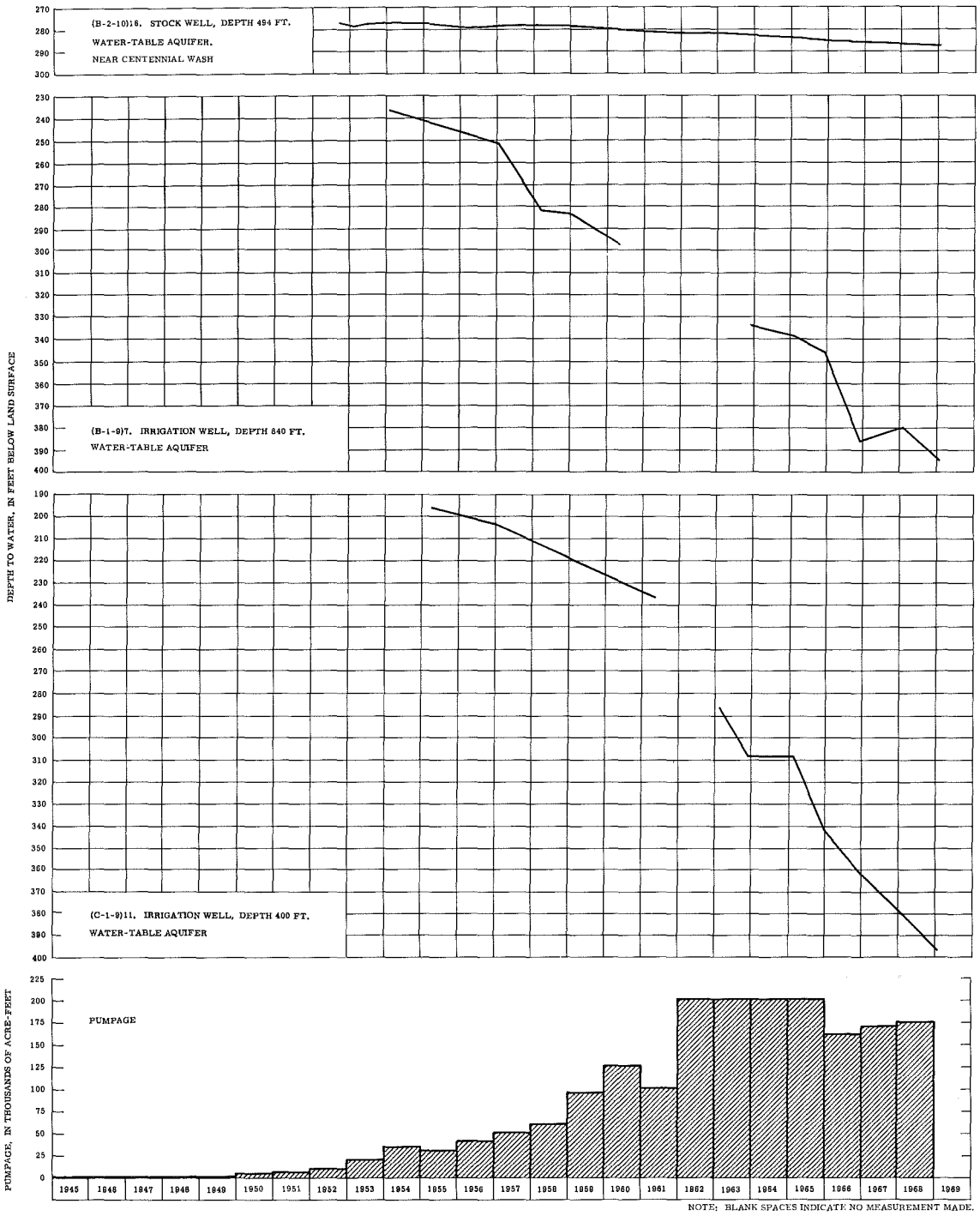


FIGURE 22.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE HARQUAHALA PLAINS AREA.

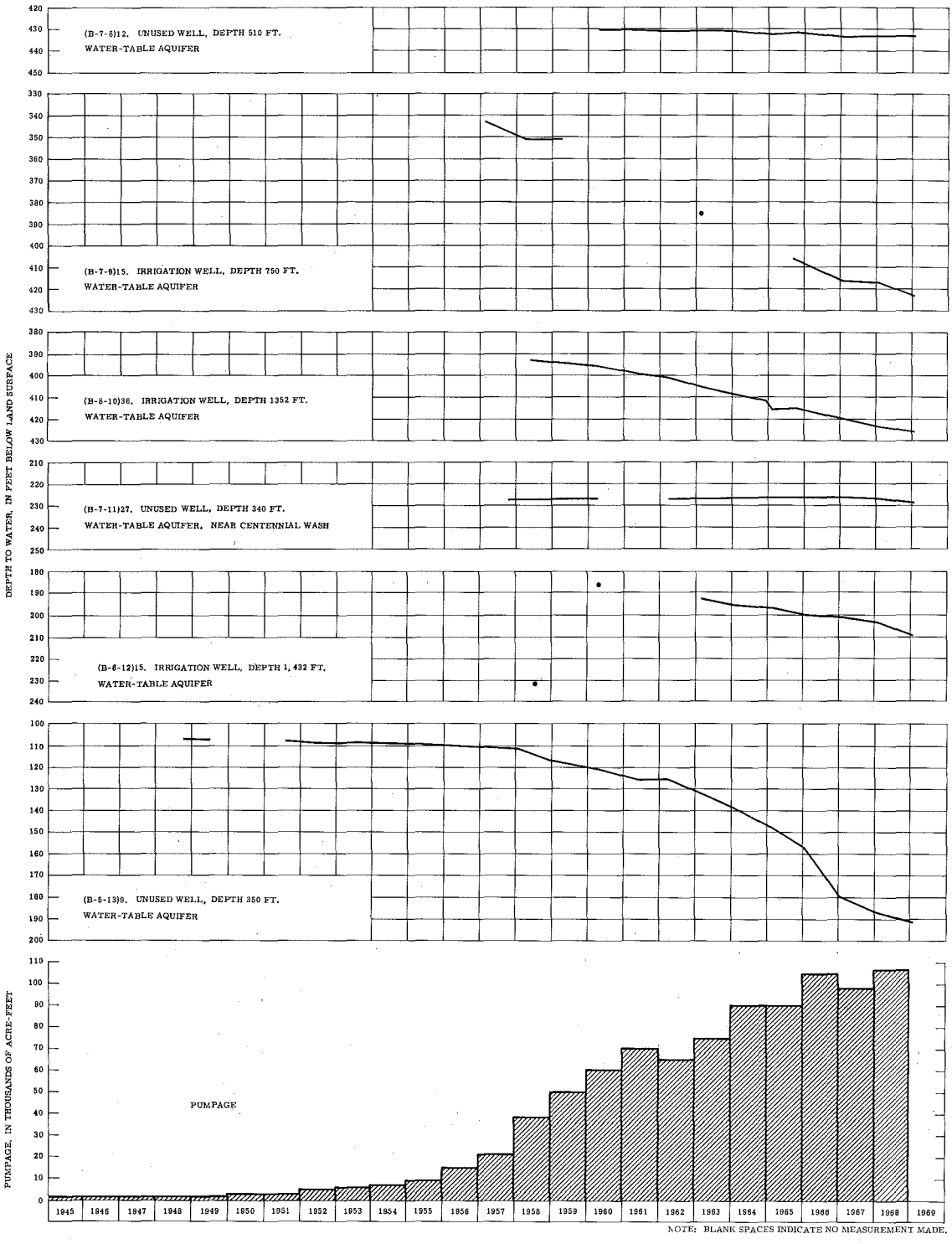


FIGURE 23.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN McMULLEN VALLEY.

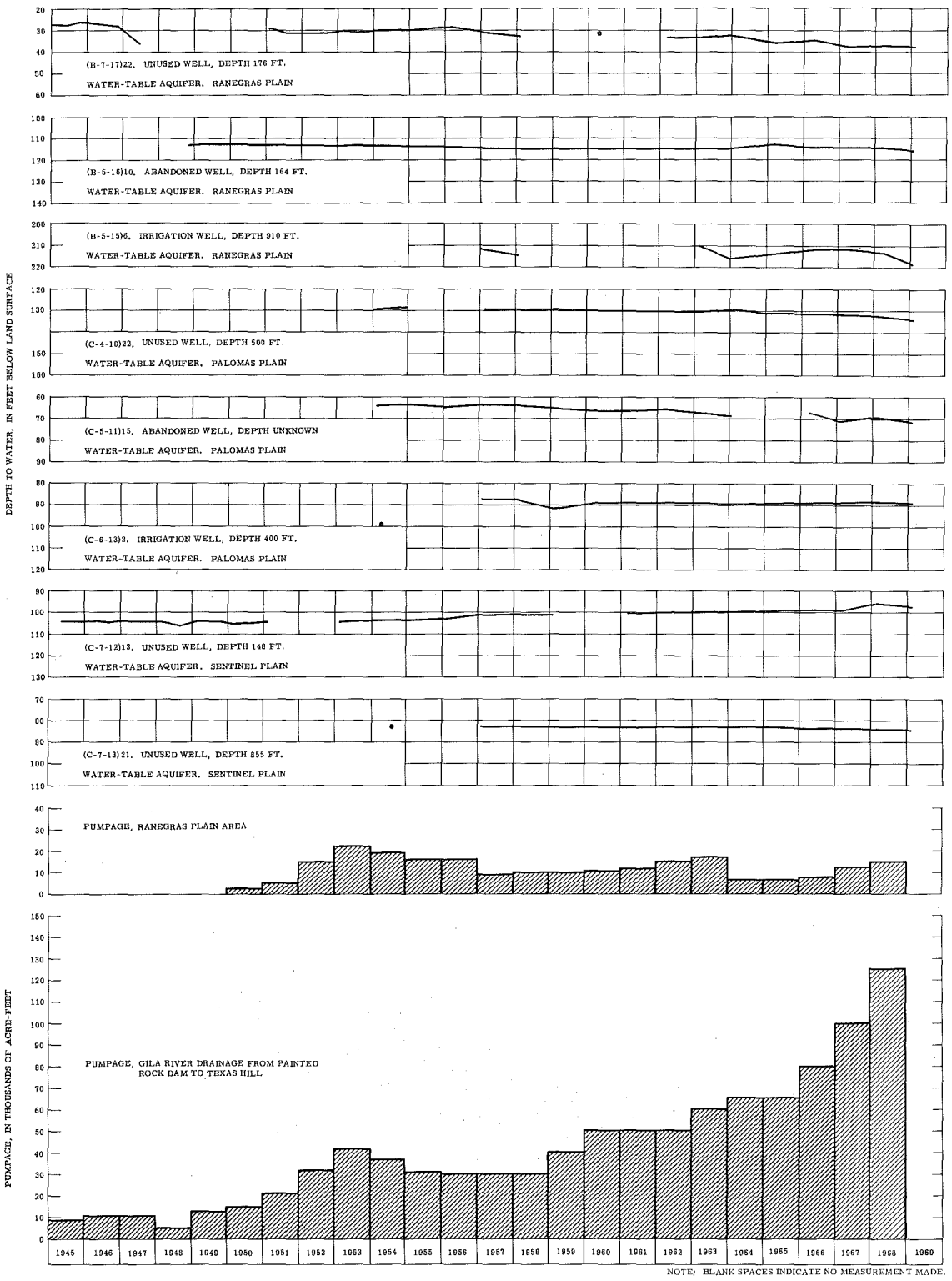


FIGURE 24.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE GILA RIVER DRAINAGE FROM PAINTED ROCK DAM TO TEXAS HILL AND IN THE RANEGRAS PLAIN AREA.

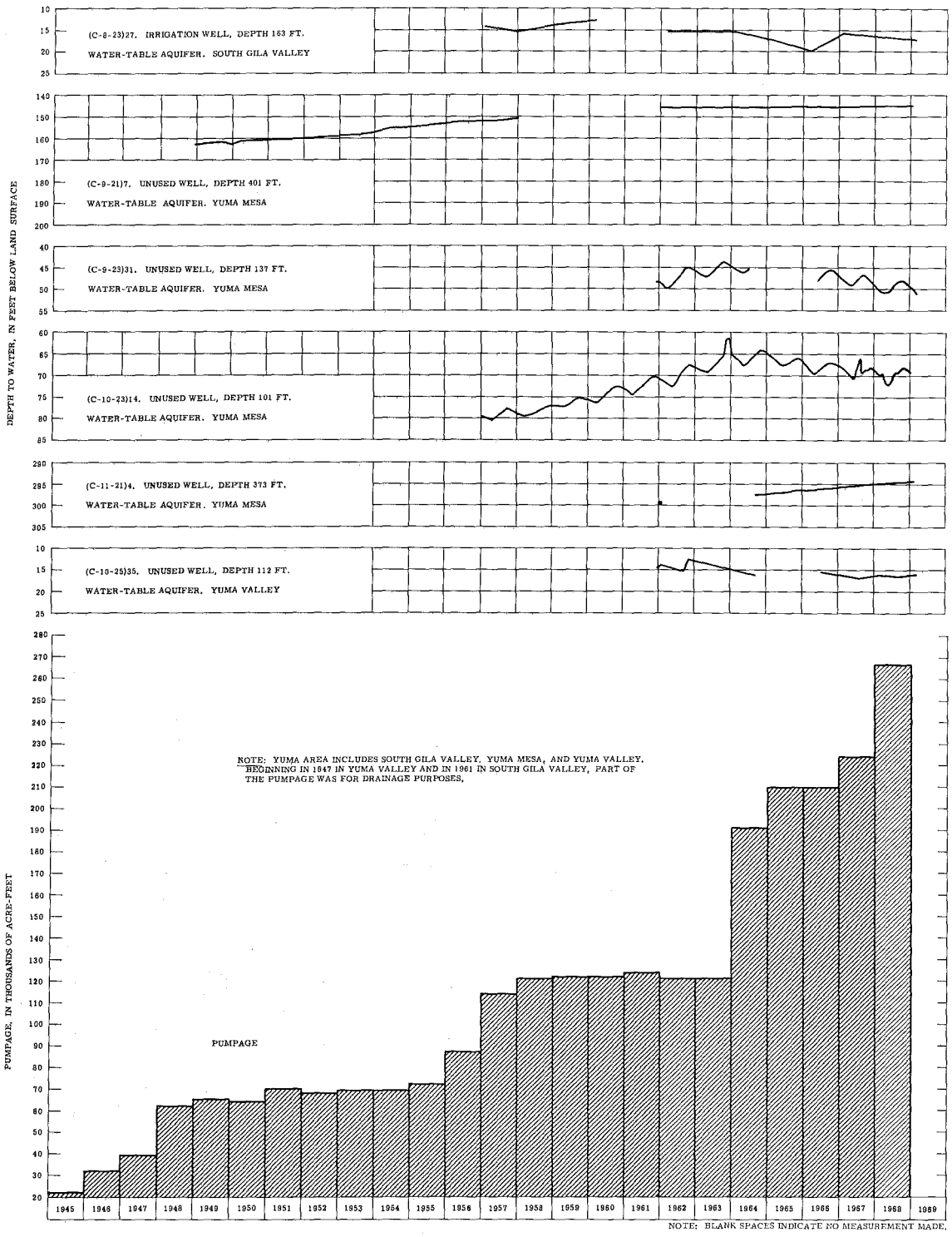


FIGURE 25.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE YUMA AREA.

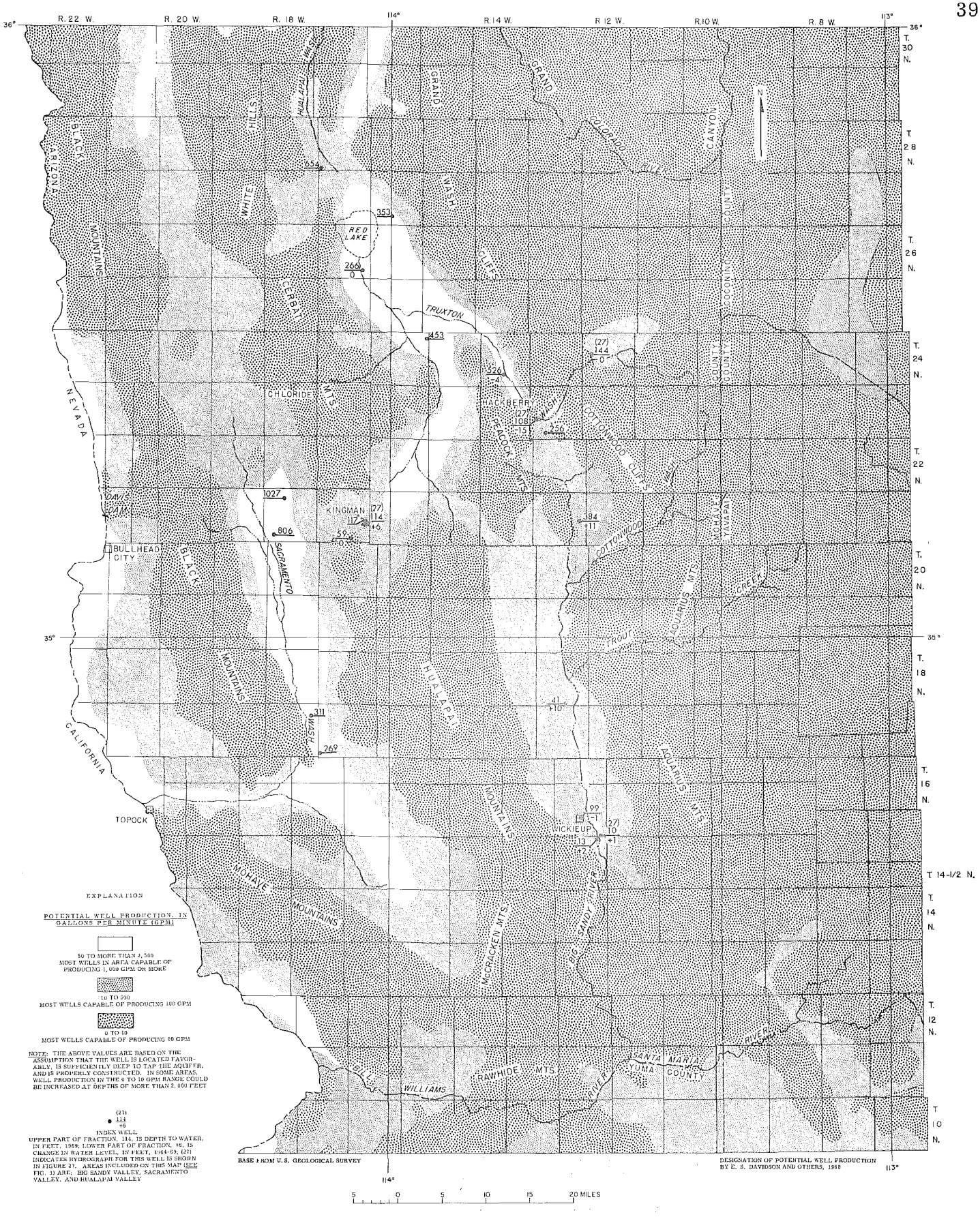
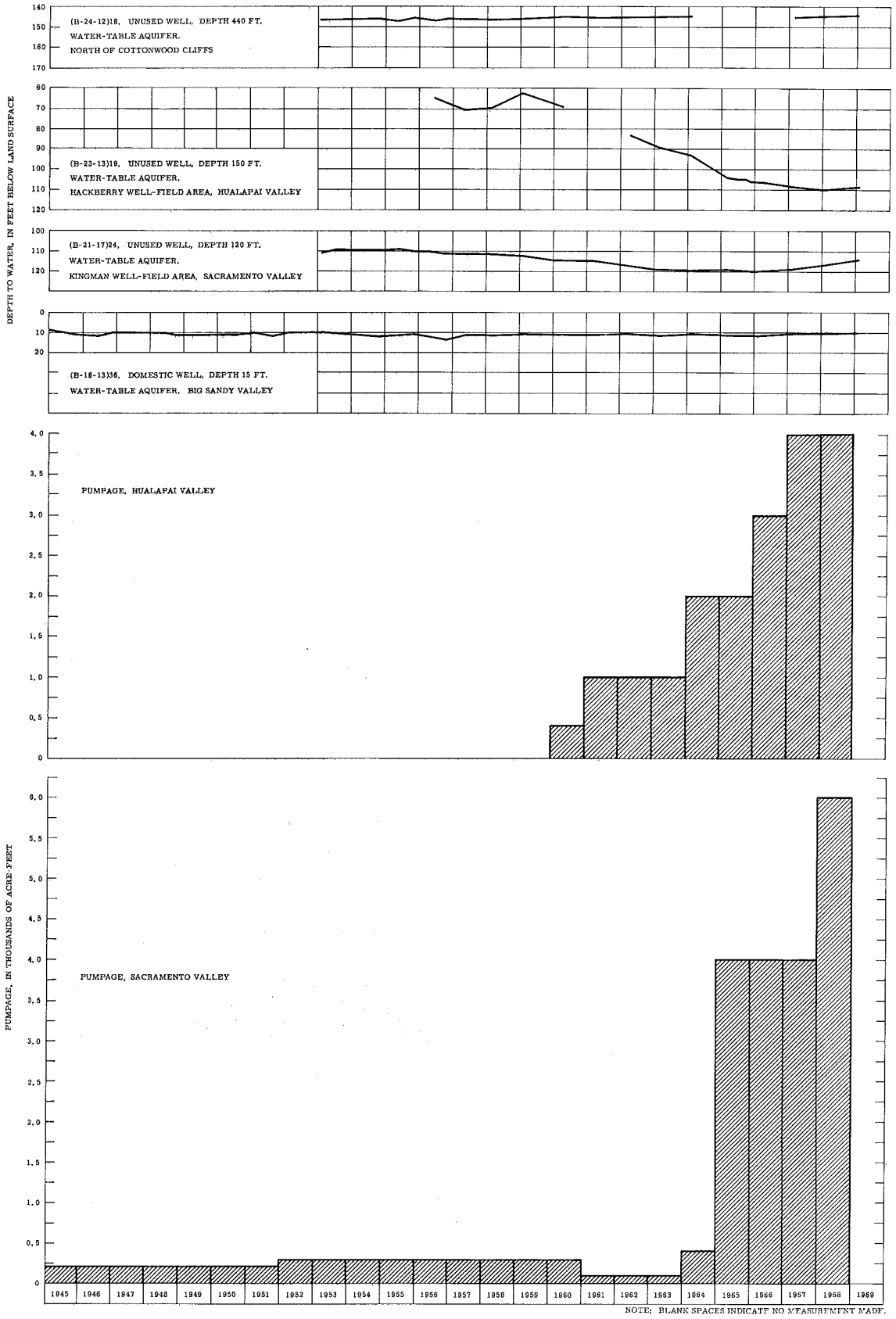
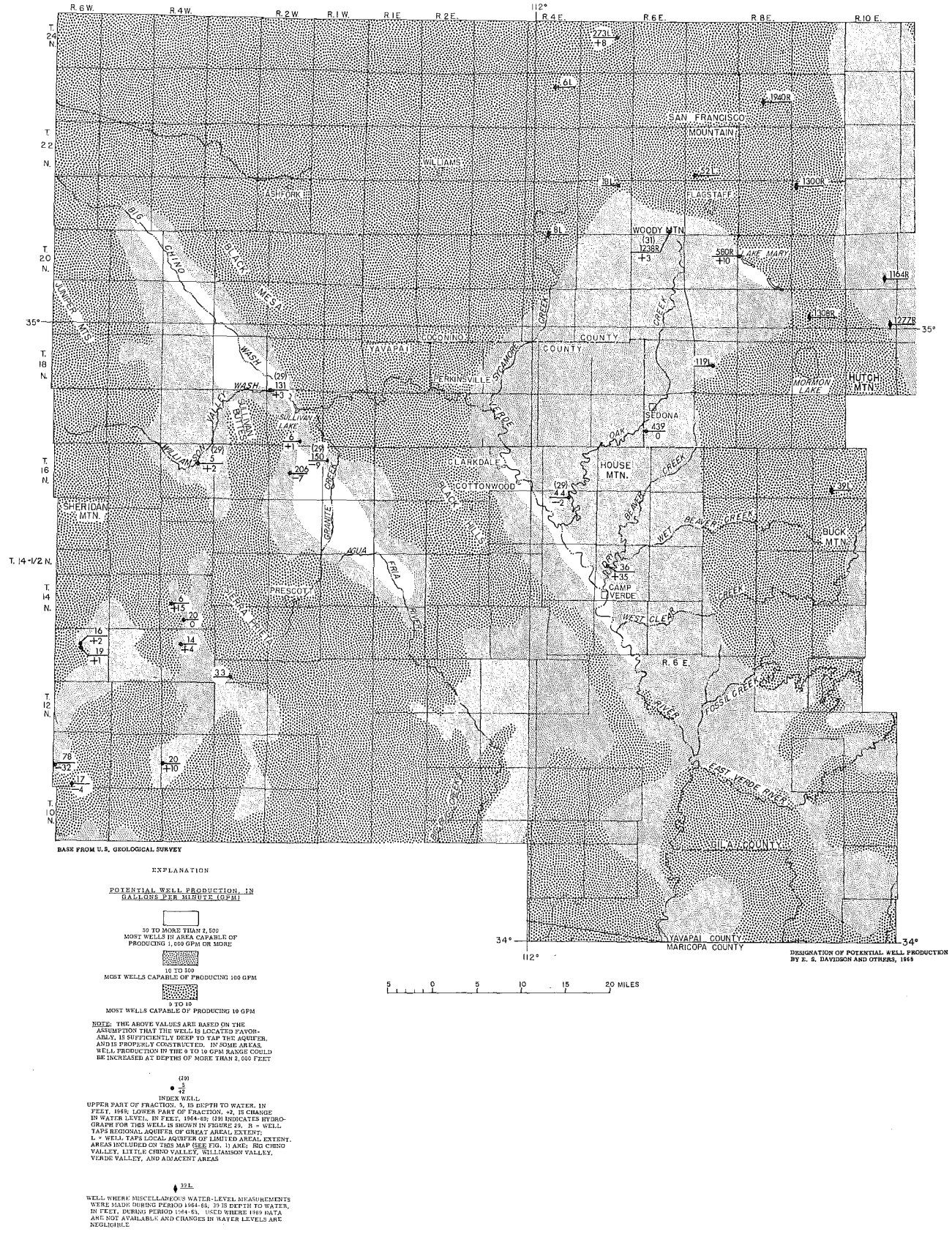


FIGURE 26.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE NORTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 27.--DEPTH TO WATER IN SELECTED WELLS IN THE NORTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE AND ESTIMATED ANNUAL PUMPAGE IN HUALAPAI AND SACRAMENTO VALLEYS.



BASE FROM U.S. GEOLOGICAL SURVEY

EXPLANATION

POTENTIAL WELL PRODUCTION, IN GALLONS PER MINUTE (GPM)

50 TO MORE THAN 2,500
MOST WELLS IN AREA CAPABLE OF PRODUCING 1,000 GPM OR MORE

10 TO 500
MOST WELLS CAPABLE OF PRODUCING 100 GPM

0 TO 10
MOST WELLS CAPABLE OF PRODUCING 10 GPM

NOTE: THE ABOVE VALUES ARE BASED ON THE ASSUMPTION THAT THE WELL IS LOCATED FAVORABLY, IS SUFFICIENTLY DEEP TO TAP THE AQUIFER, AND IS PROPERLY CONSTRUCTED. IN SOME AREAS, WELL PRODUCTION IN THE 0 TO 10 GPM RANGE COULD BE INCREASED AT DEPTHS OF MORE THAN 2,000 FEET

(29)
5/+2
INDEX WELL
UPPER PART OF FRACTION, 5, IS DEPTH TO WATER, IN FEET, 1969; LOWER PART OF FRACTION, +2, IS CHANGE IN WATER LEVEL, IN FEET, 1964-69; (29) INDICATES HYDROGRAPH FOR THIS WELL IS SHOWN IN FIGURE 29. R = WELL TAPS REGIONAL AQUIFER OF GREAT AREAL EXTENT; L = WELL TAPS LOCAL AQUIFER OF LIMITED AREAL EXTENT. AREAS INCLUDED ON THIS MAP (SEE FIG. 1) ARE: BIG CHINO VALLEY, LITTLE CHINO VALLEY, WILLIAMSON VALLEY, VERDE VALLEY, AND ADJACENT AREAS

191L
WELL WHERE MISCELLANEOUS WATER-LEVEL MEASUREMENTS WERE MADE DURING PERIOD 1964-69; 39 IS DEPTH TO WATER, IN FEET, DURING PERIOD 1964-69. USED WHERE 1969 DATA ARE NOT AVAILABLE AND CHANGES IN WATER LEVELS ARE NEGLIGIBLE

DESIGNATION OF POTENTIAL WELL PRODUCTION BY E. S. DAVIDSON AND OTHERS, 1966

FIGURE 28.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE WEST PART OF THE CENTRAL HIGHLANDS PROVINCE AND THE SOUTH-CENTRAL PART OF THE PLATEAU UPLANDS PROVINCE.

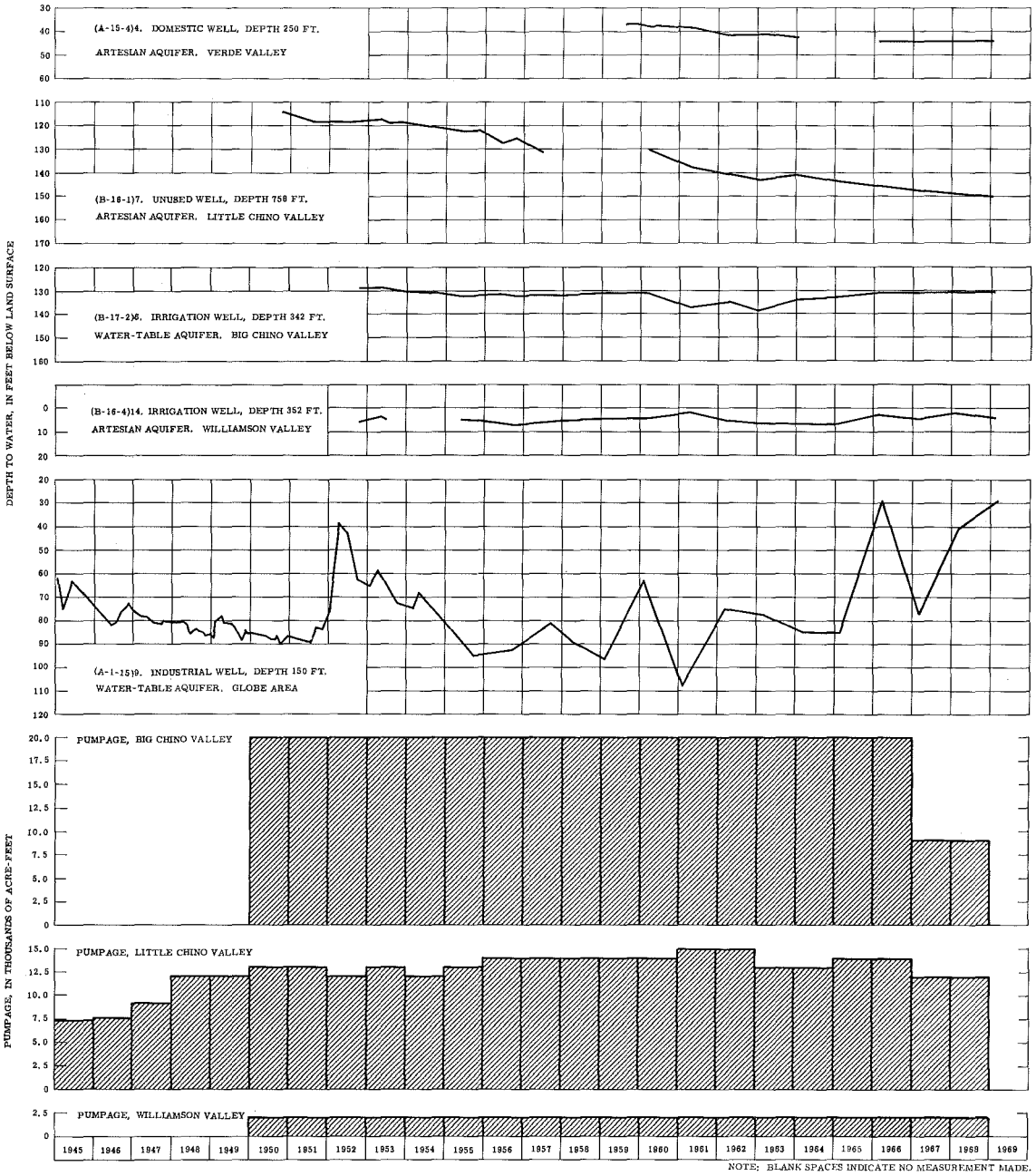


FIGURE 29.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SEVERAL AREAS IN THE CENTRAL HIGHLANDS PROVINCE.

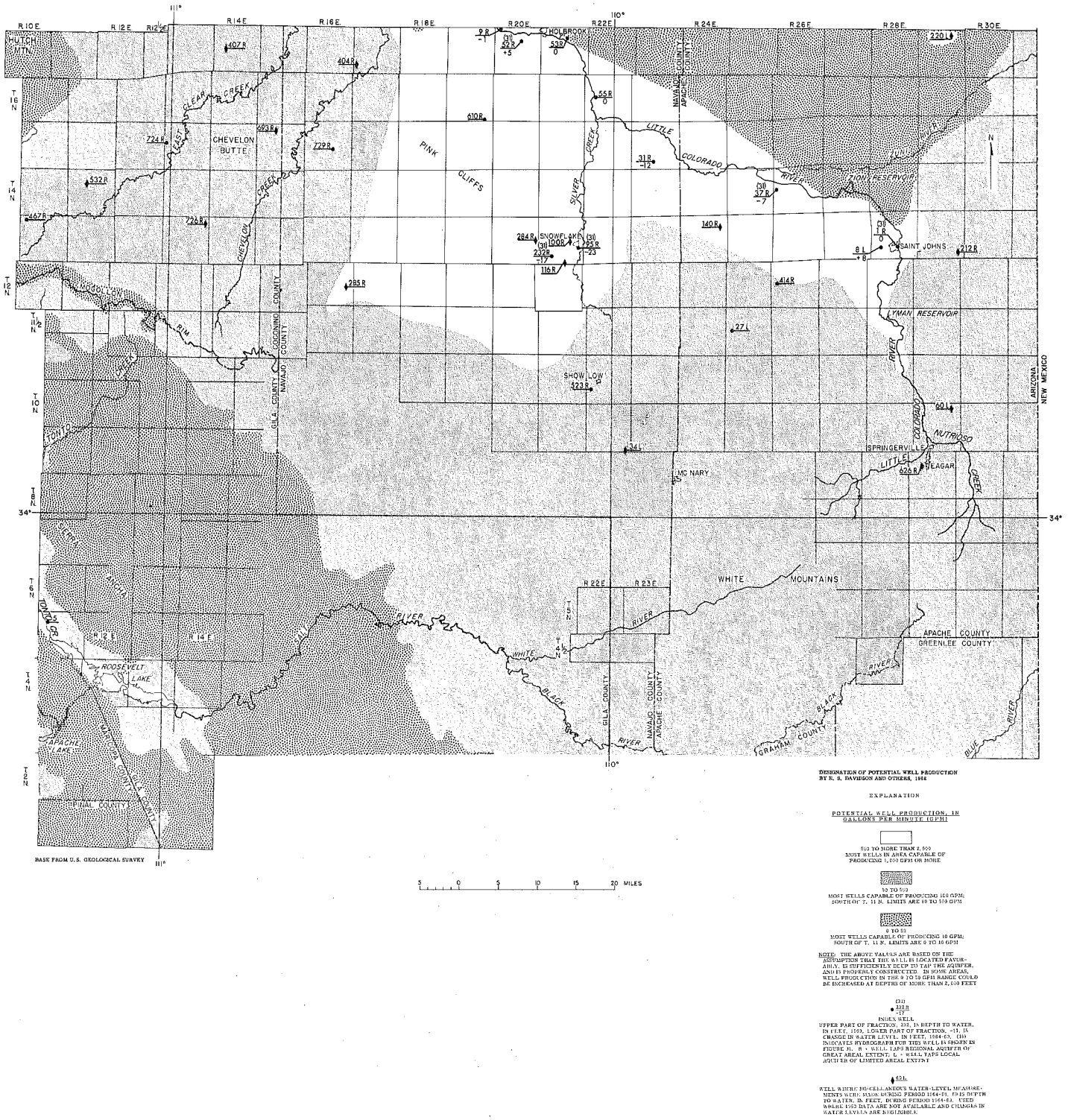
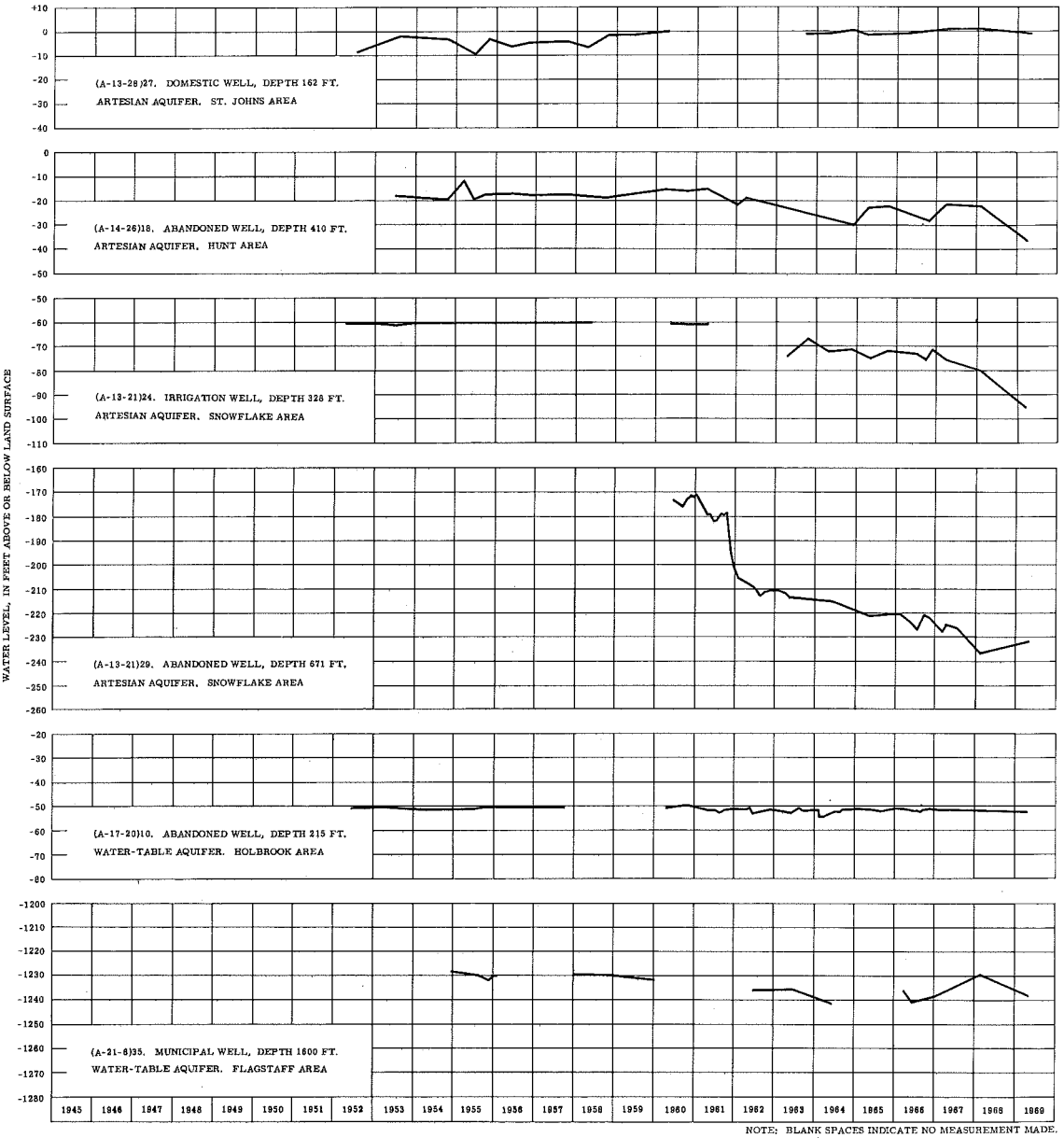
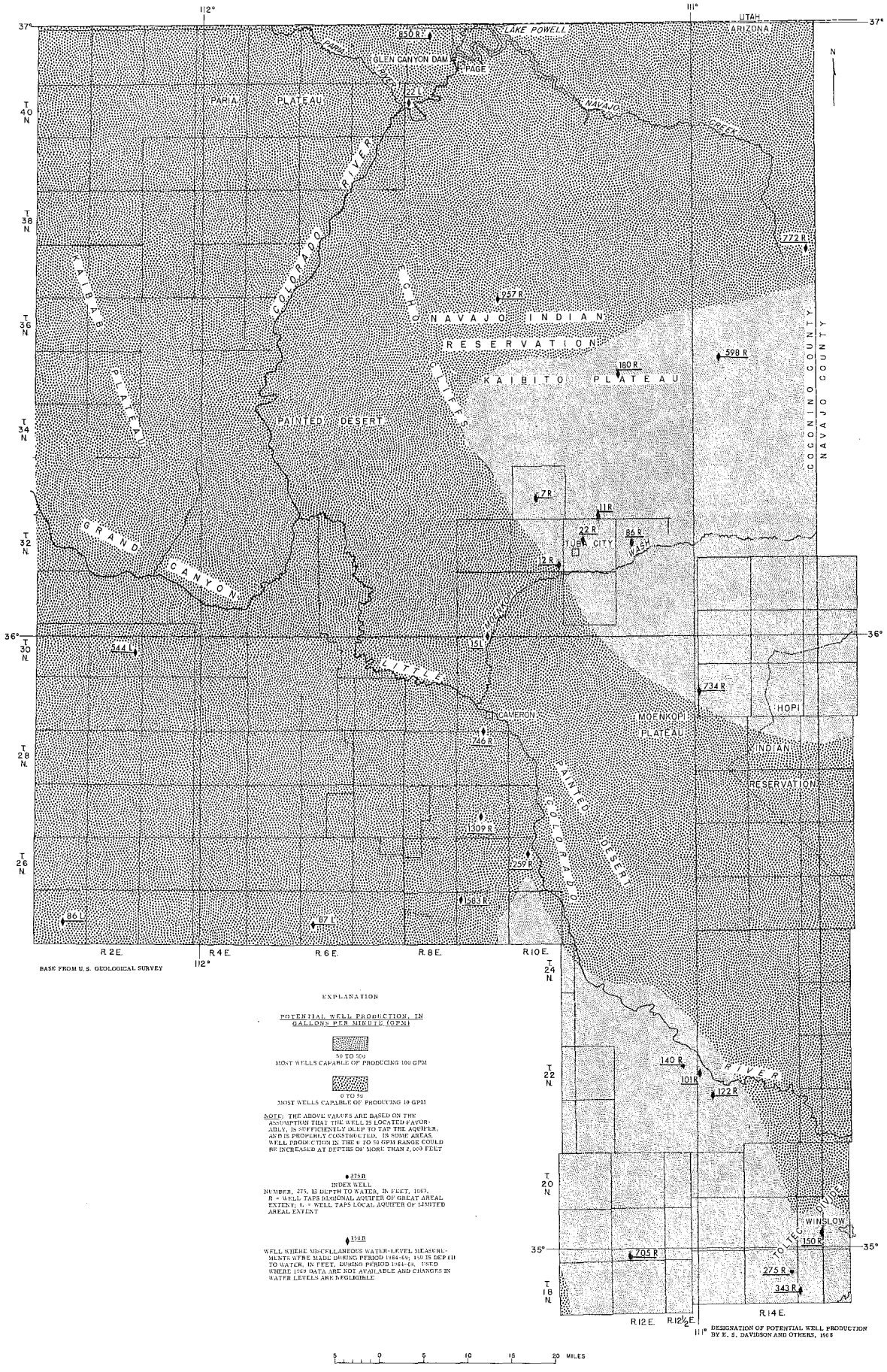


FIGURE 30. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1969, AND CHANGE IN WATER LEVEL, 1964-69, IN SELECTED WELLS IN THE EAST PART OF THE CENTRAL HIGHLANDS PROVINCE AND THE SOUTHEAST PART OF THE PLATEAU UPLANDS PROVINCE.



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE.

FIGURE 31.--DEPTH TO WATER IN SELECTED WELLS IN SEVERAL AREAS IN THE PLATEAU UPLANDS PROVINCE.



BASE FROM U. S. GEOLOGICAL SURVEY

EXPLANATION

POTENTIAL WELL PRODUCTION, IN GALLONS PER MINUTE (GPM)

50 TO 500
MOST WELLS CAPABLE OF PRODUCING 100 GPM

0 TO 50
MOST WELLS CAPABLE OF PRODUCING 10 GPM

NOTE: THE ABOVE VALUES ARE BASED ON THE ASSUMPTION THAT THE WELL IS LOCATED FAVORABLY, IS SUFFICIENTLY DEEP TO TAP THE AQUIFER, AND IS PROPERLY CONSTRUCTED. IN SOME AREAS, WELL PRODUCTION IN THE 0 TO 50 GPM RANGE COULD BE INCREASED AT DEPTHS OF MORE THAN 2,000 FEET

• 275 R
INDEX WELL
NUMBER, 275, IS DEPTH TO WATER, IN FEET, 1969.
R = WELL TAPS REGIONAL AQUIFER OF GREAT AREAL EXTENT; L = WELL TAPS LOCAL AQUIFER OF LIMITED AREAL EXTENT

150 R
WELL WHERE MISCELLANEOUS WATER-LEVEL MEASUREMENTS WERE MADE DURING PERIOD 1964-69; 150 IS DEPTH TO WATER, IN FEET, DURING PERIOD 1964-68, USED WHERE 1969 DATA ARE NOT AVAILABLE AND CHANGES IN WATER LEVELS ARE NEGLIGIBLE

DESIGNATION OF POTENTIAL WELL PRODUCTION BY E. S. DAVIDSON AND OTHERS, 1968

FIGURE 32.--POTENTIAL WELL PRODUCTION AND DEPTH TO WATER IN SELECTED WELLS IN THE NORTH-CENTRAL PART OF THE PLATEAU UPLANDS PROVINCE.

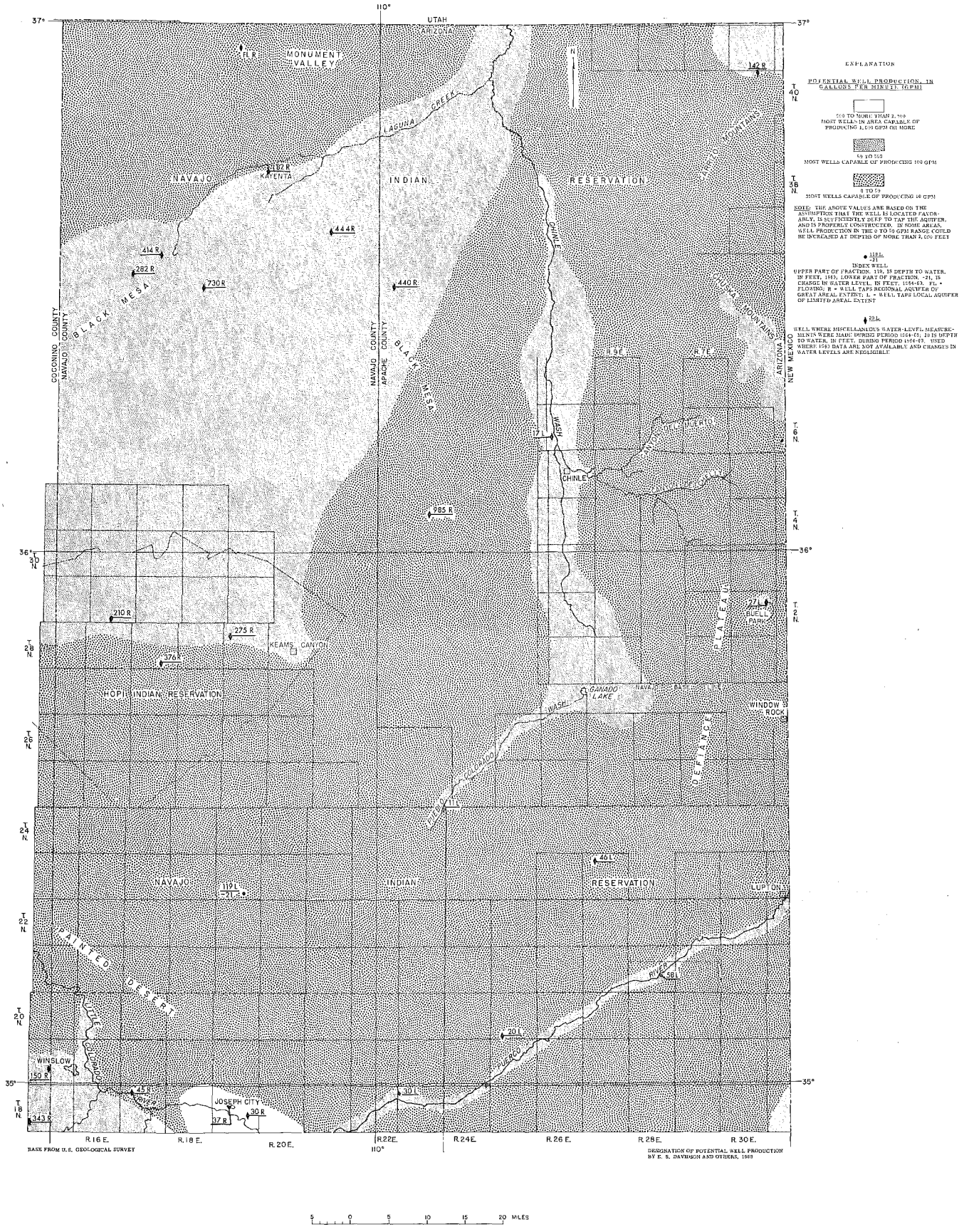


FIGURE 33. --POTENTIAL WELL PRODUCTION AND DEPTH TO WATER IN SELECTED WELLS IN THE NORTHEAST PART OF THE PLATEAU UPLANDS PROVINCE.