

ARIZONA STATE LAND DEPARTMENT

ANDREW L. BETTWY, COMMISSIONER



A N N U A L R E P O R T O N G R O U N D
W A T E R I N A R I Z O N A
S P R I N G 1 9 6 9 T O S P R I N G 1 9 7 0

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

*Water Rights Adjudication Team
Civil Division
Attorney General's Office:

COMPILED BY THE GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR

PHOENIX, ARIZONA
NOVEMBER 1970



	Page
Introduction- - - - -	1
Scope of the Federal-State cooperative ground-water program - - - - -	4
Collection and analysis of basic hydrologic data- - - - -	4
Comprehensive areal ground-water investigations - - - - -	4
Research programs - - - - -	6
Programs in cooperation with other agencies - - - - -	6
Current publications of the Arizona district - - - - -	7
Summary of ground-water conditions - - - - -	8
Basin and Range lowlands province - - - - -	11
Central highlands province- - - - -	11
Plateau uplands province - - - - -	12

ILLUSTRATIONS

	Page
Figure 1. Map showing areas for which ground-water data are given- - -	2
2. Diagram of well-numbering system in Arizona - - - - -	3
3. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the southeast part of the Basin and Range lowlands province - - -	13
4. Graphs showing depth to water in selected wells and estimated annual pumpage in the Duncan and Safford basins - - - - -	14
5. Graphs showing depth to water in selected wells and estimated annual pumpage in San Simon basin - - - - -	15

	Page
Figure 6. Graphs showing depth to water in selected wells in Willcox basin and Aravaipa Valley and estimated annual pumpage in Willcox basin- - - - -	17
7. Graphs showing depth to water in selected wells and estimated annual pumpage in Douglas basin- - - - -	19
8. Graphs showing depth to water in selected wells in the San Pedro River valley - - - - -	20
9. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the south - central part of the Basin and Range lowlands province - - - - -	21
10. Graphs showing depth to water in selected wells and estimated annual pumpage in the upper Santa Cruz basin - - - - -	22
11. Graphs showing depth to water in selected wells in Altar and Avra Valleys and estimated annual pumpage in Avra Valley - - - - -	24
12. Graphs showing cumulative average change in water level by areas and estimated annual pumpage in the lower Santa Cruz basin - - - - -	26
13. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the central part of the Basin and Range lowlands province - - -	27
14. Graphs showing 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 - - - - -	28
15. Graphs showing 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 - - - - -	29
16. Graphs showing depth to water in selected wells and estimated annual pumpage in the Waterman Wash area - - - - -	30

CONTENTS

	Page
Figure 17. Graphs showing depth to water in selected wells and estimated annual pumpage in the Gila Bend basin - - - - -	31
18. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the southwest part of the Basin and Range lowlands province - -	32
19. Graphs showing depth to water in selected wells and estimated annual pumpage in the Harquahala Plains area - - - - -	33
20. Graphs showing depth to water in selected wells and estimated annual pumpage in McMullen Valley - - - - -	34
21. Graphs showing 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 - - - - -	35
22. Graphs showing depth to water in selected wells and estimated annual pumpage in the Yuma area - - - - -	36
23. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the northwest part of the Basin and Range lowlands province - -	37
24. Graphs showing 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 - - - - -	38
25. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the west part of the Central highlands province and the south-central part of the Plateau uplands province - - - - -	39
26. Graphs showing depth to water in selected wells and estimated annual pumpage in several areas in the Central highlands province - - - - -	40
27. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the east part of the Central highlands province and the southeast part of the Plateau uplands province - - - - -	41

	Page
Figure 28. Graphs showing depth to water in selected wells in several areas in the Plateau uplands province - - - - -	42
29. Map showing potential well production and depth to water in selected wells in the north-central part of the Plateau uplands province - - - - -	43
30. Map showing potential well production, depth to water, 1970, and change in water level, 1965-70, in selected wells in the northeast part of the Plateau uplands province- - - - -	44

TABLES

	Page
Table 1. Estimated ground-water pumpage in Arizona, by areas- - - - -	9

ANNUAL REPORT ON GROUND WATER IN ARIZONA, SPRING 1969 TO SPRING 1970

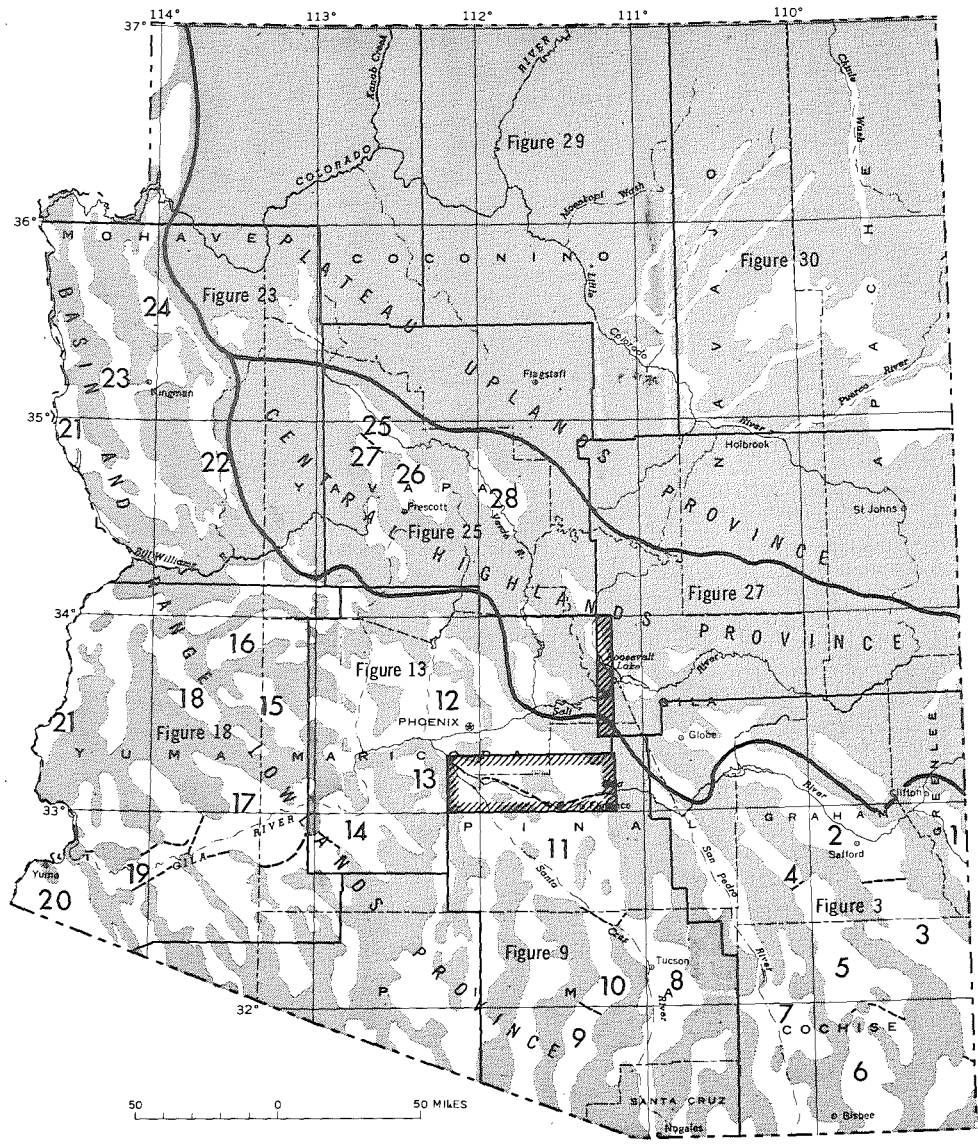
Prepared under the direction of H. M. Babcock,
District Chief, Arizona District, Water Resources Division

INTRODUCTION

In arid and semiarid regions such as Arizona, the availability of adequate water supplies has a greater influence on the overall economy than any other factor. Agriculture is greatly dependent on irrigation because rainfall is inadequate for raising crops. In parts of Arizona some surface water is available for use, but the amount is inadequate to meet the demand; therefore, most of the water supply is pumped from the ground - water reservoirs. A comprehensive knowledge of all the factors that control the ground-water reservoir and of the effects of pumping large amounts of water is necessary for proper management of this valuable resource.

Information on the ground - water resources of Arizona is obtained under the continuing program that was started in 1939. The program, which is conducted by the U. S. Geological Survey in cooperation with the Arizona State Land Department, includes the collection and analysis of geologic and hydrologic data necessary to evaluate the ground-water resources in the State. The program is conducted 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 1970, (2) change in water levels in selected wells from 1965 to 1970, 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 shown on figure 2.



EXPLANATION

BASIN AND RANGE LOWLANDS PROVINCE

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

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

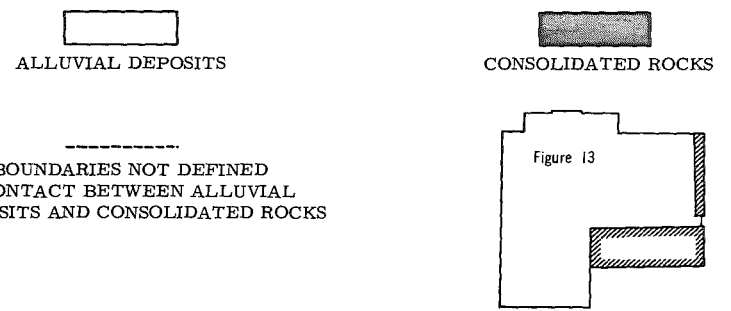
CENTRAL HIGHLANDS PROVINCE

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 | 27. WILLIAMSON VALLEY |
| 26. LITTLE CHINO VALLEY | 28. VERDE VALLEY |

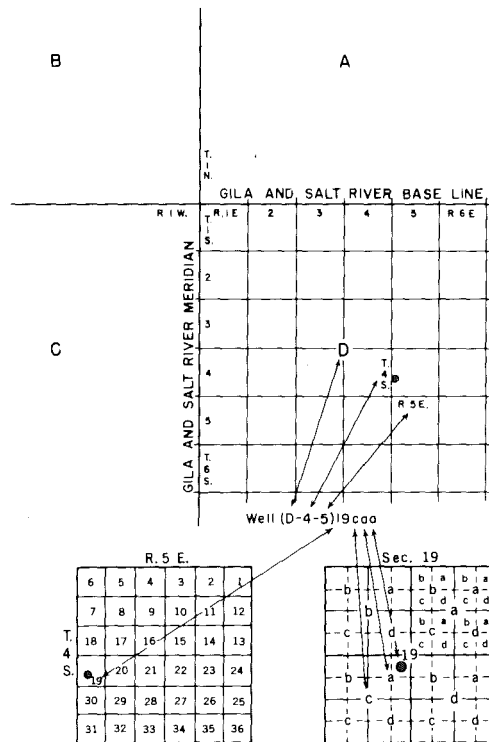
PLATEAU UPLANDS PROVINCE

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



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.

Scope of the Federal-State Cooperative Ground-Water Program

The Federal - State cooperative ground - water program 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 program 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 recently completed wells. The data collected annually are sufficient to monitor any significant changes in the ground-water regimen. Water-level measurements are made in about 860 wells, and the discharge from several hundred wells is measured each year. 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 program is set up so that individual basins will receive periodic intensive study as well as annual cursory examination. The number of water-level and discharge measurements made and the amount of other data collected in any given year depend on the basin selected for intensive study.

The "Annual Report on Ground Water in Arizona" is a result of the statewide ground-water program. Basins for which reports currently are in preparation include: Harquahala Plains, San Pedro River valley, lower Hassayampa area, and the Joseph City area. Reports for McMullen Valley and Ranegras Plain were published during the year (see section entitled "Current Publications of the Arizona District"). These reports, as well as the "Annual Report on Ground Water in Arizona," are published by the State Land Department, and copies are available to the public.

Comprehensive areal ground-water investigations. --Areal studies are undertaken to develop the information and understanding required for water management in specific areas. The areas for which studies are currently in progress under the Federal-State ground-water program are discussed below.

Big Sandy Valley area: The principal objective of the study is to determine how the geology controls the occurrence, movement, and chemical

quality of the ground water and surface water in the Big Sandy Valley. Geologic, hydrologic, geochemical, and geophysical data have been collected and analyzed, and the report for this investigation is in preparation.

Hualapai and Sacramento Valleys: The study was undertaken to determine the quantity and quality of surface water and ground water in the Hualapai and Sacramento Valleys. The lithologic characteristics and thickness of the water-bearing formations were determined by areal mapping and geophysical exploration. Streamflow measurements were made to determine the surface-water inflow to the areas. Well - performance data were used to determine the water - bearing properties of the aquifers, and chemical analyses were made of the ground water and surface water to determine the chemical quality. The results of this study are to be published in U.S. Geological Survey Water-Supply Paper 1899-H (in press).

Western part of Salt River Valley: The western part of the Salt River Valley is an area of major ground-water withdrawal for irrigation. The objectives of the study were to determine the rate of ground - water recharge, the amount of ground water in storage, the rate of water-level decline, and the effects of present withdrawals on quality of water with respect to time. The report for this project is in preparation.

Southern Coconino County: The study was undertaken in order to provide a comprehensive inventory of the water resources of the area. The inventory included estimates of (1) the amount of ground water in storage; (2) the variations in chemical quality of water in the aquifers; (3) the recharge-discharge relations in the aquifer system; and (4) the rainfall-runoff relations in the drainage basins. The report for this project is in preparation.

Hydrology of alluvial basins: The study was undertaken to provide an understanding of the factors that control the regional hydrologic systems of the State. Investigations have been made of the distribution and thickness of the water-yielding alluvial deposits using the data obtained from drillers' logs of wells in the State. The subsurface information obtained from these logs and the data obtained from surface geologic and hydrologic investigations have been used to determine the configuration of the alluvial basins and buried ridges, the extent of the main water-yielding alluvial deposits, and the hydrologic characteristics of the alluvial deposits. The report for this project is in preparation.

Comprehensive areal investigations conducted in cooperation with other agencies also benefit the State. Studies are currently in progress for the following areas: Tucson basin, Safford basin, Tonto basin, the Lake Mead area, the lower Colorado River region, and the Gila River Indian Reservation.

Research programs. --The research studies of the Water Resources Division in Arizona are directed toward acquiring knowledge of the hydrology of arid and semiarid 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 that are supported by the Federal-State cooperative program are discussed below.

Effects of vegetation manipulation on surface runoff—Sycamore Creek: The major objective of this study is to provide an evaluation of the effects of watershed treatment upon water - yield and sediment - yield characteristics from the East Fork Sycamore Creek watershed. The study involves measurements of precipitation, runoff, and sediment movement. Runoff from the treated watershed will be compared with the runoff from an adjacent untreated watershed. A progress report for this investigation is in preparation.

Potential evapotranspiration losses of the Agua Fria River drainage area: The study was undertaken to estimate the magnitude of increased transitory losses in the Agua Fria River drainage, assuming that an increase in runoff will result from vegetation modification to be made in the area. The estimates were based on the relation between water use by mesquite, grasses, and bare soils and the depth to ground water. A report for this study is in preparation.

Electrical-analog analysis of the Tuba City area: The physical characteristics of the aquifer in the Tuba City area were built into an electrical-analog model in order to ascertain the reaction of the aquifer to increased ground-water withdrawal and recharge. The model was used to predict the effects of increases in withdrawal rates on the ground-water system. A report for this study is in preparation.

Programs in Cooperation with Other Agencies

In 1969-70 ground-water studies were being conducted in cooperation with the following agencies:

City of Flagstaff
City of Tucson
Navajo Tribal Council
Navajo Tribal Utility Authority

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, 1969, through June 30, 1970.

Analysis of the ground-water system by electrical-analog model, Avra Valley, Pima and Pinal Counties, Arizona, by Otto Moosburner: U.S. Geol. Survey open-file report, 1969. 2 sheets.

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, U.S. Geological Survey: Arizona State Land Dept. Water-Resources Rept. 42, December 1969. 46 p., 33 figs., 1 table.

Ground-water conditions in McMullen Valley, Maricopa, Yuma, and Yavapai Counties, Arizona, by P. C. Briggs: Arizona State Land Dept. Water-Resources Rept. 40, July 1969. 31 p., 9 figs., 4 tables.

Ground-water conditions in the Ranegras Plain, Yuma County, Arizona, by P. C. Briggs: Arizona State Land Dept. Water-Resources Rept. 41, September 1969. 28 p., 7 figs., 4 tables.

Infiltration of streamflow in the main arroyos in the Tucson basin, Arizona [abs.], by D. E. Burkham: Tucson, Am. Assoc. Advancement Sci., 1969. 2 p.

The behavior of straight open channels with movable beds, by Thomas Maddock, Jr.: U.S. Geol. Survey Prof. Paper 622-A, 1969. 70 p., 52 figs., 3 tables.

Water, population pressure, and ancient Indian migrations, by Deric O'Bryan, M. E. Cooley, and T. C. Winter: Am. Geophys. Union Trans., v. 50, no. 6, 1969. p. 438-442, 2 figs.

- Water resources data for Arizona, 1968—Part 1. Surface water records, by U. S. Geological Survey: U. S. Geol. Survey open-file report, 1969. 251 p. , 4 figs.
- Water resources investigations in Arizona, 1969, by U.S. Geological Survey: U. S. Geol. Survey folder, October 1969.
- Depletion of streamflow by infiltration in the main channels of the Tucson basin, Arizona, by D. E. Burkham: U. S. Geol. Survey open - file report, 1970. 80 p. , 11 figs. , 7 tables.
- Error analysis of streamflow data for an alluvial stream, by D. E. Burkham and D. R. Dawdy: U.S. Geol. Survey Prof. Paper 655-C, 1970. 13 p. , 15 figs. , 3 tables.
- Geohydrology and water resources of the Tucson basin, Arizona, by E. S. Davidson: U.S. Geol. Survey open-file report, 1970. 228 p. , 12 figs. , 3 tables.
- Objectives, methods, and environment—Gila River Phreatophyte Project, Graham County, Arizona, by R. C. Culler and others: U. S. Geol. Survey Prof. Paper 655-A, 1970. 25 p. , 10 figs.
- Precipitation, streamflow, and major floods at selected sites in the Gila River drainage basin above Coolidge Dam, Arizona, by D. E. Burkham: U. S. Geol. Survey Prof. Paper 655-B, 1970. 33 p. , 23 figs. , 5 tables.

SUMMARY OF GROUND-WATER CONDITIONS

Nearly two-thirds of Arizona's water supply comes from the ground-water reservoirs. Although municipal and industrial water uses are increasing, the greatest use is still for irrigation. For the 17th consecutive year, the annual use of ground water in Arizona exceeded 4 million acre-feet. In 1969 nearly 5 million acre-feet of ground water was withdrawn in the State. Table 1 shows the amount of water pumped in each of the major developed areas in 1969 and the accumulated total since the beginning of record. Through 1969, more than 129 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 the current ground-water conditions in each of the three provinces are discussed separately in the following sections.

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	
	1969	Accumulated total through 1969
Duncan basin	25	593
Safford basin	140	2,648
San Simon basin	78	1,187
Willcox basin	291	3,484
Douglas basin	104	1,465
San Pedro River valley	79	<u>1/</u> 278
Upper Santa Cruz basin	236	5,653
Avra Valley	155	2,467
Lower Santa Cruz basin	1,043	<u>2/</u> 32,155
Salt River Valley	1,600	61,681
Waterman Wash area	60	838
Gila Bend basin	166	3,502
Harquahala Plains area	163	2,054
McMullen Valley	117	1,042
Gila River drainage from Painted Rock Dam to Texas Hill	120	1,137
Ranegras Plain area	16	242
Wellton-Mohawk area	<u>3/</u> 218	2,688
Yuma area <u>4/</u>	231	<u>5/</u> 3,084
Colorado River flood plain from Davis Dam to Imperial Dam	12	144

See footnotes at end of table.

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

Area	Pumpage, in thousands of acre-feet	
	1969	Accumulated total through 1969
Sacramento Valley	5	23
Hualapai Valley	4	22
Big Chino Valley	9	367
Little Chino Valley	12	349
Williamson Valley	2	40
Other areas	100	1,915
Total	4,986	^{6/} 129,058

^{1/} Pumpage for San Pedro River valley was not computed prior to 1966. Thus, accumulated total is for 1966-69 only. Estimated pumpage before 1966 is included under other areas.

^{2/} Total through 1968 is 31,112 (figure published in previous report was in error).

^{3/} Withdrawal for drainage purposes only.

^{4/} 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.

^{5/} Total through 1968 is 2,853 (figure published in previous report was in error).

^{6/} Total through 1968 is 124,072 (figure published in previous report was in error).

$$\frac{129,058,000 \text{ AF}}{1,222,000 \text{ ACRES} \times 17 \text{ yr}} = 6.2 \text{ FT/yr}$$

Irrigation withdrawal 4,537,000 AF

Cotton + Grains

$$\frac{786,000 \text{ acres} = 2,917,000 \text{ A.F.}}{1,222,000}$$

Another way

$$786,000 \times 4.0 \text{ AF} = 3,144,000$$

Net 1,620,000

Net 1,393,000

Basin and Range Lowlands Province

The Basin and Range lowlands province is the most highly developed of the three water provinces; it contains more than 90 percent of the cultivated land and more than 80 percent of the population, although it comprises only about 45 percent of the State. Large amounts of ground water are pumped each year, and water levels are declining 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 1969, more than 61 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 has been less in the last 2 to 3 years than in previous years. Pumpage was greatest in these areas in the middle 1950's and early 1960's; since that time, pumpage and the resulting water-level declines have been somewhat less. Other areas in the Basin and Range lowlands province where ground-water withdrawals have caused large declines in water levels are the Willcox basin, San Simon basin, upper Santa Cruz basin, Avra Valley, Gila Bend basin, and McMullen Valley.

Figures 3, 9, 13, 18, and 23 show the depth to water in spring 1970 and the change in water levels from 1965 to 1970 in selected wells in the Basin and Range lowlands province. Graphs (figs. 4, 5, 6, 7, 8, 10, 11, 16, 17, 19, 20, 21, 22, and 24) showing the depth to water in selected 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 12, 14, and 15.

Central Highlands Province

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. Some surface water also is available for irrigation in these areas. The small amount of ground-water withdrawal has not resulted in any notable declines in water level except in some parts of Chino Valley. Figures 25 and 27 show the depth to water in spring 1970 and the change in water levels from 1965 to 1970 in selected wells in the area; graphs showing depth to water in selected wells and estimated annual pumpage for several areas in the province are given in figure 26.

Plateau Uplands Province

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

Figures 25 and 27 show the depth to water in spring 1970 and the change in water levels from 1965 to 1970 in wells in the province; figures 29 and 30 show depth to water in spring 1970. Graphs showing water levels in selected wells are given in figure 28.

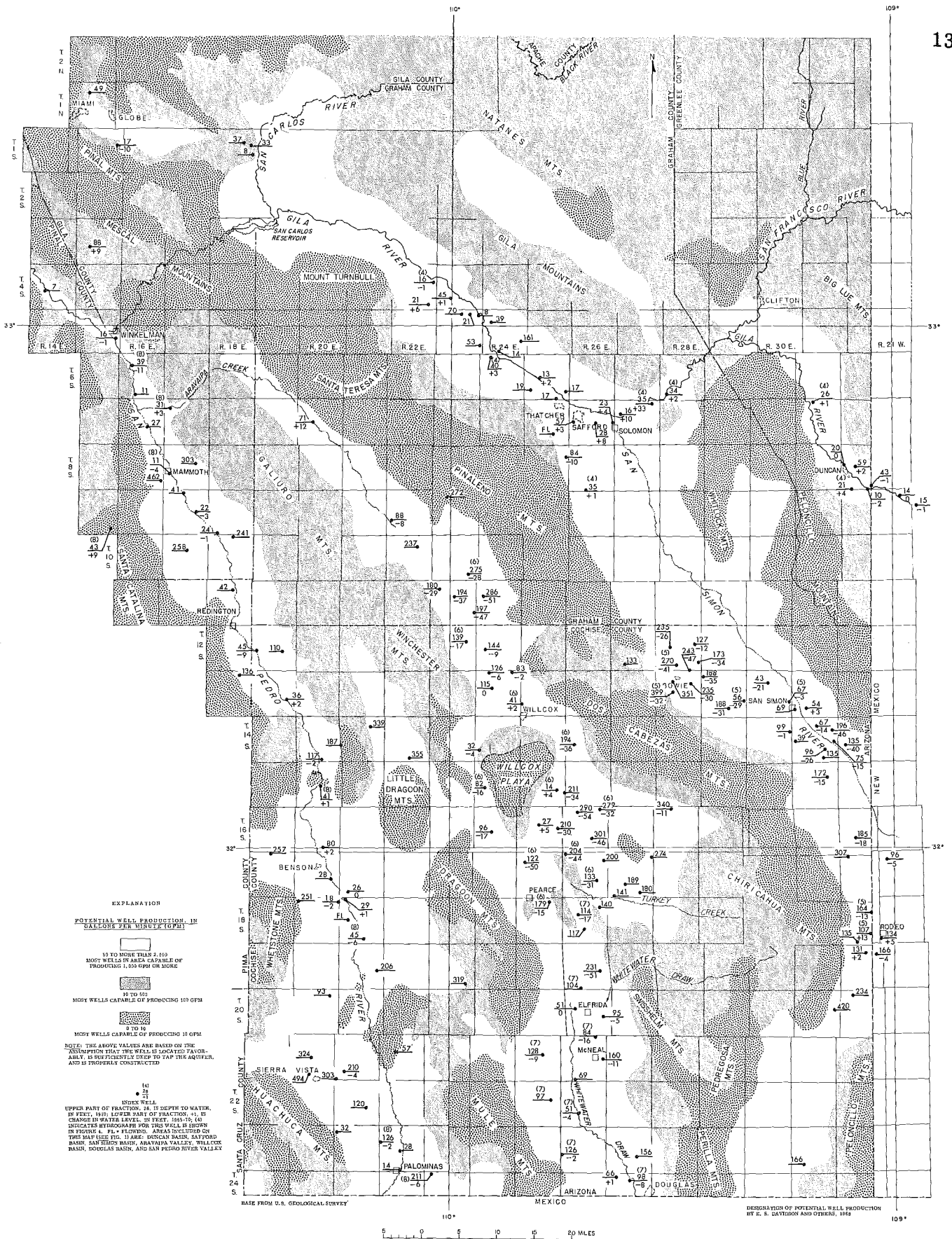


FIGURE 3. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE SOUTHEAST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

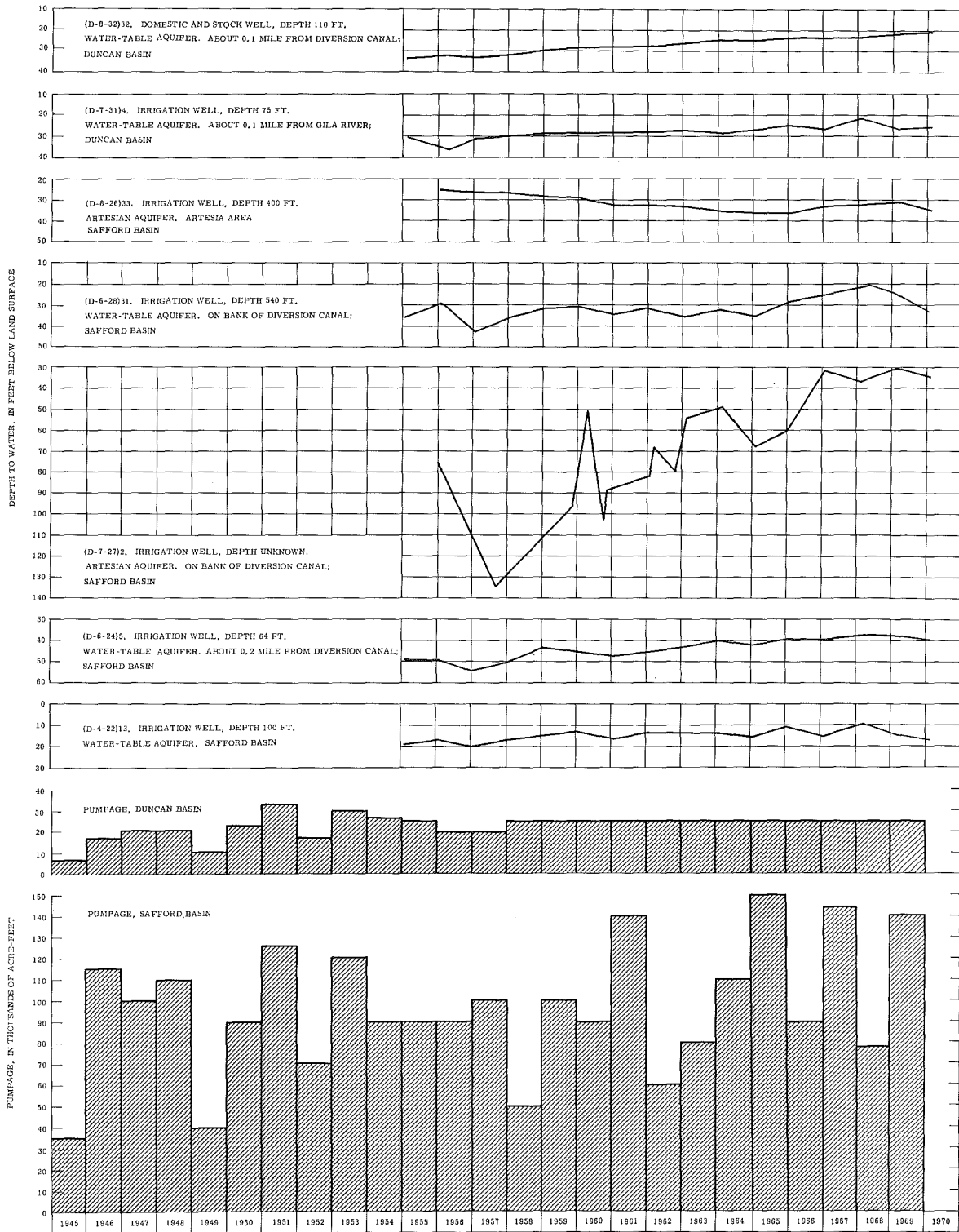


FIGURE 4. -- DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE DUNCAN AND SAFFORD BASINS.

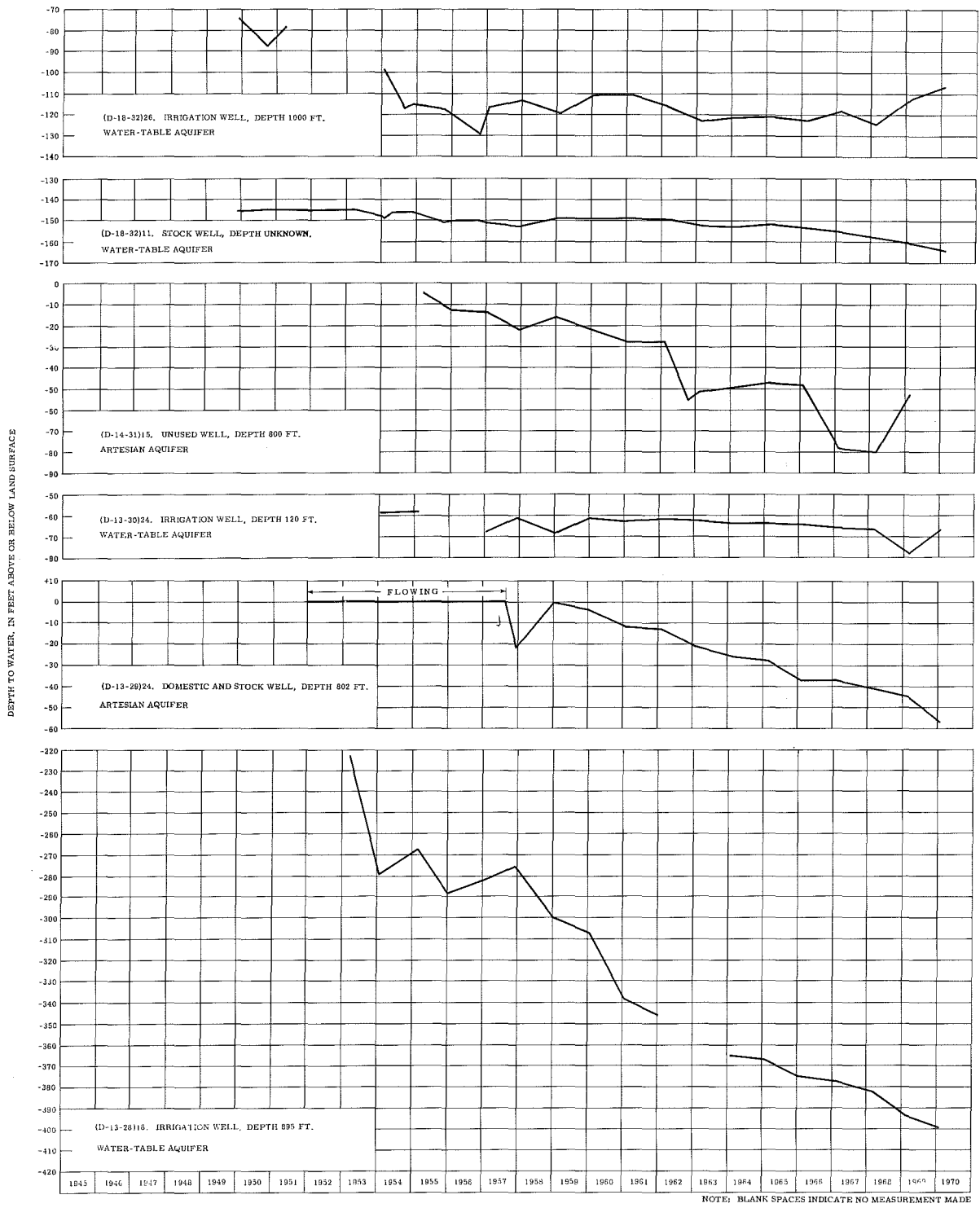


FIGURE 5.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SAN SIMON BASIN. (IN TWO SHEETS.)
SHEET 1 OF FIGURE 5

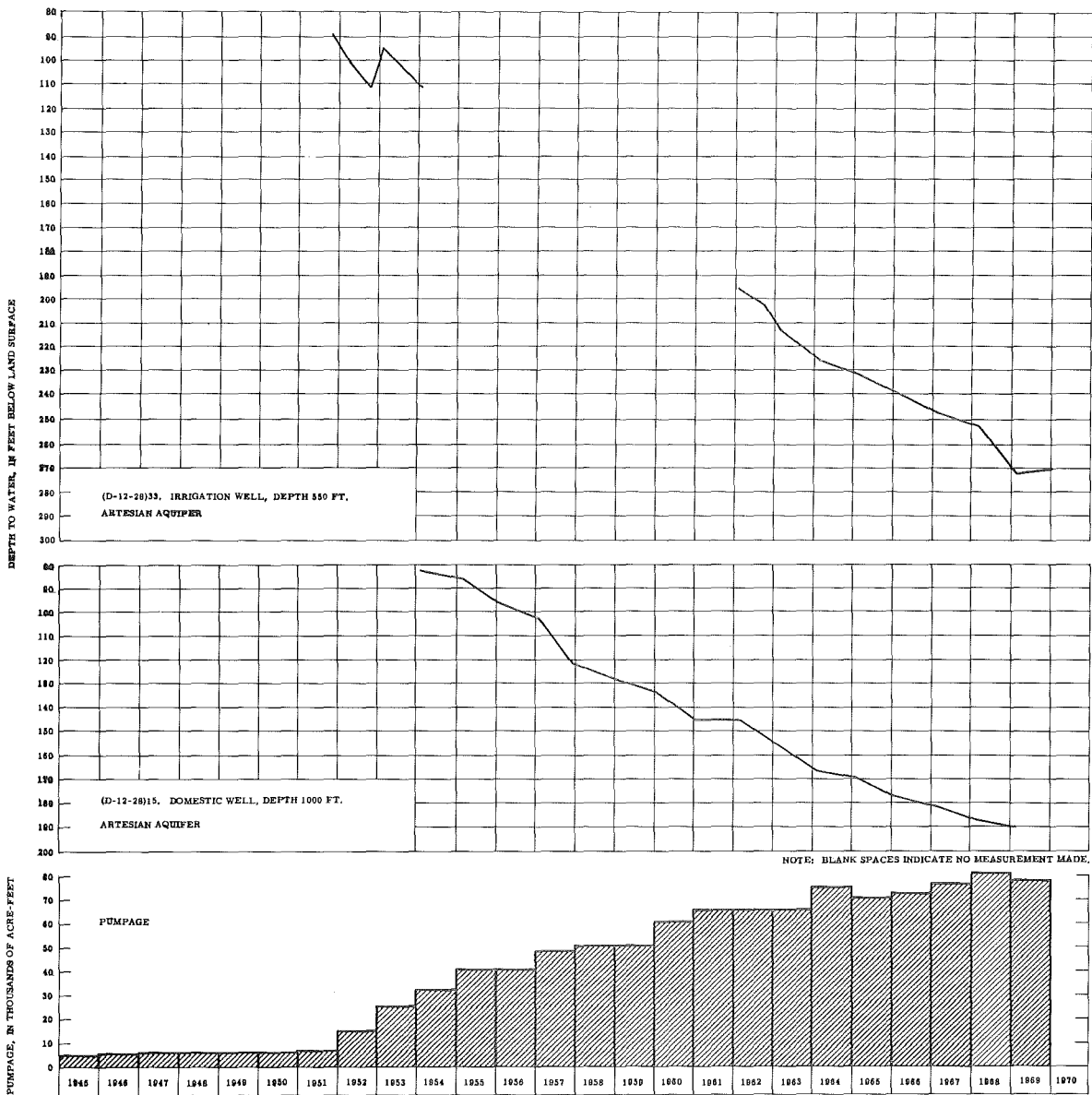


FIGURE 3.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SAN SIMON BASIN. (IN TWO SHEETS.)
SHEET 2 OF FIGURE 3

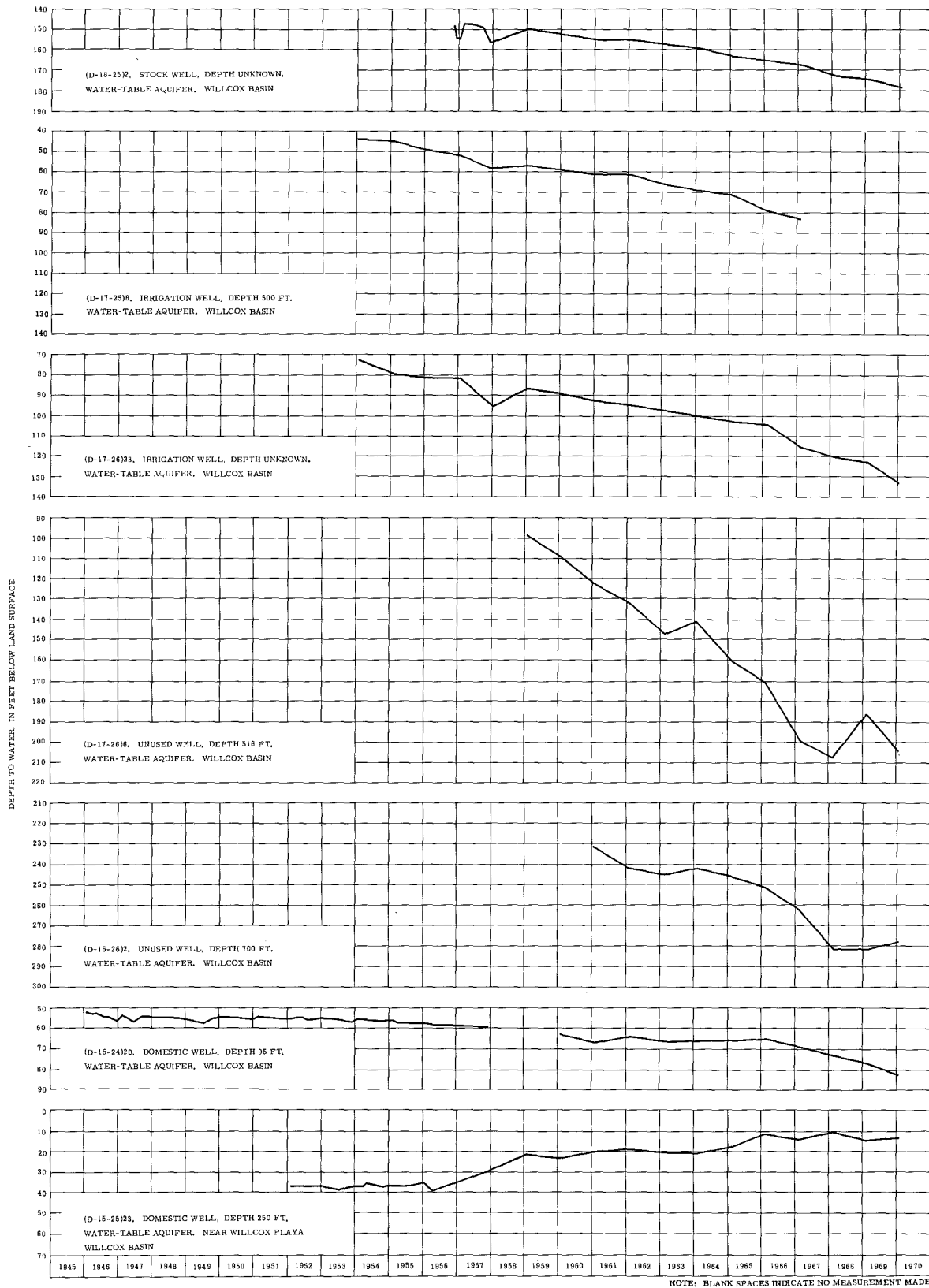


FIGURE 6.--DEPTH TO WATER IN SELECTED WELLS IN WILLCOX BASIN AND ARAVAIPA VALLEY AND ESTIMATED ANNUAL PUMPAGE IN WILLCOX BASIN. (IN TWO SHEETS.)

SHEET 1 OF FIGURE 6

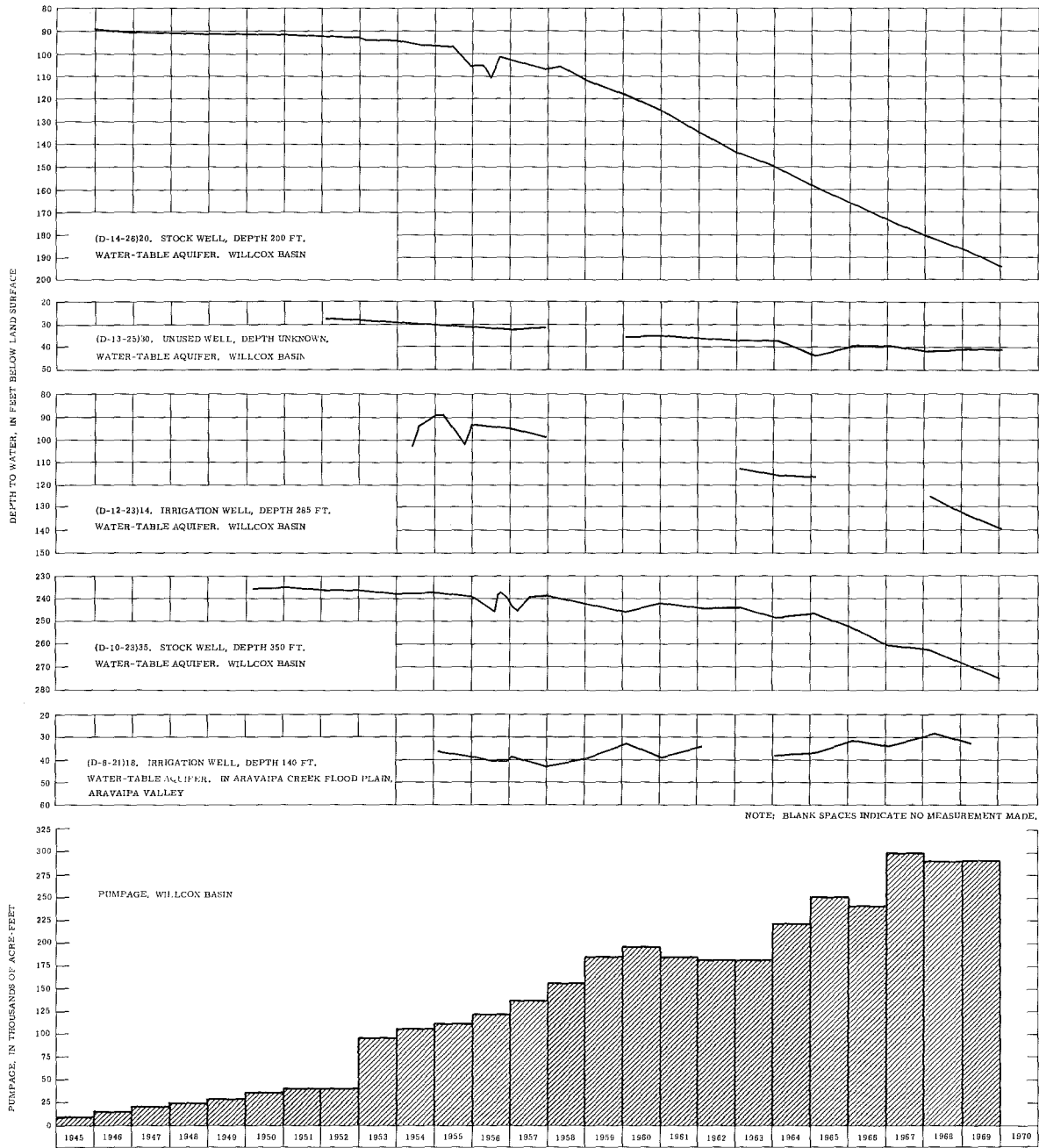
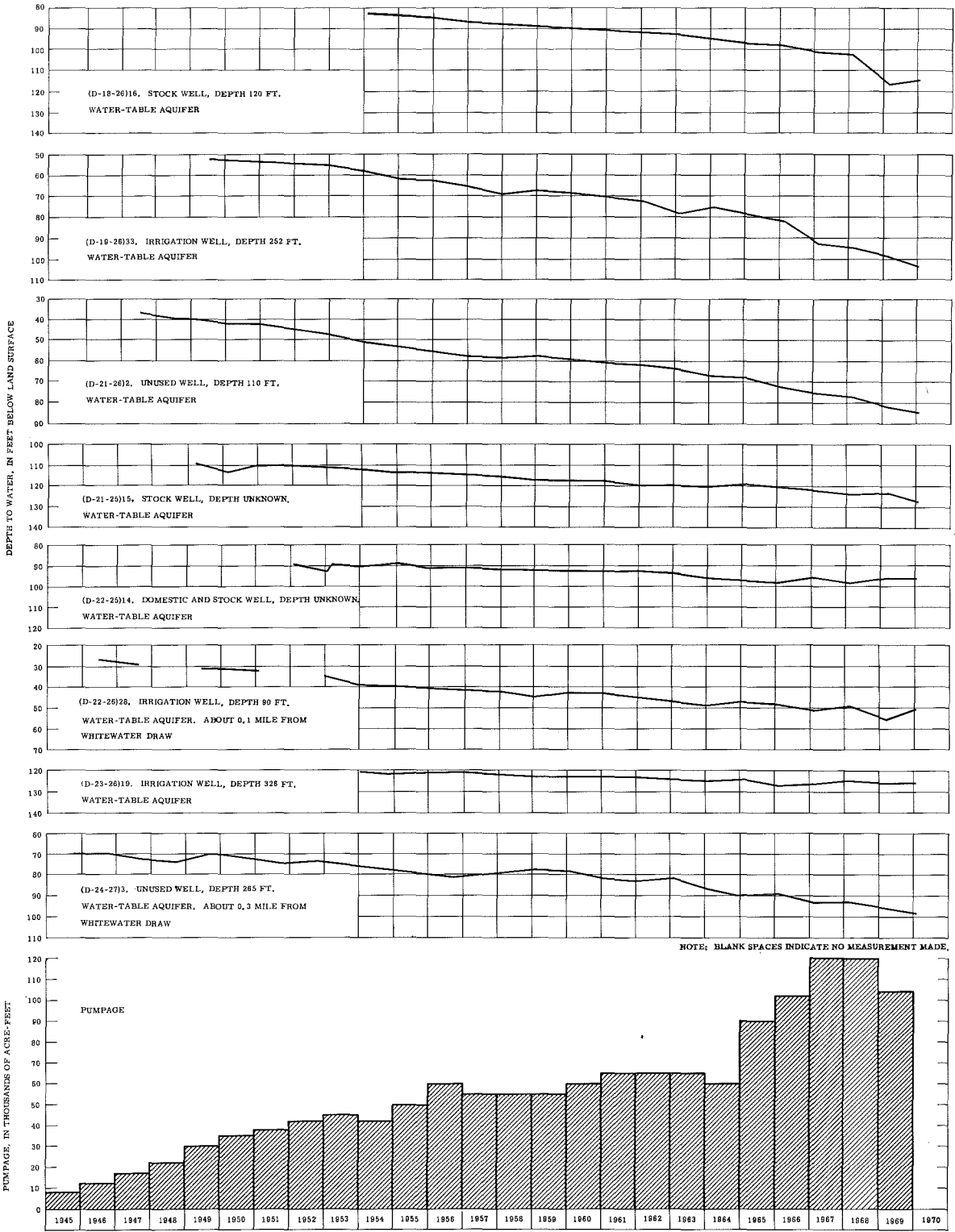


FIGURE 6. --DEPTH TO WATER IN SELECTED WELLS IN WILLCOX BASIN AND ARAVAIPA VALLEY AND ESTIMATED ANNUAL PUMPAGE IN WILLCOX BASIN. (IN TWO SHEETS.)

SHEET 2 OF FIGURE 6.

6.2



2.9 1/4

FIGURE 7. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN DOUGLAS BASIN.

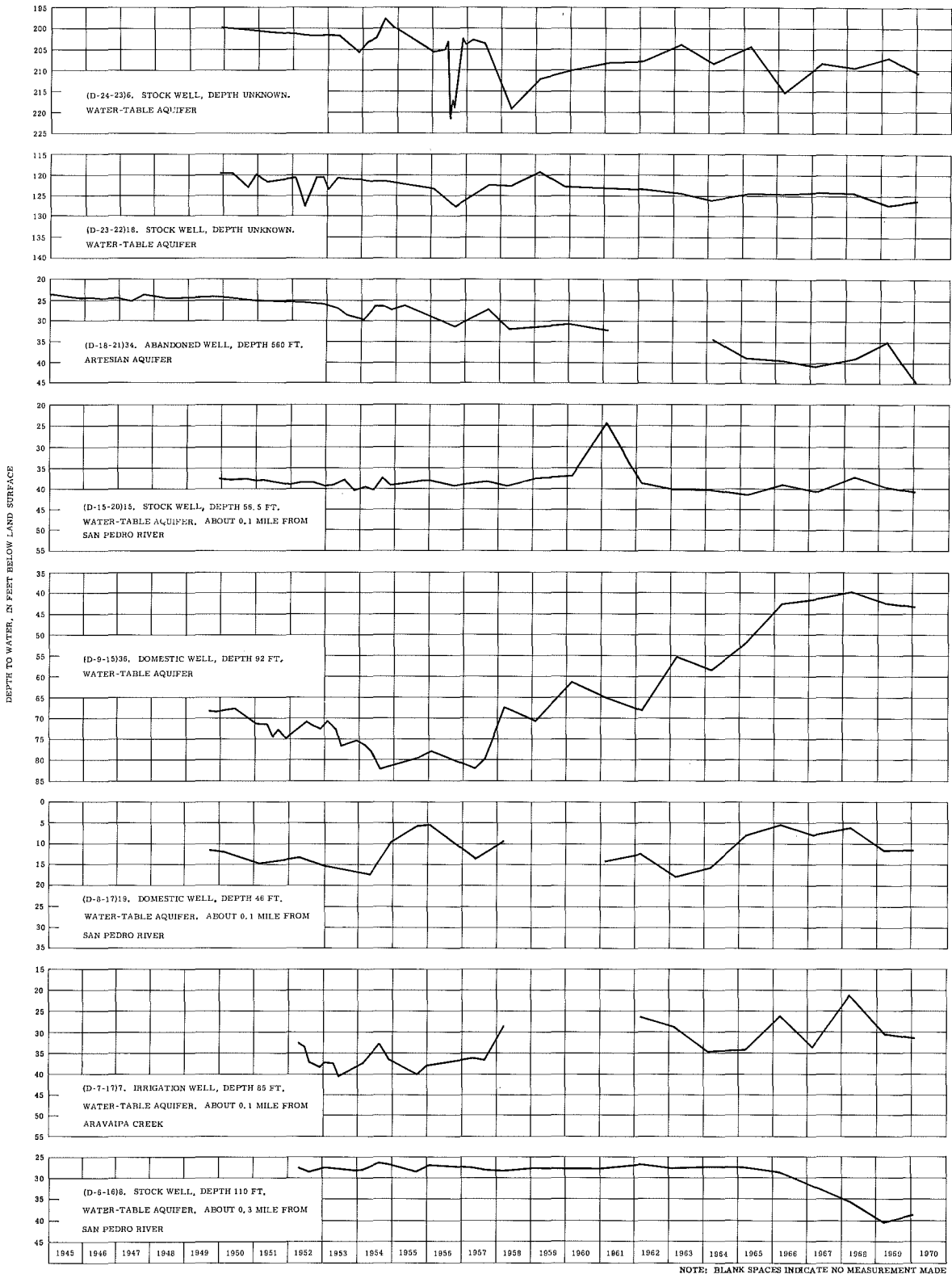


FIGURE 8. --DEPTH TO WATER IN SELECTED WELLS IN THE SAN PEDRO RIVER VALLEY.

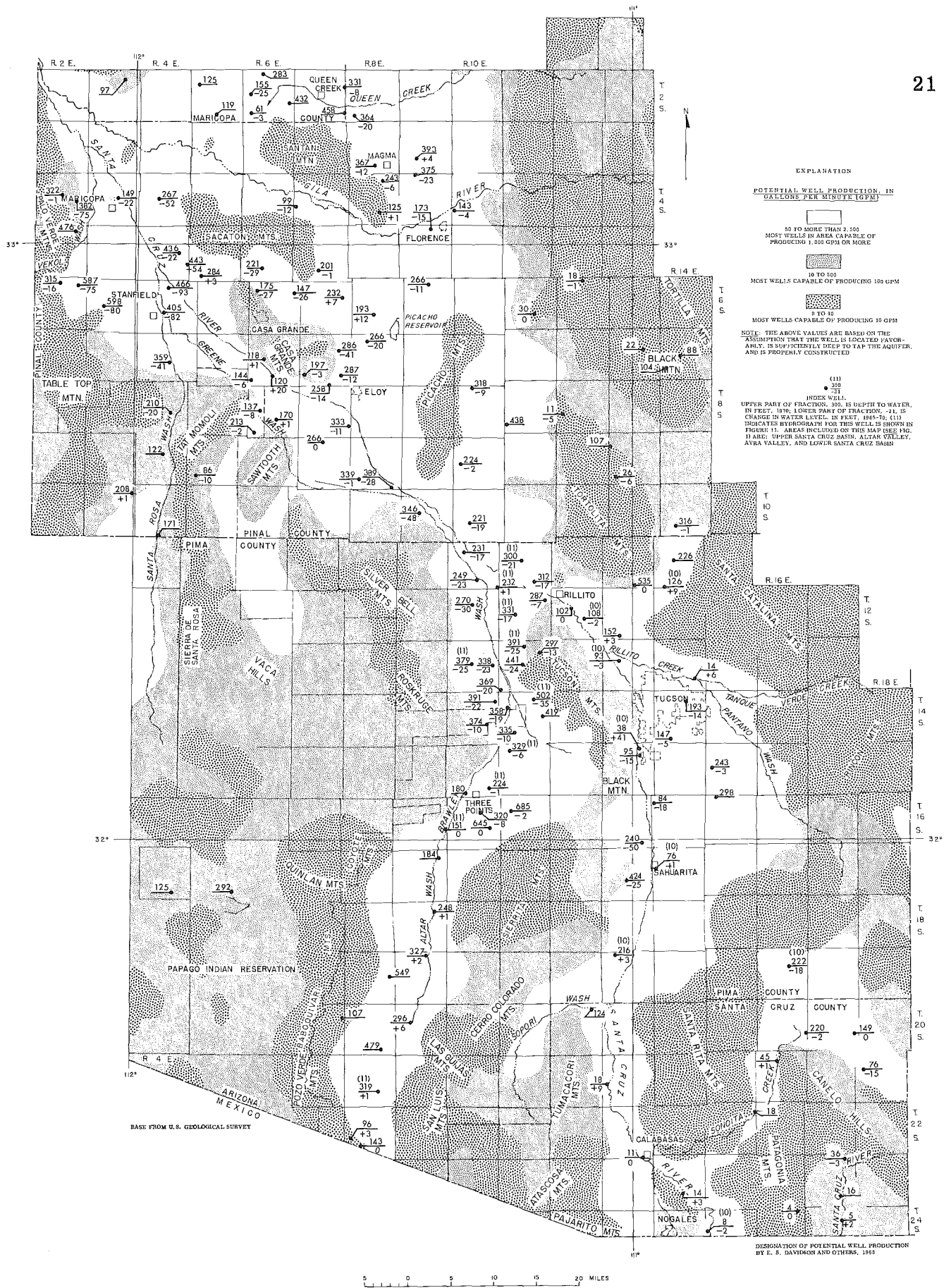


FIGURE 9. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE SOUTH-CENTRAL PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

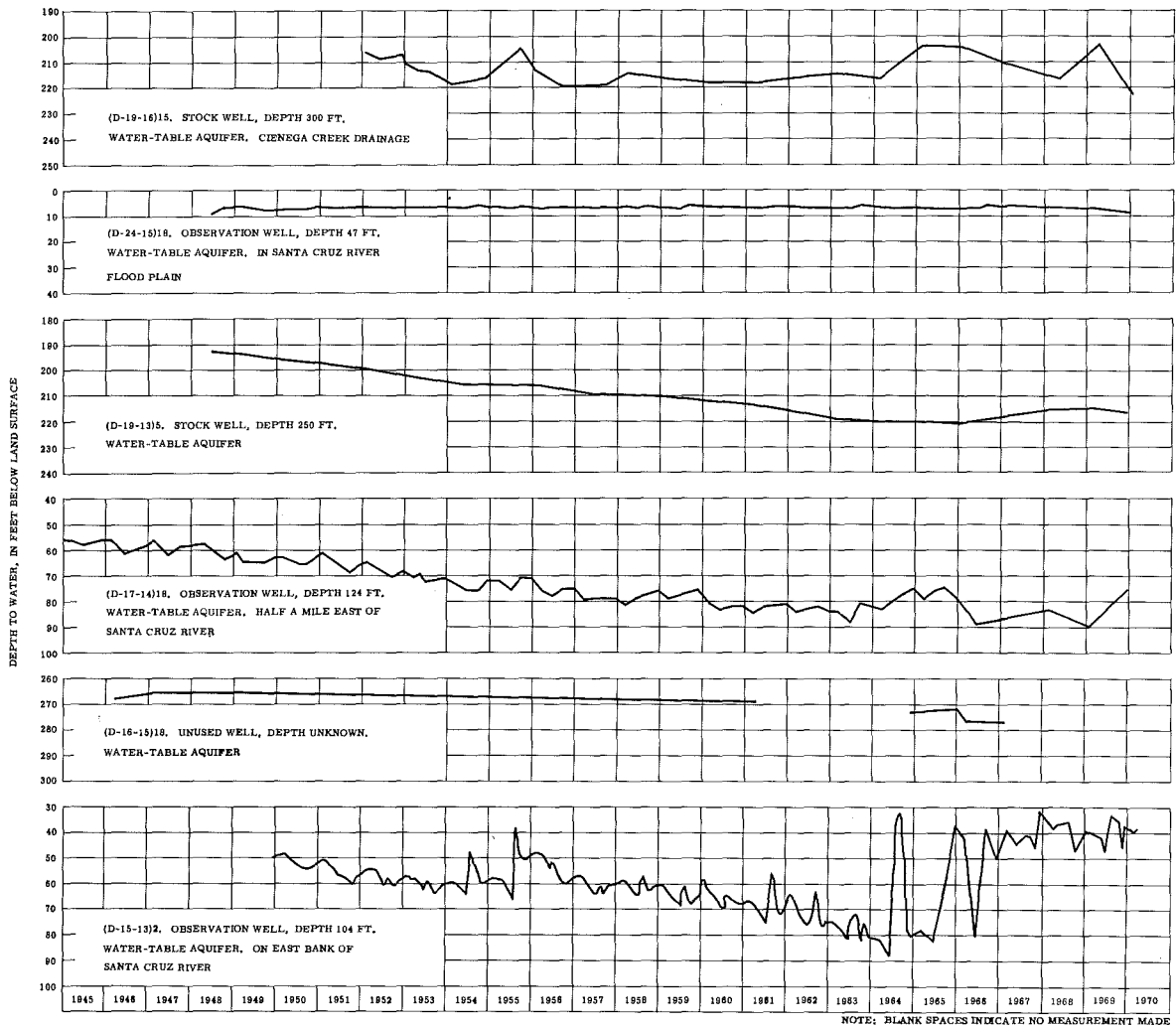


FIGURE 10. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE UPPER SANTA CRUZ BASIN. (IN TWO SHEETS.)
SHEET 1 OF FIGURE 10

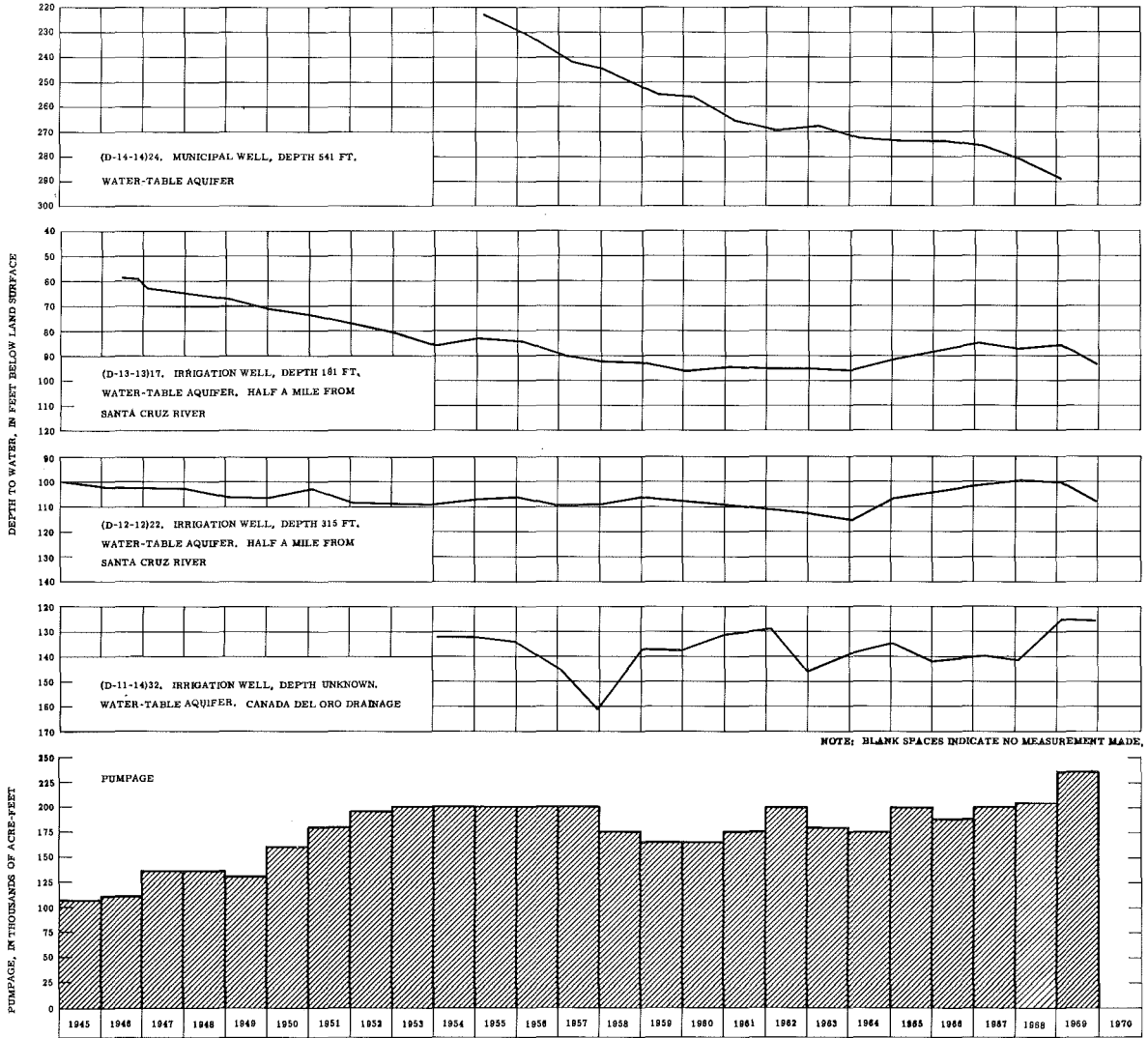
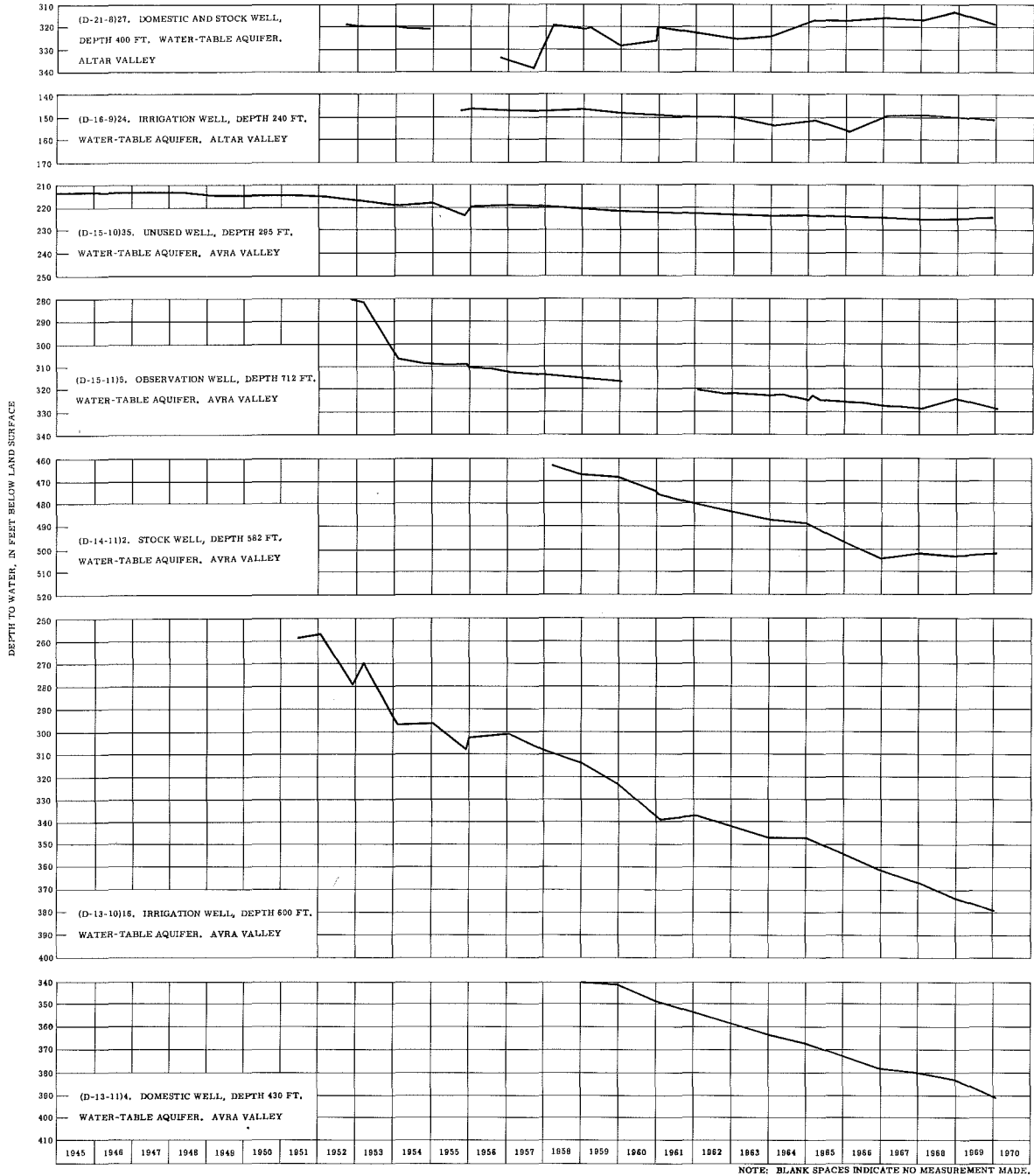


FIGURE 10. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE UPPER SANTA CRUZ BASIN. (IN TWO SHEETS.) SHEET 2 OF FIGURE 10



6.7/92

FIGURES 11. --DEPTH TO WATER IN SELECTED WELLS IN ALTAR AND AVRA VALLEYS AND ESTIMATED ANNUAL PUMPAGE IN AVRA VALLEY. (IN TWO SHEETS.)

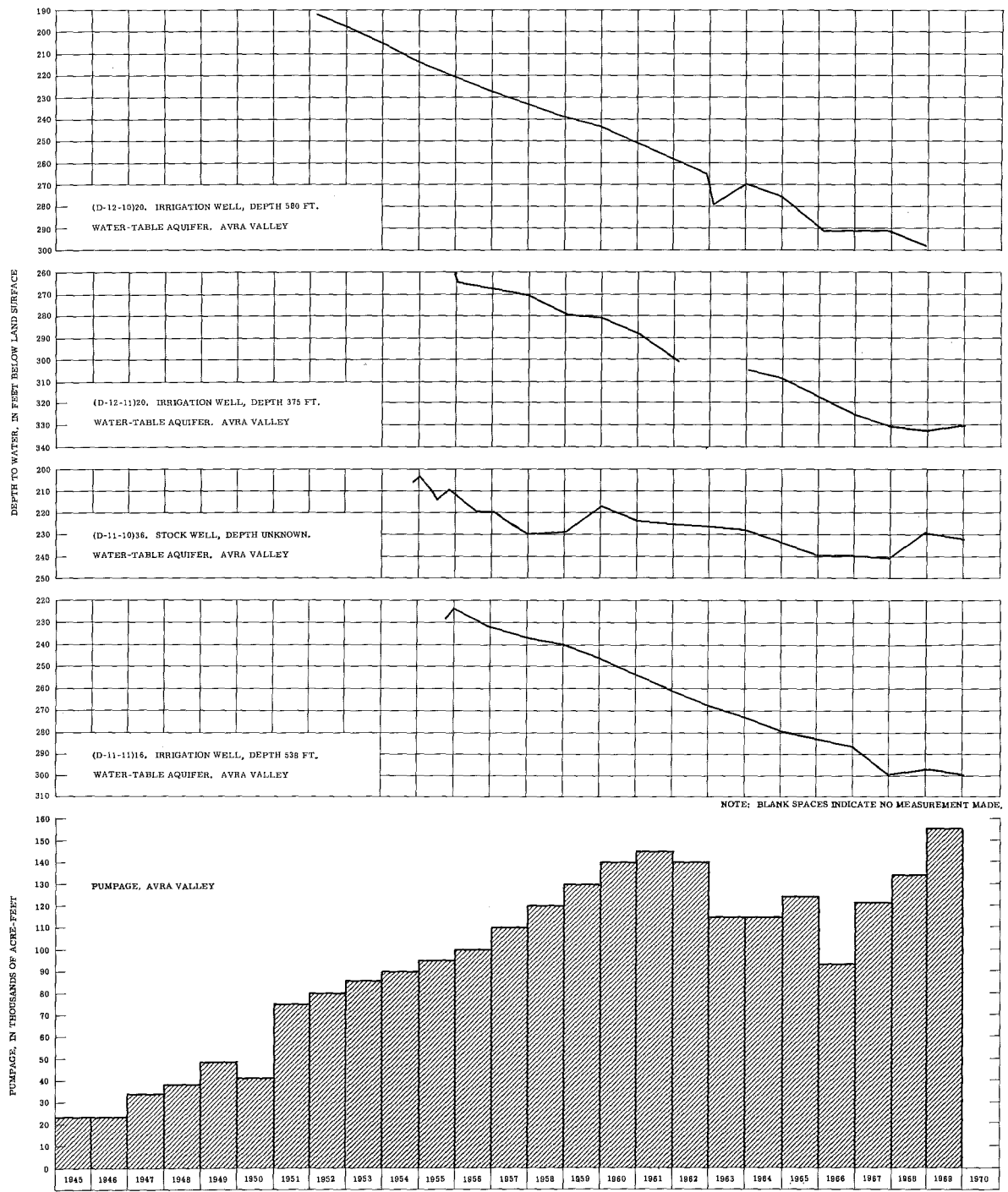
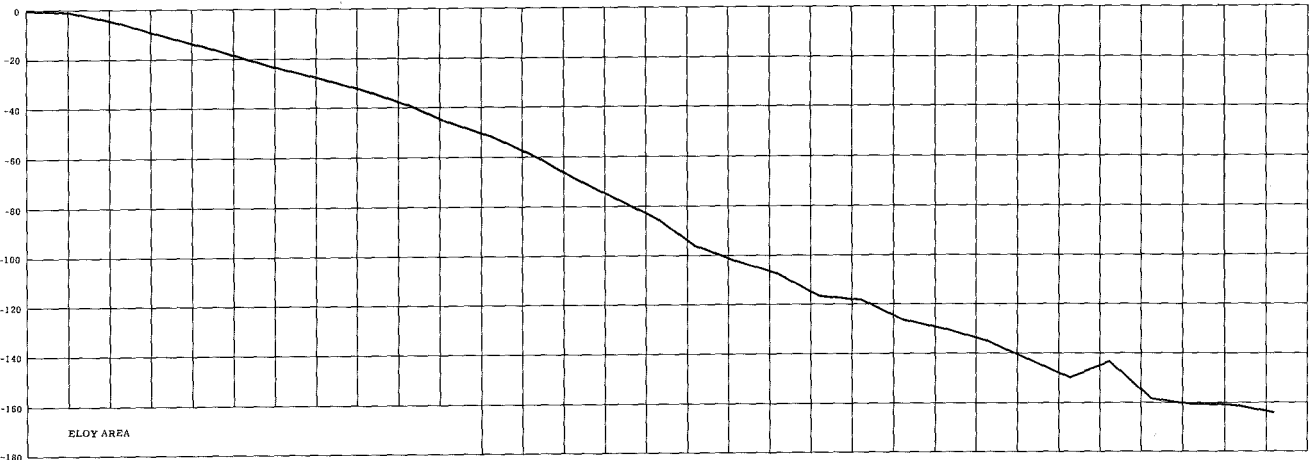
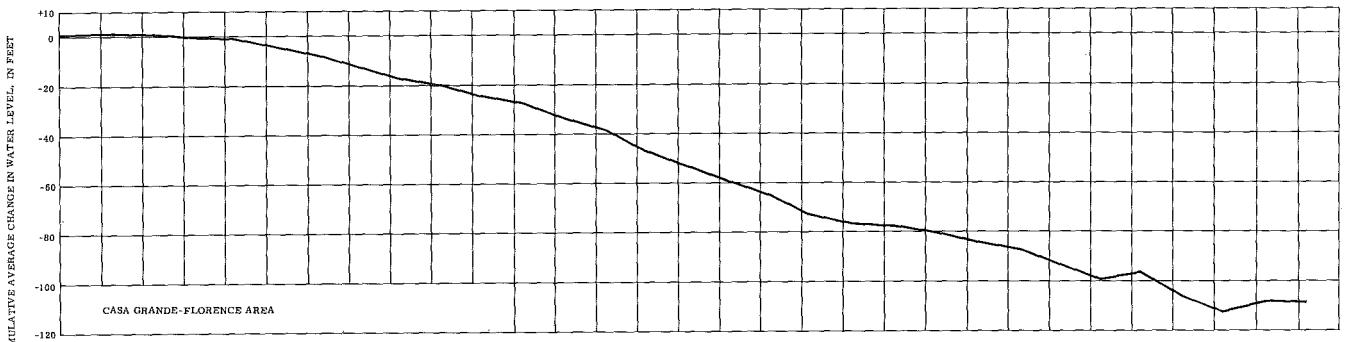


FIGURE 11. --DEPTH TO WATER IN SELECTED WELLS IN ALTAR AND AVRA VALLEYS AND ESTIMATED ANNUAL PUMPAGE IN AVRA VALLEY. (ON TWO SHEETS.) SHEET 2 OF FIGURE 11

5.3



12



6.3

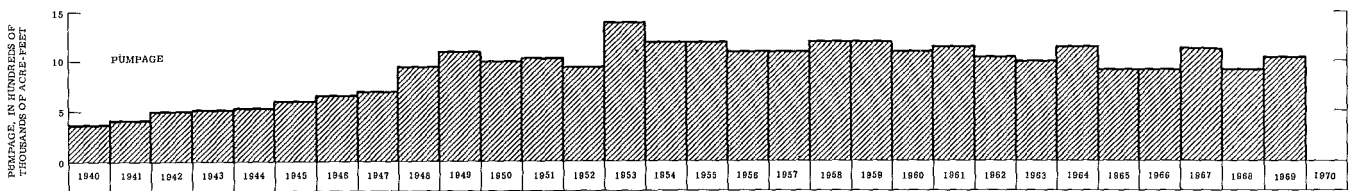
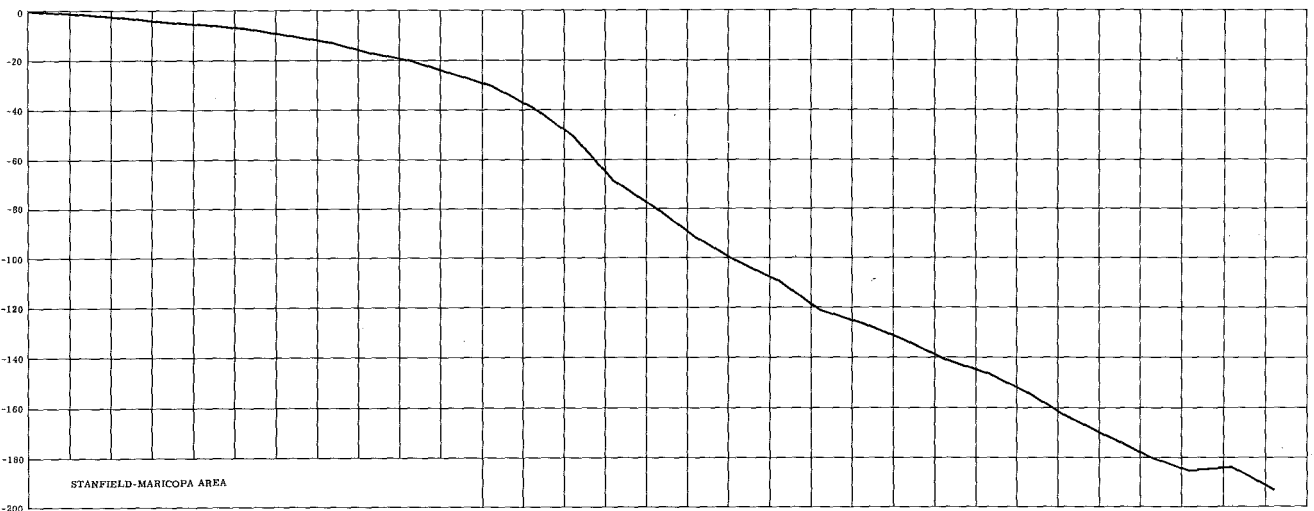


FIGURE 12. --CUMULATIVE AVERAGE CHANGE IN WATER LEVEL BY AREAS AND ESTIMATED ANNUAL PUMPAGE IN THE LOWER SANTA CRUZ BASIN.

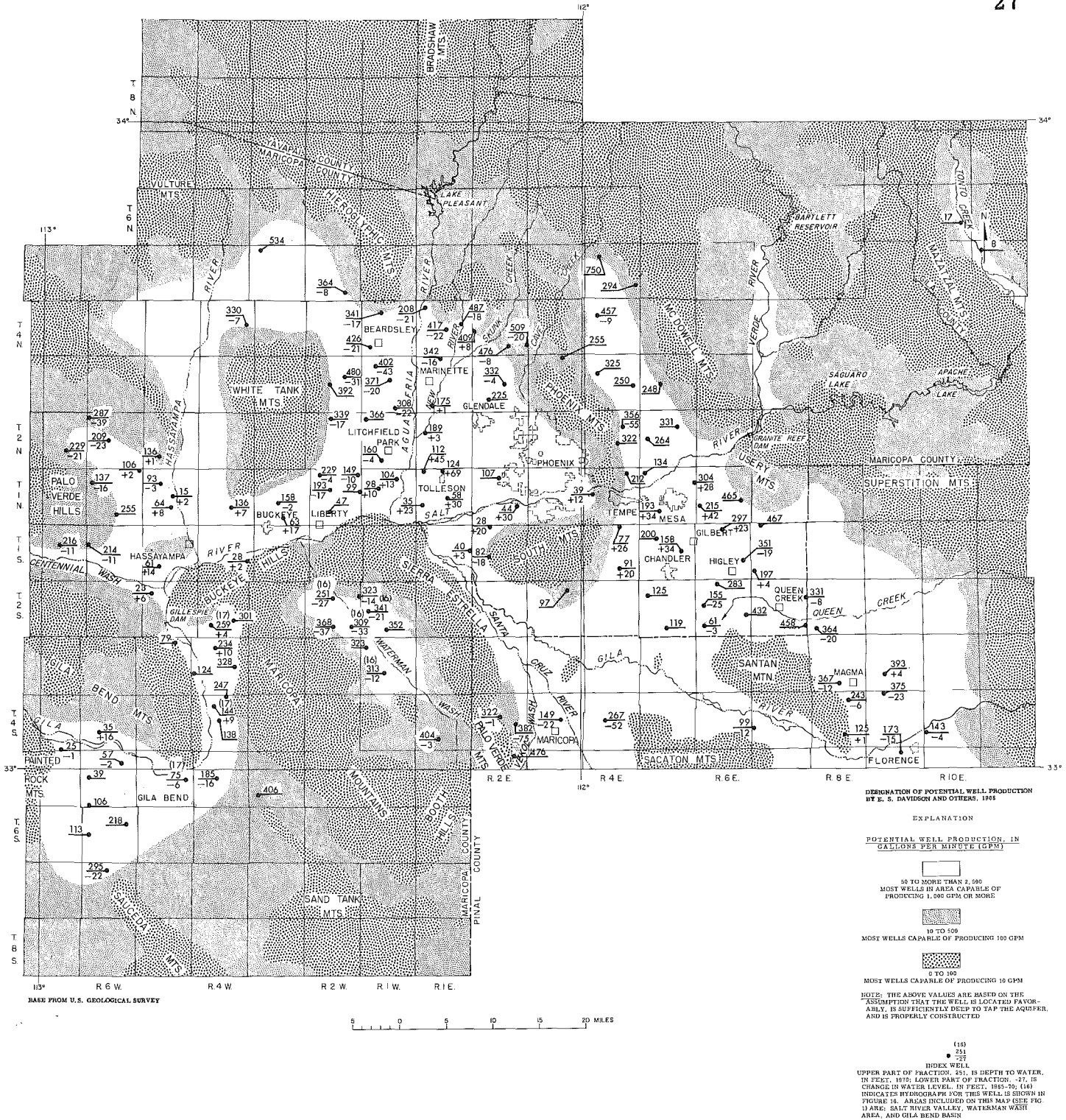


FIGURE 13. -- POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE CENTRAL PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

4 1/2

2 5/8

3 1/4

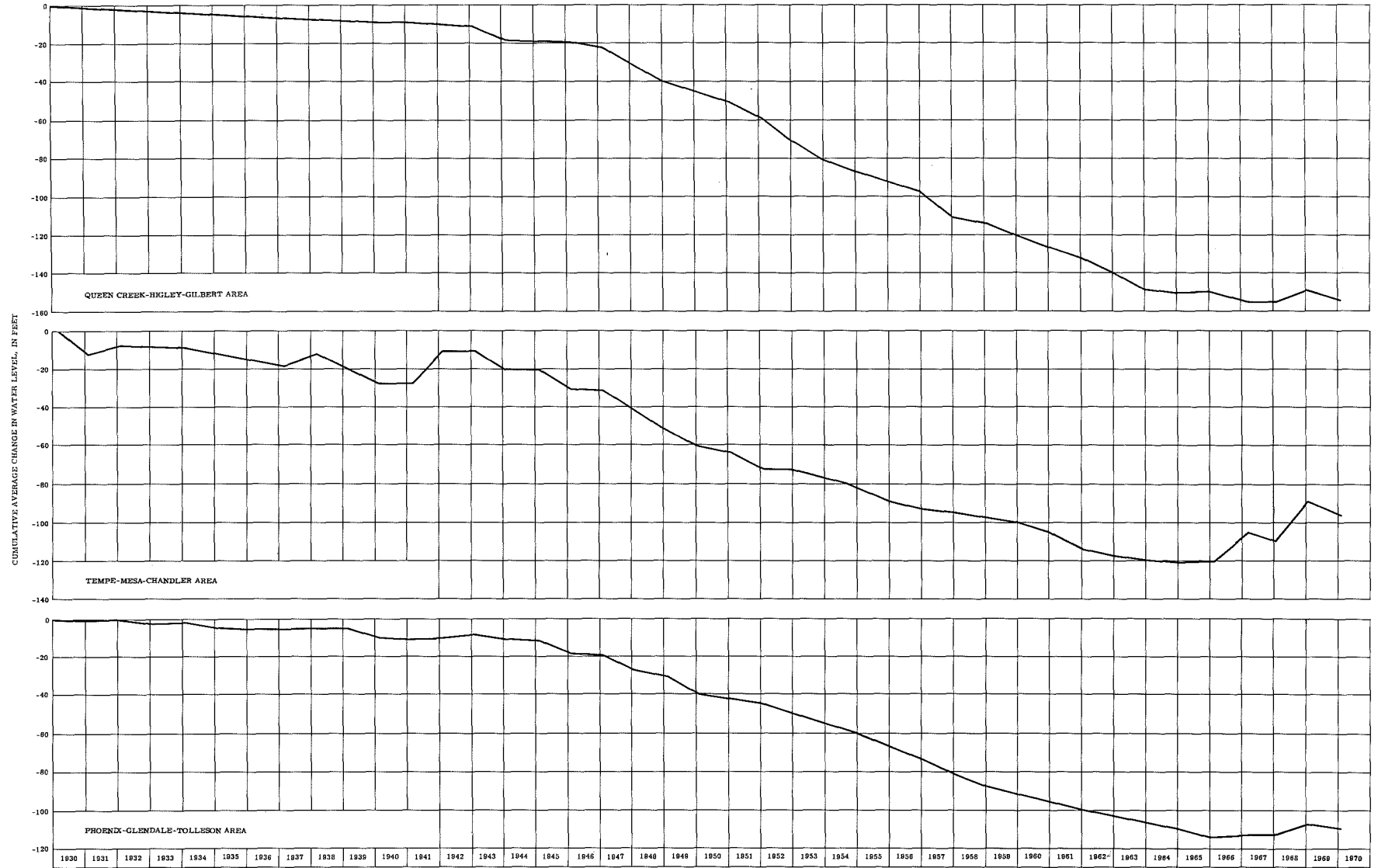


FIGURE 14. --CUMULATIVE AVERAGE CHANGE IN WATER LEVEL IN THE QUEEN CREEK-HIGLEY-GILBERT, TEMPE-MESA-CHANDLER, AND PHOENIX-GLENDALE-TOLLESON AREAS OF THE SALT RIVER VALLEY.

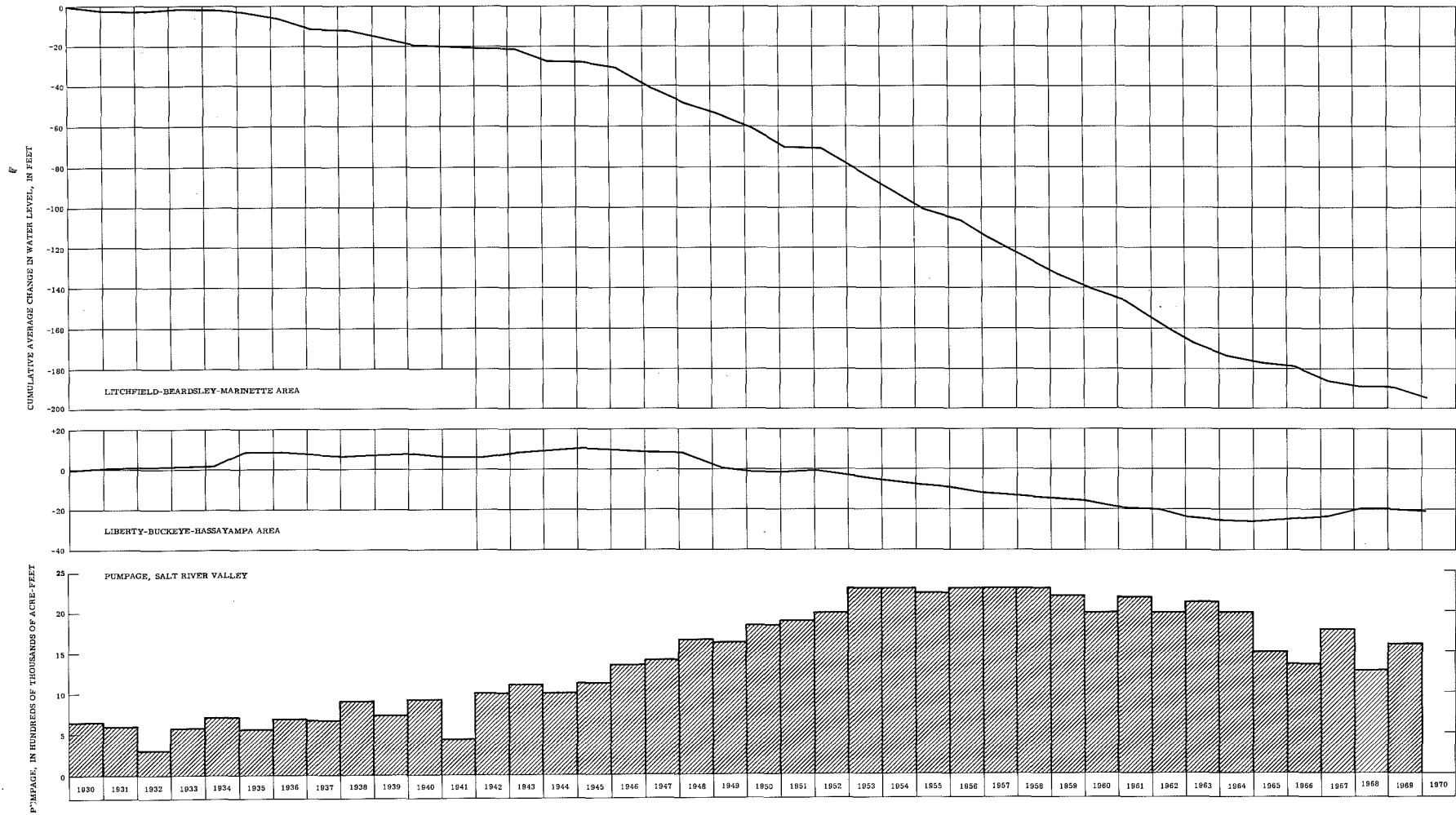


FIGURE 15. --CUMULATIVE AVERAGE CHANGE IN WATER LEVEL IN THE LITCHFIELD-BEARDSLEY-MARNETTE AND LIBERTY-BUCKEYE-HASSAYAMPA AREAS AND ESTIMATED ANNUAL PUMPAGE IN THE SALT RIVER VALLEY.

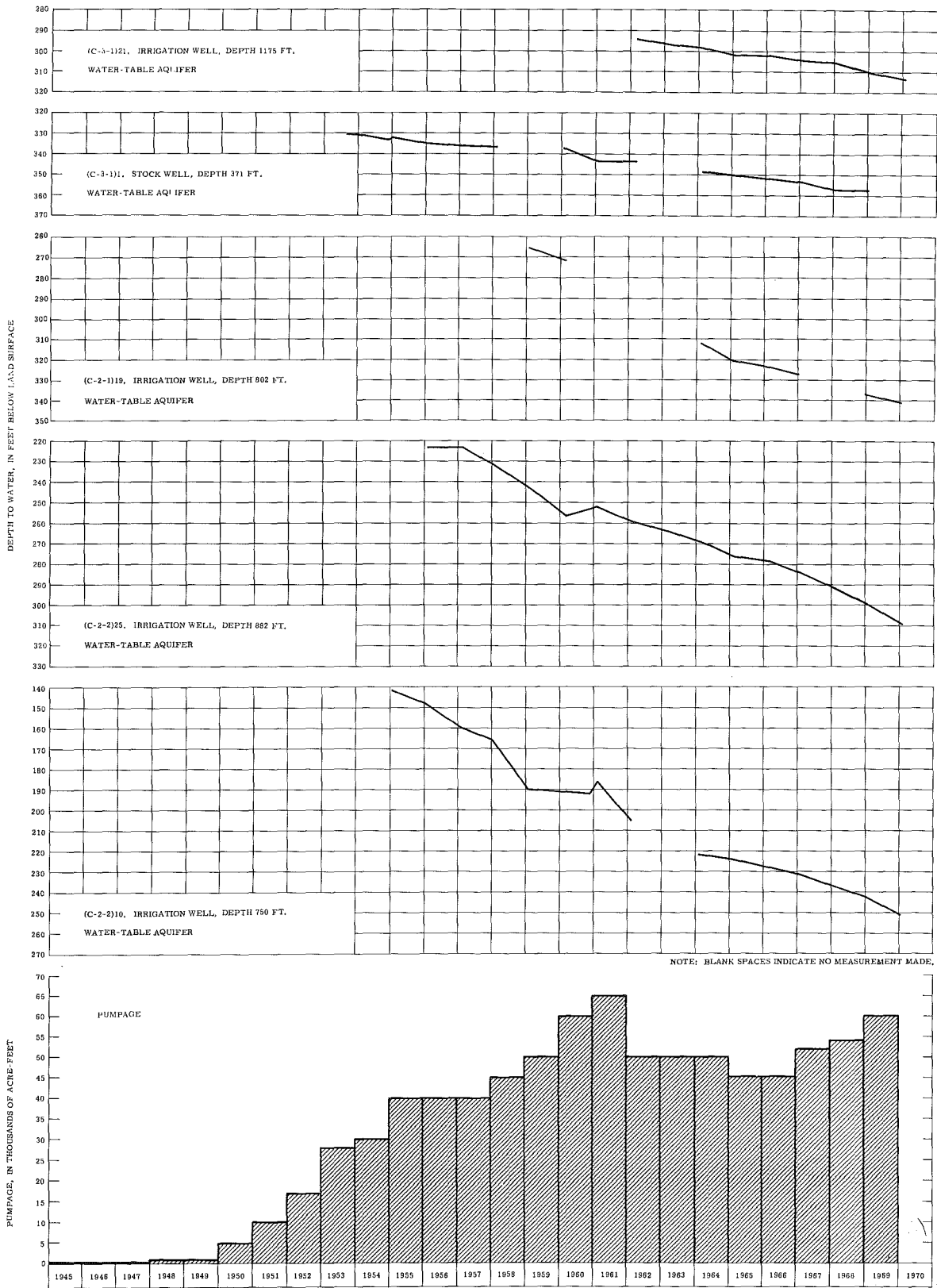


FIGURE 16. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE WATERMAN WASH AREA.

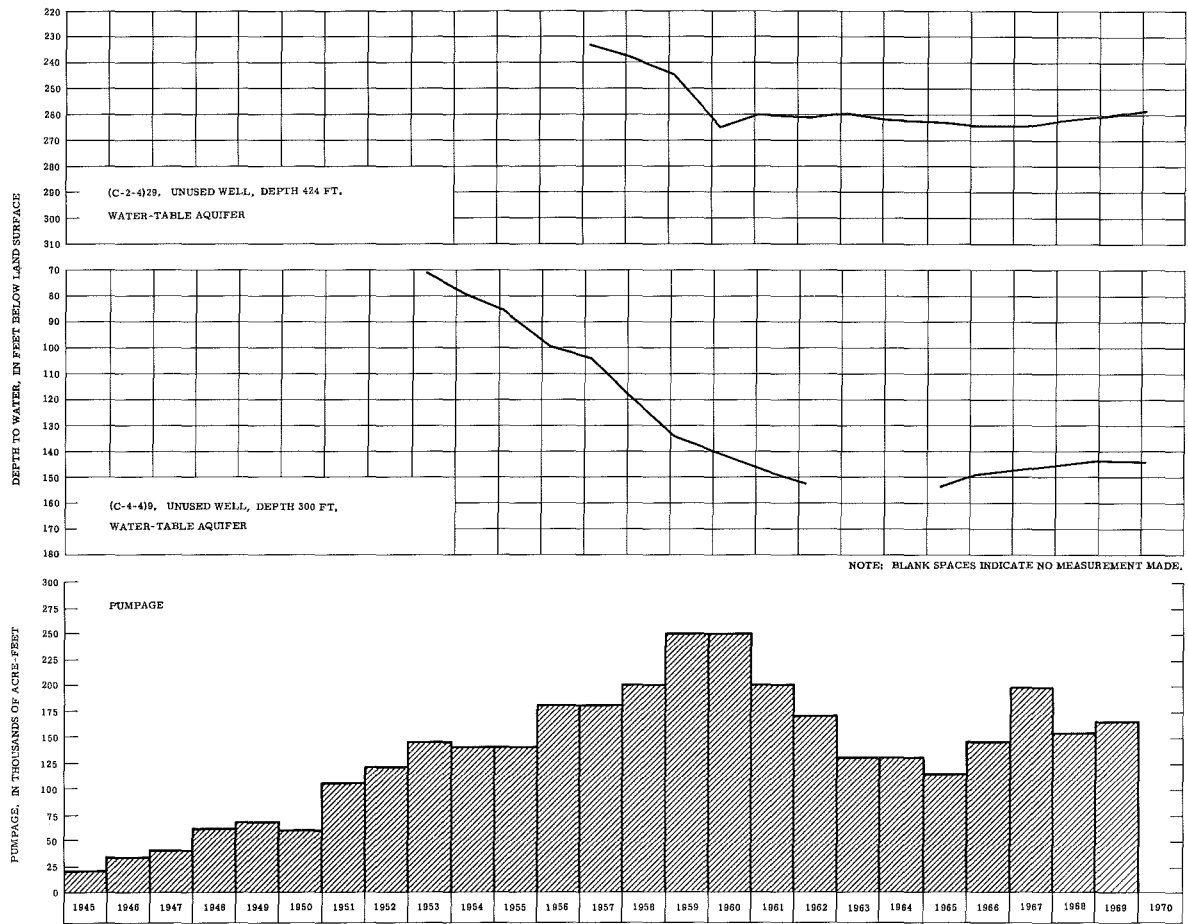


FIGURE 17. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE GILA BEND BASIN.

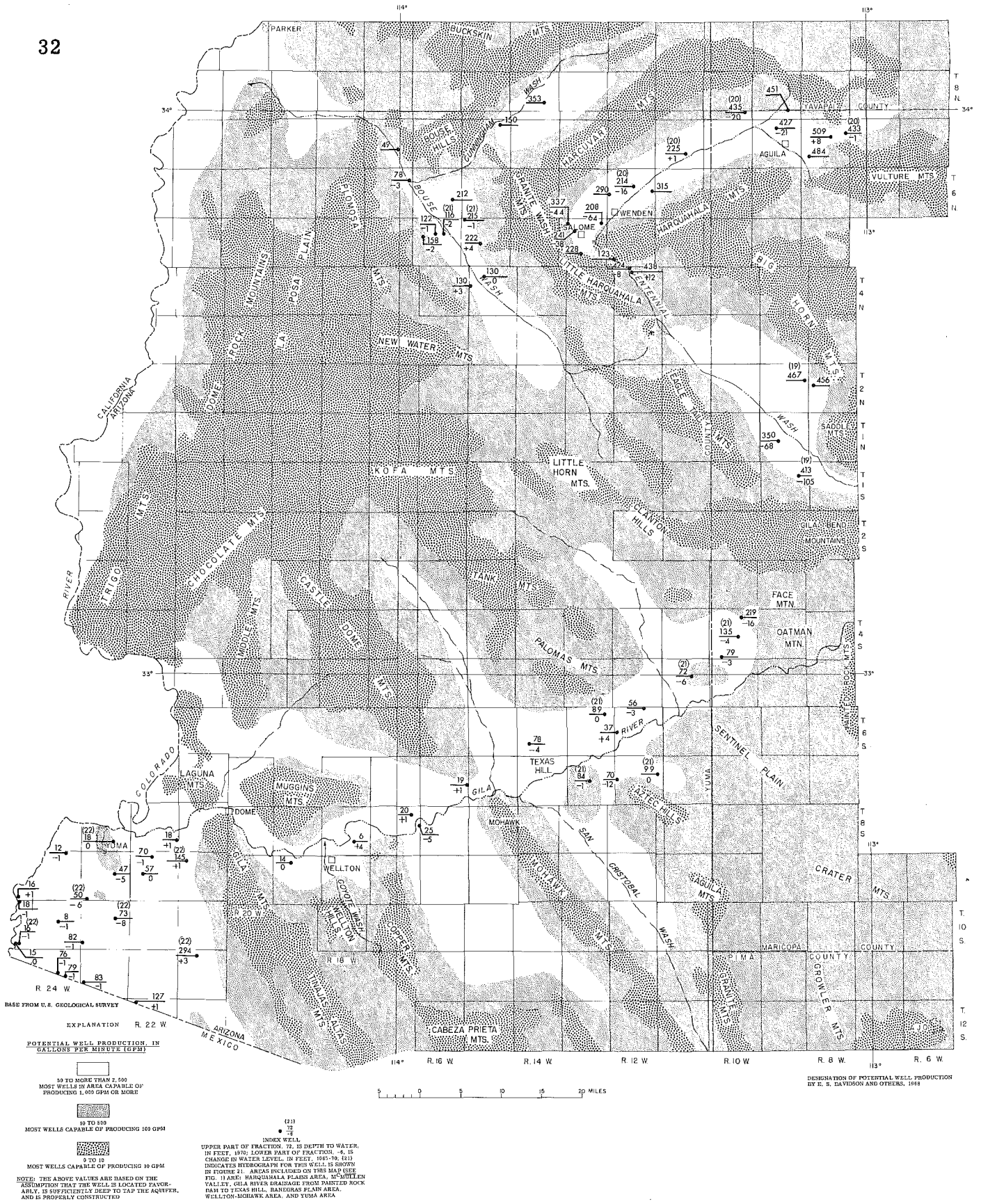


FIGURE 18. -- POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE SOUTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

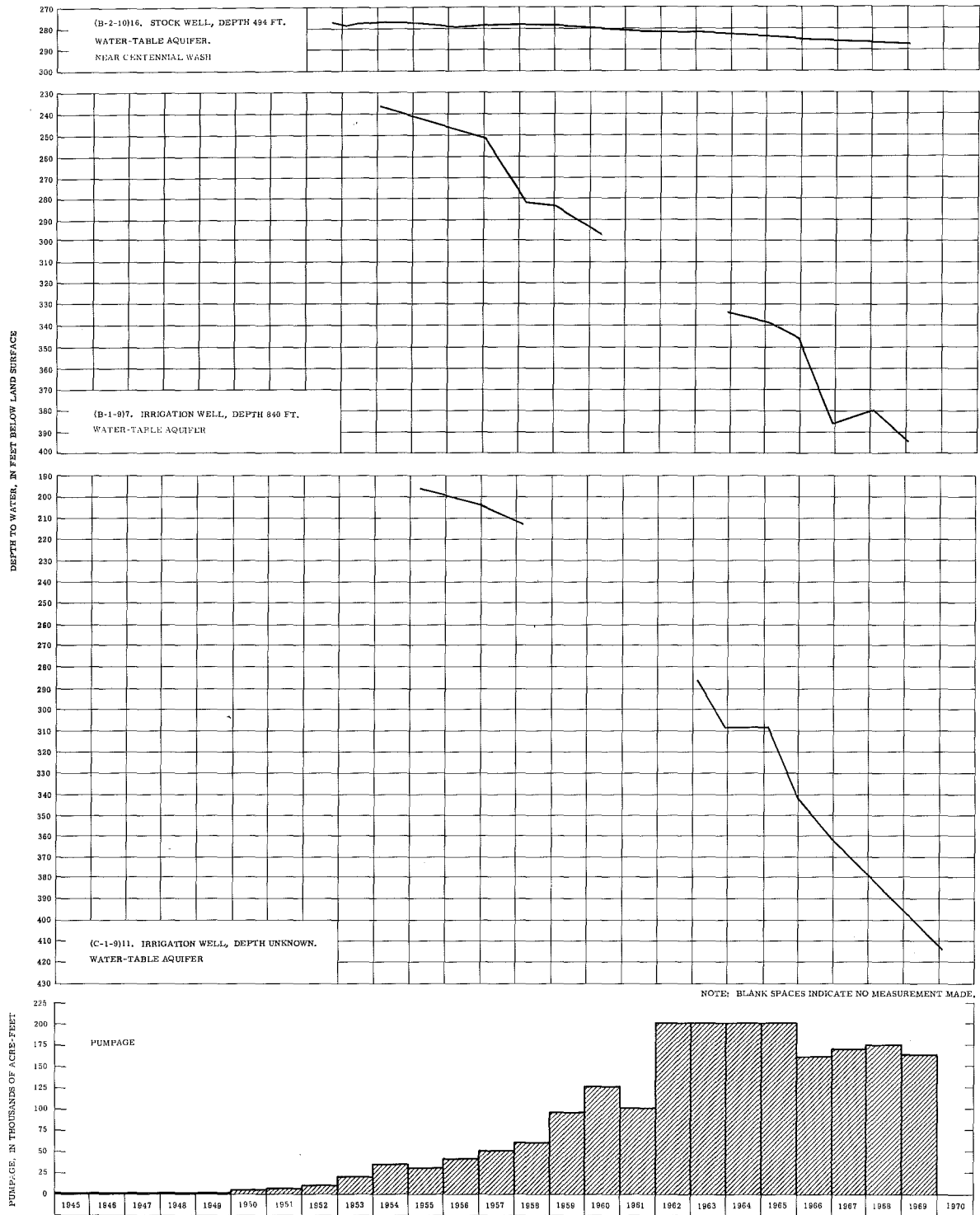


FIGURE 19. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE HARQUAHALA PLAINS AREA.

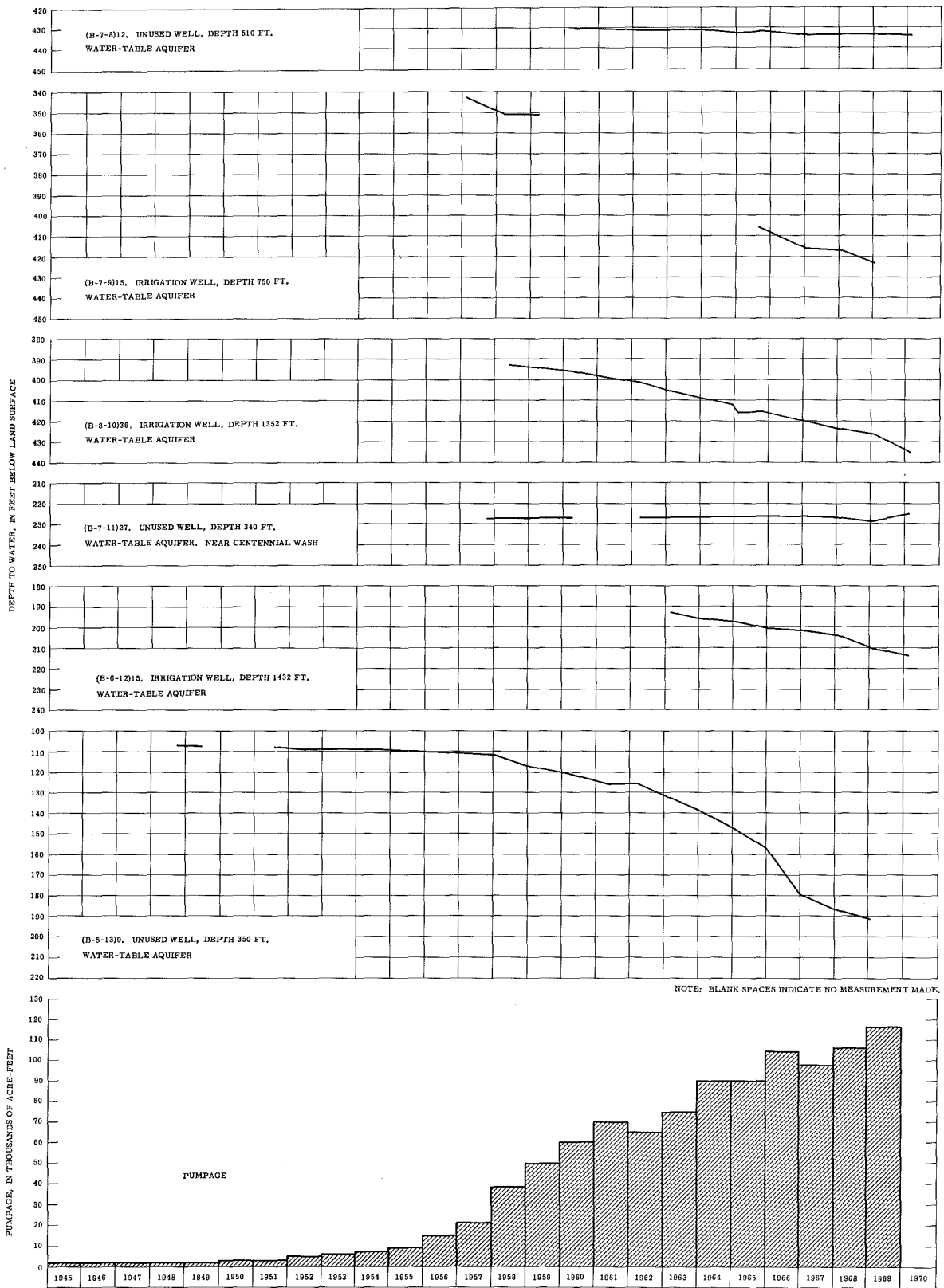


FIGURE 20. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN McCULLEN VALLEY.

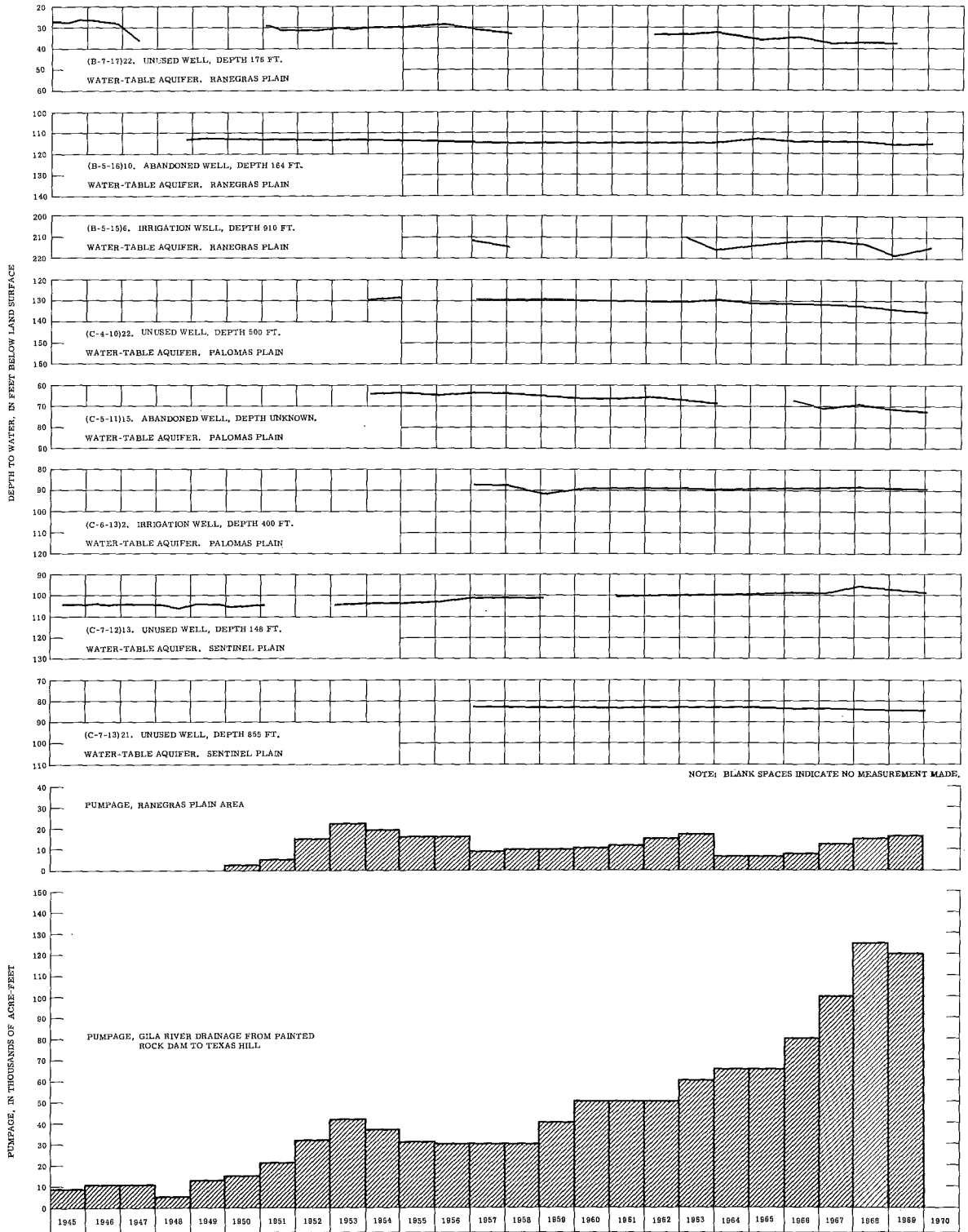


FIGURE 21. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE GILA RIVER DRAINAGE FROM PAINTED ROCK DAM TO TEXAS HILL AND IN THE RANEGRAS PLAIN AREA.

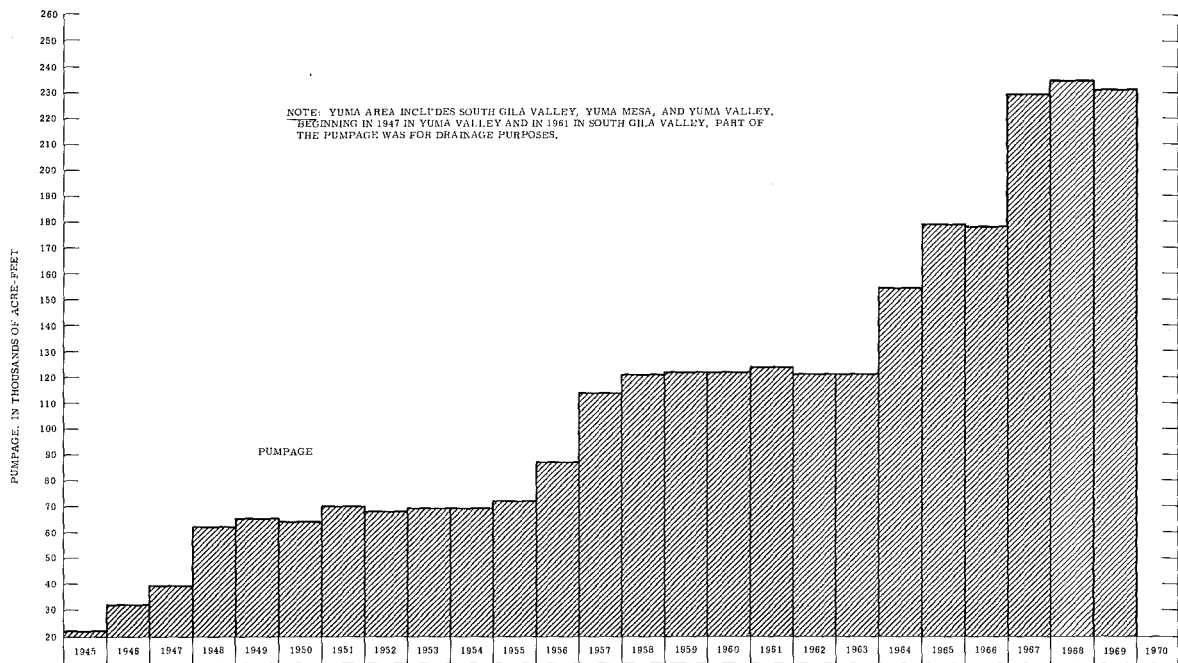
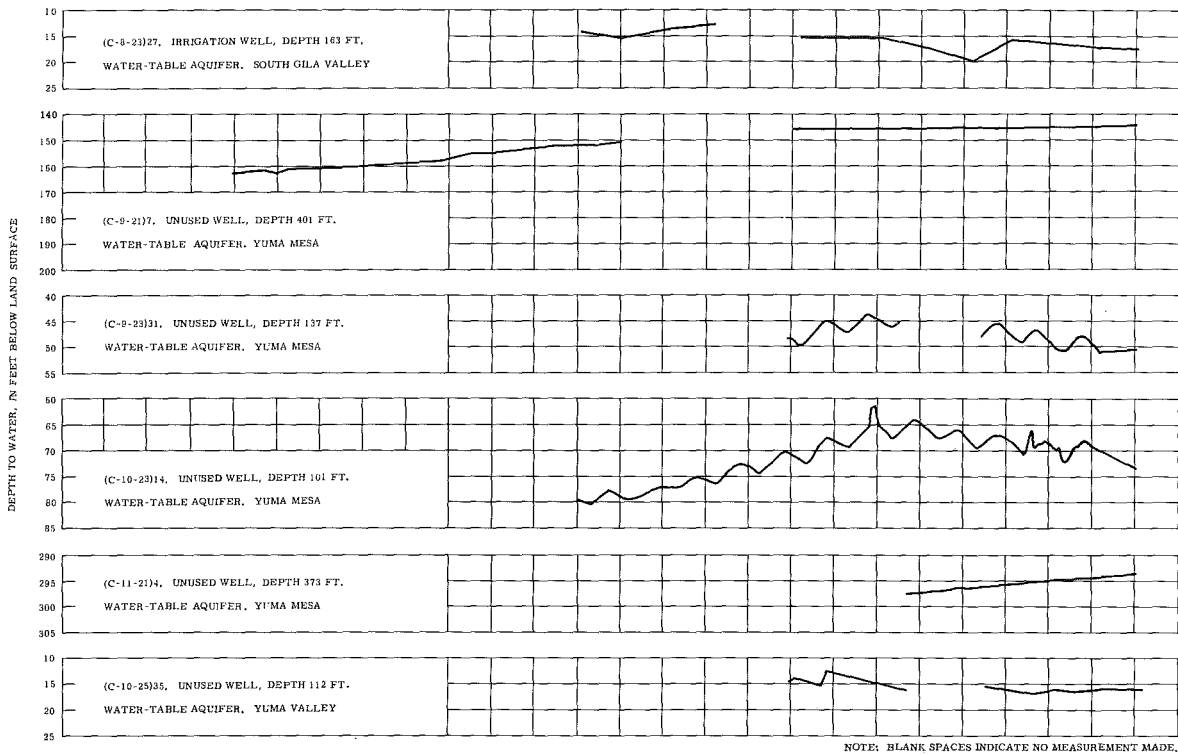


FIGURE 22. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE YUMA AREA.

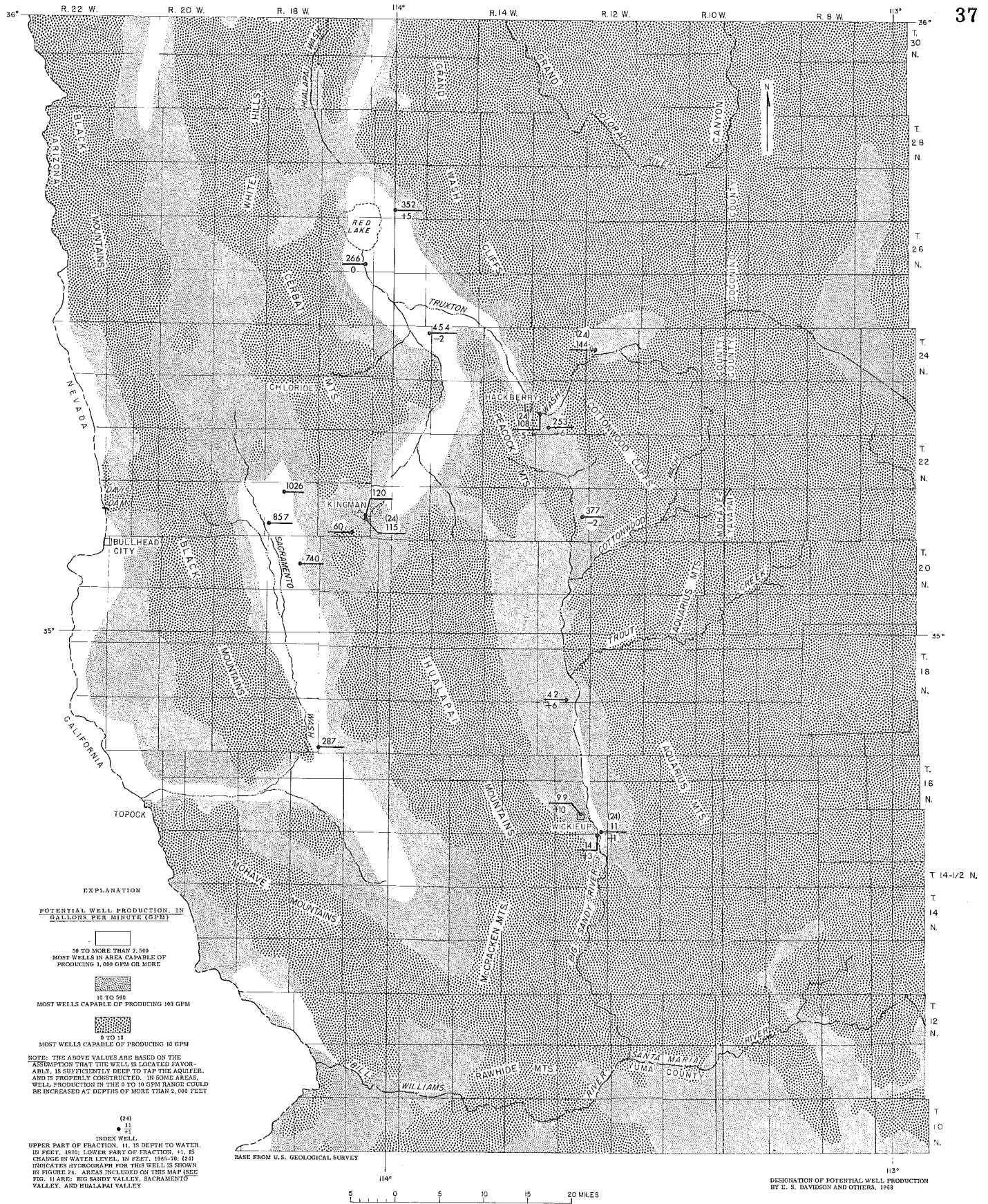


FIGURE 23. -- POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE NORTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

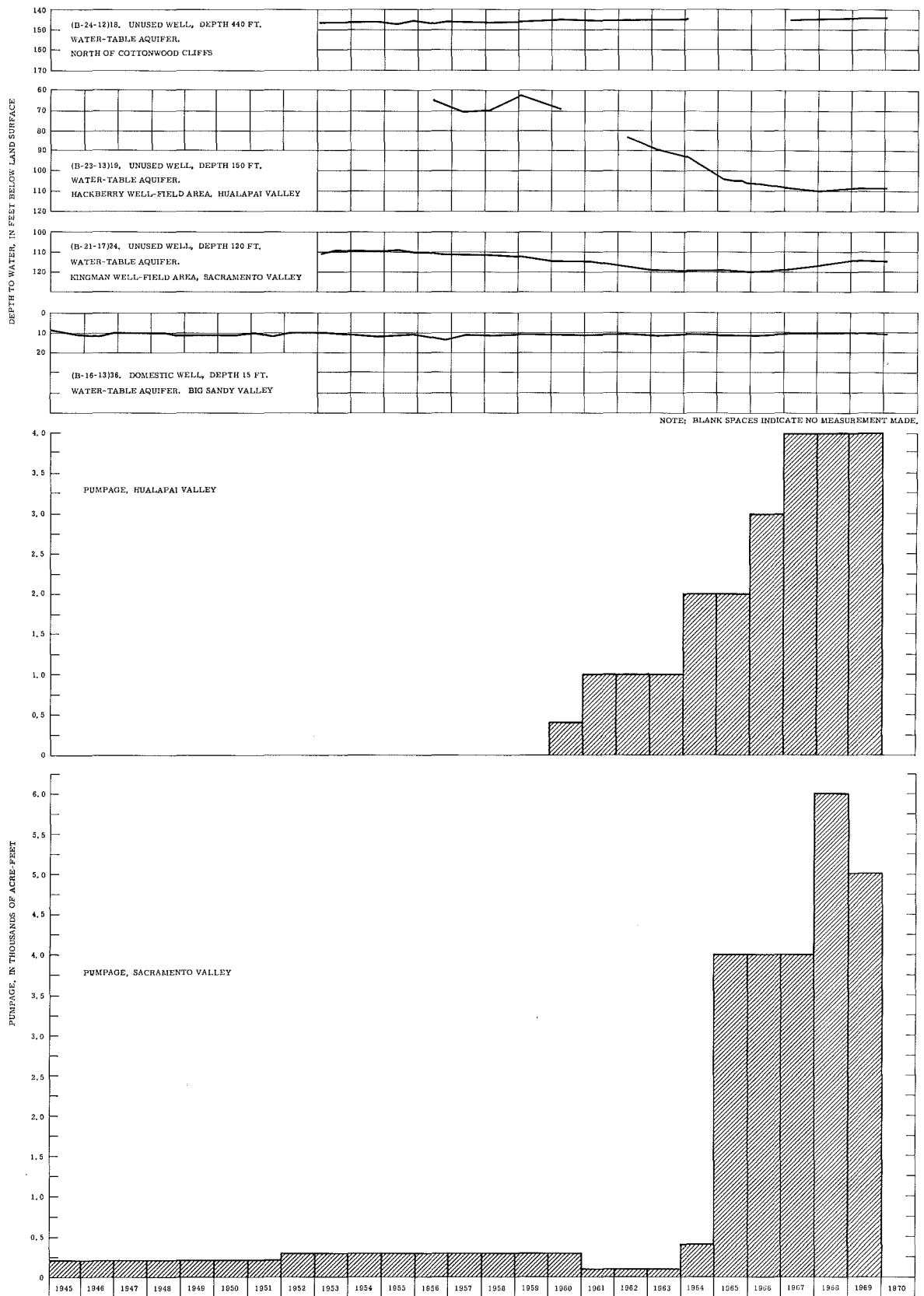


FIGURE 24.--DEPTH TO WATER IN SELECTED WELLS IN THE NORTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE AND ESTIMATED ANNUAL PUMPAGE IN HUALAPAI AND SACRAMENTO VALLEYS.

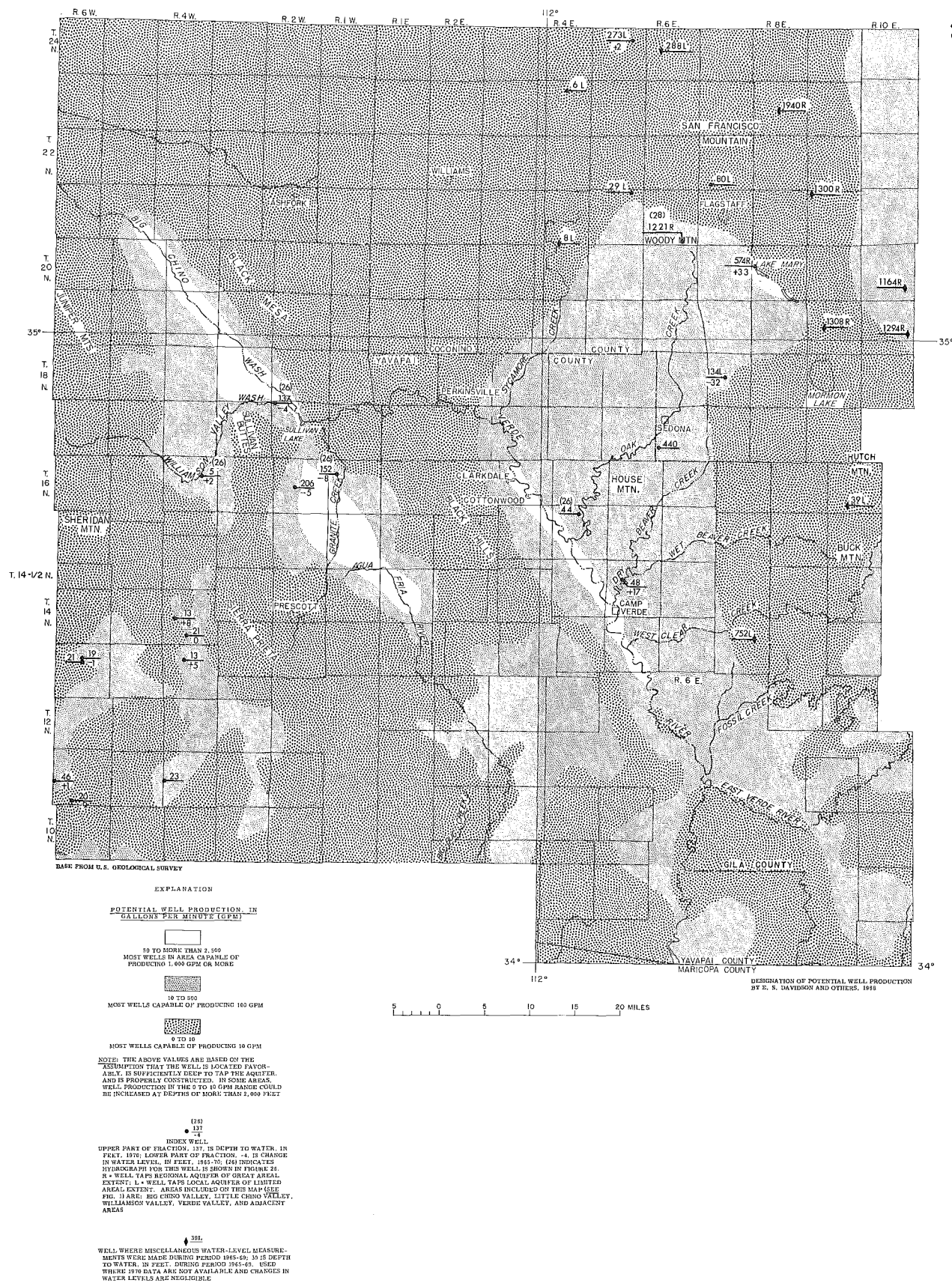


FIGURE 25. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE WEST PART OF THE CENTRAL HIGHLANDS PROVINCE AND THE SOUTH-CENTRAL PART OF THE PLATEAU UPLANDS PROVINCE.

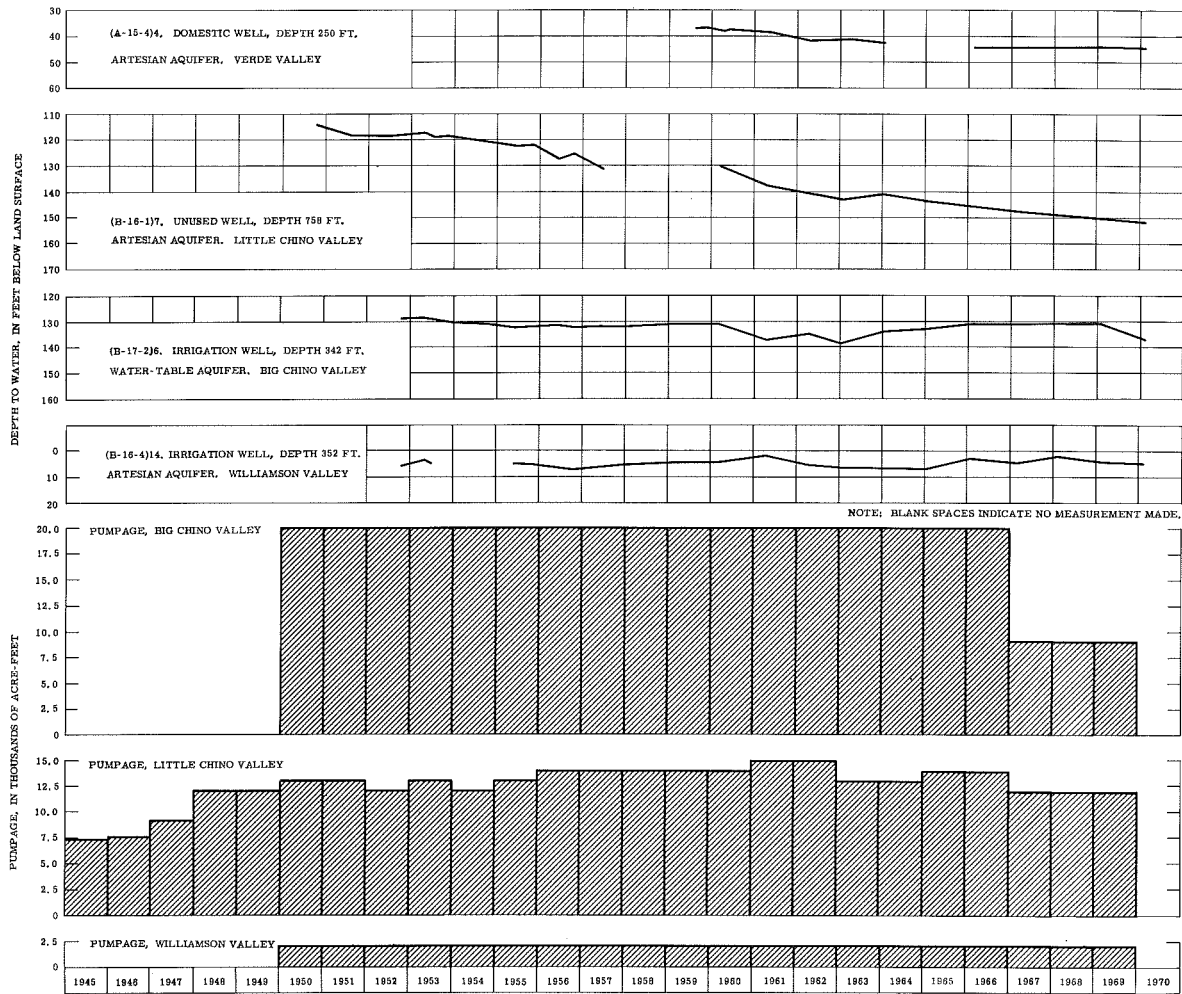


FIGURE 26. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SEVERAL AREAS IN THE CENTRAL HIGHLANDS PROVINCE.

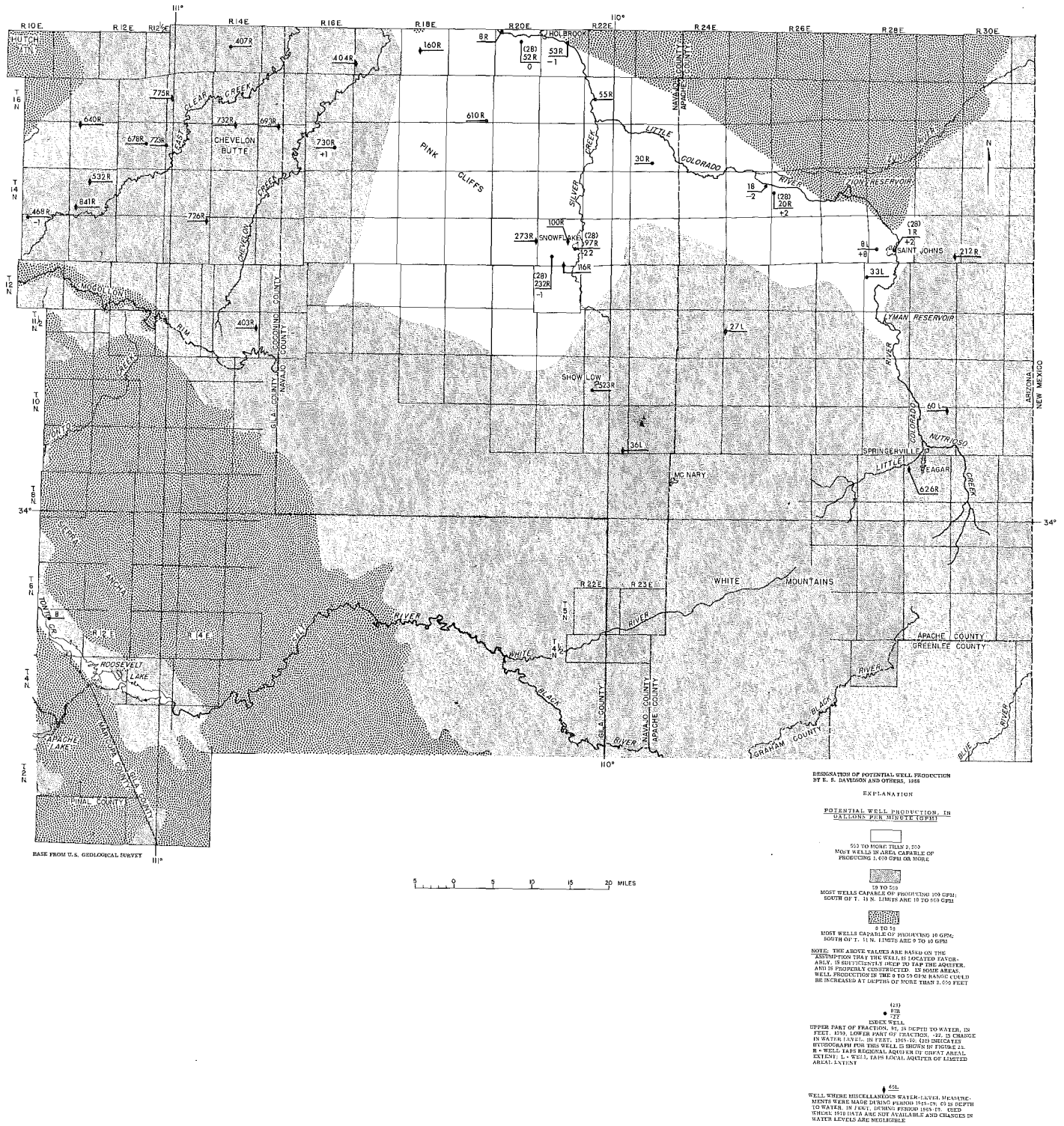
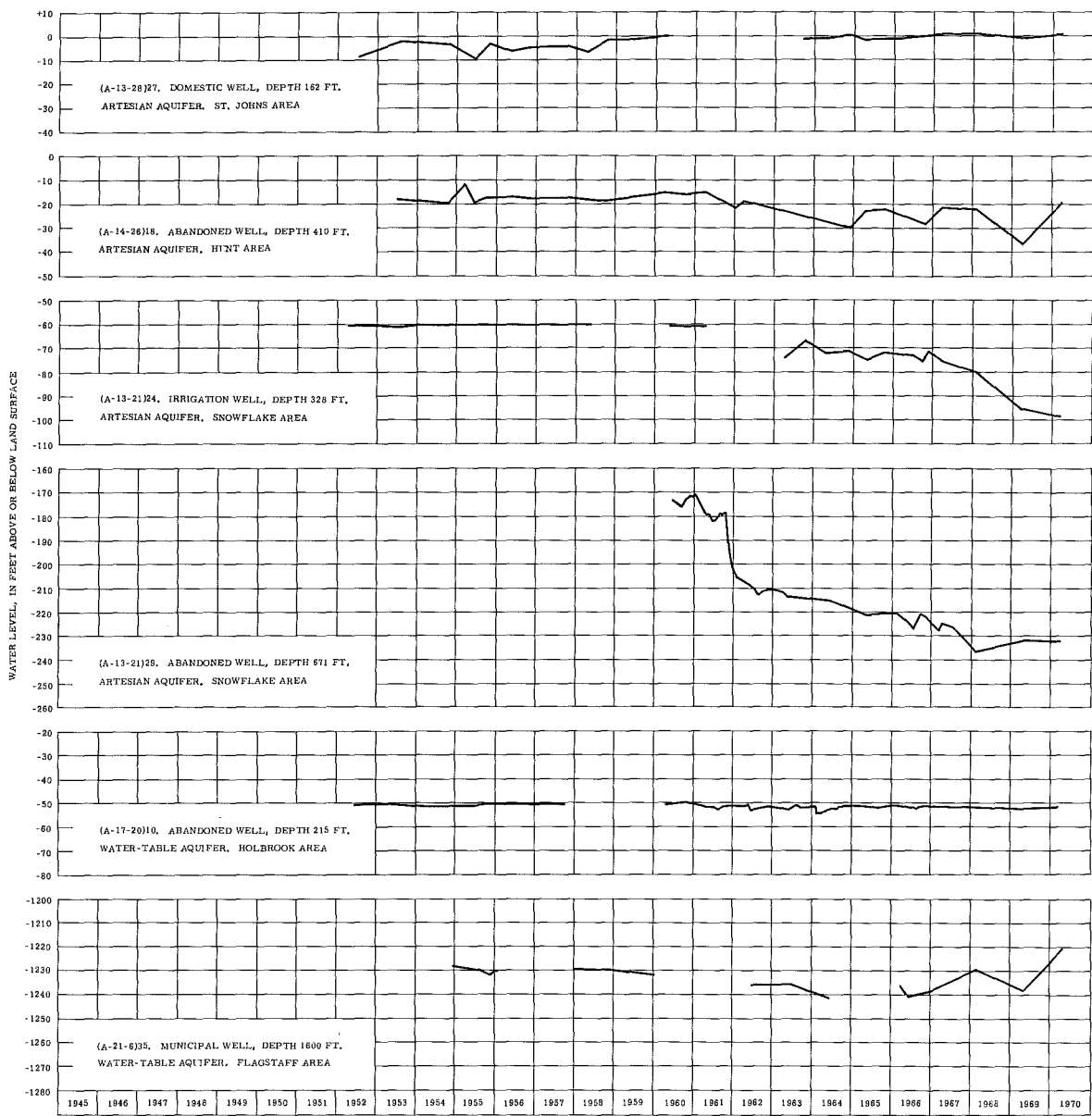


FIGURE 27. -- POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE EAST PART OF THE CENTRAL HIGHLANDS PROVINCE AND THE SOUTH-EAST PART OF THE PLATEAU UPLANDS PROVINCE.



NOTE: BLANK SPACES INDICATE NO MEASUREMENT MADE

FIGURE 28.--DEPTH TO WATER IN SELECTED WELLS IN SEVERAL AREAS IN THE PLATEAU UPLANDS PROVINCE.

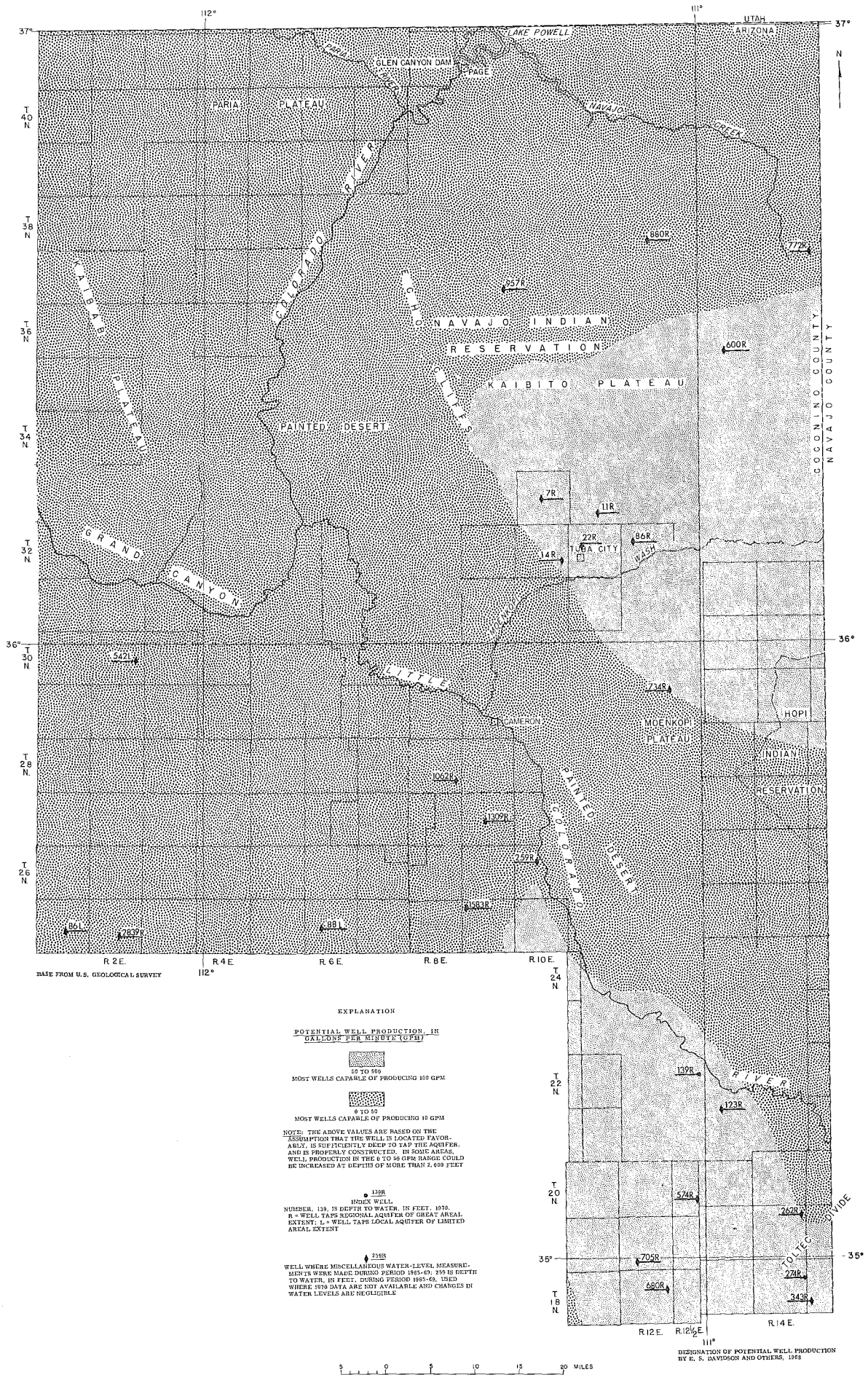


FIGURE 29. --POTENTIAL WELL PRODUCTION AND DEPTH TO WATER IN SELECTED WELLS IN THE NORTH-CENTRAL PART OF THE PLATEAU UPLANDS PROVINCE.

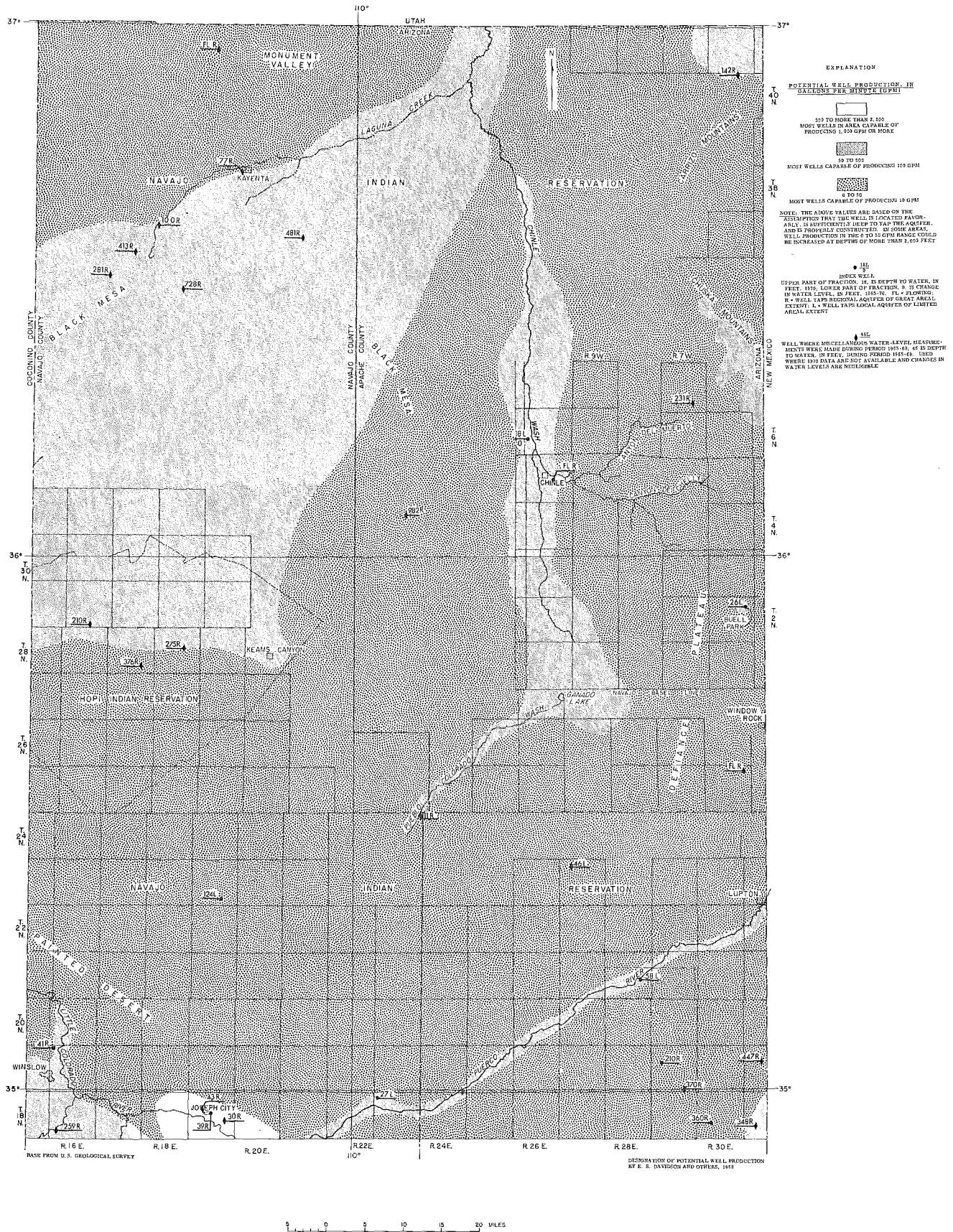


FIGURE 30. -- POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1970, AND CHANGE IN WATER LEVEL, 1965-70, IN SELECTED WELLS IN THE NORTHEAST PART OF THE PLATEAU UPLANDS PROVINCE.

