A SUMMARY OF GROUND-WATER PUMPAGE IN THE CENTRAL VALLEY, CALIFORNIA, 1961-77

By Jonathan Diamond and Alex K. Williamson

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 83-4037

6001-12

Sacramento, California
October 1983

UNITED STATES DEPARTMENT OF THE INTERIOR

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[Plate is in pocket]

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CONVERSION FACTORS

For those readers who may prefer metric (SI) units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply	By	To obtain
acres	0.004047	km^2 (square kilometers)
acre-ft (acre-feet)	0.001233	hm^3 (cubic hectometers)
acre-ft/yr (acre-feet per year)	0.001233	hm^3/a (cubic hectometers per annum)
ft (feet)	0.3048	m (meters)
gal (gallons)	0.003785	m^3 (cubic meters)
hph (horsepowerhours)	2,684,000	J (joules)
in (inches)	2.540	cm (centimeters)
kWh (kilowatthours)	3,600,000	J (joules)
mi (miles)	1.609	km (kilometers)
lb (pounds)	0.45	kg (kilograms)
mi^2 (square miles)	2.590	km^2 (square kilometers)

Degree Fahrenheit is converted to degree Celsius by using the formula: Temp °C = (temp °F-32)/1.8

ALTITUDE DATUM

National Geodetic Vertical Datum (NGVD) of 1929: A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

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ABSTRACT

In the Central Valley of California, a large agricultural economy has been developed in a semiarid environment. This economy is supported by 6 to 15 million acre-feet per year of surface water and 9 to 15 million acre-feet per year of ground water. Estimates of ground-water pumpage computed from power consumption have been compiled and summarized. Under ideal conditions, the accuracy of the methods used is about 3 percent. This level of accuracy is not sustained over the entire study area. When pumpage for the entire area is mapped, the estimates are consistent areally and through time.

A multiple linear-regression model was used to synthesize data for the years 1961 through 1977, when power data were not available. The model used a relation between ground-water pumpage and climatic indexes to develop a full suite of pumpage data to be used as input to a digital ground-water model, one of the products of the Central Valley Aquifer Project.

Statistical analysis of well-perforation data from drillers' logs and water-temperature data was used to determine the percentage of pumpage that was withdrawn from each of two depth zones.

INTRODUCTION

Many areas of the United States are dependent on ground water either as a large part of, or as their total water supply. National recognition of the importance of ground water to the economy of the United States was heightened by the energy crisis, when it was discovered that the principal untapped source of water that could be used for expanded development of the vast coal reserves of the Northern Great Plains was a little-studied limestone aquifer in the Madison Limestone of Mississippian age known as the Madison aquifer. In 1975, the U.S. Geological Survey began a study of the Madison aquifer as part of its activites in support of the national energy program. In 1976 and 1977, the western part of the United States experienced a major drought, and again the importance of ground water reached the national limelight. So important were the concerns over this national resource, the U.S. House of Representatives issued Committee Report Number 95-392 on June 6, 1977. This report introduced a national program for the analysis of regional aquifer systems and stated that "The Committee expects the Survey to press this program vigorously."

The Central Valley Aquifer Project is a part of the National Regional Aquifer Systems Analysis Program. Although the Central Valley lies entirely within the State of California, its long history of ground-water development and the complexity and immensity of the economic ties related to ground-water development make the valley among the first areas in the United States considered for study. This document is one of a series of reports produced by the Central Valley Aquifer Project.

Description of the Area

The Central Valley of California is one of the more notable structural depressions in the world. Surrounded by mountains and filled with alluvium derived from the mountains, the valley extends about 400 miles from north to south. It ranges in width from about 30 to 70 miles and covers about 20,000 mi^2. For study purposes, the Central Valley is referred to in four hydrologic subregions--Sacramento Basin, Delta, San Joaquin Basin, and Tulare Basin (fig. 1) (California Region Framework Study Committee, 1968). Most of the valley lies close to sea level in elevation, but along its margins it is higher. Maximum elevation in the valley is about 1,700 feet near the apexes of some alluvial fans in the southern part of the Tulare Basin. Most of the valley boundary along the eastern edge is about 500 feet above sea level and most of the western boundary ranges from 50 to 350 feet above sea level.

Climate in the Central Valley is arid to semiarid with average annual precipitation ranging from 14 to 20 inches in the Sacramento Basin and Delta, and from 5 to 14 inches in the San Joaquin and Tulare Basins (Rantz, 1969). Soils are deep and fertile and the growing season is long, allowing much of the valley to be double or triple cropped.

FIGURE 1. – Subregions and landforms of the California Region. (Modified from Thomas and Phoenix, 1976).

Because of its amenable climate and fertile soils, the Central Valley boasts of a large agricultural economy. Four of the Nation's top five agricultural counties (in terms of the value of crops sold, 3.1 billion dollars) lie in the San Joaquin and Tulare Basins; and approximately 40 percent of the Nation's fruits, nuts, and vegetables (1976 value about 1.5 billion dollars) are grown in the Central Valley (U.S. Agricultural Crop Reporting Service, written commun., 1976).

Agriculture has been sustained in this semiarid environment by the development of an extensive system of reservoirs and canals and also by the ready availability of ground water. Total ground-water pumpage in the Central Valley from 1961 through 1977 ranged from 9 to 15 million acre-ft/yr. In some parts of the valley, pumping has caused a progressive decline of water levels in wells and depletion of ground-water storage. Of the 15 ground-water basins identified by the California Department of Water Resources in the San Joaquin Basin, 8 have been determined to be subject to a critical condition of overdraft (California Department of Water Resources, 1980, p. 38-48).

Purpose and Scope

Ground-water pumpage is a major part of the hydrologic cycle of the Central Valley. Knowledge of the quantity and distribution of pumpage is necessary for studies of the hydrologic system, land subsidence, and water quality. Because of the importance of ground water to Central Valley agriculture and the interrelation of agriculture, energy, and water, this knowledge is also valuable to economists, agronomists, and planners. The purpose of this part of the Central Valley Aquifer Project is to gather and analyze all available information on the magnitude and distribution of ground-water pumpage in the Central Valley. These data will be used as input to a digital ground-water model, one of the products of the Central Valley Aquifer Project.

Since 1965, the U.S. Geological Survey has had a continuing program to estimate ground-water pumpage from electric power consumption in the Central Valley. Reports generated by this program have contained computed estimates of pumpage for various irregular areas and time periods. Many of these reports were published in limited quantities and are now out-of-print. This report is a compilation of data from 11 published reports and from data not previously published. Estimates of annual ground-water pumpage by township are presented for the years 1966-71 for the Sacramento Valley and 1962-71 and 1974-77 for the San Joaquin Valley. Methods used to compute the estimates are described and their accuracy examined. Compilation of all available estimated pumpage data aids in the study of areal and temporal trends and allows quantitative and qualitative checks for consistency.

Preparation of data for the Central Valley Aquifer Project (CVAP) digital ground-water model required a full 17-year record of pumpage data for the entire Central Valley. Estimation of missing data was done by means of a regression model which also provided a semiquantitative check on the reasonableness of the previously computed pumpage.

The CVAP ground-water model of the Central Valley has an upper and a lower zone. The percentage of pumpage coming from the lower zone was determined by a statistical analysis of drillers' logs, water-temperature data, and other well-construction information.

Acknowledgments

The authors wish to acknowledge the cooperation of the Pacific Gas and Electric Co., the Southern California Edison Co., the Sacramento Municipal Utility District, and the Southern California Gas Co., in supplying information on ground-water pumpage, pumping-plant efficiency tests, and agricultural power consumption. They are also grateful for the cooperation and assistance received from irrigation district officials, and city, county, State, and Federal agencies.

METHODS OF COMPUTING GROUND-WATER PUMPAGE IN THE CENTRAL VALLEY

Comparison of Methods

Discharge from agricultural wells is rarely metered in the Central Valley. Ground-water pumpage must be estimated by indirect means. The two most common methods are: estimation by consumptive use of water and estimation by power consumption.

Consumptive use of water in this context refers to all evaporation and transpiration by a particular crop type. If this quantity is known, ground-water pumpage may be estimated by taking into account surface-water supply, irrigation efficiency, and effective precipitation. Effective precipitation is precipitation that meets the demands of consumptive use--the fraction of annual precipitation that is available for use by crops during the growing season. Irrigation efficiency is the percentage of water delivered to the farm that is available for consumptive use. An estimate of pumpage may be obtained by the following formula:

$$\text{Irrigation requirement} = SW + GW = \frac{CU - EP}{IR}$$

so:

$$GW = \frac{CU - EP}{IR} - SW$$

where

GW	=	ground-water pumpage,
IR	=	irrigation efficiency,
CU	=	consumptive use,
SW	=	surface-water supply,
EP	=	effective precipitation, and
CU - EP	=	evapotranspiration of applied water.

In some areas, tables are available which list irrigation efficiency and the consumptive use of water for various crops. Where these are not available, consumptive use must be estimated from climatic data. Irrigation efficiency must be assigned on the basis of judgment and experience. Surface water released to irrigation districts in California can be determined from published data; estimates must be made for smaller areas within a district. Accuracy of the estimate of ground-water withdrawal depends on accuracy of the above estimates. A disadvantage of this method is that it has no direct connection with the quantity of pumpage; instead, it relies on estimates of factors which affect ground-water pumpage.

The power-consumption method involves estimating pumpage from the amount of power consumed by well pump motors. This information is obtained from utility company records. Data for relating power consumption (kilowatt-hours) to ground-water pumpage (acre-foot) may be obtained from plant-efficiency tests run by the utility companies at the customer's request.

Electric-power consumption can be related to the volume of ground-water pumpage by:

1 acre-ft of water lifted 1 foot = 325,850 gal x 8.34 lb/gal x 1 foot
= 2,717,589 lb x 1 foot
= 2,717,589 ft/lb

1 kilowatthour = 2,655,240 ft/lb

The power required to lift 1 acre-ft of water 1 foot at 100 percent efficiency is, therefore

$$K = \frac{2,717,589}{2,655,240}$$

$$\cong 1.02$$

where:

K = (kWh/acre-ft)/ft of lift

The average efficiency of a pumping plant determined from a sample of about 4,000 plant-efficiency tests in the San Joaquin Valley is about 54 percent.

Efficiency may be expressed as:

$$E = \frac{O}{I} \times 100,$$

where

E = efficiency, in percent
O = output,
I = input.

Solving for I, the equation becomes:

$$I = \frac{O}{E} \times 100.$$

Output may be replaced by the amount of power required to lift an acre-foot of water 1 foot which gives:

$$I = 1.02 \times \frac{100}{E}$$

where I is in units of kilowatthours per acre-foot per foot of lift.

Where pumps are powered by internal combustion engines, a similar equation may be derived using brake horsepowerhours instead of kilowatthours.

1 brake horsepowerhour = 1,980,000 ft-lb

$$Vq = \frac{2,717,589}{1,980,000} \times Vhph \times \frac{100}{E},$$

$$\cong 1.37 \times Vhph \times \frac{100}{E},$$

where

Vq = volume of fuel required to lift 1 acre-ft of water about 1 foot, and
Vhph = volume of fuel required to produce 1 brake horsepowerhour.

There are two basic approaches to computing ground-water pumpage from power consumption. One is the efficiency-lift method which requires total power consumption, average pumping-plant efficiency, and average pumping lift. The other approach is the unit power-consumption method. Unit power consumption is the number of kilowatthours required to pump an acre-foot of water during a plant-efficiency test. Data required for this method are total power consumption and an average of unit power consumption.

In a pilot study designed to explore costs and procedures for calculating ground-water pumpage, Ogilbee (1966, p. 17-31) compared six variations of the two basic approaches described above and three trials of the consumptive-use method using different assumed values for irrigation efficiency. The variations in the power-consumption methods were the timespan of the tests used to calculate an average efficiency, methods used to determine total lift, and whether or not the mean efficiency or unit power consumption was weighted by the discharge of the pump. Pumpage calculated by the consumptive-use method varied directly with the irrigation efficiency used.

Because ground-water pumpage was not metered, there can be no direct determination of the accuracy of the different methods of estimation. The estimates of pumpage are all reasonably similar.

The variance of efficiency is smaller than that of unit power consumption, hence, the mean value of efficiency can be estimated more accurately than a mean value of unit power consumption. The primary factor in the variation of efficiency is the variation of pumping lift. This implies that the most accurate method of estimating pumpage would be to use the efficiency-lift method incorporating as many measurements as possible of pumping lift. In many areas, however, there are fewer regularly monitored water-level observation wells than efficiency tests and these recorded water levels show only the static component of pumping lift, not including drawdown or discharge head. The calculation of unit power consumption integrates plant efficiency and total pumping lift and has the additional advantage of being measured throughout the pumping season.

Ogilbee (1966) concluded that the most convenient and reliable technique is to use total power consumption and annual mean unit power consumption to compute estimates of pumpage.

Methods Used in Previous Reports

Estimates of pumpage compiled in this report are classified by usage into two types, agricultural and municipal. Methods of computing estimates for the two types differ and are described below.

Agricultural Pumpage

Agricultural pumpage in the Central Valley is computed from power consumption (Appendix A). Although most of the pumps in the area are powered by electricity, pumpage from wells using internal combustion engines may be computed by methods similar to those used for electric power.

Data for computing pumpage estimates are obtained from public utility companies under an agreement of confidentiality. Raw data are classified as confidential and data from individual accounts may not be identified. Estimates of pumpage may be released to the public for areas no smaller than 36 mi^2. Estimates of pumpage are not traceable to individual accounts because raw data are summed and averaged as described below.

Agricultural ground-water pumpage is computed for each year for each unit area. The optimum size for the unit area is the smallest size that has a sufficient amount of data available. The unit area used in the Central Valley is the quarter-township (fig. 2). For public release, estimates of pumpage from the unit areas are summed. The method for computing pumpage from electric power consumption may be divided into two parts, computation of unit area totals and estimation of the mean unit power consumption.

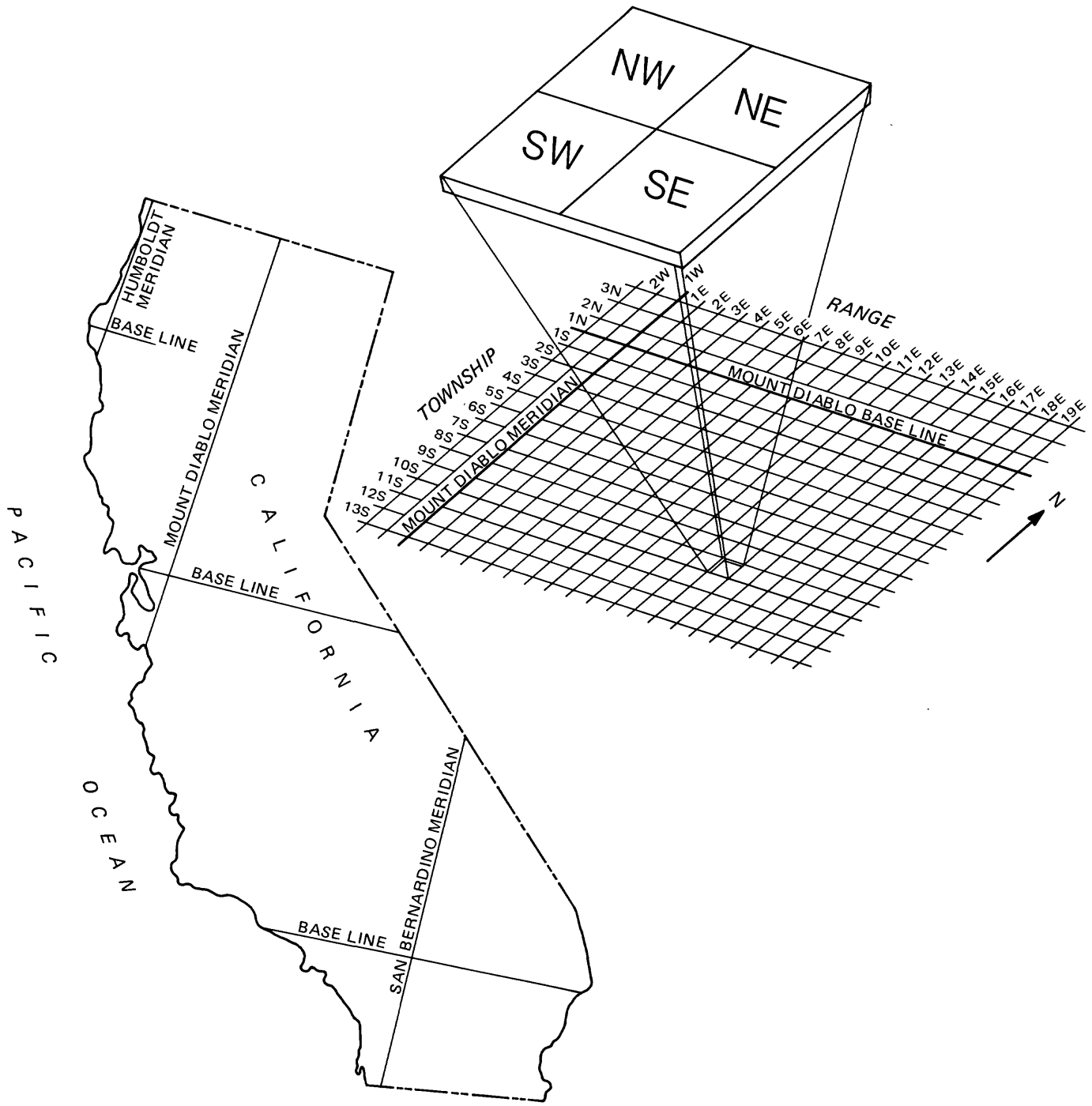


FIGURE 2. – Township and range system in California.

Computation of unit area totals.--Computation of total power consumption for each unit area would be straightforward were it not for one major flaw in the power-consumption data. There is no direct way to distinguish a well pump power-consumption record from one that indicates electrical power consumption by another type of pump or agricultural implement. Indirect methods that have been tried include: comparison of seasonal power consumption totals; identification of wells through fieldwork; and comparison of frequency distributions of motor horsepower with pumping lift.

Estimation of mean unit power consumption.--Plant-efficiency tests for each unit area are edited to delete tests on ditch pumps and booster pumps. Multiple tests on the same well are also deleted to avoid biasing the mean unit power consumption by the efficiency of one well.

Several methods have been used to estimate the mean unit power consumption. The preferred method is to take the mean value of the edited unit power consumption figures for each year in each unit area. Previous work on error analysis (Allison, 1967, p. 47-52) has indicated that reasonable estimates of the average unit power consumption may be obtained by taking the mean of as few as four values of unit power consumption from the plant-efficiency tests. For areas where less than four tests were available or due to other constraints, three alternative methods have been used: (1) The mean of unit-power consumption values from tests conducted over several years may be used; (2) values for mean unit power consumption in unit areas that have a sufficient supply of data may be mapped and contoured. Missing values may then be interpolated from the map; (3) a least-squares linear regression may be computed between total lift and unit power consumption from all available plant-efficiency tests in a larger area. An average total lift for each unit area in this larger area may be determined from water-level maps, average pumping drawdown, and average head due to use of sprinklers. An estimated value for average unit power consumption for each unit area may then be determined from the least-squares relation.

In areas where natural gas is inexpensive, pumps may be driven by internal combustion engines using natural gas as fuel. Data on natural gas consumption were available for 1965-68. Pumpage was estimated by calculating the number of brake horsepowerhours needed to lift 1 acre-ft of water 1 foot and then estimating the volume of fuel required to produce 1 brake horsepower-hour and dividing by an assumed efficiency of 60 percent. The resulting figure is the volume of natural gas required to lift 1 acre-ft of water 1 foot at 60 percent efficiency. This figure is then multiplied by the average pumping lift for each unit area. Pumpage is computed by dividing total fuel consumption per unit area by the volume of gas required to pump 1 acre-ft.

During drought conditions in 1977, new wells were drilled and many previously abandoned wells were reactivated to augment diminished surface-water supplies. Many of these wells were powered by internal combustion engines. Pumpage from these wells was prorated from data associated with nearby electrically operated wells (Mitten, 1978).

Municipal Pumpage

Data on water pumped for municipal use in the Sacramento Valley were obtained by contacting the municipal water agencies, most of whose wells are metered.

In the San Joaquin Valley, municipal pumpage was estimated on the basis of per capita use. Data on ground-water pumpage were obtained from 27 communities ranging in population from about 1,000 to 145,000. The reported volume of water used by each community was divided by its population to determine a per capita use factor. Average per capita use factors (acre-foot per year per person) obtained were: 0.25 for communities of less than 3,000; 0.30 for communities with populations of 3,000-10,000; and 0.38 for communities with populations greater than 10,000. Population data were obtained from the 1960 census and from estimates made by the Population Research Section, California Department of Finance (Ogilbee and Rose, 1969a, p. 2).

Annual municipal ground-water pumpage estimates for townships in the Central Valley, calculated by the methods described above, have been compiled and are included in this report as Appendix B.

Summary of Results

The study area was divided into 29 subareas (fig. 3) to aid in analysis of the pumpage data as described later in this report. Annual township agricultural pumpage summed over these areas is shown in table 1. Maps of agricultural and municipal pumpage data are shown in four maps (fig. 4).

The maps reflect the distribution and quantity of ground-water pumpage and the availability or nonavailability of the data. The map for 1962 (fig. 4a) shows the distribution and magnitude of ground-water pumpage data at the beginning of the study period for a year in which the climate was relatively normal. Agricultural pumpage data were not available for the Sacramento Valley in 1962. Isolated symbols in the Sacramento Valley indicate pumpage for municipal use.

Figures 4b and 4c show the contrast between a year with below normal rainfall (1966) and a year with above normal rainfall (1967). The blank area in the middle of the valley is the Delta subregion. Power data for this subregion were inadequate to compute reliable estimates of pumpage.

The year 1975 was selected as one of relative climatic normalcy at the end of the study period. The map for that year (fig. 4d) shows the absence of data for the Sacramento Basin and Delta subregions and also for an area in the southeastern part of the San Joaquin Valley. The discernible reduction in the amount of pumpage on the west side of the San Joaquin Valley was due to the increased importation of surface water by the California Aqueduct for irrigation in that area.

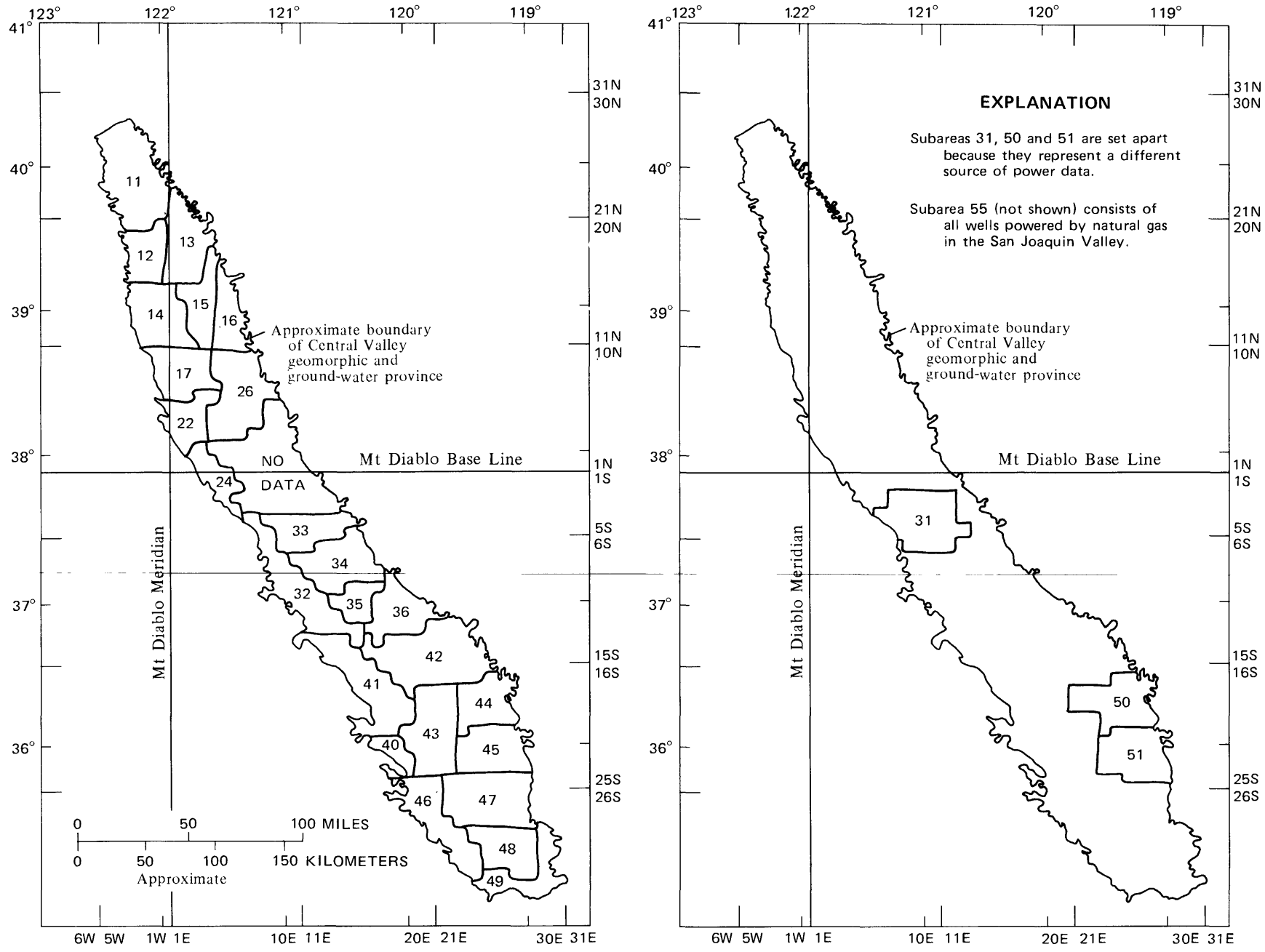
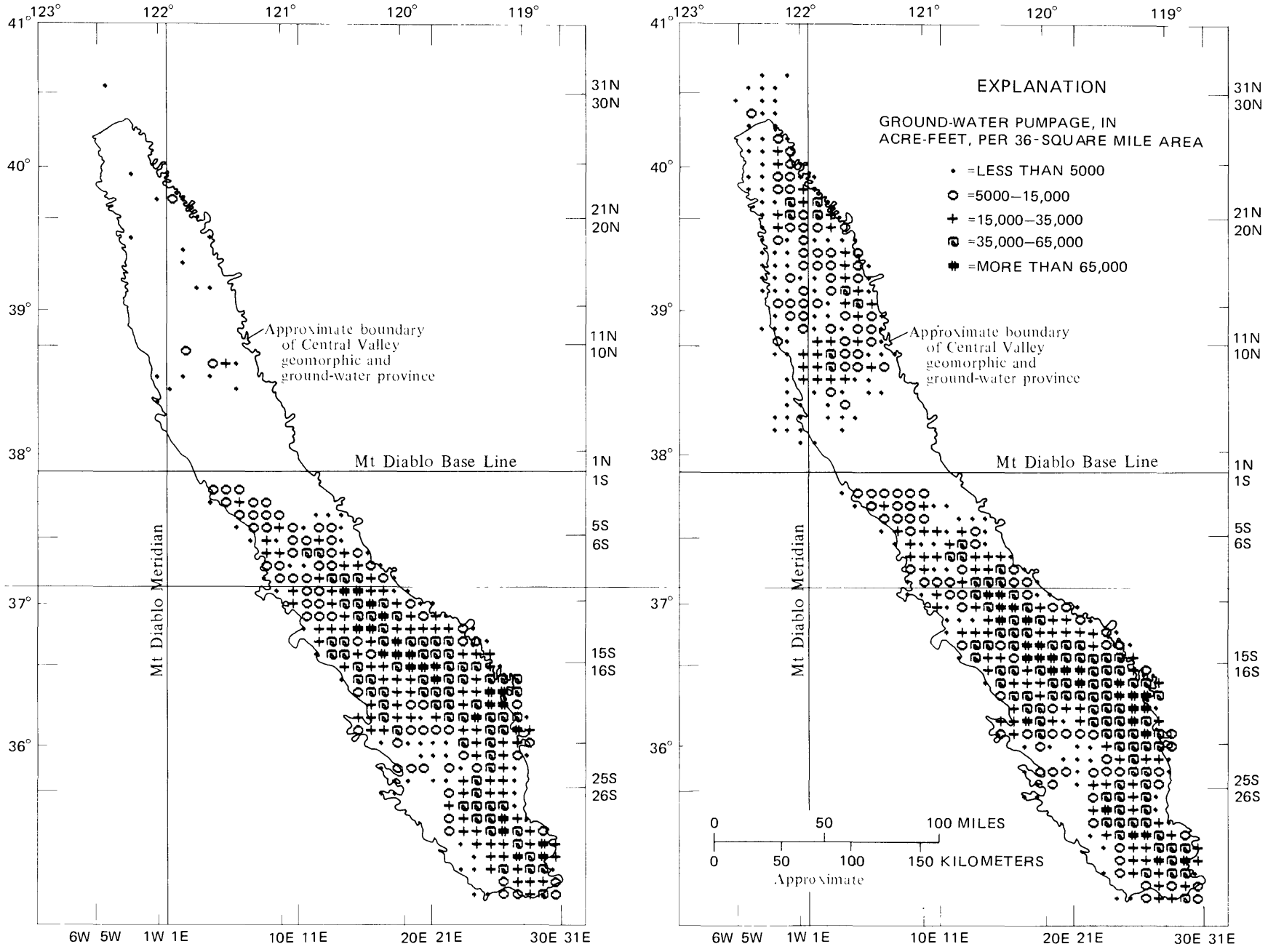


FIGURE 3. – Subareas used for regressions.

TABLE 1. - Agricultural ground-water pumpage by subarea computed from power consumption

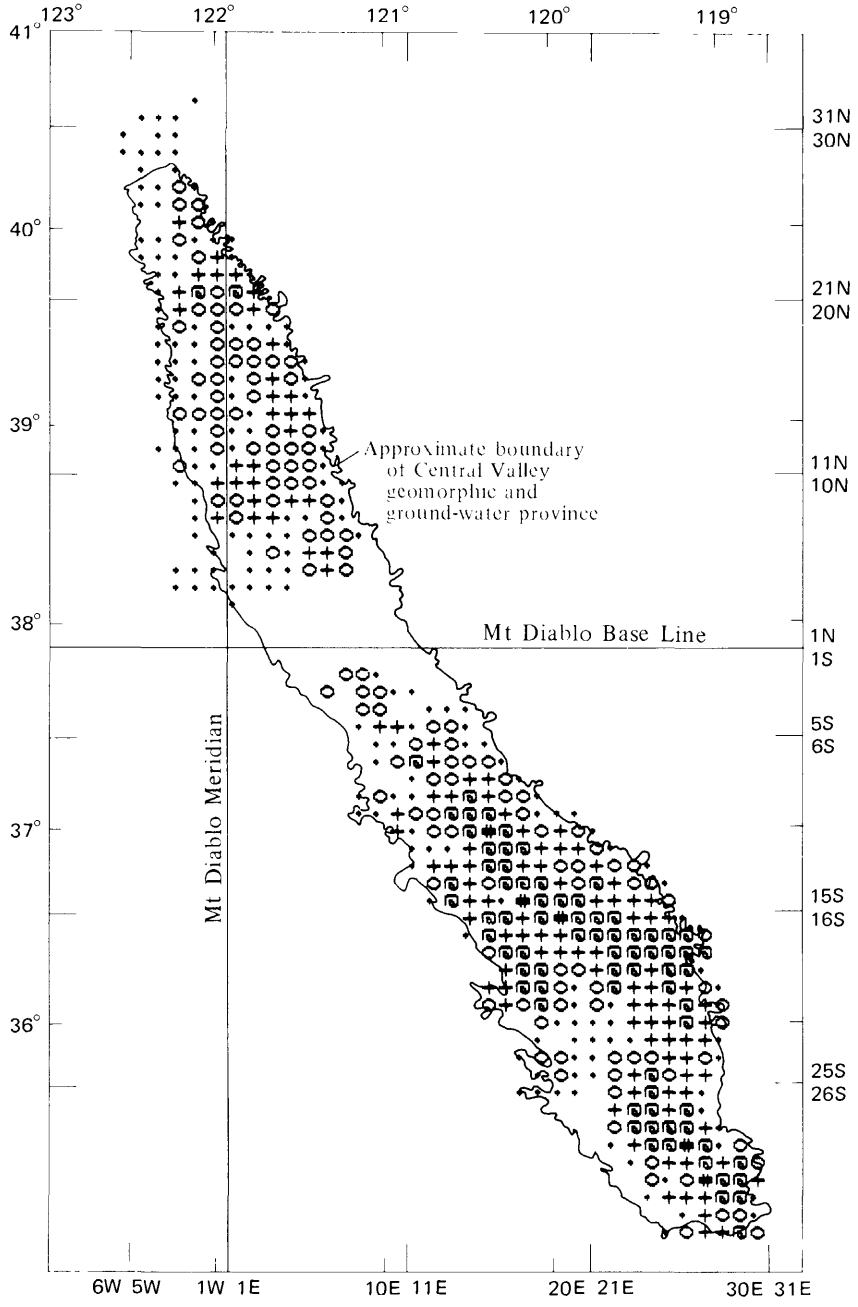
[Pumpage in thousands of acre-feet rounded to three significant figures]

Subarea (fig. 3)	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	Mean
11	--	--	--	--	--	298	233	272	284	279	288	--	--	--	--	--	--	276
12	--	--	--	--	--	41	34	50	46	57	59	--	--	--	--	--	--	43
13	--	--	--	--	--	300	251	323	286	299	330	--	--	--	--	--	--	298
14	--	--	--	--	--	153	107	156	132	150	157	--	--	--	--	--	--	143
15	--	--	--	--	--	180	139	192	153	163	156	--	--	--	--	--	--	164
16	--	--	--	--	--	196	163	221	212	201	193	--	--	--	--	--	--	198
17	--	--	--	--	--	321	236	326	262	243	262	--	--	--	--	--	--	275
Total						1,490	1,160	1,540	1,380	1,390	1,440							1,400
22	--	--	--	--	--	36	28	36	24	23	22	--	--	--	--	--	--	28
24	--	81	68	68	81	66	--	--	--	--	--	--	--	--	--	--	--	73
26	--	--	--	--	--	--	189	232	231	269	259	--	--	--	--	--	--	236
Total		81	68	68	81	102	217	268	255	292	281							337
31	54	64	63	69	75	150	117	93	154	246	258	185	175	278	296	390	550	189
32	--	437	413	420	411	424	230	208	208	249	259	--	--	--	353	408	433	343
33	--	44	39	51	50	60	40	47	47	57	65	--	--	--	51	81	84	55
34	--	320	300	376	355	448	279	349	318	372	454	--	--	--	357	545	687	397
35	--	369	364	411	415	432	336	412	371	413	433	--	--	--	393	569	608	425
36	--	489	457	515	511	521	415	503	434	480	487	--	--	--	483	695	728	517
Total	54	1,720	1,640	1,840	1,820	2,040	1,420	1,610	1,530	1,820	1,960	185	175	278	1,940	2,690	3,090	1,930
40	--	92	100	102	102	109	106	78	85	74	79	--	--	--	68	32	98	87
41	--	888	844	869	773	873	824	573	571	448	369	--	--	96	142	109	451	559
42	--	1,790	1,610	2,000	1,770	1,940	1,410	1,730	1,540	1,790	1,820	--	--	--	1,490	1,920	2,330	1,780
43	--	286	224	314	261	268	176	222	90	162	188	--	--	--	130	200	337	220
44	--	73	62	88	74	97	54	70	47	76	84	--	--	--	73	83	149	79
45	--	73	57	74	72	68	43	48	31	32	51	--	--	--	56	59	103	59
46	--	86	96	97	100	90	67	99	89	110	140	--	--	--	242	302	299	140
47	--	608	569	693	624	732	541	517	599	580	669	--	--	--	577	725	826	635
48	--	606	597	621	565	611	531	475	448	438	435	--	--	--	521	430	664	534
49	--	552	487	448	443	472	376	294	363	279	259	--	--	--	248	242	338	369
Total		5,050	4,650	5,310	4,780	5,260	4,130	4,110	3,860	3,990	4,090	--	--	96	3,550	4,100	5,600	4,460
50	--	995	994	1,290	1,020	1,020	634	1,000	--	--	--	--	--	--	--	--	--	993
51	--	570	567	717	546	583	460	762	--	--	--	--	--	--	--	--	--	601
55	--	--	--	--	130	155	122	159	--	--	--	--	--	--	--	--	--	142
Total		1,560	1,560	2,010	1,700	1,760	1,220	1,920										1,730
Grand total	54	8,420	7,910	9,220	8,380	10,600	8,140	9,450	7,020	7,490	7,780	185	175	374	5,480	6,790	8,680	8,460

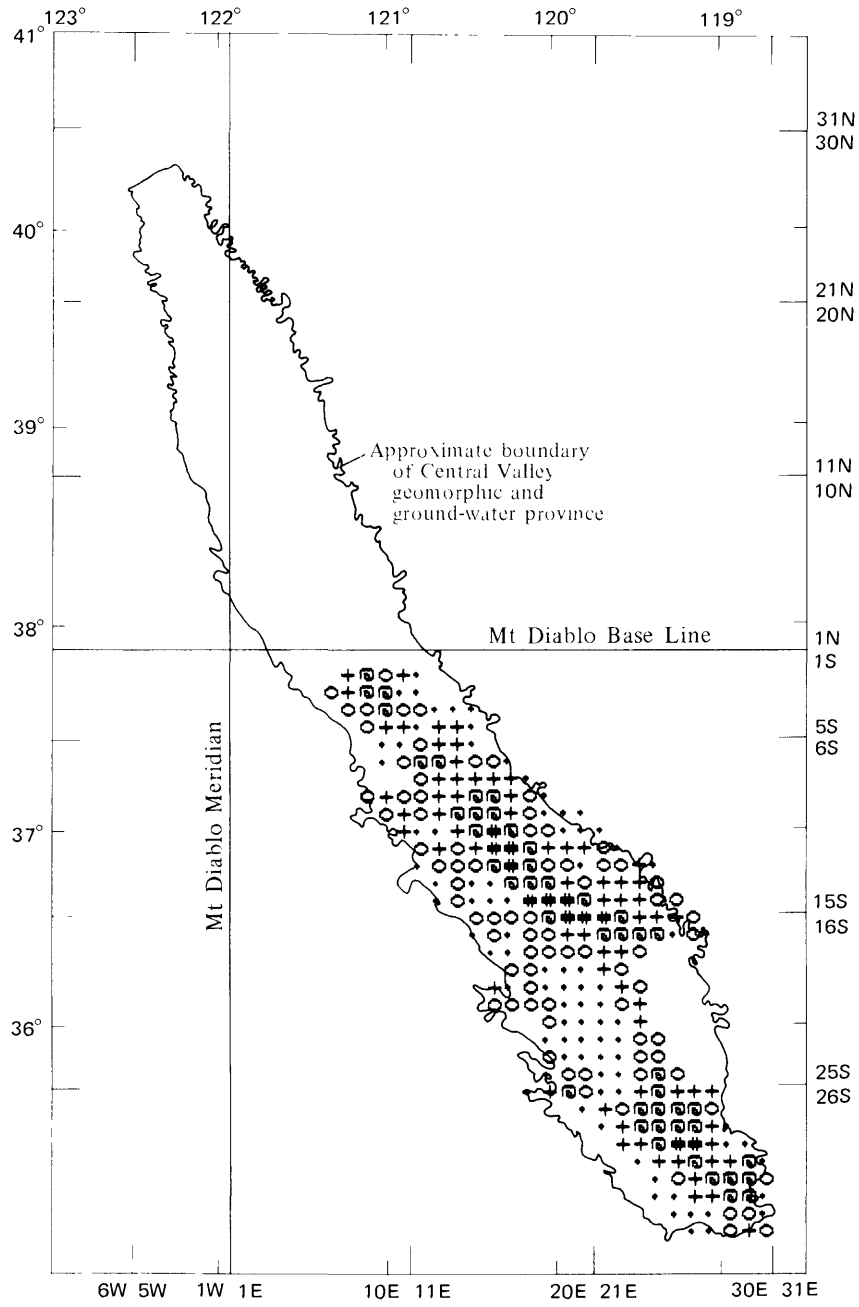

123°
122°
121°
120°
119°
41°
40°
39°
38°
37°
36°
31N
30N
21N
20N
11N
10N
1N
1S
5S
6S
15S
16S
25S
26S
Approximate boundary of Central Valley geomorphic and ground-water province
Mt Diablo Base Line
Mt Diablo Meridian
6W 5W 1W 1E 10E 11E 20E 21E 30E 31E
EXPLANATION
GROUND-WATER PUMPAGE, IN ACRE-FEET, PER 36-SQUARE MILE AREA
• =LESS THAN 5000
O =5000–15,000
+ =15,000–35,000
a =35,000–65,000
# =MORE THAN 65,000
0 50 100 MILES
0 50 100 150 KILOMETERS
Approximate

a. 1962

b. 1966



c. 1967



d. 1975

FIGURE 4. — Ground-water pumpage computed from power.

Accuracy of Estimates of Computed Pumpage

The only method for making an absolute determination of the accuracy of pumpage estimates computed by the methods shown would be to accurately meter the discharge of all wells in a selected area and compare the total annual discharge to the computed estimate.

A comparison of metered and estimated pumpage for two townships in Santa Clara County was described in a progress report for the pilot pumpage study referred to earlier (Ogilbee and Mitten, 1970, p. 19). Ground-water pumpage from about 200 wells was metered. The water meters were new and factory calibrated to a maximum error of 2 percent. Calculated pumpage using annual mean unit power consumption differed from metered pumpage by a maximum of 2.7 percent. This represents the expected error under close to ideal conditions.

The following are some assumptions which may cause systematic errors in the calculation of estimates of pumpage.

1. Annual total power consumption represents only power used by well pump motors.
2. The sample mean unit power consumption accurately estimates the true mean number of kilowatthours used to pump 1 acre-ft of water in a particular unit area.

Because ground-water pumpage is total power divided by average unit power consumption, pumpage will vary directly with total kilowatthours. Any power consumption included in this total that is not used for pumping will result in overestimating ground-water pumpage. Despite the techniques described in the previous section to edit out power accounts that do not represent wells, it is inevitable that some power consumption for other purposes is erroneously added to the total. Errors of this type may be detected by comparison. An annual value for a township may be compared to totals for years before and after to determine if the value makes sense in terms of the general trend. A unit area may also be compared with surrounding areas if the land use is comparable. Finally, pumpage estimated from power consumption could be checked against pumpage computed by another method such as the consumptive-use method.

A plant-efficiency test measures the unit power consumption of a particular well for the duration of the test. Thus, an individual test is a sample in time from a population comprising all values of unit power consumption for a particular well. Unit power-consumption values from tests of several different wells in a unit area represent a sample taken from the population of all the wells in that area.

The standard error of a sample mean unit power consumption was calculated by Allison (1967, p. 52-53) for one sample township in the San Joaquin Valley as part of an analysis of error in ground-water modeling. He showed the relation of the number of tests to the standard error of pumped withdrawals. In the township sampled, the error expected for about two-thirds of the cases ranged from about 12 percent with a sample of 4 to about 4 percent with a sample of 49.

One way to test the accuracy of average unit power-consumption data would be to compare it to water-level data to see if the resulting efficiency values were reasonable.

A regression using about 350 mean values of unit power consumption and pumping water levels estimated from independent measurements produced an average kilowatthour per acre-foot value of 1.78 and a coefficient of determination (R^2) of 0.88. When plugged into the equation derived on page 7,

$$I = 1.02 \times \frac{100}{E} ,$$

this value is equivalent to an efficiency of about 57 percent which coincides well with the average efficiencies reported by other authors (Ogilbee, 1966, p. 15; Allison, 1967, p. 53).

Another aspect of the accuracy of the average unit power consumption is the possibility of bias in the wells selected for plant-efficiency tests. Three different possibilities for bias can be identified: (1) Plants selected for testing may be consistently more or less efficient than the population mean; (2) plants selected for testing may be clustered in one part of a unit area; (3) plant-efficiency tests may tend to be conducted during a particular time of the year. This is of particular concern if seasonal regional drawdown is significant and most tests occur after the water levels have recovered. A 10-foot decline in water level will require approximately 18 additional kilowatthours per acre-foot for a plant operating at 55 percent efficiency.

Bias in the plant-efficiency test data may be detectible by comparison with contiguous areas. A more reasonable value may be calculated or interpolated from adjoining areas.

Compilation of all the previously segmented pumpage data into tables (Appendixes A and C) permitted several indirect analyses of its accuracy. One of these was simply that when the data were arranged in tabular form some discrepancies that had previously gone unnoticed became evident. When the source of these could be traced they were corrected; otherwise, they were left as the best available data.

To identify areas of anomalously high pumpage, pumpage estimated from power was compared to a maximum value of water use derived by the consumptive-use method. Assumed values of irrigation efficiency (55 percent), evapotranspiration of applied water (2.5 acre-ft/acre), and 95 percent irrigated land per unit area were used as follows:

$$\frac{\text{2.5 acre-ft/acre}}{\text{0.55 irrigation efficiency}} \times 0.95 = 4.3 \text{ acre-ft/acre}$$

4.3 acre-ft/acre x 5,760 acre/unit area = 25,000 acre-ft/unit area.

Frequency distributions of estimated pumpage in the areas where anomalously high pumpages occurred show a secondary grouping of unit areas with high pumpages. This suggests a systematic effect acting to produce high estimates of pumpage. A map analysis of the same areas shows that unit areas with high pumpage tend to be clustered in a few geographical areas. Investigation of these areas, consisting of a telephone survey of irrigation district personnel, turned up several possible explanations for this effect:

1. Over application of irrigation water by farmers.
2. Export of water from well fields.
3. Autumn and winter application of water to prevent frost.
4. In one area on the southeast side of the San Joaquin Valley, it appeared that a systematic error may have been caused by inclusion of power from electric wind machines used for frost prevention.

Estimation of Pumpage by Regression Model

A complete record of ground-water pumpage for the period 1961 through 1977 was required as input to the Central Valley Aquifer Project transient-state digital ground-water model. Because power-consumption data were not available for the entire period, agricultural pumpage could not be computed by the methods described. There were also many years for which estimates of municipal pumpage had not been computed. Regression models were used to predict pumpage data for the missing years.

Agricultural Pumpage

The most common role of ground water used for irrigation in the Central Valley is to supply the difference between the available supply of surface water and the total demand. In most areas of the valley, the demand always exceeds the available surface-water supply. The quantity of ground water pumped is highly dependent on the quantity of surface water available in a particular year.

At the scale of the quarter-township unit area or the 36 mi^2 nodal area used in the model, the effects of surface-water availability on pumpage were obscured by variations in land use. To avoid this problem, pumpage was summed over larger areas. The areas used were modified from ground-water basins that were identified by the California Department of Water Resources (1980) on the basis of hydrologic and political boundaries. The areas were

further subdivided according to the source of the power data originally used to estimate pumpage. The resulting 29 subareas (fig. 3) represent homogeneous populations of pumpage data. In three western subareas in the San Joaquin Valley (40, 41, 46), the introduction of water from the California Aqueduct in 1968 caused a marked reduction in ground-water pumpage. Two regressions were done for each of these subareas, one for the period 1961-67 using annual streamflow in a major associated river as an index of surface-water supply and a second for the period 1968-77 using deliveries in the California Aqueduct.

The regression model was designed to simulate three effects on ground-water pumpage.

1. The inverse relation of ground-water pumpage to surface-water supply was simulated by an independent variable used as an index of surface-water supply. Precipitation data for each subarea, either from a single station or an areally weighted average of several stations, were reduced to a percentage of the mean of the 17-year period from 1961 through 1977. Annual streamflow from a major river associated with each subarea was treated in a similar fashion. The choice between the two was made on the basis of which produced the best regression results.

2. The availability for irrigation of surface water stored during the previous year by various Federal, State, and local water projects serving the Central Valley was simulated by using the previous year's value of the surface-water index as a second independent variable. There should be an inverse relation between this variable and ground-water pumpage.

3. Long-term average increase or decrease in ground-water pumpage due to changes in farming practices or land use was simulated by including a third independent variable that had a value of the last two digits of the calendar year, that is, 61 through 77. The relation between this and the dependent variable may be either direct or inverse, depending on the area.

The dependent variable in the regression model was the annual total pumpage for a subarea. This was expressed as a percentage of the mean subarea pumpage over the period of record available.

The relation of dependent to independent variables was first investigated graphically. In all subareas, pumpage was plotted against the year to examine the average trend. Graphs for representative subareas are shown in figure 5. When the percentage of average pumpage was plotted against the year, a biannual fluctuation during the period 1962-70 was immediately noticeable. An example is shown for subarea 44 in figure 6. This correlates very well with a biannual fluctuation in rainfall (and streamflow). The most significant independent variable for subarea 44, annual streamflow in the Kaweah River, is shown as an example in figure 7.

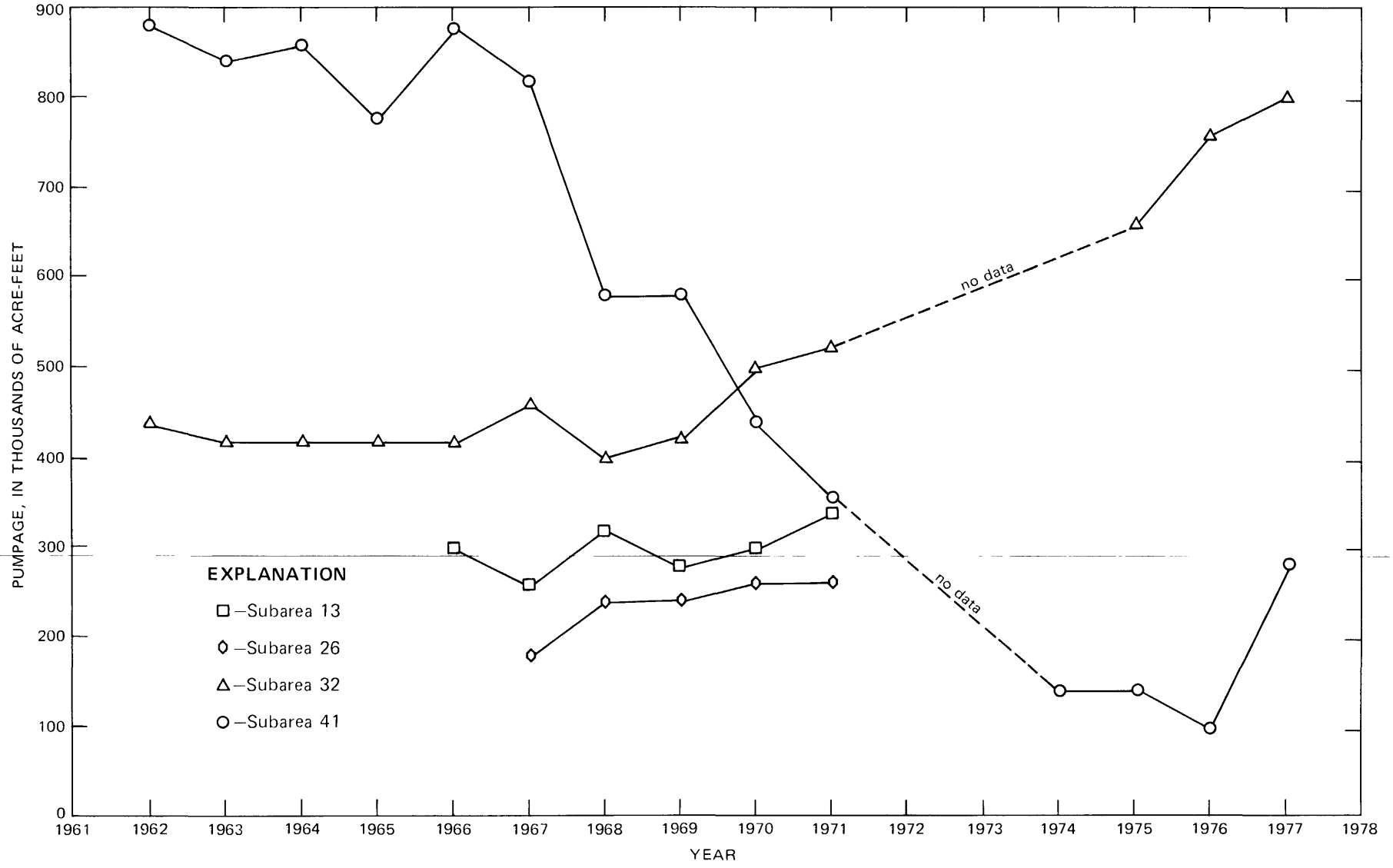


FIGURE 5. – Annual pumpage in four subareas.

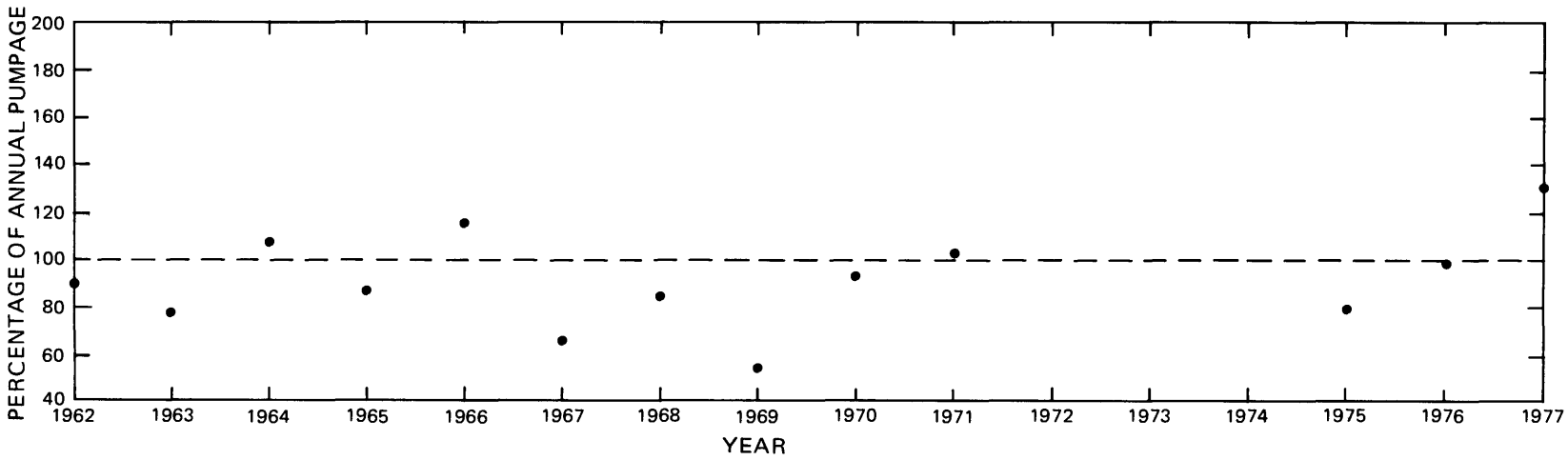


FIGURE 6. – Annual pumpage for subarea 44. (Expressed as a percentage of the average of 1961–77).

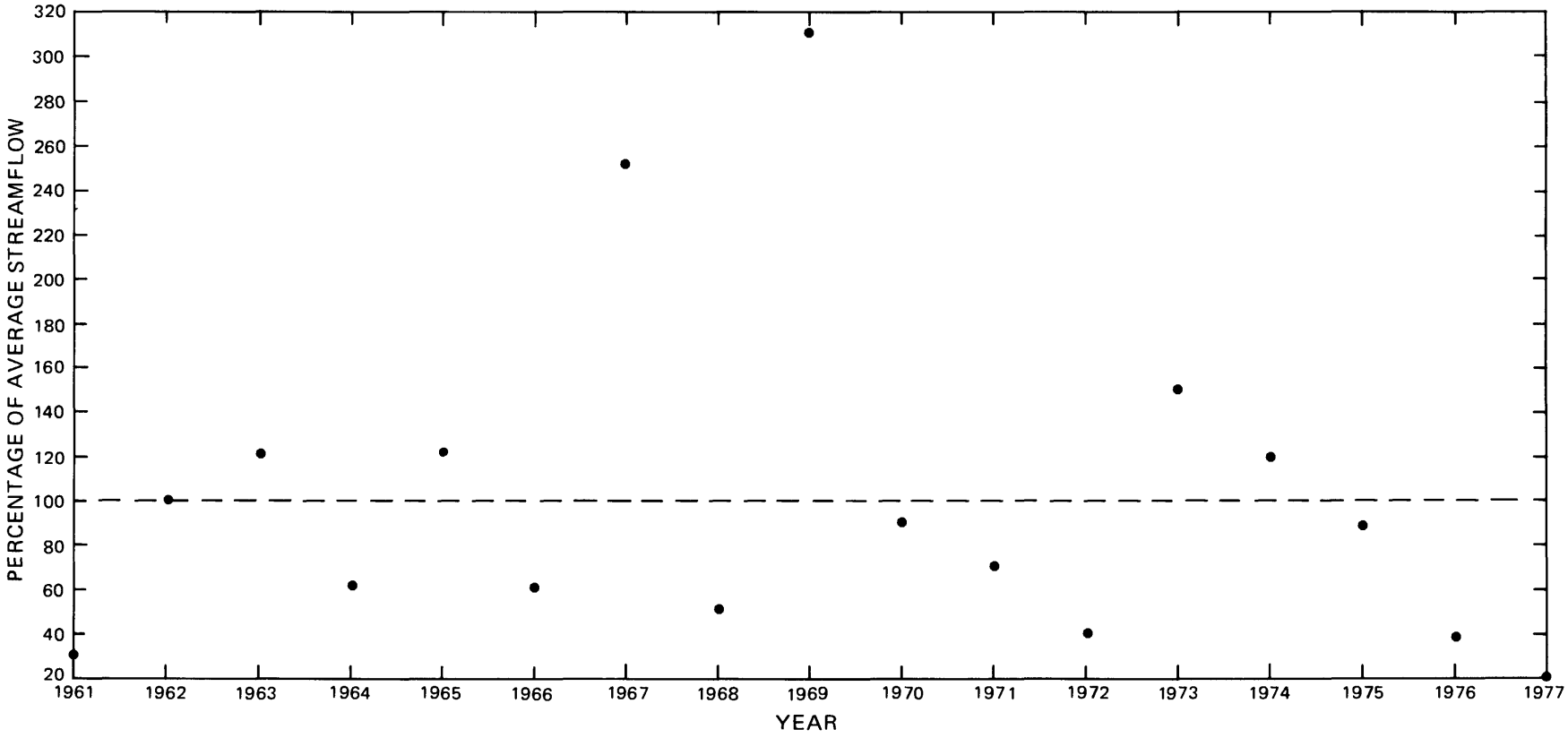


FIGURE 7. – Annual streamflow in the Kaweah River. (Expressed as a percentage of the average of 1920–79).

When percentage of average pumpage was graphed against the surface-water index and enough data points were available, the relation appeared to be curvilinear (fig. 8). Accordingly, the regression model used the $\log_{10}$ of the pumpage ratio and $\log_{10}$ of the surface-water index which transformed the relation to a linear one (fig. 9). The basic form of the regression model is:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3$$

where

Y = $\log_{10}$ pumpage ratio,
X_1 = $\log_{10}$ of surface-water index,
X_2 = $\log_{10}$ of previous year's surface-water index,
X_3 = year (61-77),
a = regression constant, and
b_1, b_2, b_3 = regression coefficients.

This model was used for subareas where there were 12 or more years of pumpage data available.

The regression equations thus generated were used to predict the percentage of average pumpage. These predicted percentages seemed to follow the original percentages fairly closely (fig. 10). A complete set of pumpage data was created for each quarter-township by multiplying the percentage of average pumpage by the mean of the annual pumpage for that quarter-township The resulting figures (Appendix C) represent a smoothed curve fit to the original data by the simulated effects described above.

In subareas where pumpage data were available only prior to 1972, the biannual fluctuation of precipitation resulted in a positive relation between pumpage and the previous year's surface-water index (X_2) because this variable was above average for the previous wet year when pumpage was above normal for the current dry year. It is not reasonable to assume that above-normal precipitation in a previous year would cause increased pumpage in the current year. In subareas where more data were available, the sign of the coefficient of X_2 was negative. For subareas where no data were available after 1972, the regression model was modified by removing the X_2 variable.

Municipal Pumpage

Municipal pumpage usually is a small percentage of the annual total estimated pumpage per township. Data compiled from previous work done by the pumpage project were extended using a simple linear regression of pumpage against year to predict pumpage for years 1961 through 1977 (Appendix D). The implied assumption of a linear increase or decrease was deemed to be adequate for municipal pumpage.

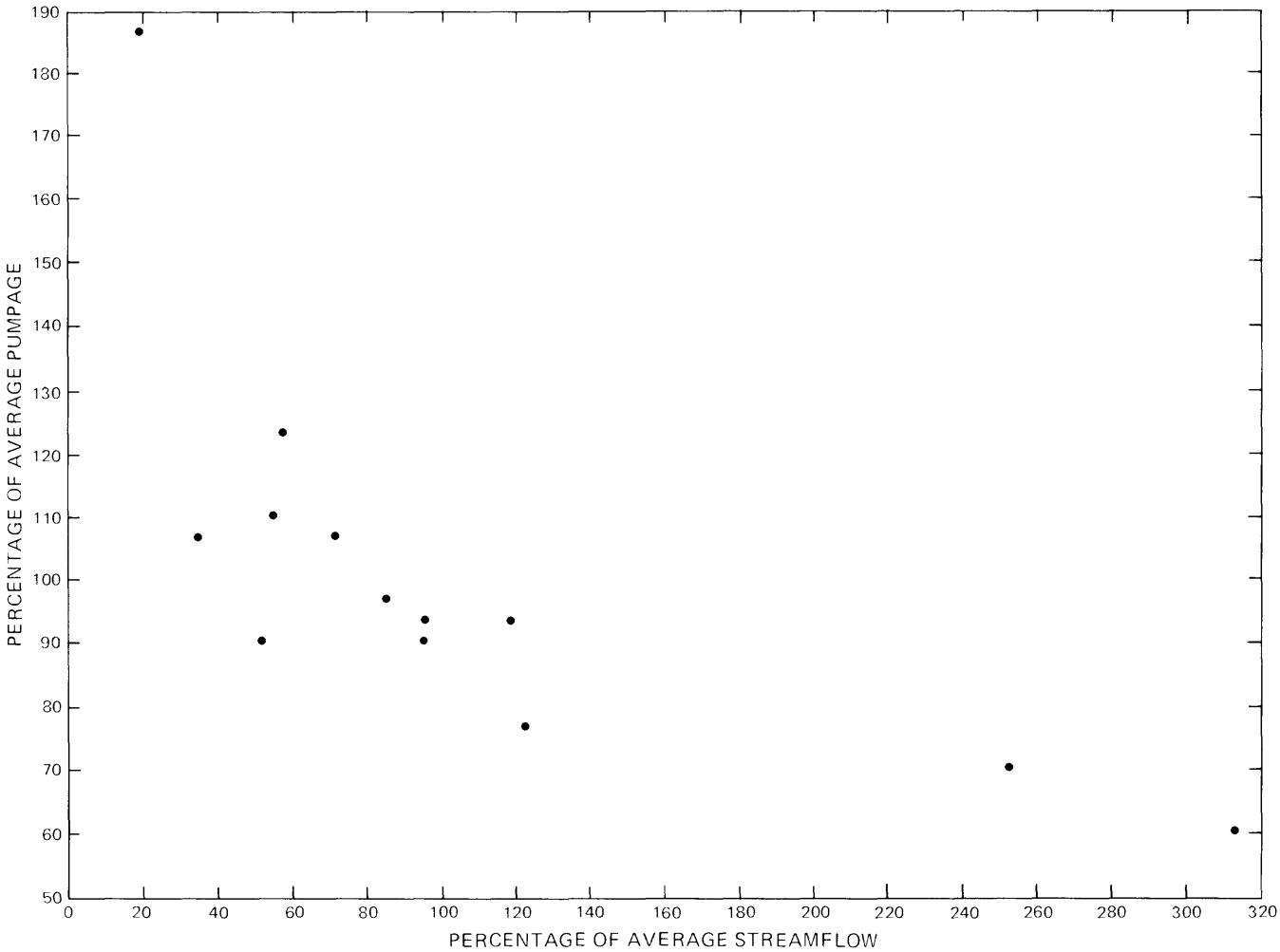


FIGURE 8. – Relation of pumpage in subarea 44 to streamflow in the Kaweah River, 1961–77.

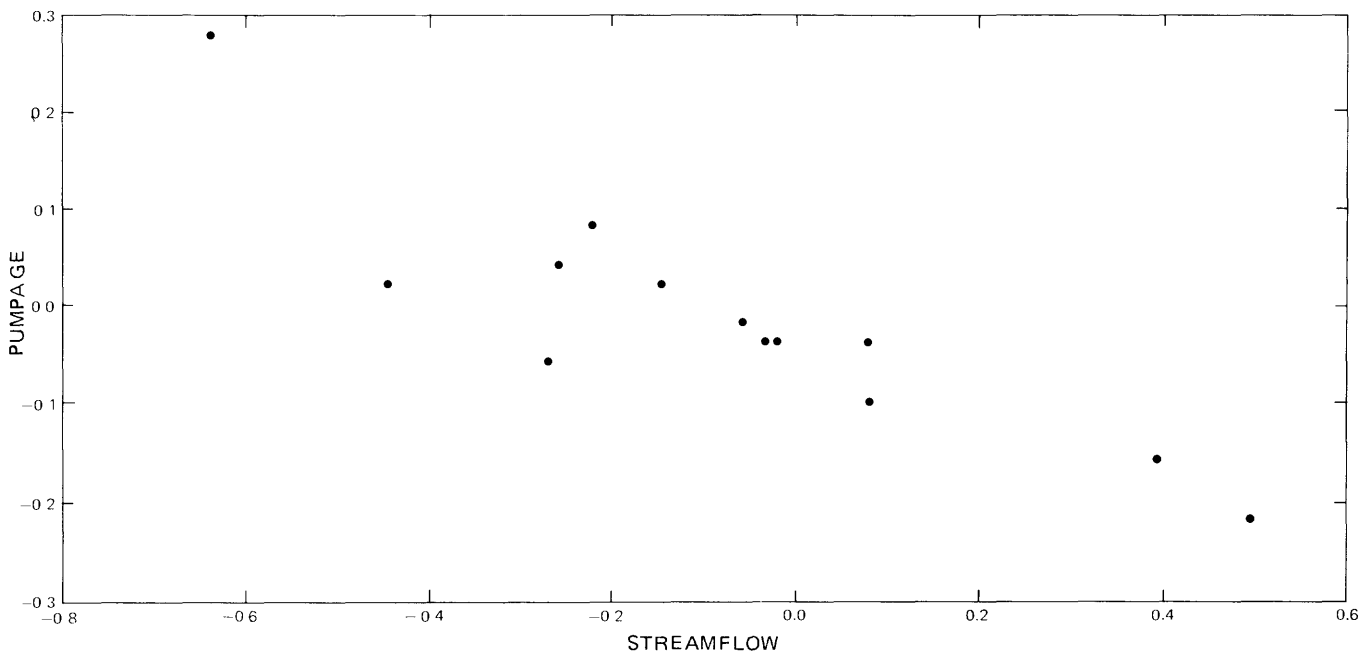


FIGURE 9. – Relation of pumpage in subarea 44 to streamflow in the Kaweah River after a $\log_{10}$ transformation.

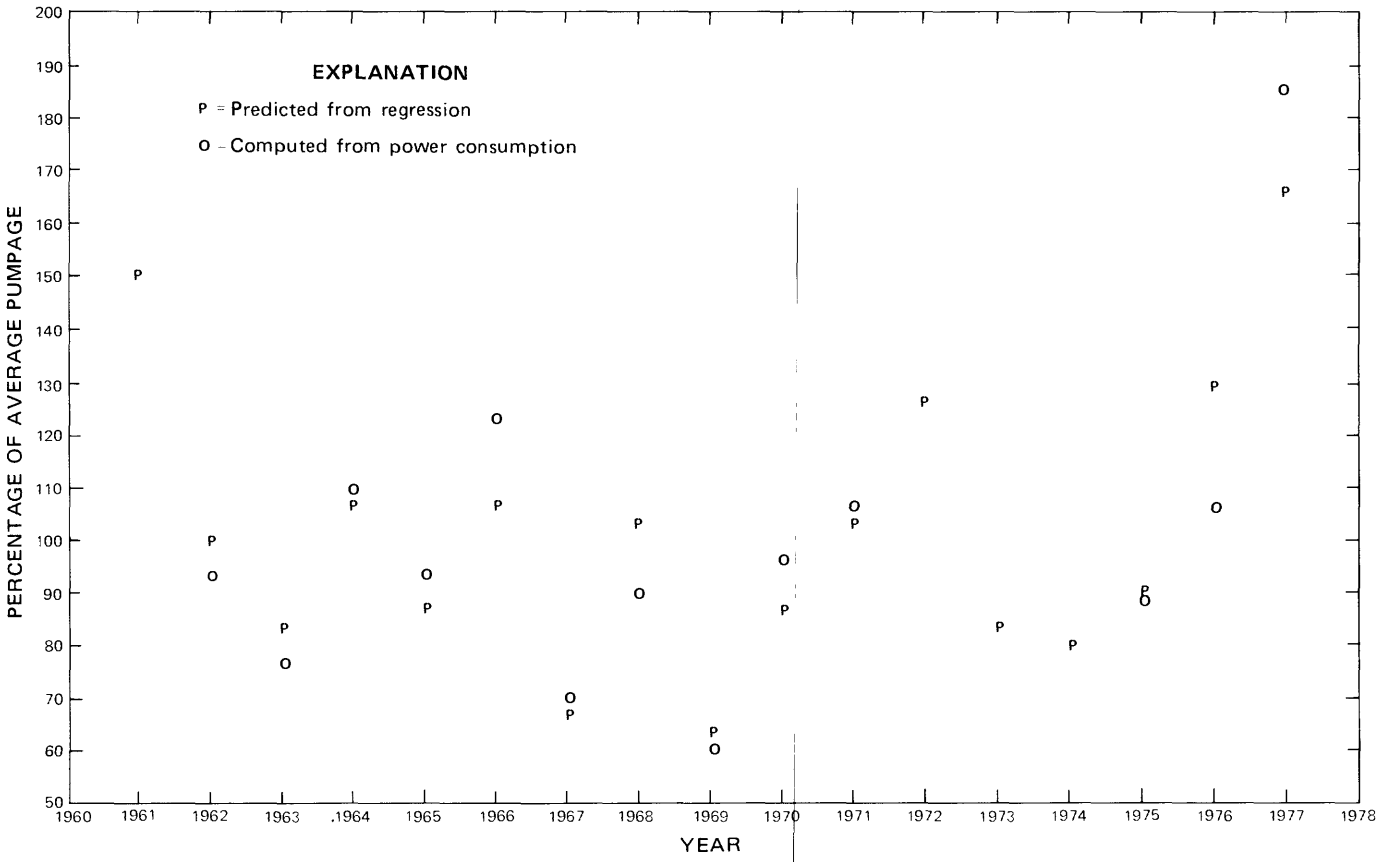


FIGURE 10. – Predicted and original annual pumpage in subarea 44.

Summary of Results

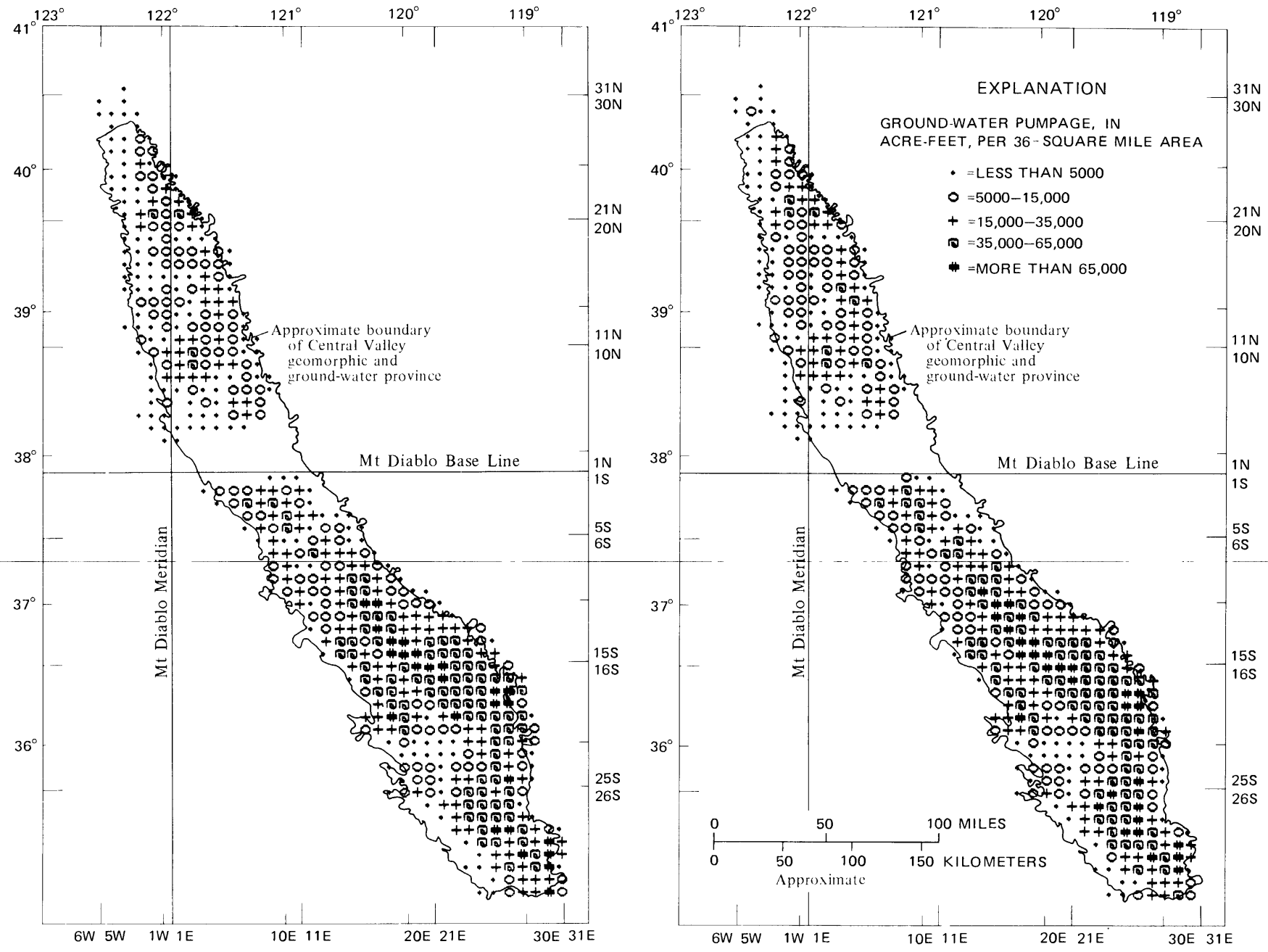
The data are summarized in table 2, which shows annual agricultural pumpage in each subarea. These totals are higher than those of the computed pumpage data (table 1) owing to the addition of the predicted pumpage data.

Maps of the magnitude and distribution of the synthesized pumpage data (fig. 11) are included for comparison with maps prepared using power consumption of the computed pumpage data (table 1 and fig. 4). Data could not be synthesized for the Delta subregion because pumpage data were not available. Pumpage data required as input for the CVAP ground-water model are estimated in this area by a water-budget method.

TABLE 2. - Agricultural ground-water pumpage by subarea synthesized from regression

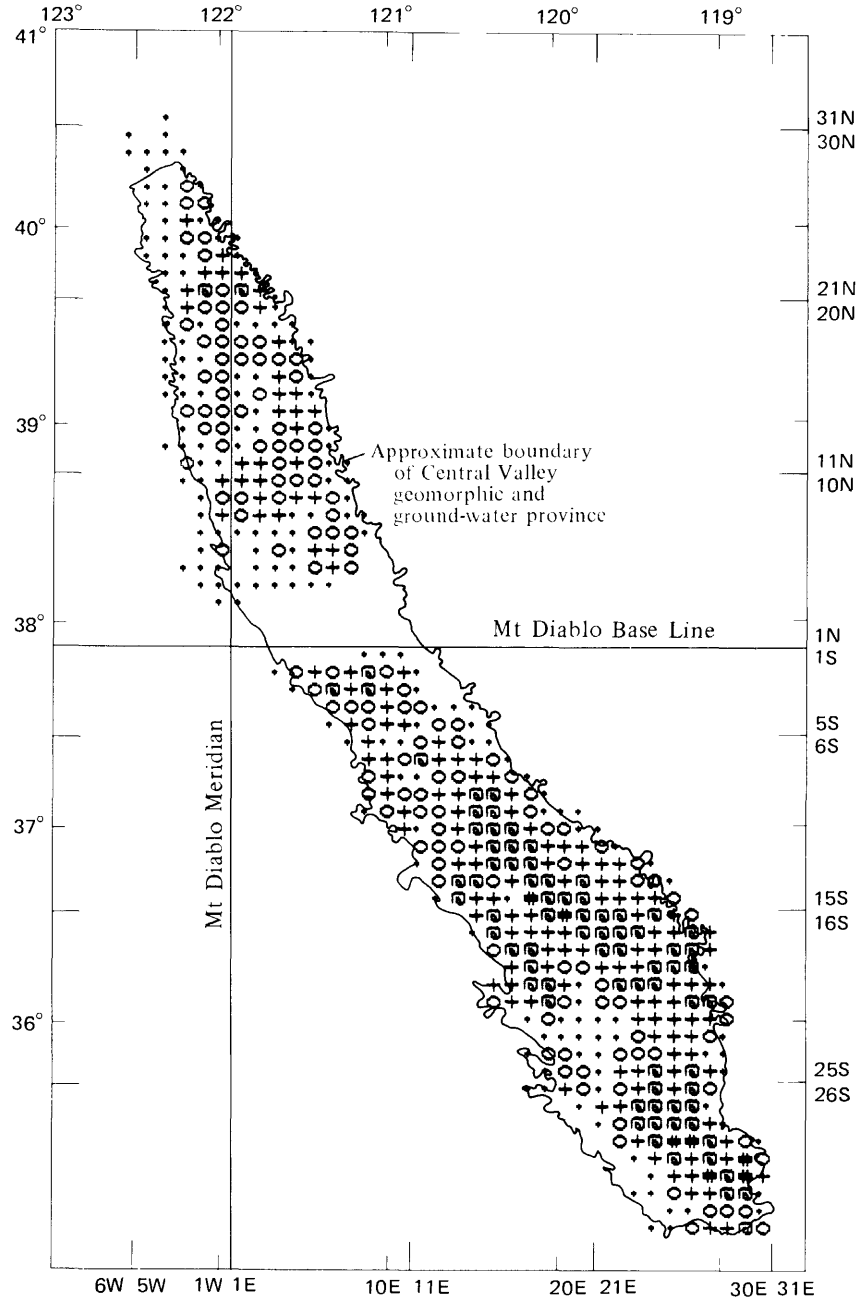
[Pumpage in thousands of acre-feet rounded to three significant figures]

Subarea (fig. 3)	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	Mean
11	241	238	226	269	236	299	234	272	285	280	289	331	316	298	340	411	464	296
12	23	25	25	34	33	41	34	51	47	58	60	88	67	81	96	148	149	62
13	243	252	231	283	271	304	255	327	290	303	334	405	319	354	381	478	519	326
14	113	118	103	146	126	156	109	159	134	153	160	233	143	168	191	320	289	166
15	163	150	127	182	130	182	140	194	154	164	157	217	193	165	206	304	389	189
16	177	181	172	193	188	199	165	224	215	204	196	235	207	219	228	253	270	208
17	318	291	243	342	237	325	238	329	265	245	265	340	288	237	302	443	552	309
Total	1,280	1,260	1,130	1,450	1,220	1,510	1,180	1,560	1,390	1,410	1,460	1,850	1,530	1,520	1,740	2,360	2,630	1,560
22	37	35	31	36	32	34	27	34	33	30	29	34	27	28	29	33	33	32
24	65	81	68	68	81	66	78	62	78	67	65	61	66	66	64	51	45	67
26	141	148	152	176	177	203	192	235	235	273	262	322	310	335	374	444	482	262
Total	243	264	251	280	290	303	297	331	346	370	356	417	403	429	467	528	560	361
31	430	328	271	415	272	416	291	430	296	387	428	494	363	342	364	477	606	389
32	457	440	416	423	414	427	445	402	372	440	458	425	413	405	380	434	474	425
33	51	47	41	55	53	64	42	51	51	61	69	79	59	58	55	87	90	60
34	380	323	302	379	358	451	281	351	321	374	457	573	390	354	359	549	693	406
35	411	369	364	411	415	432	336	412	371	413	433	547	417	398	398	569	608	430
36	534	491	458	517	513	523	416	505	436	482	489	675	498	460	485	697	731	524
Total	2,260	2,000	1,850	2,200	2,020	2,310	1,810	2,150	1,850	2,160	2,330	2,790	2,140	2,020	2,040	2,810	3,200	2,234
40	100	96	104	107	106	114	110	79	85	74	80	61	63	60	73	37	114	86
41	916	894	850	875	778	879	829	591	588	462	380	201	205	134	146	113	465	547
42	2,330	1,790	1,610	2,000	1,780	1,940	1,410	1,730	1,540	1,800	1,820	1,910	1,610	1,510	1,490	1,920	2,330	1,800
43	629	294	231	324	269	276	181	229	93	167	193	235	140	112	134	206	348	239
44	129	79	67	95	79	105	59	76	51	82	91	108	71	69	78	90	161	88
45	130	75	58	76	74	70	44	50	32	33	53	82	55	40	58	61	106	65
46	283	207	230	232	240	216	161	121	110	135	171	190	216	248	272	340	348	219
47	928	753	706	859	773	907	671	641	743	718	829	842	753	701	644	803	919	776
48	837	695	685	712	648	700	609	545	514	502	499	668	604	523	635	519	798	629
49	674	600	530	487	482	513	409	319	394	303	281	373	352	270	264	259	358	404
Total	6,960	5,480	5,070	5,770	5,230	5,720	4,480	4,380	4,150	4,280	4,400	4,670	4,070	3,670	3,790	4,350	5,950	4,850
50	1,740	999	998	1,290	1,020	1,020	636	1,010	541	794	782	831	567	540	567	795	843	831
51	850	571	568	719	547	668	461	763	424	642	666	743	544	547	603	874	973	657
55	196	154	154	182	149	177	140	182	132	169	173	185	155	155	165	205	219	170
Total	2,790	1,720	1,720	2,190	1,720	1,860	1,240	1,960	1,100	1,600	1,620	1,760	1,270	1,240	1,340	1,870	2,040	10,700
Grand total	13,500	10,700	10,000	11,900	10,500	11,700	9,000	10,400	8,830	9,820	10,200	11,500	9,410	8,880	9,380	11,900	14,400	--

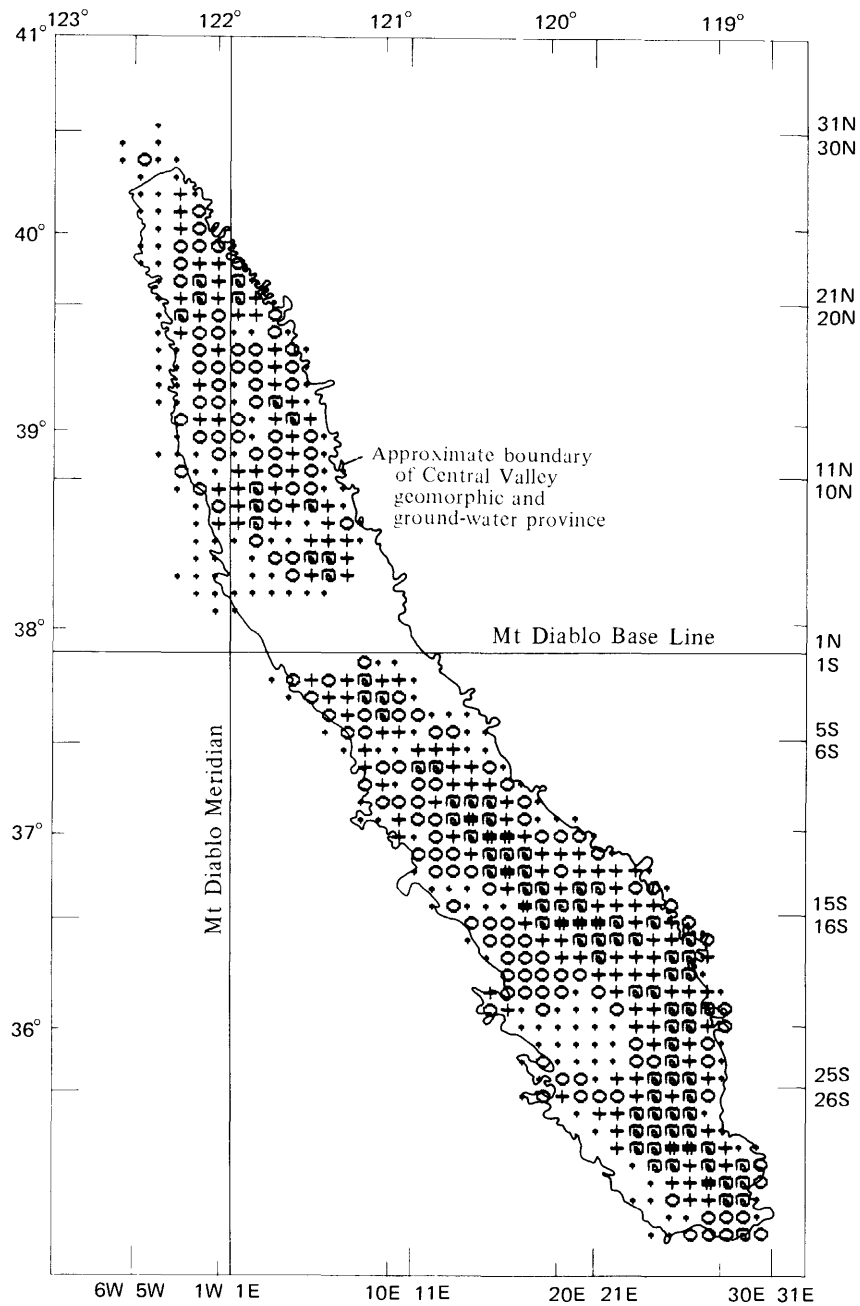

123°
122°
121°
120°
119°
41°
40°
39°
38°
37°
36°
31N
30N
21N
20N
11N
10N
1N
1S
5S
6S
15S
16S
25S
26S
Approximate boundary of Central Valley geomorphic and ground-water province
Mt Diablo Base Line
Mt Diablo Meridian
6W 5W 1W 1E 10E 11E 20E 21E 30E 31E
EXPLANATION
GROUND-WATER PUMPAGE, IN ACRE-FEET, PER 36-SQUARE MILE AREA
=LESS THAN 5000
=5000–15,000
=15,000–35,000
=35,000–65,000
=MORE THAN 65,000
0 50 100 MILES
0 50 100 150 KILOMETERS
Approximate

a. 1962

b. 1966



c. 1967



d. 1975

FIGURE 11. – Ground-water pumpage synthesized from regression.

DETERMINATION OF THE SOURCE OF GROUND-WATER PUMPAGE

In order to adequately model the stresses on the ground-water system caused by pumpage, the proportion of pumpage coming from the deeper zone of the aquifer was needed (pl. 1). The division between the shallow and the deep zones was determined on the basis of the following criteria:

1. In areas where a large amount of well-construction data existed, the division between the shallow and the deep zones was based on the vertical zonation of perforation intervals. A depth at which most wells in the vicinity had no perforation was chosen as the boundary between the two zones.

2. In most of the area where the Corcoran Clay Member of the Tulare Formation of Pliocene and Pleistocene age has been mapped, more than half of the San Joaquin Valley (R. W. Page, U.S. Geological Survey, written commun., 1982), the division was made above and below the clay.

3. In the remaining areas, the division was interpolated and extrapolated from adjacent areas.

Several methods were used to estimate the proportion of pumpage from the deeper zone. A discussion of each of these follows.

Drillers' Logs

An initial determination of the proportion of pumpage from the deep zone was done for the part of the San Joaquin Valley underlain by the Corcoran Clay Member of the Tulare Formation.

A sample of drillers' logs was randomly selected for every township underlain by the clay. Well-construction information from the logs indicated the perforated interval of the well. The sample of wells from each township was tabulated in three categories: wells perforated only above the clay, wells perforated only below the clay, and composite wells perforated both above and below the clay. An initial assumption was made that composite wells draw 50 percent of their water from each zone.

This tabulation shows that most of the wells in the area underlain by the clay are composite. Therefore, the area mean proportion of pumpage is highly related to the assumed proportion of pumpage drawn from each zone by the composite wells. Because the reliability of the 50-percent assumption was in doubt, more detailed methods were investigated.

Construction Information

Construction information on perforated interval and depth for 7,339 wells in the Central Valley is available in the Geological Survey Ground Water Site Inventory (GWSI) file. Of these, 3,307 are irrigation or public supply wells analyzed by computer to calculate the proportion of perforated interval of each well in the deeper zone. The proportion of perforated interval in each zone was assumed to equal the proportion of pumpage from that zone.

The proportions for individual wells were averaged for each nodal area and the resulting mean values seemed reasonable in comparison with all known information. However, only 320 of the 529 nodes in the model contained wells, and only 160 of those nodes represented means from seven or more wells per node. With a sample size of 7, the level of confidence of computing a mean proportion within 0.07 of the true mean is 62 percent.

Temperature Data

There is a high correlation between water temperature and depth in the Central Valley owing to the natural geothermal gradient. This water temperature gradient was found to be consistent (141, 168, and 176 ft/°C) in three test wells drilled for the Central Valley Aquifer Project in the Sacramento Valley. These gradients intercept land surface at temperatures near the mean annual air temperature of 17°C.

Discharge water-temperature measurements were available from 35,000 PG&E pumping-plant efficiency tests representing about 13,000 wells. Water temperatures were also available from 3,000 chemical analyses from wells with construction information. Linear least-squares regressions were computed with the top and bottom of the perforated intervals (in feet) related to water temperature (in°C) as follows:

Dependent variable	R^2	Slope	Intercept	Number of wells
Depth to top of perforations	0.64	43.4	-712	2,179
Depth to bottom of perforations	.67	125	-2,229	2,957

These relations were used to predict perforated intervals from the average water temperature for each well with at least one efficiency test. The proportion of perforated interval in the deeper zone was calculated and averaged for all the wells in each node. This resulted in proportions for 328 nodes of which 164 had more than 16 wells each.

The correlation coefficient (R) for 25 nodes which had more than 15 wells with construction information and more than 30 wells with water temperatures, was 0.87, showing high consistency between the two methods. There was no significant systematic difference between the two methods.

The confidence level of computing a mean proportion within 0.07 of the true mean was determined for both methods on the basis of the sample size in each node. The confidence levels of proportions from temperature data were corrected by a factor of 0.75 to account for the uncertainty in predicting a perforation zone from discharge temperature. These confidence levels were used as weighting factors for a mean of the proportions for nodes which had values from both methods. Final proportions were adjusted in nodes where the confidence level was low and assigned where no values existed by interpolating from adjacent areas. The resulting values were contoured and are shown on plate 1.

SUMMARY

Estimates of agricultural and municipal pumpage presented in Appendix A and B comprise all the available pumpage data for the study area for the period 1961 through 1977. The estimates were computed for unit areas using total power consumption (kWh/yr) and coefficient of power consumption (kWh/acre-ft). It is difficult to determine the accuracy of these figures. Previous studies indicate that under close to ideal conditions, the accuracy of the methods described in this report is about 3 percent. The quality and quantity of data used to compute pumpage have made it impossible to maintain this level of accuracy for the entire Central Valley. Estimates of annual pumpage exceeding 100,000 acre-ft per township are probably overestimated. However, these make up less than 1 percent of the number of annual township pumpages reported. When pumpage for the entire valley is mapped, the data seem to be consistent both areally and over time.

A complete record of pumpage for the period 1961 through 1977 is required as input for the transient-state digital ground-water model. A multiple linear regression was used to predict pumpage for years in which power data were not available. The regression model simulates the inverse relation of ground-water pumpage to surface-water availability and also the average trend of pumpage through time. Therefore, predicted pumpage (Appendixes C and D) is based on the amount of variability in the computed data that is accounted for by the variability in surface-water supply and the average increase or decrease of pumpage through time.

Additionally, adequate modeling of the ground-water system required knowledge about the proportion of pumpage coming from deeper zones in the aquifer. Initial determinations of the proportions for part of the San Joaquin Valley were developed from construction information from drillers' logs. More detailed information for the whole valley was developed from statistical analysis of the relation of water temperature to average depth of well perforations. The resulting proportions were contoured and seem to be consistent with known information on water use and water quality in the Central Valley.

SELECTED REFERENCES

Allison, S. V., 1967, Cost, precision and value relationships of data collection and design activities in water development planning: University of California, Berkeley, Water Resources Center Contribution 120, 142 p.

Bertoldi, G. L., 1979, A plan to study the aquifer system of the Central Valley of California: U.S. Geological Survey Open-File Report 79-1480, 48 p.

California Department of Water Resources, 1980, Ground-water basins in California: California Department of Water Resources Bulletin 118-80, 73 p.

McClelland, E. J., 1963, Methods of estimating ground-water pumpage in California: U.S. Geological Survey Open-File Report, 19 p.

Mitten, H. T., 1971, Ground-water pumpage in parts of Yolo, Sacramento, Solano, Sutter, Colusa, and Napa Counties, California, 1966-68: U.S. Geological Survey Open-File Report, 4 p.

----- 1972a, Estimated ground-water pumpage in the northern part of the Sacramento Valley, California, 1966-69: U.S. Geological Survey Open-File-Report, 6 p.

----- 1972b, Ground-water pumpage, San Joaquin Valley, California, 1967-68: U.S. Geological Survey Open-File Report, 6 p.

----- 1973, Estimated ground-water pumpage in the northern part of the Sacramento Valley, California, 1970-71: U.S. Geological Survey Open-File Report, 4 p.

----- 1974, Estimated ground-water pumpage in the southern part of the Sacramento Valley, California, 1969-71: U.S. Geological Survey Open-File Report, 4 p.

----- 1976, Estimated ground-water pumpage in parts of the San Joaquin Valley, California, 1969-71: U.S. Geological Survey Open-File Report, 9 p.

----- 1978, Estimated agricultural ground-water pumpage in parts of Fresno, Kings, and Madera Counties, San Joaquin Valley, California, 1974-77: U.S. Geological Survey Open-File Report 78-826, 3 p.

----- 1980, Estimated agricultural ground-water pumpage in parts of the San Joaquin Valley, California, 1975-77: U.S. Geological Survey Open-File Report 80-1281, 11 p.

Mitten, H. T., and Ogilbee, William, 1970, Ground-water pumpage in parts of Merced, Madera, Fresno, Kings, and Tulare Counties, California, 1962-66: U.S. Geological Survey Open-File Report, 8 p.

Ogilbee, William, 1966, Progress report--Methods for estimating ground-water withdrawals in Madera County, California: U.S. Geological Survey Open-File Report, 32 p.

Ogilbee, William, and Mitten, H. T., 1970, A continuing program for estimating ground-water pumpage in California--Methods: U.S. Geological Survey Open-File Report, 22 p.

Ogilbee, William, and Rose, M. A., 1969a, Ground-water pumpage in Kern County, San Joaquin Valley, California, 1962-66: U.S. Geological Survey Open-File Report, 5 p.

----- 1969b, Ground-water pumpage on the west side of the San Joaquin Valley, California, 1962-66: U.S. Geological Survey Open-File Report, 7 p.

Rantz, S. E., 1969, Mean annual precipitation in the California region: U.S. Geological Survey Open-File Map.

Thomas, H. E., and Phoenix, D. A., 1976, Summary appraisal of the Nation's ground-water resources--California region: U.S. Geological Survey Professional Paper 813-E, 51 p.

Appendix A.-- Agricultural ground-water pumpage computed from power for townships in the Central Valley

[Pumpage, in acre-feet, rounded to three significant figures. Township: Townships are on the Mount Diablo baseline and meridian, except where followed by an "S" which are on the San Bernardino baseline and meridian. ·, no data]

TOWNSHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
32N04W	·	·	·	·	·	547	·	244	200	643	759	·	·	·	·	·	·
32N03W	·	·	·	·	·	·	·	·	261	·	·	·	·	·	·	·	·
32N02W	·	·	·	·	·	290	535	188	312	346	203	·	·	·	·	·	·
31N04W	·	·	·	·	·	1280	1040	1140	1130	1780	1200	·	·	·	·	·	·
31N03W	·	·	·	·	·	2310	3100	3860	3510	3230	2840	·	·	·	·	·	·
31N02W	·	·	·	·	·	·	·	·	·	335	262	·	·	·	·	·	·
30N06W	·	·	·	·	·	326	233	79	·	·	·	·	·	·	·	·	·
30N04W	·	·	·	·	·	472	606	812	700	620	768	·	·	·	·	·	·
30N03W	·	·	·	·	·	2960	2430	3100	2990	2530	2190	·	·	·	·	·	·
29N06W	·	·	·	·	·	·	42	269	19	260	171	·	·	·	·	·	·
29N05W	·	·	·	·	·	5910	4630	4800	5820	5990	5280	·	·	·	·	·	·
29N04W	·	·	·	·	·	1620	1550	1190	728	1680	1530	·	·	·	·	·	·
29N03W	·	·	·	·	·	1870	1360	1280	1120	1820	1590	·	·	·	·	·	·
28N05W	·	·	·	·	·	484	412	396	459	340	333	·	·	·	·	·	·
28N03W	·	·	·	·	·	1230	1550	843	1900	579	386	·	·	·	·	·	·
27N05W	·	·	·	·	·	337	263	236	191	148	172	·	·	·	·	·	·
27N04W	·	·	·	·	·	1380	1190	1290	1430	1490	1520	·	·	·	·	·	·
27N03W	·	·	·	·	·	10700	8730	11700	11600	13700	12300	·	·	·	·	·	·
27N02W	·	·	·	·	·	3360	2320	3330	2760	2250	2060	·	·	·	·	·	·
26N05W	·	·	·	·	·	1290	822	869	920	753	593	·	·	·	·	·	·
26N04W	·	·	·	·	·	3180	2780	2830	3390	3350	2940	·	·	·	·	·	·
26N03W	·	·	·	·	·	17200	14400	14900	15900	13500	14700	·	·	·	·	·	·
26N02W	·	·	·	·	·	12400	8720	10400	11200	7410	7950	·	·	·	·	·	·
25N04W	·	·	·	·	·	1030	·	359	429	984	384	·	·	·	·	·	·
25N03W	·	·	·	·	·	25800	17800	18900	21500	22100	21200	·	·	·	·	·	·
25N02W	·	·	·	·	·	6260	5410	4760	6650	5560	5630	·	·	·	·	·	·
25N01W	·	·	·	·	·	1210	937	1110	789	781	681	·	·	·	·	·	·
24N05W	·	·	·	·	·	349	161	260	232	196	234	·	·	·	·	·	·
24N04W	·	·	·	·	·	3210	1290	1390	923	1030	784	·	·	·	·	·	·
24N03W	·	·	·	·	·	11300	7250	8030	8540	9180	8110	·	·	·	·	·	·
24N02W	·	·	·	·	·	6580	4730	7480	8140	8840	8370	·	·	·	·	·	·

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
24N01W	.	.	.	.	.	4710	4600	4680	4930	5800	5790	.	.	.	.	.	.
24N01E	.	.	.	.	.	478	433	416	452	363	360	.	.	.	.	.	.
23N05W	.	.	.	.	.	281	249	807	458	428	381	.	.	.	.	.	.
23N04W	.	.	.	.	.	226	137	167	711	790	698	.	.	.	.	.	.
23N03W	.	.	.	.	.	5490	3740	3770	3770	4600	4110	.	.	.	.	.	.
23N02W	.	.	.	.	.	14200	13100	15800	15900	18900	16400	.	.	.	.	.	.
23N01W	.	.	.	.	.	26000	21700	22900	22100	25300	27500	.	.	.	.	.	.
23N01E	.	.	.	.	.	4760	3640	5080	3360	4300	4260	.	.	.	.	.	.
22N04W	.	.	.	.	.	4660	3600	4020	3630	3190	3150	.	.	.	.	.	.
22N03W	.	.	.	.	.	4980	4560	4520	4440	3840	4680	.	.	.	.	.	.
22N02W	.	.	.	.	.	38600	28600	32400	30300	33200	38100	.	.	.	.	.	.
22N01W	.	.	.	.	.	21000	18400	15900	14200	15900	20100	.	.	.	.	.	.
22N01E	.	.	.	.	.	22800	17900	22900	19800	21100	23300	.	.	.	.	.	.
22N02E	.	.	.	.	.	1660	1610	1670	1440	1450	1500	.	.	.	.	.	.
21N04W	.	.	.	.	.	1740	2190	2090	888	1060	2250	.	.	.	.	.	.
21N03W	.	.	.	.	.	28700	24000	27100	27600	24000	24400	.	.	.	.	.	.
21N02W	.	.	.	.	.	52800	44100	50800	55300	49600	55400	.	.	.	.	.	.
21N01W	.	.	.	.	.	12900	8830	12400	14000	13300	13100	.	.	.	.	.	.
21N01E	.	.	.	.	.	50800	35500	50200	44900	50100	61800	.	.	.	.	.	.
21N02E	.	.	.	.	.	23300	18100	27500	23400	24400	23500	.	.	.	.	.	.
20N04W	.	.	.	.	.	1230	1100	1020	793	1040	1220	.	.	.	.	.	.
20N03W	.	.	.	.	.	26900	20400	30900	34100	34800	39200	.	.	.	.	.	.
20N02W	.	.	.	.	.	9600	7270	12400	11000	9670	12700	.	.	.	.	.	.
20N01W	.	.	.	.	.	7300	7130	12800	10500	7390	7490	.	.	.	.	.	.
20N01E	.	.	.	.	.	12700	11300	15000	17400	15600	19100	.	.	.	.	.	.
20N02E	.	.	.	.	.	24800	22300	34100	26400	19500	21100	.	.	.	.	.	.
20N03E	.	.	.	.	.	6590	5040	4720	5240	5850	3980	.	.	.	.	.	.
19N04W	.	.	.	.	.	2830	2080	2670	2580	2580	2520	.	.	.	.	.	.
19N03W	.	.	.	.	.	5210	4300	5340	6370	7360	10000	.	.	.	.	.	.
19N02W	.	.	.	.	.	2210	2430	3660	3770	4840	4670	.	.	.	.	.	.
19N01W	.	.	.	.	.	11100	9230	14400	8510	11700	14200	.	.	.	.	.	.
19N01E	.	.	.	.	.	2590	2920	2900	1020	1450	1220	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
19N02E	.	.	.	.	.	2840	2400	3590	2500	3300	2060	.	.	.	.	.	.
19N03E	.	.	.	.	.	2290	3290	4660	3910	3580	3160	.	.	.	.	.	.
19N04E	.	.	.	.	.	368	287	245	202	221	212	.	.	.	.	.	.
18N04W	.	.	.	.	.	189	83	324	102	271	135	.	.	.	.	.	.
18N03W	.	.	.	.	.	131	453	167	164	459	1220	.	.	.	.	.	.
18N02W	.	.	.	.	.	3510	3420	2800	3240	5970	6480	.	.	.	.	.	.
18N01W	.	.	.	.	.	12800	10700	11600	7880	16000	17700	.	.	.	.	.	.
18N01E	.	.	.	.	.	6050	6430	8820	9830	8040	9230	.	.	.	.	.	.
18N02E	.	.	.	.	.	6900	5400	6160	6460	4360	3830	.	.	.	.	.	.
18N03E	.	.	.	.	.	18500	15300	19100	20500	22800	21100	.	.	.	.	.	.
18N04E	.	.	.	.	.	6280	4260	6540	6330	6140	6080	.	.	.	.	.	.
18N05E	.	.	.	.	.	.	.	.	.	.	765	.	.	.	.	.	.
17N04W	.	.	.	.	.	498	439	448	243	428	562	.	.	.	.	.	.
17N03W	.	.	.	.	.	1870	1040	1750	1040	1560	1820	.	.	.	.	.	.
17N02W	.	.	.	.	.	4300	3530	6180	6200	8330	7380	.	.	.	.	.	.
17N01W	.	.	.	.	.	8000	7630	11000	7130	11500	14800	.	.	.	.	.	.
17N01E	.	.	.	.	.	8010	8150	7080	11900	9370	11300	.	.	.	.	.	.
17N02E	.	.	.	.	.	8140	7240	8050	7910	7470	7440	.	.	.	.	.	.
17N03E	.	.	.	.	.	17200	14000	18300	15300	15600	15600	.	.	.	.	.	.
17N04E	.	.	.	.	.	6650	7680	9530	9270	8460	10900	.	.	.	.	.	.
17N05E	.	.	.	.	.	808	3	66	84	139	156	.	.	.	.	.	.
16N04W	.	.	.	.	.	980	720	1130	1170	1040	1050	.	.	.	.	.	.
16N03W	.	.	.	.	.	1800	1730	2510	2590	2900	2030	.	.	.	.	.	.
16N02W	.	.	.	.	.	8000	6670	10900	8520	12400	8590	.	.	.	.	.	.
16N01W	.	.	.	.	.	4780	3990	6500	3080	3870	4470	.	.	.	.	.	.
16N01E	.	.	.	.	.	1150	1910	1250	1640	3400	3860	.	.	.	.	.	.
16N02E	.	.	.	.	.	5850	5810	6780	6300	4680	4160	.	.	.	.	.	.
16N03E	.	.	.	.	.	26300	18600	26200	22100	24300	23100	.	.	.	.	.	.
16N04E	.	.	.	.	.	6820	5430	5810	5190	5750	5850	.	.	.	.	.	.
16N05E	.	.	.	.	.	910	252	227	.	.	.	.	.	.	.	.	.
15N04W	.	.	.	.	.	543	453	1290	1540	1570	2290	.	.	.	.	.	.
15N03W	.	.	.	.	.	2120	1600	3400	3430	3940	4760	.	.	.	.	.	.
15N02W	.	.	.	.	.	3830	2970	4740	3430	3610	2930	.	.	.	.	.	.
15N01W	.	.	.	.	.	6360	6890	8810	9290	15800	17900	.	.	.	.	.	.
15N01E	.	.	.	.	.	3890	2200	4690	1870	1640	2720	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
15N02E	.	.	.	.	.	10600	7460	10500	8630	11100	10800	.	.	.	.	.	.
15N03E	.	.	.	.	.	34400	26200	35700	26400	30600	29600	.	.	.	.	.	.
15N04E	.	.	.	.	.	28900	22000	27400	26400	22000	20700	.	.	.	.	.	.
15N05E	.	.	.	.	.	1940	2380	2080	1500	974	1390	.	.	.	.	.	.
14N03W	.	.	.	.	.	10000	6510	11300	10900	15000	14500	.	.	.	.	.	.
14N02W	.	.	.	.	.	10500	8970	11800	12700	13000	12500	.	.	.	.	.	.
14N01W	.	.	.	.	.	12800	7720	10900	12100	13400	13100	.	.	.	.	.	.
14N01E	.	.	.	.	.	11500	9660	13200	4520	8260	6760	.	.	.	.	.	.
14N02E	.	.	.	.	.	2250	1780	2550	910	755	721	.	.	.	.	.	.
14N03E	.	.	.	.	.	28100	20500	25500	21600	24600	22900	.	.	.	.	.	.
14N04E	.	.	.	.	.	40800	32000	39400	33000	36300	31300	.	.	.	.	.	.
14N05E	.	.	.	.	.	20600	16600	22200	22200	22900	22100	.	.	.	.	.	.
13N03W	.	.	.	.	.	410	336	460	409	390	393	.	.	.	.	.	.
13N02W	.	.	.	.	.	14200	4810	6320	6490	6880	7000	.	.	.	.	.	.
13N01W	.	.	.	.	.	11500	7270	10100	12000	10600	12700	.	.	.	.	.	.
13N01E	.	.	.	.	.	4050	2830	4240	3230	3010	3710	.	.	.	.	.	.
13N02E	.	.	.	.	.	2550	1990	2460	3160	2790	2000	.	.	.	.	.	.
13N03E	.	.	.	.	.	8380	9060	10700	9480	8230	6650	.	.	.	.	.	.
13N04E	.	.	.	.	.	20500	17400	25100	28100	28400	28200	.	.	.	.	.	.
13N05E	.	.	.	.	.	10300	7920	12700	12500	12000	14600	.	.	.	.	.	.
13N06E	.	.	.	.	.	987	918	1050	1260	1060	855	.	.	.	.	.	.
12N04W	.	.	.	.	.	397	188	351	.	.	.	.	.	.	.	.	.
12N03W	.	.	.	.	.	3290	1520	3000	3020	3160	3430	.	.	.	.	.	.
12N02W	.	.	.	.	.	1330	771	1110	884	312	942	.	.	.	.	.	.
12N01W	.	.	.	.	.	8540	5750	7880	8360	8090	11300	.	.	.	.	.	.
12N01E	.	.	.	.	.	1940	2090	2860	28	23	28	.	.	.	.	.	.
12N02E	.	.	.	.	.	12200	7140	13400	5280	4160	4720	.	.	.	.	.	.
12N03E	.	.	.	.	.	4880	5880	10300	7500	5700	6140	.	.	.	.	.	.
12N04E	.	.	.	.	.	14900	13500	21500	18500	11400	12500	.	.	.	.	.	.
12N05E	.	.	.	.	.	7460	6800	10400	8430	8710	8180	.	.	.	.	.	.
12N06E	.	.	.	.	.	4060	3210	3940	1290	1210	1310	.	.	.	.	.	.
11N03W	.	.	.	.	.	13600	9100	12200	9600	7900	7930	.	.	.	.	.	.
11N02W	.	.	.	.	.	1300	887	1200	1810	1580	867	.	.	.	.	.	.
11N01W	.	.	.	.	.	.	30	557	634	724	798	.	.	.	.	.	.
11N01E	.	.	.	.	.	20800	17500	25700	21000	19400	18200	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
11N02E	.	.	.	.	.	29800	19600	28800	18500	23500	23800	.	.	.	.	.	.
11N03E	.	.	.	.	.	11700	9810	13600	10500	10800	10300	.	.	.	.	.	.
11N04E	.	.	.	.	.	16500	14300	22700	27200	26600	19700	.	.	.	.	.	.
11N05E	.	.	.	.	.	8050	8330	10400	10700	8940	8590	.	.	.	.	.	.
11N06E	.	.	.	.	.	164	138	120	152	108	102	.	.	.	.	.	.
11N07E	.	.	.	.	.	.	.	.	.	.	51	.	.	.	.	.	.
10N03W	.	.	.	.	.	1150	856	845	1610	891	1230	.	.	.	.	.	.
10N02W	.	.	.	.	.	4090	2950	4790	7340	7120	8210	.	.	.	.	.	.
10N01W	.	.	.	.	.	33900	24000	35500	24500	22700	23200	.	.	.	.	.	.
10N01E	.	.	.	.	.	27400	18700	27200	23800	19700	25900	.	.	.	.	.	.
10N02E	.	.	.	.	.	32700	22000	34300	34300	32000	35500	.	.	.	.	.	.
10N03E	.	.	.	.	.	12000	12600	16500	17500	14700	15000	.	.	.	.	.	.
10N04E	.	.	.	.	.	6050	6810	9170	8570	9630	5970	.	.	.	.	.	.
10N05E	.	.	.	.	.	1190	6130	7660	7900	6620	7940	.	.	.	.	.	.
10N06E	.	.	.	.	.	765	907	830	770	3100	2880	.	.	.	.	.	.
10N07E	.	.	.	.	.	116	131	189	239	39	31	.	.	.	.	.	.
09N02W	.	.	.	.	.	.	54	63	.	.	.	.	.	.	.	.	.
09N01W	.	.	.	.	.	16700	10100	13100	11400	11100	12400	.	.	.	.	.	.
09N01E	.	.	.	.	.	21700	14600	19200	16200	14800	14500	.	.	.	.	.	.
09N02E	.	.	.	.	.	35500	31600	36500	37600	34300	37500	.	.	.	.	.	.
09N03E	.	.	.	.	.	9740	6880	11000	3570	1790	2960	.	.	.	.	.	.
09N04E	.	.	.	.	.	.	15000	21900	21000	12300	10400	.	.	.	.	.	.
09N05E	.	.	.	.	.	.	457	481	412	550	642	.	.	.	.	.	.
09N06E	.	.	.	.	.	.	199	400	357	.	.	.	.	.	.	.	.
09N07E	.	.	.	.	.	.	15	13	19	.	.	.	.	.	.	.	.
08N02W	.	.	.	.	.	751	380	933	836	747	839	.	.	.	.	.	.
08N01W	.	.	.	.	.	27700	17900	31500	22900	21300	23500	.	.	.	.	.	.
08N01E	.	.	.	.	.	16000	14000	21400	9950	14400	14700	.	.	.	.	.	.
08N02E	.	.	.	.	.	28600	22200	27800	25500	23700	20600	.	.	.	.	.	.
08N03E	.	.	.	.	.	30000	22900	27700	11800	11900	12400	.	.	.	.	.	.
08N04E	.	.	.	.	.	.	22	1	185	192	163	.	.	.	.	.	.
08N05E	.	.	.	.	.	.	1330	2000	1690	2150	1910	.	.	.	.	.	.
08N06E	.	.	.	.	.	.	9470	11000	10300	10400	10200	.	.	.	.	.	.
08N07E	.	.	.	.	.	.	3160	4440	4170	3790	2620	.	.	.	.	.	.
08N08E	.	.	.	.	.	.	.	.	.	1640	1030	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
07N02W	.	.	.	.	.	26	11	19	433	23	13	.	.	.	.	.	.
07N01W	.	.	.	.	.	.	.	.	457	272	101	.	.	.	.	.	.
07N01E	.	.	.	.	.	2790	4010	3710	3230	2700	3580	.	.	.	.	.	.
07N02E	.	.	.	.	.	6290	4430	5690	6000	4700	5540	.	.	.	.	.	.
07N03E	.	.	.	.	.	4440	3160	4090	3880	2570	3400	.	.	.	.	.	.
07N04E	.	.	.	.	.	.	1830	1480	1780	2270	2470	.	.	.	.	.	.
07N05E	.	.	.	.	.	.	12400	15400	12300	15700	14500	.	.	.	.	.	.
07N06E	.	.	.	.	.	.	11800	14200	15500	20900	21100	.	.	.	.	.	.
07N07E	.	.	.	.	.	.	11800	13900	12900	15700	15600	.	.	.	.	.	.
07N08E	.	.	.	.	.	.	645	47	323	1200	1610	.	.	.	.	.	.
06N02W	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
06N02E	.	.	.	.	.	2400	1860	2770	2050	1680	1760	.	.	.	.	.	.
06N03E	.	.	.	.	.	7670	6900	7650	6110	5710	6930	.	.	.	.	.	.
06N04E	.	.	.	.	.	.	2910	4740	1260	5270	4590	.	.	.	.	.	.
06N05E	.	.	.	.	.	.	24200	29900	27100	42600	40400	.	.	.	.	.	.
06N06E	.	.	.	.	.	.	22100	24800	23700	29900	31100	.	.	.	.	.	.
06N07E	.	.	.	.	.	.	8910	10900	9720	13600	14500	.	.	.	.	.	.
05N03W	.	.	.	.	.	1410	867	1260	327	342	384	.	.	.	.	.	.
05N02W	.	.	.	.	.	3860	2830	3170	2340	2700	3180	.	.	.	.	.	.
05N01W	.	.	.	.	.	1520	892	929	458	392	197	.	.	.	.	.	.
05N02E	.	.	.	.	.	2420	2110	3150	2400	2580	2160	.	.	.	.	.	.
05N03E	.	.	.	.	.	1	35	153	288	262	262	.	.	.	.	.	.
05N04E	.	.	.	.	.	33	2150	3140	2630	6060	5330	.	.	.	.	.	.
05N05E	.	.	.	.	.	.	9990	13100	11200	13300	12900	.	.	.	.	.	.
05N06E	.	.	.	.	.	.	29300	33700	45000	40600	37100	.	.	.	.	.	.
05N07E	.	.	.	.	.	.	10400	12800	12100	13600	13300	.	.	.	.	.	.
04N03W	.	.	.	.	.	494	264	474	.	.	.	.	.	.	.	.	.
04N02W	.	.	.	.	.	1010	843	438	.	.	.	.	.	.	.	.	.
04N01W	.	.	.	.	.	1520	19	600	36	23	36	.	.	.	.	.	.
04N01E	.	.	.	.	.	.	233	.	.	.	.	.	.	.	.	.	.
04N02E	.	.	.	.	.	.	15	.	.	.	.	.	.	.	.	.	.
04N04E	.	.	.	.	.	.	308	274	305	58	24	.	.	.	.	.	.
04N05E	.	.	.	.	.	.	.	.	.	843	785	.	.	.	.	.	.
04N06E	.	.	.	.	.	.	.	64	67	31	28	.	.	.	.	.	.

Appendix D.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
03S08E	0	0	0	0	0	0	0	130	519	915	1190	1200	1090	1240	1270	1310	3010
03S09E	12500	13600	13100	16400	17000	19400	18300	20300	20400	22900	21600	24600	23800	23600	24700	27800	31800
04S07E	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
04S09E	2170	2990	2170	2170	2170	2170	2170	2400	2010	2900	2780	5020	4380	4560	4570	4700	4200
05S08E	636	640	685	695	700	720	741	758	776	793	811	828	846	863	881	898	916
05S10E	7400	7400	7400	7400	7900	8020	7880	7470	8040	8010	8120	8720	8810	9180	9590	7970	7650
05S11E	0	0	543	290	744	323	1050	385	1100	289	382	384	1010	1360	750	797	682
06S08E	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
06S11E	542	612	612	612	612	669	719	748	812	812	834	866	896	925	954	984	1010
06S13E	1050	1050	1050	1050	1050	1050	1050	1050	1070	1070	1030	1050	1050	1050	1050	1050	1050
07S09E	578	595	610	625	640	660	674	690	706	722	738	754	770	786	802	818	834
07S12E	2670	2200	2200	4440	4580	4580	4250	4510	4590	4980	4820	5560	5820	6080	6340	6600	6870
07S13E	948	948	948	948	948	948	948	948	1010	928	911	948	948	948	948	948	948
07S14E	8450	8380	9400	8550	9180	9180	9400	9560	9520	9580	10500	10200	10400	10500	10700	10800	11000
08S09E	569	635	665	695	810	825	884	936	989	1040	1090	1150	1200	1250	1300	1360	1410
09S16E	1370	1360	1360	1360	1380	1380	1360	1360	1380	1380	1310	1350	1350	1350	1350	1350	1340
10S10E	2600	2210	2600	2980	3020	3050	2850	2900	2980	2980	2760	3070	3110	3150	3200	3240	3280
11S12E	581	590	625	655	665	670	701	721	741	761	781	801	821	841	861	881	901
11S17E	5750	5770	5810	6100	6100	6370	6300	6390	6640	6650	6420	6760	6850	6950	7040	7130	7220
12S14E	567	560	580	600	620	640	631	642	678	678	629	684	695	705	716	727	737
13S15E	507	570	590	620	640	670	754	795	940	940	812	959	1000	1040	1080	1120	1160
13S20E	18900	18900	19600	20200	21100	21200	21400	21900	22500	22900	22700	23600	24000	24500	24900	25300	25700
13S21E	1640	2330	2360	2370	2380	4580	3920	4300	4760	4770	5540	5830	6210	6590	6970	7350	7730
14S17E	475	492	492	636	636	636	678	712	765	765	800	848	882	916	950	984	1020
14S20E	37700	37700	39300	40400	42100	42500	42900	43800	45000	45800	45300	47200	48100	48900	49800	50600	51500
14S22E	2120	2560	2560	2560	2800	2890	3330	3540	4020	4020	4040	4350	4550	4750	4950	5160	5360
15S16E	408	415	425	435	445	450	450	456	414	414	557	484	491	497	504	511	518
15S21E	456	473	473	473	473	487	494	501	487	489	560	526	533	539	545	552	558
15S22E	309	342	342	342	351	486	432	453	487	487	498	535	556	576	597	618	638
15S23E	1930	1990	2030	2140	2140	2140	2260	2310	2420	2420	2460	2530	2580	2640	2690	2740	2800
15S24E	126	360	360	360	416	416	710	807	1080	1080	1020	1200	1290	1390	1490	1590	1680
16S22E	4010	4040	4080	4090	4210	4210	4220	4260	4220	4300	4430	4400	4430	4460	4500	4530	4570
16S24E	1830	1870	1870	2100	2100	2110	2190	2240	2350	2350	2380	2480	2540	2600	2650	2710	2770
17S26E	988	988	988	988	988	988	988	988	976	976	1010	988	988	988	988	988	988
17S27E	650	656	656	675	675	675	685	690	696	702	707	713	719	724	730	736	742
18S19E	3290	3290	3290	3290	3290	3290	3290	3290	2920	3290	3650	3290	3290	3290	3290	3290	3290
18S21E	11300	11200	11600	11800	12000	12300	12100	12200	12300	12300	12600	12700	12800	12900	13100	13200	13300
18S25E	6140	6800	7130	7440	8420	9440	9540	10100	11000	11000	11600	12400	12900	13500	14100	14600	15200
19S19E	1800	1800	1800	1800	1800	1800	1800	1800	1720	2000	1670	1800	1800	1800	1800	1800	1800

Appendix D.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
19S20E	597	750	800	845	890	930	1130	1220	1420	1420	1440	1570	1660	1750	1840	1920	2010
19S26E	2180	2190	2190	2270	2270	2410	2350	2380	2450	2450	2380	2490	2520	2550	2580	2600	2630
20S15E	1970	1870	1910	1950	2100	2250	2030	2040	2110	2110	1850	2080	2080	2090	2100	2110	2120
20S17E	317	325	330	330	335	340	347	352	353	353	381	373	378	383	388	393	398
20S20E	174	175	180	180	185	185	189	191	194	196	199	201	204	206	209	211	214
20S24E	5530	5660	5690	5710	5860	6380	6160	6260	6420	6420	6490	6680	6780	6890	6990	7090	7200
20S27E	1920	1930	1930	1930	1930	1930	1940	1940	2000	2000	1870	1950	1950	1960	1960	1960	1970
21S22E	1680	1600	1660	1710	1760	1820	1710	1720	1760	1790	1580	1730	1740	1740	1750	1750	1760
21S27E	1880	2630	2700	2800	2830	2830	3850	4170	4860	4970	5180	5490	5810	6140	6470	6800	7130
22S17E	785	790	795	800	805	810	815	820	825	830	835	840	845	850	855	860	865
22S19E	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
22S25E	396	396	396	396	396	396	396	396	389	396	403	396	396	396	396	396	396
23S25E	1010	1010	1010	1010	1010	1010	1010	1010	918	924	1200	1010	1010	1010	1010	1010	1010
25S25E	5020	5040	5160	5300	5440	5580	5580	5670	5860	5860	5820	6050	6140	6230	6330	6420	6520
26S25E	900	985	976	995	1010	1030	1120	1160	1240	1250	1250	1300	1340	1380	1410	1450	1490
27S24E	1920	2050	2050	2050	2050	2050	2220	2270	2350	2350	2480	2470	2520	2570	2620	2670	2720
28S25E	1560	1480	1540	1590	1650	1700	1600	1610	1590	1590	1600	1640	1640	1650	1660	1660	1670
29S23E	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
29S27E	8250	8170	8470	8680	8890	9110	9050	9180	9500	9500	9270	9720	9850	9980	10100	10300	10400
29S28E	16500	16300	16900	17400	17800	18200	18100	18400	19000	19000	18500	19400	19700	20000	20200	20500	20800
30S29E	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850	1850
31S28E	2100	2100	2100	2100	2100	2100	2100	2100	2070	2100	2130	2100	2100	2100	2100	2100	2100
31S29E	1650	1630	1630	1630	1630	1630	1620	1620	1630	1630	1560	1600	1590	1590	1590	1580	1580
32S23E	2190	2190	2210	2240	2340	2430	2370	2400	2520	2510	2320	2510	2540	2570	2600	2630	2660
11N24W S	173	170	174	178	183	189	183	185	189	189	185	192	194	196	198	200	201

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
03N01W	.	.	.	.	.	505	.	1750	.	.	.	.	.	.	.	.	.
03N01E	.	.	.	.	.	1740	2320	2000	.	.	.	.	.	.	.	.	.
02S03E	.	.	.	.	.	79	.	.	.	.	.	.	.	.	.	.	.
02S04E	.	5120	5470	9280	9860	7980	.	.	.	.	.	.	.	.	.	.	.
02S05E	.	9520	10000	9290	9240	7550	.	.	.	.	.	.	.	.	.	.	.
02S06E	.	11100	12500	10200	13500	10100	.	.	.	.	.	.	.	.	.	.	.
02S07E	.	.	.	.	.	13200	12900	.	.	22400	21600	.	.	16200	17000	31000	46400
02S08E	.	.	.	.	.	11500	10900	.	11300	33200	33700	.	.	31800	35500	58200	63700
02S09E	.	.	.	.	.	5440	2790	.	4240	5680	5900	.	.	5890	11100	18400	23700
02S10E	.	.	.	.	.	.	.	.	1700	5360	8220	.	.	10700	13100	30700	27800
02S11E	.	.	.	.	.	.	.	.	.	864	843	.	.	54	139	1240	3000
03S04E	.	2	2	2	3	4	.	.	.	.	.	.	.	.	.	.	.
03S05E	.	12000	9780	11000	9220	8820	.	.	.	.	.	.	.	.	.	.	.
03S06E	.	34600	26100	23200	34800	34900	10400	.	9910	11100	11700	.	.	5020	7890	8380	6480
03S07E	.	8790	4540	5550	5040	7400	.	.	.	.	.	.	12500	16500	17900	18300	18800
03S08E	10100	11900	9860	13000	11200	11800	10200	11700	10500	12600	11400	11100	35500	41200	43800	36800	37300
03S09E	.	.	.	.	7570	22100	9950	20300	8700	13100	16600	20200	12400	13400	14200	15400	16700
03S10E	.	.	.	.	436	2840	1260	1390	534	6430	6930	1930	1310	1480	1720	12000	25000
03S11E	.	.	.	.	1020	2970	656	2460	972	1060	1300	3510	1340	2720	2870	9850	13200
04S06E	.	8720	9070	10500	9960	11400	.	.	.	.	.	.	.	.	.	.	.
04S07E	.	4920	7690	9330	7700	7780	.	.	3550	3690	3360	.	.	4900	6880	11900	9780
04S08E	9500	10100	9700	15200	10300	14800	11200	13000	11900	14400	14900	17500	11800	16500	13500	15600	20000
04S09E	10800	10900	10200	11900	10800	14100	12500	13300	33800	35200	37700	41300	38100	38000	35100	36000	60000
04S10E	.	.	.	.	.	.	.	.	8340	12500	13400	17700	9250	9960	13300	16700	52100
04S11E	.	.	.	.	.	.	.	.	5450	10900	11000	14000	11900	12100	11700	13700	36700
04S12E	.	1170	1780	1970	1870	1800	1500	2730	2810	4800	5510	2550	2040	2350	2610	2760	2320
04S13E	.	832	729	969	883	1170	962	1030	1060	1110	1220	.	.	.	848	1730	1970
04S14E	.	461	392	755	541	1210	863	616	876	834	707	.	.	.	560	963	691
05S06E	.	293	487	462	472	377	.	.	.	.	.	.	.	.	.	.	.
05S07E	.	12600	12700	14200	13700	19300	.	.	.	.	.	.	.	.	.	.	.
05S08E	1630	5080	7970	6360	9970	7610	4040	3620	3890	4140	4220	5510	4020	7340	7670	7490	13700
05S09E	14200	18900	18500	18500	19700	22800	18000	17000	22000	29300	31400	30500	20300	23900	25100	27200	55200
05S10E	6910	8090	9340	6480	9480	13600	12000	9750	14600	19000	18200	16200	12600	14900	14200	15300	16000

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
05S11E	1000	1170	1230	1330	1150	1350	986	1240	3260	4050	3960	3440	2580	3090	1540	3640	2170
05S12E	.	13200	13000	15900	14800	15600	14100	16500	12000	13000	13300	.	.	.	16000	19500	22500
05S13E	.	5570	4660	7510	9830	10700	9690	11000	11700	11400	9150	.	.	.	18500	29700	31300
05S14E	.	504	578	829	640	585	569	526	567	517	741	.	.	.	4820	5460	4490
05S15E	.	.	.	5	7	.	.	.	.	.	.	.	.	.	.	.	.
06S07E	.	570	715	822	829	886	.	.	.	.	.	.	.	.	.	.	.
06S08E	.	20200	24400	21700	21100	27000	.	.	.	.	.	.	.	.	.	.	.
06S09E	.	4150	3840	4820	6050	4700	621	890	503	409	883	.	.	.	889	1290	1300
06S10E	.	5530	3890	4330	4100	3810	3720	4620	4740	5620	3720	.	.	.	2070	3260	3180
06S11E	.	13500	10900	15600	12000	21300	8590	10400	14000	22500	33400	.	.	.	12700	24900	23900
06S12E	.	23200	27000	31700	32200	57000	22000	31900	36700	39200	64900	.	.	.	19700	41500	50200
06S13E	.	6860	10600	9490	10300	14000	9030	11400	20600	21400	21800	.	.	.	17300	28800	28400
06S14E	.	844	817	949	1230	2200	1060	1100	862	874	1260	.	.	.	475	947	1090
06S15E	.	.	.	.	.	.	56	31	46	24	15	.	.	.	.	.	.
07S08E	.	18300	17300	21700	20400	25200	.	.	.	.	.	.	.	.	.	.	.
07S09E	.	15000	14800	11200	14800	15600	1410	877	1670	1770	1510	.	.	.	772	2170	3090
07S10E	.	12700	9190	14800	12000	15600	9000	14200	11000	11800	12900	.	.	.	11700	14100	20600
07S11E	.	56600	43400	53100	51500	49500	39500	43700	41400	56100	57700	.	.	.	61300	73100	80000
07S12E	.	35300	26900	43000	33400	34800	20600	25400	24000	33400	39000	.	.	.	44200	68100	78800
07S13E	.	11600	10500	16300	14000	32700	14200	27600	11700	14500	31500	.	.	.	15500	47800	63900
07S14E	.	13400	13300	19800	15200	23600	8410	16200	5970	9920	14700	.	.	.	7430	18600	33400
07S15E	.	6650	8070	13200	11700	19900	10200	12900	13000	13500	15400	.	.	.	9170	11400	20100
07S16E	.	2720	1560	2330	2050	1950	1460	1320	1370	1270	1670	.	.	.	1030	1290	1410
08S08E	.	11300	10900	12400	9740	9820	.	.	.	.	.	.	.	.	.	.	.
08S09E	.	14100	13500	18000	21400	18000	.	.	.	.	.	.	.	.	.	.	.
08S10E	.	1440	939	1410	1410	834	.	.	.	.	.	.	.	.	.	.	.
08S11E	.	4600	3260	4940	2260	2440	1850	2120	3140	2640	3700	.	.	.	5890	8370	5330
08S12E	.	10200	9020	11900	8690	13300	10300	12400	13900	16700	21000	.	.	.	17900	27500	37900
08S13E	.	8870	10800	13100	11400	20300	12800	17400	12500	18300	19400	.	.	.	18600	25200	38700
08S14E	.	18700	17100	22000	20500	33700	15400	22100	16900	23300	27800	.	.	.	27200	45100	67500
08S15E	.	33500	36600	39800	46800	43600	32600	34900	38900	33500	40400	.	.	.	26800	38000	48000
08S16E	.	10300	11000	13200	15700	14000	11000	11100	10100	12500	14400	.	.	.	16400	20100	21100
08S17E	.	136	93	189	140	138	491	434	194	47	389	.	.	.	324	396	253
09S08E	.	4360	4490	3870	1960	3000	2730	3170	5590	6080	5870	.	.	.	8310	12400	7240

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
09S09E	.	10600	10700	9050	10100	12300	10600	9660	15300	15600	15100	.	.	.	19100	27000	25700
09S10E	.	9730	6380	5780	5480	5520	2400	1690	4660	4830	12500	.	.	.	8770	8370	14800
09S11E	.	5310	4700	5000	5930	6900	4890	5070	3450	5390	7400	.	.	.	14900	19200	15500
09S12E	.	22800	20600	20600	26800	28800	25300	27000	20400	26700	25800	.	.	.	18500	20700	30000
09S13E	.	41400	39800	44900	39200	40000	33900	35800	35400	36000	39800	.	.	.	32900	49200	56700
09S14E	.	47300	51100	52400	54700	55300	40900	51200	40300	42100	44300	.	.	.	36700	48300	55200
09S15E	.	39300	38200	42300	41100	41500	34500	39900	41300	41900	47600	.	.	.	44300	64900	65500
09S16E	.	17800	16700	21200	17200	12300	10800	15500	15000	19200	21200	.	.	.	25500	34900	42000
09S17E	.	10300	9010	11200	13200	12000	11200	9810	9020	8740	9040	.	.	.	7040	13100	18000
09S18E	.	112	102	114	229	544	363	300	252	166	174	.	.	.	23	41	17
10S08E	.	.	.	303	178	281	252	310	481	445	431	.	.	.	.	.	.
10S09E	.	2170	1710	1900	1890	2060	1400	1920	7130	6650	6140	.	.	.	11200	14500	7900
10S10E	.	22700	20000	19200	21500	18000	17600	16300	21700	21700	23600	.	.	.	30400	34700	41200
10S11E	.	12900	14500	14000	16800	13700	10100	12100	13100	10400	13100	.	.	.	14300	17500	19400
10S12E	.	9360	11600	11200	10300	9170	7930	10200	4180	10800	13900	.	.	.	19200	17600	33500
10S13E	.	30100	33900	37800	35500	43800	35700	37700	31100	39200	41600	.	.	.	38300	57700	51800
10S14E	.	66400	62700	82000	71900	74100	56700	72400	66900	68700	78400	.	.	.	59900	91800	105000
10S15E	.	66800	60000	62900	53300	72900	47500	65500	41900	55400	53900	.	.	.	36800	75400	89600
10S16E	.	27600	25900	30000	27400	37000	19500	34500	22900	31500	32800	.	.	.	22600	51600	61700
10S17E	.	16700	12600	9730	18200	14300	10600	14200	12700	13900	14300	.	.	.	12900	20600	24400
10S18E	.	4000	4410	4110	4880	4110	3760	1110	5380	8480	7210	.	.	.	4920	7800	7190
10S19E	.	653	855	762	2600	3010	1790	2190	7080	6300	6680	.	.	.	857	873	1100
10S20E	.	.	.	.	.	.	239	313	212	178	195	.	.	.	73	.	27
11S10E	.	26400	21600	16400	18000	19100	18000	13800	21500	15800	20800	.	.	.	30300	37700	35700
11S11E	.	6250	4610	2190	2780	1990	2130	1810	4080	3500	3340	.	.	.	1010	1570	1970
11S12E	.	5000	6490	5820	3670	4570	5770	2920	2860	2970	3140	.	.	.	4890	8400	6170
11S13E	.	23100	30300	21900	28600	19200	14800	16100	10100	25100	23400	.	.	.	25500	28800	26200
11S14E	.	47000	45200	51400	53400	57800	45200	56100	57500	63300	56600	.	.	.	60600	76100	79500
11S15E	.	54500	56800	61600	88100	75000	65300	74200	77400	83900	90100	.	.	.	96200	120000	120000
11S16E	.	79300	75300	77200	87100	80100	54800	74200	68800	71900	73700	.	.	.	52800	80700	89000
11S17E	.	38600	33000	39700	29500	31900	20100	31700	17100	24500	26000	.	.	.	15000	35300	39000
11S18E	.	17300	14800	17600	11500	16400	11500	14900	7580	9400	9380	.	.	.	11800	16900	16600
11S19E	.	5490	4210	6530	4770	8330	16700	17000	8870	8450	5640	.	.	.	3990	4140	5100
11S20E	.	2770	2710	4570	4030	5040	9800	10200	2230	3350	3830	.	.	.	2700	3050	2320
11S21E	.	23	13	14	19	21	31	52	45	37	43	.	.	.	221	301	225

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
12S11E	.	8570	6490	7750	3860	4010	2630	1350	1390	985	1260	.	.	.	12200	12400	19400
12S12E	.	6690	5090	5460	4090	3590	2860	2280	2380	1980	2290	.	.	.	15900	19800	15100
12S13E	.	9430	5570	8070	4900	4770	3250	3370	8320	11100	9230	.	.	.	12200	13500	10100
12S14E	.	28900	22800	25600	26700	31000	24200	25200	19200	32700	27000	.	.	.	29000	37600	37300
12S15E	.	44400	44600	55500	69100	67000	59300	54100	65700	62000	75800	.	.	.	91200	105000	90300
12S16E	.	39600	42000	45600	48800	47000	43000	48000	53100	60500	54700	.	.	.	68100	80500	79700
12S17E	.	70100	67600	74100	70600	68100	47100	67300	45000	51000	48900	.	.	.	47200	87200	94900
12S18E	.	42900	32900	41000	34800	39100	26900	35600	24300	33000	27200	.	.	.	28900	51700	59100
12S19E	.	18400	16500	20700	20700	23700	18100	21400	17900	21700	23000	.	.	.	24300	31700	35900
12S20E	.	13400	13500	16400	16900	21000	15600	19200	18200	22000	25500	.	.	.	21800	23000	24900
12S21E	.	21600	13600	16900	14100	12900	12200	17900	28400	20100	20400	.	.	.	7920	13100	17500
12S22E	.	4690	3310	2420	3560	4480	3720	5400	4960	4520	4030	.	.	.	3720	4120	3830
13S11E	.	277	281	285	723	1890	1020	928	664	1080	1090	.	.	.	3060	3740	709
13S12E	.	22800	23200	25400	20700	20100	16500	9270	9200	2700	1120	.	.	.	8370	11000	9980
13S13E	.	21600	19500	21100	18900	22900	18900	7920	3950	2840	2700	.	.	2680	6010	6160	10500
13S14E	.	18300	20900	19600	18400	20200	15200	11000	5140	15500	11500	.	.	.	13600	15200	20000
13S15E	.	65500	47900	54200	45500	49400	36800	45800	37100	45000	48900	.	.	.	62500	56800	68600
13S16E	.	71100	70400	77200	64000	64200	60400	67000	66100	65200	69000	.	.	.	89500	104000	104000
13S17E	.	57700	49200	58800	50700	48300	31200	44400	41900	45600	39600	.	.	.	43700	78600	91300
13S18E	.	31600	22900	28700	19700	24600	17900	21100	13800	19200	20800	.	.	.	14100	37200	46900
13S19E	.	19200	14200	18200	15600	19000	13200	16100	13700	13700	13500	.	.	.	12200	19100	20300
13S20E	.	7280	6590	6480	7170	7270	7780	8210	10300	10600	9100	.	.	.	4440	4960	4930
13S21E	.	24700	18800	27700	20500	26600	17000	21200	17700	19900	19600	.	.	.	12000	17400	17600
13S22E	.	24900	15000	20400	15800	27000	14400	19900	22700	27700	27800	.	.	.	12600	18200	22900
13S23E	.	5090	4320	7050	6660	10000	5760	8480	12800	12500	12400	.	.	.	30200	42600	42800
13S24E	.	1690	1730	2560	2460	3550	3580	5420	9630	7530	9390	.	.	.	4860	4020	5350
14S12E	.	15200	16600	11300	16000	13700	13500	8310	4540	5140	5110	.	.	.	2500	2690	9810
14S13E	.	48300	39800	33300	39300	37600	39600	13700	12600	14700	8890	.	.	967	5310	4910	10200
14S14E	.	43800	41400	41600	29000	36200	30500	13700	11200	7130	6350	.	.	2090	3390	6170	13700
14S15E	.	8640	8860	11800	13000	11300	9080	4950	5570	4360	4150	.	.	.	2140	2060	3580
14S16E	.	26000	25700	28600	32500	36400	36100	34600	38800	41800	43100	.	.	.	37900	38800	34700
14S17E	.	52000	52900	61400	68100	67000	56600	60300	72400	67400	66800	.	.	.	62400	73100	89100
14S18E	.	78900	68600	80500	69800	75700	49200	60900	53100	57600	54600	.	.	.	49700	76500	97900
14S19E	.	40200	37600	37200	33700	37900	26500	31400	24900	28100	25800	.	.	.	27000	41800	46700
14S20E	.	21200	13300	20200	14000	18600	11700	17200	11400	13500	14500	.	.	.	10500	17100	21900
14S21E	.	54700	42200	51400	45100	49100	37500	47000	33400	39500	37700	.	.	.	28900	40400	46400
14S22E	.	34600	24600	42400	30600	26800	28900	42000	29500	39500	37100	.	.	.	28700	37400	44200

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
14S23E	.	11700	9940	14500	10800	12300	7900	15100	14100	17900	17200	.	.	.	16200	22100	31100
14S24E	.	8170	9070	11100	13500	14900	12200	18700	17300	20200	20600	.	.	.	10500	7950	13700
14S25E	.	4	5	1	4	3	2	373	586	802	867	.	.	.	.	.	.
15S12E	.	4500	4540	1840	3230	2810	3830	1910	1820	1400	2290	.	.	.	127	176	59
15S13E	.	41500	39900	30300	33300	38900	38100	22600	21000	17500	13000	.	.	1110	7100	10000	6040
15S14E	.	44400	39200	35200	28400	31500	25800	18500	16600	8340	7510	.	.	54	4420	6520	14000
15S15E	.	26000	28900	25100	20600	21100	20100	13700	17500	13900	11600	.	.	292	595	322	9590
15S16E	.	6740	3860	4570	4300	5090	3960	4820	4440	6910	7150	.	.	497	3590	1770	6490
15S17E	.	86300	88400	90700	92300	102000	83100	77100	89600	92100	84600	.	.	.	76700	72400	90700
15S18E	.	77300	80000	81200	77000	84200	59200	49600	59700	55600	65300	.	.	.	80600	92600	101000
15S19E	.	78200	73800	79100	77200	70300	56300	67600	68400	63100	60200	.	.	.	71700	85600	94400
15S20E	.	55400	44100	62800	55600	57100	39800	51300	50800	55700	52600	.	.	.	44800	63500	64700
15S21E	.	39700	24900	47700	32200	40900	20200	42000	27700	39400	43400	.	.	.	25400	46500	53400
15S22E	.	37000	24000	45500	31800	45000	17500	41200	23000	43500	44000	.	.	.	23400	43300	50600
15S23E	.	30100	22200	39900	31500	35400	19900	42900	24200	40200	38100	.	.	.	25100	32900	42300
15S24E	.	31800	23900	39900	29600	37300	18900	40600	27900	43400	44100	.	.	.	13300	18600	36400
15S25E	.	15200	12500	14300	15500	15800	12200	14600	18900	21300	22100	.	.	.	13600	9780	17400
16S14E	.	27100	23500	28900	26200	29200	26900	21500	20100	14300	10200	.	.	3970	13500	7100	14600
16S15E	.	45700	41700	39700	41300	48000	44900	31200	21700	12900	7680	.	.	2360	5040	2250	29500
16S16E	.	26700	28500	30900	35400	38100	37500	32600	32400	27200	26000	.	.	2310	7100	3080	28900
16S17E	.	32400	29700	30700	22200	26900	19700	17700	12100	21500	22000	.	.	.	14700	17100	33700
16S18E	.	37300	41900	51200	52200	46900	43000	48500	38600	42100	47200	.	.	.	41500	53000	60400
16S19E	.	86800	97400	108000	96800	93500	83500	83700	83400	69000	67000	.	.	.	69500	76300	79900
16S20E	.	77600	68800	83300	76500	75900	60500	71300	70000	71300	75500	.	.	.	74900	99200	108000
16S21E	.	77200	65500	87800	72600	79500	56500	70500	77500	77000	78800	.	.	.	76400	92100	104000
16S22E	.	45800	38000	46600	47800	49200	35000	50800	35600	49400	52800	.	.	.	35300	52400	58700
16S23E	.	37200	29600	48100	34900	44000	29000	45500	26900	45600	47300	.	.	.	22300	38300	55300
16S24E	.	36100	31900	52800	39900	45300	30600	45000	32800	58700	60400	.	.	.	29300	43800	72200
16S25E	.	28700	20900	31700	27000	31500	22400	32000	25500	40000	42500	.	.	.	21600	23800	46800
16S26E	.	2690	6090	7760	9010	9330	3640	3990	3510	3980	3850	.	.	.	8060	5320	9400
17S14E	.	2290	1920	2320	1980	3510	3930	1590	748	933	829	.	.	688	349	359	420
17S15E	.	48900	51800	53300	43800	46700	50200	39800	39800	37400	32000	.	.	8110	7110	4580	16200
17S16E	.	36600	36900	36800	27900	28600	32200	24500	23000	16600	16500	.	.	2500	3030	2920	20300
17S17E	.	33300	34300	37000	30100	34500	31500	28900	29600	29100	30200	.	.	4880	11300	11400	35800
17S18E	.	26100	23900	34400	23800	29800	16900	21800	19500	26800	29700	.	.	620	14500	19600	34900
17S19E	.	33100	40000	46000	33600	40100	23400	29400	21900	35600	37300	.	.	.	27500	40300	53700

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
17S20E	.	46400	45800	52400	55300	51700	41300	45200	27000	44600	42200	.	.	.	25300	44500	48900
17S21E	.	70000	69500	70300	76800	76600	62400	61800	63800	71800	77200	.	.	.	60200	65800	71900
17S22E	.	60900	59500	60400	63300	62700	47100	53400	47500	53800	57400	.	.	.	55800	65700	73600
17S23E	.	44600	51200	60400	56800	59800	42900	48700	35100	52400	50600	.	.	.	55800	61000	69600
17S24E	.	31800	31900	41200	36600	65200	36000	56200	22500	28600	24500	.	.	.	36900	28400	54000
17S25E	.	39400	32700	48600	38700	64000	40200	62300	536	735	289	.	.	.	2920	1750	6780
17S26E	.	58100	43300	78300	60400	61500	45800	61600	23600	25700	25400	.	.	.	12800	10200	20800
17S27E	.	35200	29900	32800	25400	15300	11400	13700	.	.	.	.	.	.	174	152	165
18S15E	.	11700	11700	11900	9620	11200	11500	5320	2520	1710	1550	.	.	.	1050	804	789
18S16E	.	46900	36600	39700	37600	43500	37100	28200	27200	15500	7960	.	.	2980	2880	4650	9490
18S17E	.	46900	41600	44300	43200	48600	43700	34400	28400	9690	13600	.	.	9240	7710	942	23500
18S18E	.	31400	33000	30900	28700	33400	28400	23800	31000	23300	21100	.	.	4660	6050	2690	37500
18S19E	.	22300	23200	41000	31600	63100	33900	37000	11400	15500	21300	.	.	.	10300	12100	25500
18S20E	.	53200	50700	59200	50200	56000	23600	38100	10100	16400	17000	.	.	.	10600	16600	28400
18S21E	.	48700	46700	60100	43200	41000	26700	38900	15000	20200	21700	.	.	.	26600	29000	42200
18S22E	.	48800	44700	61900	59000	57500	40200	58300	15400	20600	22300	.	.	.	19000	23500	25500
18S23E	.	23300	20500	22300	21300	58500	46000	58100	1800	4080	6760	.	.	.	7510	7850	6820
18S24E	.	29800	31700	37500	33600	67000	37300	59900	.	.	.	.	.	.	.	.	.
18S25E	.	88500	88200	106000	99300	61900	43100	58800	.	.	.	.	.	.	.	.	.
18S26E	.	83800	105000	120000	91500	70400	46900	69800	.	.	.	.	.	.	.	.	.
18S27E	.	62000	58900	63500	68600	46000	36500	47100	.	.	.	.	.	.	.	.	.
19S16E	.	28200	25900	26800	23400	30600	32300	22700	25100	20600	16000	.	.	8170	5660	3220	6680
19S17E	.	62000	58500	64100	56200	61000	61500	31400	34800	33300	20000	.	.	4860	6360	2430	18600
19S18E	.	28900	28400	36900	27800	38100	41100	20100	19600	19900	16800	.	.	867	1910	156	6940
19S19E	.	10300	11500	12400	13100	14000	10600	9410	10900	11200	11200	.	.	1830	4260	4120	18200
19S20E	.	14000	10600	13500	18500	17400	9520	11700	2640	4490	5480	.	.	.	4080	3210	10300
19S21E	.	44100	44500	55000	51200	31900	30500	50500	6560	13000	15900	.	.	.	20600	18600	38800
19S22E	.	40000	33700	46900	41700	61500	36700	47800	7200	23000	26700	.	.	.	13200	21100	40100
19S23E	.	30700	32700	45000	33500	59800	35200	55000	.	.	.	.	.	.	.	.	.
19S24E	.	59800	54000	71400	60400	55500	31000	56200	.	.	.	.	.	.	.	.	9
19S25E	.	65200	67600	92800	78800	68600	38400	61700	.	.	.	.	.	.	.	.	.
19S26E	.	64600	63900	77300	63000	71200	39300	64600	.	.	.	.	.	.	.	.	.
19S27E	.	7640	8720	12000	7380	4730	2160	2730	.	.	.	.	.	.	.	.	.
20S15E	.	27000	23300	22700	19900	24900	23700	21400	23900	20600	22500	.	.	.	18700	5420	21800
20S16E	.	15900	17600	21100	19100	19600	22000	17100	16000	13700	12100	.	.	3200	4380	3020	4590
20S17E	.	64100	62300	62900	57100	67100	63600	44800	54000	48200	38900	.	.	10600	9960	5760	21400

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
20S18E	.	34500	37400	41700	40200	36600	36100	30600	34000	24700	18700	.	.	4600	4810	6760	20100
20S19E	.	20500	14000	33400	15900	27800	9430	9770	9460	8640	8850	.	.	1590	2520	845	32800
20S20E	.	3140	1080	2910	1050	1260	174	555	1300	1420	1320	.	.	.	2580	2550	12800
20S21E	.	19400	11900	22600	7840	20900	7510	10500	2030	6690	33900	.	.	.	3240	21700	52600
20S22E	.	63200	47100	65200	56900	46300	45700	56000	9430	52400	41100	.	.	.	21100	62000	81300
20S23E	.	49700	48100	70500	45300	59700	31600	57600	3860	8970	10500	.	.	.	13400	11400	26900
20S24E	.	59700	47900	69900	53100	46700	23300	45600	.	.	.	.	.	.	.	.	.
20S25E	.	42300	40400	62000	45500	72800	41000	68600	.	.	.	.	.	.	.	.	.
20S26E	.	60900	66200	69200	64300	47200	27300	46800	.	.	.	.	.	.	.	.	.
20S27E	.	61800	77300	94900	78500	18200	9810	17100	.	.	.	.	.	.	.	.	.
20S28E	.	733	804	822	717	.	101	287	.	.	.	.	.	.	.	.	.
21S15E	.	9480	12500	12600	9710	11400	10700	7910	10200	8730	11500	.	.	.	12700	4730	15400
21S16E	.	20500	23900	25200	25100	24600	26200	20100	24100	21800	25500	.	.	.	13400	4060	30500
21S17E	.	18100	18600	17500	8640	12300	12300	9670	8660	7120	4470	.	.	3800	5860	4560	8510
21S18E	.	41200	36300	39600	37400	41800	40900	35100	33100	18300	11700	.	.	4870	12500	10300	37800
21S19E	.	10900	5880	15300	8570	13300	10500	9360	5360	3430	3250	.	.	.	155	53	6190
21S20E	.	10900	4420	12400	2860	5220	798	85	626	631	507	.	.	.	713	1960	2910
21S21E	.	10200	2560	11100	4880	6120	6310	5520	873	1770	2340	.	.	.	1720	1360	9110
21S22E	.	9420	4660	11900	8220	8580	3700	3060	7590	7870	8550	.	.	.	9250	8400	11200
21S23E	.	27100	23600	35400	20300	46900	17700	51900	7390	10200	11200	.	.	.	15000	26000	38500
21S24E	.	27100	25700	41600	28200	36600	21000	39000	.	.	.	.	.	.	.	270	.
21S25E	.	43300	35900	47200	35500	52100	32600	56200	.	.	.	.	.	.	.	.	.
21S26E	.	58400	54900	62000	61600	74100	50200	74000	.	.	.	.	.	.	.	.	.
21S27E	.	72400	69900	76000	64600	35400	26800	35500	.	.	.	.	.	.	.	.	.
21S28E	.	23300	22600	17100	16500	7330	6930	9620	.	.	.	.	.	.	.	.	.
22S18E	.	6130	6010	6580	7320	8110	7080	2710	3940	3790	2510	.	.	1990	5380	6110	10500
22S19E	.	2050	3300	1480	2680	3490	3920	928	437	503	480	.	.	.	2830	1920	3090
22S20E	.	80	97	123	90	.	50	.	.	.	15	.	.	.	394	176	241
22S21E	.	309	258	293	303	272	291	364	517	317	306	.	.	.	290	432	282
22S22E	.	3460	2120	4160	2730	1970	980	875	1060	1170	1180	.	.	.	512	2170	5470
22S23E	.	41200	29200	39300	36800	32800	18500	23200	7180	9160	25400	.	.	.	21100	27500	48200
22S24E	.	25300	23200	31800	25900	39800	25900	39100	.	.	.	.	.	.	.	.	.
22S25E	.	38700	31600	45500	31300	50700	34900	60600	.	.	.	.	.	.	.	.	.
22S26E	.	28000	25500	35200	28400	48800	35500	61500	.	.	.	.	.	.	.	.	.
22S27E	.	22500	37000	42600	25200	35700	31600	38100	.	.	.	.	.	.	.	.	.
22S28E	.	7400	14400	11300	12600	13300	10200	12100	.	.	.	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
23S18E	.	.	.	.	.	.	18	14	15	12	12	.	.	.	2280	.	2460
23S19E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2720	1740	681
23S20E	.	647	702	1310	1010	1000	704	2	58	23	32	.	.	.	217	232	396
23S21E	.	1150	1230	1830	1670	2260	1520	1210	823	1290	450	.	.	.	1430	1430	1140
23S22E	.	1360	415	243	182	248	408	150	661	2760	1220	.	.	.	169	82	128
23S23E	.	10800	9090	11600	9880	6950	4310	5650	2180	3200	5370	.	.	.	10500	9670	18400
23S24E	.	20000	15500	21600	20100	19800	22800	25300	8070	8420	8030	.	.	.	9300	8510	13500
23S25E	.	50200	41300	65000	42900	40500	22100	38300	.	.	.	.	.	.	.	.	.
23S26E	.	20800	20800	26800	18100	31700	20000	39500	.	.	.	.	.	.	.	.	.
23S27E	.	5310	4900	6050	4620	24500	22000	26300	.	.	.	.	.	.	.	.	.
23S28E	.	1690	1460	2320	1660	545	454	561	.	.	.	.	.	.	.	.	.
24S17E	.	191	428	394	583	469	228	428	.	.	.	.	.	.	.	.	437
24S18E	.	5600	6740	7450	10800	11800	8000	5770	5240	4510	5010	.	.	.	5530	6070	10300
24S19E	.	7270	9510	6560	9710	8700	8400	3440	1820	1450	856	.	.	.	3510	1440	1720
24S20E	.	6220	6690	7160	6820	6900	5000	.	51	34	213	.	.	.	3500	563	320
24S21E	.	.	.	41	79	236	54	162	10	6	68	.	.	.	143	.	2
24S22E	.	5010	3310	8670	5010	9020	7080	11200	9950	7420	11000	.	.	.	1480	4300	5150
24S23E	.	2540	1770	3110	2070	6060	7890	7990	4900	4690	4850	.	.	.	5620	6480	13700
24S24E	.	10600	12000	13300	14600	14800	11600	12900	9600	7430	8020	.	.	.	10300	7590	9680
~~24S25E~~	.	~~35100~~	~~43800~~	~~55200~~	~~37600~~	~~36600~~	~~23600~~	~~48500~~	.	.	.	.	.	.	.	.	.
24S26E	.	23600	28700	34800	30000	49400	23000	52400	.	.	.	.	.	.	.	.	.
24S27E	.	3070	2970	4750	3200	10400	8780	10200	.	.	.	.	.	.	.	.	.
24S28E	.	.	.	.	.	1070	895	1590	.	.	.	.	.	.	.	.	.
25S18E	.	1690	1610	1590	2190	1860	1800	538	175	156	135	.	.	.	745	560	590
25S19E	.	4170	8690	5790	9010	6530	5450	2700	5390	4390	6980	.	.	.	14900	14900	8790
25S20E	.	.	.	.	.	.	57	3610	4750	4990	4380	.	.	.	11900	15500	9780
25S21E	.	178	626	853	1640	1570	174	290	26	123	.	.	.	.	1140	3910	7340
25S22E	.	2980	11100	14300	28200	20800	8860	8950	5660	5250	6370	.	.	.	1500	7200	13000
25S23E	.	18800	19900	18800	18000	22900	16900	14100	16300	15700	20800	.	.	.	7710	12500	14000
25S24E	.	41300	35900	41000	43200	47100	48500	46500	42500	34800	37700	.	.	.	48900	58200	54900
25S25E	.	26300	28000	36700	27500	18700	9730	26700	2550	5430	5050	.	.	.	8980	22600	28200
25S26E	.	28700	26800	36500	31500	38100	21100	44900	.	.	.	.	.	.	.	.	.
25S27E	.	3210	3230	5350	4190	13200	16000	26300	.	.	.	.	.	.	.	.	.
25S28E	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
26S17E	.	683	555	512	335	513	474	.	.	.	.	.	.	.	10	1360	2210
26S18E	.	2300	1170	1370	1160	1070	837	2840	2450	4280	6450	.	.	.	15600	15300	16000
26S19E	.	.	.	.	.	.	600	12000	10400	14700	24800	.	.	.	37400	28700	21100
26S20E	.	.	.	..	.	.	28	2250	3180	2510	5180	.	.	.	10500	11100	12200
26S21E	.	.	.	.	.	.	.	.	.	561	237	.	.	.	4880	4540	9330
26S22E	.	11400	13100	15100	10300	11300	9460	8250	7910	7990	7410	.	.	.	3270	3410	7950
26S23E	.	28000	28200	35900	33200	41900	30800	27100	31100	32600	37200	.	.	.	30100	31400	33600
26S24E	.	40300	39500	45300	47000	58200	48900	40400	39400	36600	38000	.	.	.	55000	64000	60900
26S25E	.	27600	23300	38600	25200	25500	15100	26400	20800	23600	28900	.	.	.	18100	36200	39600
26S26E	.	26600	22200	33400	25500	36100	28500	43300	16400	17400	21500	.	.	.	16100	19500	22700
26S27E	.	1260	305	1100	911	3270	3840	4880	3240	3520	2130	.	.	.	17000	13400	14500
27S20E	.	.	.	.	.	.	.	.	2120	1950	1690	.	.	.	3320	3410	2610
27S21E	.	.	.	.	.	.	.	.	11900	10100	10000	.	.	.	28800	28000	22500
27S22E	.	30600	22200	39800	23200	23900	17500	15000	15100	14200	16700	.	.	.	7720	7670	20700
27S23E	.	57900	57400	67500	58200	66600	63000	51000	60700	55800	63500	.	.	.	41000	48400	66700
27S24E	.	45300	40200	44100	47900	46400	41300	36800	39700	37500	37600	.	.	.	48800	61100	61500
27S25E	.	36000	32000	39900	36000	31300	27600	28400	31400	29200	41400	.	.	.	37000	60900	67600
27S26E	.	50100	46900	65600	57700	47300	38200	41100	52000	55700	69700	.	.	.	40800	51400	61300
27S27E	.	2510	3230	3490	2630	2780	1690	1510	4140	3670	5410	.	.	.	8310	6530	5470
28S21E	.	.	.	.	.	.	.	.	1540	1230	1560	.	.	.	2190	1860	1620
28S22E	.	14900	19200	14100	16500	14500	13900	21000	8020	11000	15100	.	.	.	23200	35000	41700
28S23E	.	33900	35600	42400	39800	35900	35000	33400	50200	46600	55100	.	.	.	35000	42400	54500
28S24E	.	42800	39700	44100	48500	45600	45500	36800	48000	44400	43800	.	.	.	52500	56800	57800
28S25E	.	34800	37600	47300	47600	44100	38400	44400	40100	40500	39400	.	.	.	37100	50900	56200
28S26E	.	67900	54700	55900	58100	58400	43900	42800	55600	52600	75900	.	.	.	43600	59100	65000
28S27E	.	22300	21000	20700	17100	18300	15500	12000	16900	16900	15900	.	.	.	19500	11800	20400
28S28E	.	347	.	.	280	151	118	117	133	151	188	.	.	.	32	53	15
29S22E	.	6080	4640	4480	4360	4560	1270	2470	2580	3420	5370	.	.	.	24000	39800	29500
29S23E	.	30600	33300	43000	41000	31900	24400	31400	17400	29200	38900	.	.	.	29700	49700	60400
29S24E	.	32900	37000	42500	45000	41600	35700	40800	34400	38000	39300	.	.	.	42400	47500	53700
29S25E	.	59000	72300	70800	64900	69700	59700	56500	58700	54300	46900	.	.	.	69900	49200	78600
29S26E	.	81200	79700	83500	95100	92100	89400	97900	75600	72700	69300	.	.	.	81800	63600	91700
29S27E	.	29500	30400	31000	43600	40600	36300	29900	18200	16300	18400	.	.	.	29600	23400	34600
29S28E	.	1270	2540	4790	7320	3510	2410	1660	805	657	685	.	.	.	1350	1270	1510
29S29E	.	7670	8680	7430	8220	8070	6840	5300	7990	7050	7450	.	.	.	3290	1930	5620
29S30E	.	.	.	.	.	.	.	45	.	.	.	.	.	.	.	.	.

Appendix A.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
30S23E	.	567	405	949	420	428	55	.	63	253	328	.	.	.	1170	2960	4030
30S24E	.	17400	18100	15300	17300	14300	9540	11600	10500	15600	17600	.	.	.	26200	37200	42900
30S25E	.	25800	27100	27900	29700	32500	31300	28700	25600	23400	22300	.	.	.	23000	15800	32500
30S26E	.	18600	17100	17600	17800	21600	18500	20000	21000	21700	19900	.	.	.	37700	28100	47100
30S27E	.	55800	52300	55200	42100	49200	45400	38100	30800	27700	27100	.	.	.	29000	23300	39000
30S28E	.	34400	32100	33900	27400	36100	28500	15800	23500	19400	21200	.	.	.	19600	16500	25800
30S29E	.	92900	69800	65800	71500	61300	53700	47100	44400	40900	41000	.	.	.	36100	39900	48200
30S30E	.	21000	23800	17000	14600	16000	10700	9120	7990	6310	4660	.	.	.	3920	3470	6020
31S24E	.	3590	4380	5130	4200	7150	5630	5460	3560	2590	1620	.	.	.	4430	4720	4580
31S25E	.	31900	23300	32700	14600	30300	2980	7290	3250	10500	13600	.	.	.	6890	18300	27200
31S26E	.	15600	12900	17800	13400	21700	8830	12500	9070	14300	15200	.	.	.	34600	22400	43200
31S27E	.	74600	79900	76400	71300	72300	82000	60000	62800	62700	61000	.	.	.	58000	47600	83000
31S28E	.	49800	44800	43500	42900	43500	48500	37800	31800	27900	29200	.	.	.	38100	29300	47000
31S29E	.	77500	67500	59000	65500	65700	52600	47500	54400	52600	49300	.	.	.	56200	58300	71900
31S30E	.	29700	21900	21400	25400	25600	25100	20000	17900	11800	13300	.	.	.	11600	10400	12900
32S23E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	58
32S24E	.	4820	3850	4530	3130	6860	3650	4040	5990	3510	.	.	.	.	2660	3840	2060
32S25E	.	19700	21400	15500	14700	34700	21300	12800	14900	6370	1560	.	.	.	4980	10700	12700
32S26E	.	38600	34200	25800	32800	41900	29300	29400	22800	16300	16800	.	.	.	25800	14000	34600
32S27E	.	31500	28200	26500	21800	26600	23000	18500	18600	17200	16300	.	.	.	16400	15600	20000
32S28E	.	64700	58200	57500	57400	59200	48800	40200	34500	31400	35000	.	.	.	38700	33300	45300
32S29E	.	64100	58200	57600	55100	56900	43900	29600	44600	36300	42800	.	.	.	39300	39100	46300
32S30E	.	1080	902	981	791	1200	739	688	858	785	605	.	.	.	66	131	164
12N23W S	.	.	.	.	.	.	.	.	.	.	10	.	.	.	753	1210	634
12N22W S	.	8490	7020	7390	4790	5010	2110	973	2760	1920	207	.	.	.	519	429	3210
12N21W S	.	20600	21500	22200	19800	22000	18400	17600	15900	3710	1240	.	.	.	855	1760	2880
12N20W S	.	16600	15800	14800	12800	13000	12400	10200	10900	9500	9460	.	.	.	6170	8690	11800
12N19W S	.	19500	17400	13000	14300	15200	14500	5390	14200	12000	10700	.	.	.	10500	7260	13100
12N18W S	.	8960	6410	6260	6700	5810	3710	.	4270	2920	3000	.	.	.	2290	1140	3960
11N23W S	.	769	566	577	467	1090	482	.	.	.	.	.	.	.	.	484	715
11N22W S	.	14600	12300	16200	16100	12600	5770	4190	4440	292	336	.	.	.	1060	1560	1410
11N21W S	.	13900	19000	16400	14200	20600	15200	16900	17400	9090	296	.	.	.	4120	3960	5980
11N20W S	.	27300	25200	22500	26700	24700	21200	17200	22000	14800	9350	.	.	.	9160	9130	13500
11N19W S	.	59800	48400	50300	55600	60600	56000	43500	45200	40600	40100	.	.	.	25600	22100	33600
11N18W S	.	9930	7830	8220	10700	9190	9160	3880	10200	5760	7270	.	.	.	6660	6570	9420

Appendix B.--Municipal ground-water pumpage for townships in the Central Valley estimated by population or reported by municipal water agency

[Pumpage, in acre-feet, rounded to three significant figures. Township: Townships are on the Mount Diablo baseline and meridian, except where followed by an "S" which are on the San Bernardino baseline and meridian. ·, no data]

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
31N05W	·	99	94	122	123	135	139	144	164	181	164	·	·	·	·	·	·
27N03W	·	·	·	·	·	4050	4030	3880	4110	4280	4200	·	·	·	·	·	·
24N03W	258	594	674	1020	1080	1180	1080	1050	1200	1230	1250	·	·	·	·	·	·
22N01W	·	215	211	264	250	272	244	269	285	298	331	·	·	·	·	·	·
22N01E	10600	10800	9780	11700	11600	13300	12200	12900	13100	14300	13800	·	·	·	·	·	·
22N02E	1040	1070	966	1150	1150	1310	1200	1280	1290	1290	1490	·	·	·	·	·	·
19N03W	1230	1170	1170	1410	1300	1470	1420	1430	1460	1540	1500	·	·	·	·	·	·
19N03E	·	·	·	·	·	·	·	959	1890	2600	2230	·	·	·	·	·	·
19N04E	471	449	319	470	291	508	453	607	708	549	897	·	·	·	·	·	·
18N02W	·	·	·	·	·	·	·	·	·	5870	5680	·	·	·	·	·	·
18N02E	1090	1030	663	337	416	477	1080	1090	1030	1000	1270	·	·	·	·	·	·
18N03E	·	·	·	·	·	·	·	·	134	147	·	·	·	·	·	·	·
17N02E	423	461	669	772	703	756	748	526	597	576	622	·	·	·	·	·	·
16N01W	·	·	·	·	·	·	1270	1490	1500	1580	1580	·	·	·	·	·	·
15N03E	2090	1920	1720	1920	1880	2080	1980	2060	2060	2140	2070	·	·	·	·	·	·
15N04E	953	878	787	876	857	952	905	940	939	2960	2750	·	·	·	·	·	·
15N05E	·	·	·	·	·	·	·	·	·	1820	1840	·	·	·	·	·	·
11N06E	·	·	·	1440	1720	1910	1240	1240	1810	2120	1140	·	·	·	·	·	·
10N02E	5920	7390	5540	6840	5970	7130	7070	7980	7700	8340	8660	·	·	·	·	·	·
10N05E	·	·	·	·	·	·	959	952	1670	1880	2010	·	·	·	·	·	·
10N06E	·	·	·	·	·	·	·	·	·	499	506	·	·	·	·	·	·
09N04E	5630	5470	5510	6370	6520	7250	6560	·	·	·	·	·	·	·	·	·	·
09N05E	17800	18300	17600	21300	23500	32500	30400	34600	39800	42300	42600	·	·	·	·	·	·
09N06E	2040	1950	1740	2390	7020	8410	7820	15100	15700	12800	12700	·	·	·	·	·	·
08N01W	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1400	·	·	·	·	·	·
08N02E	2650	2760	2750	3640	3740	4530	4790	5230	4840	5010	5240	·	·	·	·	·	·
08N03E	·	·	·	·	·	137	63	67	·	·	·	·	·	·	·	·	·
08N04E	221	207	177	213	190	218	183	·	·	·	·	·	·	·	·	·	·
08N05E	·	·	·	·	·	355	422	593	448	569	649	·	·	·	·	·	·
08N06E	·	·	·	·	·	·	·	·	4010	4320	4000	·	·	·	·	·	·
07N01E	681	673	641	787	803	927	908	978	991	1040	1030	·	·	·	·	·	·
07N05E	·	·	·	3010	476	628	620	738	601	697	648	·	·	·	·	·	·
07N06E	652	608	629	774	752	896	841	912	·	·	·	·	·	·	·	·	·
06N01W	2420	2570	2000	1950	1890	2180	2810	2860	4700	4500	4680	·	·	·	·	·	·
05N02W	·	·	·	·	·	·	·	120	71	156	·	·	·	·	·	·	·
05N01W	·	·	·	·	·	·	·	·	15	15	15	·	·	·	·	·	·
04N03E	·	·	·	·	·	1210	1260	1210	963	1180	·	·	·	·	·	·	·
02S05E	·	4750	4860	5120	5380	5660	·	·	·	·	·	·	·	·	·	·	·
02S08E	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	958
02S09E	·	·	·	·	·	·	·	·	·	·	·	·	·	98	118	141	1040

Appendix B.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
02S10E	.	.	.	.	.	.	.	.	.	.	.	.	1930	2750	4860	5440	2490
03S08E	.	.	.	.	.	.	.	.	.	915	1190	1200	1090	1240	1270	1310	.
03S09E	.	.	.	.	.	.	.	.	.	22900	21600	24600	23700	23600	24700	27800	.
04S07E	.	80	80	80	80	80	.	.	.	.	.	.	.	.	.	.	.
04S09E	.	.	.	.	.	.	.	.	.	2680	2560	5020	4380	4560	4570	4690	.
05S08E	.	640	685	695	700	720	.	.	.	.	.	.	.	.	.	.	.
05S10E	.	.	.	.	.	7570	7430	7030	7600	7570	7670	8690	8780	9150	9570	7940	7650
05S11E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	750	797	682
06S08E	.	90	90	90	90	90	.	.	.	.	.	.	.	.	.	.	.
06S11E	.	612	612	612	612	669	.	.	812	812	834	.	.	.	.	.	.
06S13E	.	.	.	.	.	.	.	.	1070	1070	1030	.	.	.	.	.	.
07S09E	.	595	610	625	640	660	.	.	.	.	.	.	.	.	.	.	.
07S12E	.	2200	2200	4440	4580	4580	.	.	4590	4980	4820	.	.	.	.	.	.
07S13E	.	.	.	.	.	.	.	.	1010	928	911	.	.	.	.	.	.
07S14E	.	8380	9400	8550	9180	9180	.	.	9520	9580	10500	.	.	.	.	.	.
08S09E	.	635	665	695	810	825	.	.	.	.	.	.	.	.	.	.	.
09S16E	.	1360	1360	1360	1380	1380	.	.	1380	1380	1310	.	.	.	.	.	.
10S10E	.	2210	2600	2980	3020	3050	.	.	2980	2980	2760	.	.	.	.	.	.
11S12E	.	590	625	655	665	670	.	.	.	.	.	.	.	.	.	.	.
11S17E	.	5770	5810	6100	6100	6370	.	.	6640	6650	6420	.	.	.	.	.	.
12S14E	.	560	580	600	620	640	.	.	678	678	629	.	.	.	.	.	.
13S15E	.	570	590	620	640	670	.	.	940	940	812	.	.	.	.	.	.
13S20E	.	18900	19600	20200	21100	21200	.	.	22500	22900	22700	.	.	.	.	.	.
13S21E	.	2330	2360	2370	2380	4580	.	.	4760	4770	5540	.	.	.	.	.	.
14S17E	.	492	492	636	636	636	.	.	765	765	800	.	.	.	.	.	.
14S20E	.	37700	39300	40400	42100	42500	.	.	45000	45800	45300	.	.	.	.	.	.
14S22E	.	2560	2560	2560	2800	2890	.	.	4020	4020	4040	.	.	.	.	.	.
15S16E	.	415	425	435	445	450	.	.	234	234	377	.	.	.	.	.	.
15S21E	.	473	473	473	473	487	.	.	487	489	560	.	.	.	.	.	.
15S22E	.	342	342	342	351	486	.	.	487	487	498	.	.	.	.	.	.
15S23E	.	1990	2030	2140	2140	2140	.	.	2420	2420	2460	.	.	.	.	.	.
15S24E	.	360	360	360	416	416	.	.	1080	1080	1020	.	.	.	.	.	.
16S22E	.	3010	3050	3060	3170	3170	.	.	3180	3190	3390	.	.	.	.	.	.
16S24E	.	1870	1870	2100	2100	2110	.	.	2350	2350	2380	.	.	.	.	.	.
17S26E	.	.	.	.	.	.	.	.	976	976	1010	.	.	.	.	.	.
17S27E	.	656	656	675	675	675	.	.	.	.	.	.	.	.	.	.	.
18S19E	.	.	.	.	.	.	.	.	715	2210	1450	.	.	.	.	.	.
18S21E	.	5110	5480	5710	5940	6190	.	.	6190	6210	6420	.	.	.	.	.	.
18S25E	.	6800	7130	7440	8420	9440	.	.	11000	11000	11600	.	.	.	.	.	.

Appendix B.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
19S19E	.	.	.	.	.	.	.	.	1720	2000	1670	.	.	.	.	.	.
19S20E	.	750	800	845	890	930	.	.	1420	1420	1440	.	.	.	.	.	.
19S26E	.	2190	2190	2270	2270	2410	.	.	2450	1240	2380	.	.	.	.	.	.
20S15E	.	1870	1910	1950	2100	2250	.	.	2110	2110	1850	.	.	.	.	.	.
20S17E	.	325	330	330	335	340	.	.	353	353	381	.	.	.	.	.	.
20S20E	.	175	180	180	185	185	.	.	.	.	.	.	.	.	.	.	.
20S24E	.	5660	5690	5710	5860	6380	.	.	6420	6420	6490	.	.	.	.	.	.
20S27E	.	1620	1620	1620	1620	1620	.	.	2000	2000	1870	.	.	.	.	.	.
21S22E	.	1600	1660	1710	1760	1820	.	.	1760	1790	1580	.	.	.	.	.	.
21S27E	.	2630	2700	2800	2830	2830	.	.	4860	4970	5180	.	.	.	.	.	.
22S17E	.	790	795	800	805	810	.	.	.	.	.	.	.	.	.	.	.
22S19E	.	160	160	160	160	160	.	.	.	.	.	.	.	.	.	.	.
22S25E	.	.	.	.	.	.	.	.	389	396	403	.	.	.	.	.	.
23S25E	.	.	.	.	.	.	.	.	918	924	1200	.	.	.	.	.	.
25S25E	.	5040	5160	5300	5440	5580	.	.	5860	5860	5820	.	.	.	.	.	.
26S25E	.	985	976	995	1010	1030	.	.	1240	1250	1250	.	.	.	.	.	.
27S24E	.	2050	2050	2050	2050	2050	.	.	2350	2350	2480	.	.	.	.	.	.
28S25E	.	1480	1540	1590	1650	1700	.	.	1590	1590	1600	.	.	.	.	.	.
29S23E	.	.	.	.	.	.	.	.	.	298	.	.	.	.	.	.	.
29S27E	.	8170	8470	8680	8890	9110	.	.	9500	9500	9270	.	.	.	.	.	.
29S28E	.	16300	16900	17400	17800	18200	.	.	19000	19000	18500	.	.	.	.	.	.
30S29E	.	1850	1850	1850	1850	1850	.	.	.	.	.	.	.	.	.	.	.
31S28E	.	.	.	.	.	.	.	.	2070	2100	2130	.	.	.	.	.	.
31S29E	.	1630	1630	1630	1630	1630	.	.	1630	1630	1560	.	.	.	.	.	.
32S23E	.	2190	2210	2240	2340	2430	.	.	2520	2510	2320	.	.	.	.	.	.
11N24W S	.	170	174	178	183	189	.	.	189	189	185	.	.	.	.	.	.

Appendix C.--Agricultural ground-water pumpage synthesized from regression for townships in the Central Valley

[Pumpage, in acre-feet, rounded to three significant figures. Township: Townships are on the Mount Diablo baseline and meridian, except where followed by an "S" which are on the San Bernardino baseline and meridian. , no data]

TOWNSHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
31N04W	504	497	473	562	493	624	488	569	594	584	604	690	659	621	709	858	968
30N06W	185	183	174	207	181	229	180	209	218	215	222	254	242	228	261	316	356
30N04W	644	637	605	719	630	798	625	728	760	748	772	883	843	795	908	1100	1240
29N06W	132	131	124	148	129	164	128	149	156	154	159	181	173	163	186	226	255
29N05W	4750	4680	4450	5290	4640	5880	4600	5350	5590	5500	5680	6500	6210	5850	6680	8080	9110
29N04W	1200	1190	1130	1340	1180	1490	1170	1360	1420	1400	1440	1650	1580	1490	1700	2050	2310
29N03W	1360	1340	1270	1510	1330	1680	1310	1530	1600	1570	1620	1860	1770	1670	1910	2310	2600
28N05W	385	380	361	430	376	477	373	434	455	448	462	529	505	475	543	657	741
28N03W	943	930	884	1050	921	1170	914	1060	1110	1090	1130	1290	1230	1160	1330	1610	1810
27N05W	239	235	224	266	234	295	231	269	281	276	286	328	312	295	337	407	460
27N04W	1200	1190	1130	1340	1180	1490	1170	1360	1420	1400	1440	1650	1580	1490	1700	2050	2310
27N03W	10000	9870	9380	11200	9780	12400	9700	11300	11800	11600	12000	13700	13100	12300	14100	17000	19200
27N02W	2380	2350	2230	2650	2330	2950	2310	2680	2810	2760	2850	3260	3110	2930	3350	4050	4570
26N05W	762	752	714	850	745	943	739	860	899	884	912	1040	996	939	1070	1300	1460
26N04W	2680	2650	2520	2990	2630	3330	2600	3030	3170	3110	3220	3680	3510	3310	3780	4570	5160
26N03W	13200	13000	12400	14700	12900	16300	12800	14900	15600	15300	15800	18100	17300	16300	18600	22500	25300
26N02W	8450	8350	7930	9430	8270	10500	8200	9540	9970	9810	10100	11600	11100	10400	11900	14400	16200
25N04W	555	548	521	619	543	688	538	627	655	644	665	761	726	685	781	946	1070
25N03W	18500	18300	17400	20700	18100	22900	18000	20900	21800	21500	22200	25400	24200	22800	26100	31500	35600
25N02W	4980	4920	4680	5560	4870	6170	4830	5620	5880	5780	5970	6820	6520	6140	7010	8480	9570
25N01W	801	790	751	893	783	992	776	903	944	928	959	1100	1050	988	1130	1360	1540
24N05W	222	218	208	248	217	275	215	250	261	257	266	305	291	274	312	379	427
24N04W	1250	1240	1170	1400	1220	1550	1210	1410	1480	1450	1500	1720	1640	1550	1760	2130	2410
24N03W	7620	7520	7150	8500	7450	9440	7390	8600	8990	8840	9130	10400	9970	9390	10700	13000	14600
24N02W	6420	6340	6020	7160	6280	7950	6220	7240	7570	7440	7690	8790	8400	7910	9030	10900	12300
24N01W	4120	4270	3910	4800	4580	5150	4310	5540	4900	5130	5660	6850	5400	5990	6440	8090	8780
24N01E	335	347	319	391	373	419	351	451	399	417	461	558	440	488	525	659	716
23N05W	378	374	355	422	370	469	367	427	446	439	453	518	495	467	533	644	727
23N04W	656	648	616	732	641	813	636	741	774	761	786	899	858	809	924	1120	1260
23N03W	4080	4030	3830	4550	3990	5050	3960	4610	4810	4740	4890	5590	5340	5030	5740	6950	7840

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
23N02W	13700	13600	12900	15300	13400	17000	13300	15500	16200	15900	16400	18800	18000	16900	19300	23400	26400
23N01W	19500	20200	18600	22800	21700	24400	20400	26200	23200	24300	26800	32500	25600	28400	30500	38300	41700
23N01E	3410	3530	3240	3970	3800	4260	3570	4580	4060	4240	4690	5670	4470	4960	5330	6700	7270
22N04W	3290	3250	3090	3670	3210	4070	3190	3710	3880	3810	3940	4500	4300	4050	4630	5600	6310
22N03W	3930	3880	3690	4380	3840	4870	3810	4430	4630	4560	4710	5380	5140	4840	5530	6690	7540
22N02W	29300	28900	27500	32700	28600	36300	28400	33000	34500	34000	35100	40100	38300	36100	41200	49800	56200
22N01W	14200	14700	13500	16500	15800	17700	14800	19000	16900	17600	19500	23600	18600	20600	22100	27800	30200
22N01E	17200	17800	16300	20000	19100	21400	18000	23100	20400	21400	23600	28500	22500	24900	26800	33700	36600
22N02E	1260	1300	1200	1470	1400	1570	1320	1690	1500	1570	1730	2090	1650	1830	1970	2470	2680
21N04W	1680	1660	1570	1870	1640	2080	1630	1890	1980	1940	2010	2300	2190	2070	2360	2850	3220
21N03W	22700	22400	21300	25300	22200	28100	22000	25600	26700	26300	27200	31100	29700	28000	31900	38600	43500
21N02W	44800	44200	42000	50000	43800	55500	43400	50600	52800	52000	53700	61400	58600	55200	63000	76300	86000
21N01W	9990	10300	9500	11600	11100	12500	10500	13400	11900	12400	13700	16600	13100	14500	15600	19600	21300
21N01E	39400	40800	37400	45900	43800	49200	41200	52900	46900	49000	54100	65500	51600	57300	61600	77300	84000
21N02E	18900	19600	17900	22000	21000	23600	19800	25400	22500	23500	26000	31400	24700	27400	29500	37100	40300
20N04W	938	925	880	1050	917	1160	909	1060	1110	1090	1120	1280	1230	1160	1320	1600	1800
20N03W	27100	26800	25400	30200	26500	33600	26300	30600	32000	31400	32500	37100	35500	33400	38100	46100	52000
20N02W	4900	5450	5360	7360	7160	8890	7380	10900	10200	12500	12800	18700	14400	17300	20500	31600	31800
20N01W	7070	7320	6720	8240	7870	8830	7400	9500	8410	8800	9720	11800	9270	10300	11100	13900	15100
20N01E	12500	12900	11800	14500	13900	15600	13000	16700	14800	15500	17100	20700	16300	18100	19500	24500	26600
20N02E	20600	21400	19600	24000	23000	25800	21600	27700	24600	25700	28400	34300	27000	30000	32300	40500	44000
20N03E	4220	4370	4010	4910	4690	5270	4420	5670	5020	5250	5800	7020	5530	6130	6600	8280	8990
19N04W	1190	1330	1310	1800	1740	2170	1800	2650	2480	3050	3120	4560	3520	4220	4990	7700	7750
19N03W	3230	3590	3530	4850	4710	5860	4860	7170	6690	8230	8430	12300	9500	11400	13500	20800	20900
19N02W	1690	1880	1850	2540	2470	3060	2540	3750	3500	4310	4410	6450	4970	5970	7060	10900	11000
19N01W	9290	9610	8830	10800	10300	11600	9720	12500	11100	11600	12800	15400	12200	13500	14500	18200	19800
19N01E	1750	1820	1670	2040	1950	2190	1840	2360	2090	2180	2410	2920	2300	2550	2740	3440	3740
19N02E	2310	2390	2200	2690	2570	2890	2420	3110	2750	2880	3180	3850	3030	3360	3610	4540	4930
19N03E	2800	2900	2660	3270	3120	3500	2940	3770	3340	3490	3850	4660	3670	4080	4380	5500	5980
19N04E	225	229	219	245	239	253	210	285	273	259	249	299	263	277	289	328	343
18N04W	110	122	120	165	161	200	166	244	228	282	288	421	324	390	461	712	716
18N03W	202	225	221	304	296	367	304	449	419	517	528	773	596	716	847	1310	1310
18N02W	2200	2450	2410	3310	3220	4000	3320	4900	4570	5620	5760	8420	6490	7800	9220	14200	14300

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
18N01W	10300	10700	9790	12000	11500	12900	10800	13800	12300	12800	14200	17100	13500	15000	16100	20200	22000
18N01E	7350	7610	6990	8560	8180	9180	7700	9880	8750	9150	10100	12200	9630	10700	11500	14400	15700
18N02E	4440	4600	4220	5180	4940	5550	4650	5970	5290	5530	6110	7390	5830	6460	6950	8730	9480
18N03E	19300	17800	15000	21500	15400	21500	16600	22900	18200	19400	18600	25700	22800	19500	24400	35900	46000
18N04E	5250	5350	5110	5710	5570	5900	4900	6640	6360	6030	5800	6960	6120	6470	6740	7640	7990
18N05E	675	689	657	735	717	760	631	855	819	777	747	897	787	834	868	983	1030
17N04W	204	227	223	307	299	371	308	455	424	522	534	782	602	724	856	1320	1330
17N03W	710	789	776	1070	1040	1290	1070	1580	1470	1810	1860	2720	2090	2510	2970	4580	4610
17N02W	2810	3130	3070	4220	4110	5100	4240	6240	5830	7170	7340	10700	8270	9940	11700	18100	18200
17N01W	8070	8350	7670	9400	8980	10100	8450	10800	9600	10000	11100	13400	10600	11700	12600	15800	17200
17N01E	7630	7900	7260	8890	8490	9540	7990	10300	9090	9500	10500	12700	10000	11100	11900	15000	16300
17N02E	6210	6430	5900	7230	6910	7750	6500	8340	7390	7720	8530	10300	8130	9020	9700	12200	13200
17N03E	15800	14600	12300	17600	12600	17600	13600	18800	14900	15900	15200	21100	18700	16000	20000	29400	37700
17N04E	7810	7960	7600	8500	8290	8790	7290	9880	9470	8980	8640	10400	9110	9640	10000	11400	11900
17N05E	677	690	659	737	719	762	632	857	821	779	749	899	789	836	870	986	1030
16N04W	475	529	520	715	694	863	717	1060	987	1210	1240	1820	1400	1680	1990	3070	3090
16N03W	1060	1180	1160	1590	1550	1920	1600	2350	2200	2700	2770	4050	3120	3750	4430	6840	6880
16N02W	4310	4800	4710	6480	6300	7830	6500	9580	8940	11000	11300	16500	12700	15300	18000	27800	28000
16N01W	3830	3960	3640	4460	4260	4780	4010	5140	4560	4760	5260	6370	5020	5570	5990	7520	8160
16N01E	2600	2690	2470	3030	2890	3250	2720	3490	3090	3240	3570	4330	3410	3780	4060	5100	5540
16N02E	4510	4670	4280	5250	5010	5630	4720	6060	5360	5610	6190	7500	5910	6550	7050	8850	9610
16N03E	23100	21300	18000	25800	18500	25800	19900	27500	21800	23200	22300	30800	27400	23300	29200	43000	55100
16N04E	5730	5850	5580	6240	6090	6450	5360	7260	6950	6590	6340	7610	6690	7080	7370	8350	8740
16N05E	801	816	779	872	850	901	748	1010	971	921	886	1060	933	989	1030	1170	1220
15N04W	997	1040	909	1290	1110	1380	960	1400	1180	1350	1410	2060	1260	1480	1680	2820	2540
15N03W	2500	2610	2280	3230	2780	3450	2410	3510	2970	3370	3520	5150	3170	3700	4220	7050	6370
15N02W	2970	3100	2710	3840	3300	4090	2860	4170	3520	4000	4180	6110	3760	4390	5010	8380	7570
15N01W	8490	8870	7750	11000	9450	11700	8180	11900	10100	11500	12000	17500	10800	12600	14300	24000	21700
15N01E	3470	3190	2700	3870	2770	3860	2990	4120	3270	3480	3340	4620	4100	3500	4380	6450	8260
15N02E	9720	8930	7560	10800	7760	10800	8370	11500	9160	9750	9340	12900	11500	9800	12300	18100	23100
15N03E	30100	27700	23500	33600	24100	33500	26000	35800	28400	30300	29000	40100	35600	30400	38000	56000	71700
15N04E	21700	22100	21100	23600	23100	24400	20300	27500	26300	25000	24000	28800	25300	26800	27900	31600	33100
15N05E	1640	1670	1590	1780	1740	1840	1530	2070	1980	1880	1810	2170	1910	2020	2100	2380	2490
14N03W	8870	9260	8090	11500	9870	12200	8540	12500	10500	12000	12500	18300	11200	13100	15000	25000	22600
14N02W	9010	9420	8230	11700	10000	12400	8680	12700	10700	12200	12700	18600	11400	13300	15200	25400	23000

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
14N01W	9080	9490	8290	11800	10100	12500	8750	12800	10800	12300	12800	18700	11500	13400	15300	25600	23200
14N01E	7000	7320	6390	9070	7790	9670	6750	9840	8320	9450	9870	14400	8880	10400	11800	19800	17900
14N02E	2050	1890	1600	2290	1640	2280	1770	2440	1940	2060	1980	2730	2430	2070	2590	3820	4890
14N03E	23600	21700	18400	26300	18900	26300	20300	28000	22200	23700	22700	31400	27900	23800	29800	43900	56100
14N04E	31300	31900	30500	34100	33300	35200	29200	39600	38000	36000	34600	41600	36500	38600	40200	45600	47700
14N05E	18700	19000	18200	20300	19800	21000	17400	23600	22600	21400	20600	24800	21700	23000	24000	27200	28400
13N03W	361	378	330	468	402	498	348	508	430	488	509	746	459	535	610	1020	924
13N02W	5940	6210	5420	7690	6610	8200	5720	8350	7050	8020	8370	12200	7530	8790	10000	16800	15200
13N01W	8410	8790	7680	10900	9360	11600	8100	11800	9990	11400	11900	17300	10700	12400	14200	23700	21500
13N01E	3160	3300	2890	4090	3520	4360	3050	4440	3750	4270	4450	6510	4010	4680	5330	8920	8060
13N02E	2460	2260	1920	2750	1970	2740	2120	2920	2320	2470	2370	3280	2910	2480	3110	4580	5860
13N03E	8650	7960	6730	9650	6910	9630	7450	10300	8160	8690	8320	11500	10200	8720	10900	16100	20600
13N04E	21700	22200	21200	23700	23100	24500	20300	27500	26400	25000	24000	28900	25400	26800	27900	31700	33100
13N05E	10300	10500	10000	11200	11000	11600	9630	13000	12500	11900	11400	13700	12000	12700	13300	15000	15700
13N06E	901	920	878	982	958	1020	843	1140	1090	1040	997	1200	1050	1110	1160	1310	1380
12N04W	243	254	222	314	270	335	234	341	288	328	342	501	308	359	410	686	620
12N03W	2260	2370	2070	2930	2520	3120	2180	3180	2690	3060	3190	4660	2870	3350	3820	6390	5770
12N02W	693	725	633	898	772	957	668	976	824	937	978	1430	879	1030	1170	1960	1770
12N01W	7010	7320	6400	9070	7800	9670	6750	9850	8320	9460	9880	14400	8890	10400	11800	19800	17900
12N01E	1490	1560	1360	1930	1660	2060	1440	2100	1770	2020	2100	3080	1890	2210	2520	4220	3810
12N02E	7710	7100	6000	8610	6170	8590	6640	9160	7270	7750	7420	10300	9120	7780	9730	14300	18400
12N03E	6660	6120	5180	7430	5320	7410	5730	7910	6280	6690	6400	8860	7870	6710	8400	12400	15900
12N04E	13600	13900	13200	14800	14400	15300	12700	17200	16500	15600	15000	18000	15800	16800	17500	19800	20700
12N05E	7350	7500	7160	8000	7810	8270	6870	9300	8910	8450	8130	9760	8570	9080	9450	10700	11200
12N06E	2250	2290	2190	2450	2390	2530	2100	2850	2730	2590	2490	2990	2620	2780	2890	3270	3430
11N03W	11500	10500	8790	12400	8570	11700	8610	11900	9580	8870	9560	12300	10400	8530	10900	16000	19900
11N02W	1460	1330	1110	1570	1090	1490	1090	1510	1210	1120	1210	1560	1320	1080	1390	2030	2530
11N01W	427	446	390	553	475	590	412	601	507	577	602	881	542	632	721	1210	1090
11N01E	15900	16600	14500	20600	17700	22000	15300	22400	18900	21500	22500	32800	20200	23600	26900	45000	40600
11N02E	18700	19500	17100	24200	20800	25800	18000	26300	22200	25200	26400	38500	23700	27700	31600	52800	47700
11N03E	11000	10100	8540	12200	8770	12200	9450	13000	10300	11000	10600	14600	13000	11100	13800	20400	26100
11N04E	18700	19100	18200	20400	19900	21000	17500	23700	22700	21500	20700	24800	21800	23100	24000	27200	28500
11N05E	8100	8260	7880	8820	8600	9110	7560	10200	9820	9310	8950	10700	9440	9990	10400	11800	12300
11N06E	123	127	120	134	132	139	114	156	150	142	137	165	143	154	160	181	189
11N07E	45	45	43	49	47	50	42	57	54	51	49	59	52	55	57	65	68

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
10N03W	1280	1170	977	1370	952	1300	956	1320	1060	985	1060	1370	1160	948	1210	1780	2210
10N02W	6590	6020	5030	7080	4910	6710	4930	6810	5480	5080	5480	7040	5950	4890	6250	9160	11400
10N01W	31300	28600	23900	33600	23300	31900	23400	32400	26000	24100	26000	33400	28300	23200	29700	43500	54200
10N01E	27200	24900	20800	29300	20300	27800	20400	28200	22700	21000	22600	29100	24600	20200	25900	37900	47100
10N02E	36400	33300	27800	39200	27100	37100	27300	37700	30300	28100	30300	38900	32900	27000	34600	50700	63100
10N03E	15800	14800	12900	17400	13200	17200	13500	18100	15500	15400	16000	20200	17900	16200	19700	26800	32000
10N04E	8260	7930	7430	8470	7850	8600	7130	9000	8710	8720	8440	10100	8690	9140	9810	11400	11900
10N05E	4820	4950	4970	5730	5650	6410	5910	7280	7230	8190	7870	9610	9080	9770	10900	12900	13900
10N06E	2010	2020	1980	2280	2200	2470	2210	2740	2700	2960	2850	3470	3200	3430	3780	4460	4770
10N07E	128	123	116	132	123	136	113	143	138	140	135	163	141	148	159	186	194
09N02W	67	61	51	72	49	68	50	69	55	51	55	71	60	49	63	93	116
09N01W	14300	13000	10900	15300	10600	14500	10700	14700	11900	11000	11900	15200	12900	10600	13500	19800	24700
09N01E	19300	17600	14700	20700	14400	19700	14400	19900	16100	14900	16000	20600	17400	14300	18300	26800	33400
09N02E	40700	37200	31100	43700	30300	41500	30400	42100	33900	31400	33800	43500	36800	30200	38600	56600	70400
09N03E	9100	8340	7030	9820	6910	9380	6960	9570	7790	7310	7820	10000	8550	7170	9070	13100	16200
09N04E	9500	10000	10300	11900	11900	13700	12900	15900	15800	18400	17700	21700	20900	22600	25200	29900	32500
09N05E	326	343	353	409	411	471	445	546	545	635	609	747	718	776	868	1030	1120
09N06E	186	196	201	232	234	269	254	312	311	362	347	427	410	444	495	589	640
09N07E	9	9	9	11	11	13	12	15	15	17	17	21	20	21	24	29	31
08N02W	1020	929	777	1090	758	1040	761	1050	840	783	846	1090	919	754	966	1420	1760
08N01W	27700	25300	21100	29700	20600	28200	20700	28600	23000	21300	23000	29500	25000	20500	26300	38500	47900
08N01E	17300	15800	13200	18600	12900	17600	12900	17900	14400	13300	14300	18400	15600	12800	16400	24000	29900
08N02E	28300	25900	21600	30400	21100	28900	21200	29300	23600	21800	23500	30200	25600	21000	26900	39400	49000
08N03E	22300	20300	17000	23900	16600	22700	16700	23000	18500	17200	18500	23800	20100	16500	21100	31000	38500
08N04E	127	134	136	159	158	183	172	212	211	246	236	291	279	301	337	401	434
08N05E	1100	1160	1190	1370	1380	1580	1500	1830	1830	2130	2040	2510	2410	2610	2910	3460	3760
08N06E	6030	6350	6520	7550	7580	8680	8210	10100	10100	11700	11200	13800	13300	14300	16000	19000	20600
08N07E	2150	2260	2320	2690	2700	3090	2930	3590	3580	4170	4000	4910	4720	5100	5700	6780	7350
08N08E	784	825	847	982	987	1130	1070	1310	1310	1520	1460	1790	1720	1860	2080	2470	2680
07N02W	100	91	76	107	74	102	75	103	83	77	83	107	90	74	95	139	173
07N01W	316	289	242	340	236	323	237	327	263	244	263	338	286	235	300	440	548
07N01E	3820	3490	2920	4110	2850	3890	2860	3950	3180	2940	3180	4080	3450	2830	3630	5310	6610
07N02E	6330	5790	4840	6810	4720	6460	4740	6550	5270	4880	5260	6760	5730	4700	6010	8810	11000
07N03E	4260	3980	3610	4100	3680	3960	3080	3950	3760	3440	3350	3940	3120	3200	3320	3770	3750

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
07N04E	1240	1310	1340	1550	1560	1790	1690	2080	2070	2410	2310	2840	2730	2950	3290	3910	4250
07N05E	8280	8710	8940	10400	10400	11900	11300	13800	13800	16100	15400	18900	18200	19600	21900	26100	28300
07N06E	9820	10300	10600	12300	12400	14100	13400	16400	16400	19100	18300	22400	21600	23300	26000	31000	33600
07N07E	8210	8650	8880	10300	10300	11800	11200	13700	13700	15900	15300	18800	18100	19500	21800	25900	28100
07N08E	592	623	640	742	745	853	808	990	988	1150	1100	1360	1300	1410	1570	1870	2030
06N02W	3	3	3	3	3	3	2	3	3	2	2	3	2	2	2	3	3
06N02E	2540	2370	2150	2440	2190	2360	1840	2350	2240	2050	2000	2350	1860	1910	1980	2250	2240
06N03E	8100	7560	6870	7790	7000	7530	5860	7510	7160	6550	6370	7500	5930	6090	6310	7170	7130
06N04E	2210	2320	2380	2760	2770	3180	3000	3680	3680	4280	4110	5040	4850	5240	5850	6950	7540
06N05E	19300	20300	20900	24200	24300	27800	26300	32300	32200	37500	35900	44100	42400	45800	51200	60900	66000
06N06E	15500	16300	16700	19400	19500	22300	21100	25900	25800	30000	28800	35400	34000	36700	41000	48800	52900
06N07E	6800	7160	7350	8520	8560	9790	9270	11400	11300	13200	12700	15500	15000	16200	18000	21400	23300
05N03W	906	846	769	872	783	842	655	840	801	732	713	838	663	681	706	802	797
05N02W	3590	3350	3040	3450	3100	3330	2600	3320	3170	2900	2820	3320	2630	2700	2790	3180	3160
05N01W	866	809	735	833	748	805	626	803	765	700	681	801	634	651	675	767	762
05N02E	2990	2790	2540	2880	2580	2780	2160	2770	2640	2420	2350	2770	2190	2250	2330	2650	2630
05N03E	197	184	167	190	170	183	143	183	174	159	155	183	144	148	154	175	174
05N04E	2310	2420	2480	2870	2880	3290	3100	3810	3800	4410	4230	5190	4980	5380	6000	7130	7730
05N05E	7110	7480	7680	8890	8940	10200	9680	11900	11800	13800	13200	16200	15600	16900	18800	22400	24300
05N06E	21800	23000	23600	27300	27500	31400	29800	36500	36400	42400	40700	49900	48000	51900	57900	68800	74700
05N07E	7330	7720	7930	9180	9220	10600	9990	12300	12200	14200	13700	16800	16100	17400	19400	23100	25100
04N02W	953	891	808	918	824	887	690	883	844	771	750	882	698	718	743	845	839
04N01W	599	559	508	576	517	557	432	554	529	483	471	554	439	450	467	530	527
04N01E	275	257	234	264	237	256	199	255	243	222	216	255	201	207	215	243	242
04N02E	17	16	15	17	15	16	12	16	15	14	13	16	13	13	13	15	15
04N04E	113	119	123	142	143	164	155	190	189	221	212	260	250	270	302	359	389
04N05E	478	503	517	599	602	689	652	799	797	929	891	1090	1050	1140	1270	1510	1640
04N06E	55	58	59	69	69	79	75	92	92	107	103	127	122	132	147	175	190
03N01W	1340	1250	1130	1290	1160	1240	966	1240	1180	1080	1050	1240	978	1010	1040	1180	1180
03N01E	2450	2290	2080	2360	2120	2280	1770	2270	2170	1980	1930	2270	1800	1850	1910	2170	2160
01S08E	5730	3380	3190	5120	2770	5560	3730	6330	3900	5380	5940	6930	5790	5530	6130	10300	9450
01S09E	501	295	280	449	243	454	253	554	248	404	469	607	480	406	485	900	1330
01S10E	446	263	249	400	216	404	225	494	221	418	324	541	427	345	325	373	1120

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
02S03E	70	87	73	73	88	71	84	67	84	73	70	65	71	71	69	55	49
02S04E	6740	8360	7040	7050	8400	6850	8050	6430	8090	6970	6710	6280	6840	6850	6590	5310	4710
02S05E	8160	10100	8520	8530	10200	8290	9740	7780	9790	8430	8120	7600	8270	8290	7970	6420	5700
02S06E	10300	12700	10700	10700	12800	10400	12300	9790	12300	10600	10200	9560	10400	10400	10000	8080	7170
02S07E	29500	17400	16500	26400	14300	29300	21900	32600	15700	33500	34200	37100	29400	20400	22900	41900	51600
02S08E	52500	28800	27500	47100	24500	51400	35100	57500	34800	52000	56600	65700	50000	42400	51100	78400	84800
02S09E	19600	10300	9570	19300	8850	19000	10500	21600	11200	17300	19800	23700	15700	13300	16600	25300	29100
02S10E	25100	14600	13200	22600	12500	27200	13400	28700	13500	19400	21800	31400	20900	18400	22000	33800	33900
02S11E	2220	1060	991	1570	848	1610	887	2170	867	1780	1900	2120	1680	1280	1480	2910	3010
03S04E	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
03S05E	9080	11300	9490	9500	11300	9230	10800	8670	10900	9390	9040	8460	9220	9240	8880	7150	6350
03S06E	34300	36900	31600	34600	36200	36800	41200	34100	40900	37600	37200	34400	34300	31100	32900	28600	24400
03S07E	20100	19800	18400	21700	19800	21600	22100	24400	20600	23900	23800	25600	25200	24400	25500	23500	27000
03S08E	39500	40600	36600	53600	39500	49900	38200	49700	38600	46800	45300	49900	37000	41900	43800	37800	37300
03S09E	27600	12000	12300	28500	11700	25900	13300	23800	11600	16200	20100	24100	13000	13900	14700	16000	18000
03S10E	18800	7410	7240	18400	6680	17700	7420	19000	7420	13400	16000	21900	11100	11000	11900	16400	25900
03S11E	5950	3510	3270	6430	3390	6140	3090	5930	3510	4020	4520	7220	3700	3860	4110	10200	13300
04S06E	10700	10300	9740	9910	9700	10000	10400	9410	8720	10300	10700	9960	9670	9490	8890	10200	10800
04S07E	16100	12800	11800	14500	11200	13600	11800	15700	12700	14200	16900	17000	14800	13500	15200	19600	17900
04S08E	16300	16100	12600	19900	13200	18100	13400	17100	13100	14900	16800	20400	12700	16800	13500	15600	20000
04S09E	40400	37500	29200	38200	32600	37800	30900	37200	35800	37200	40300	44100	39400	38400	35100	36400	60500
04S10E	26000	23100	13000	18600	13500	15800	10500	16000	11000	13500	17800	24500	14400	12700	14400	19800	52300
04S11E	28900	25500	12600	20700	13800	14800	9870	17700	10700	12600	17400	23400	18900	14900	14000	20900	36700
04S12E	3550	3190	2190	3770	3040	3570	2330	3320	2640	4240	5060	5410	4160	4450	4600	5890	5580
04S13E	1130	1050	920	1220	1180	1420	941	1120	1120	1360	1540	1750	1300	1280	1210	1910	2000
04S14E	960	886	780	1040	998	1210	798	953	953	1150	1300	1490	1100	1090	1030	1620	1690
05S06E	449	434	410	417	408	421	439	396	367	433	451	419	406	399	374	427	454
05S07E	15600	15000	14200	14500	14200	14600	15200	13700	12700	15000	15600	14500	14100	13800	13000	14800	15800
05S08E	13100	12700	11800	12900	10800	13000	11000	13300	9570	11400	12800	15100	11100	11900	12100	14000	17900
05S09E	37200	39300	29800	35200	31000	35700	26400	30900	28900	30900	37500	37400	29600	28400	28400	39000	55200
05S10E	11100	12200	12000	9820	12300	15400	13300	12000	15100	18800	18200	16200	12400	14600	13900	15000	15500
05S11E	1640	1730	1490	1760	1420	1650	1180	2830	3260	4050	3960	3440	2580	3090	1540	3640	2170
05S12E	13300	12300	10800	14300	13800	16700	11100	13200	13200	15900	18000	20600	15300	15100	14300	22500	23400
05S13E	11400	10500	9260	12300	11800	14300	9470	11300	11300	13600	15400	17600	13100	12900	12200	19200	20000
05S14E	2270	1930	1810	2270	2140	2700	1680	2100	1920	2240	2730	3430	2340	2110	2150	3290	4140

Appendix C.--Continued

TOWNSHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
05S15E	5	4	4	5	5	6	4	5	4	5	6	8	5	5	5	8	10
06S07E	821	793	749	762	746	769	802	723	670	792	823	765	743	729	683	781	830
06S08E	24600	23800	22400	22800	22400	23100	24000	21700	20100	23700	24700	22900	22300	21900	20500	23400	24900
06S09E	4370	4030	3550	4710	4540	5480	3630	4340	4330	5230	5920	6760	5020	4950	4680	7380	7690
06S10E	3510	3240	2850	3780	3650	4400	2920	3480	3480	4200	4750	5420	4030	3970	3760	5930	6170
06S11E	15100	13900	12200	16200	15700	18900	12500	15000	14900	18000	20400	23300	17300	17100	16100	25500	26500
06S12E	34900	29600	27700	34700	32900	41400	25800	32300	29400	34400	41900	52600	35800	32400	33000	50400	63500
06S13E	15400	13100	12200	15300	14500	18200	11400	14200	13000	15100	18500	23200	15800	14300	14500	22200	28000
06S14E	1020	865	809	1010	959	1210	754	941	858	1000	1220	1540	1050	946	963	1470	1850
06S15E	32	27	25	32	30	38	24	30	27	32	39	49	33	30	30	47	59
07S08E	22200	21400	20200	20500	20100	20700	21600	19500	18100	21400	22200	20600	20000	19700	18400	21100	22400
07S09E	15800	15300	14400	14700	14400	14800	15500	14000	12900	15300	15900	14800	14300	14100	13200	15100	16000
07S10E	12400	10500	9850	12300	11700	14700	9170	11500	10500	12200	14900	18700	12700	11500	11700	17900	22600
07S11E	51700	43900	41100	51500	48700	61400	38300	47800	43600	50900	62100	77900	53100	48000	48900	74700	94100
07S12E	37000	31500	29500	36900	34900	44000	27400	34300	31300	36500	44600	55900	38100	34400	35000	53500	67500
07S13E	22800	19400	18100	22700	21500	27100	16900	21100	19200	22500	27400	34400	23400	21200	21600	32900	41500
07S14E	14600	12400	11600	14600	13800	17300	10800	13500	12300	14400	17600	22000	15000	13600	13800	21100	26600
07S15E	12100	10300	9600	12000	11400	14300	8940	11200	10200	11900	14500	18200	12400	11200	11400	17400	22000
07S16E	1980	1680	1570	1970	1860	2350	1460	1830	1670	1950	2380	2980	2030	1840	1870	2860	3600
08S08E	11600	11200	10600	10800	10600	10900	11400	10200	9490	11200	11700	10800	10500	10300	9680	11100	11800
08S09E	18300	17700	16700	17000	16600	17100	17900	16100	14900	17600	18400	17100	16600	16200	15200	17400	18500
08S10E	1300	1250	1180	1200	1180	1210	1260	1140	1060	1250	1300	1210	1170	1150	1080	1230	1310
08S11E	5370	4570	4270	5350	5060	6380	3980	4970	4530	5300	6460	8110	5520	5000	5080	7760	9790
08S12E	15400	13100	12300	15400	14500	18300	11400	14300	13000	15200	18500	23200	15800	14300	14600	22300	28100
08S13E	16600	14100	13200	16600	15700	19700	12300	15400	14000	16400	20000	25100	17100	15500	15700	24000	30300
08S14E	26100	22200	20800	26000	24600	31000	19300	24100	22000	25700	31400	39400	26800	24300	24700	37700	47600
08S15E	36100	30600	28700	35900	34000	42800	26700	33400	30400	35500	43400	54400	37000	33500	34100	52100	65700
08S16E	13200	11200	10500	13200	12500	15700	9800	12200	11200	13000	15900	20000	13600	12300	12500	19100	24100
08S17E	235	200	187	235	222	280	174	218	199	232	283	355	242	219	223	340	429
09S08E	5920	5710	5390	5490	5370	5540	5770	5210	4830	5700	5930	5510	5350	5250	4920	5630	5980
09S09E	15900	15300	14500	14700	14400	14900	15500	14000	13000	15300	15900	14800	14400	14100	13200	15100	16100
09S10E	7970	7690	7260	7390	7230	7460	7780	7020	6500	7680	7990	7430	7210	7070	6630	7580	8060
09S11E	8580	8280	7820	7950	7790	8030	8370	7560	7000	8270	8600	7990	7760	7610	7140	8160	8670
09S12E	23000	19500	18300	22900	21600	27300	17000	21200	19400	22600	27600	34600	23600	21300	21700	33200	41800

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
09S13E	38400	32600	30500	38200	36100	45600	28400	35500	32400	37800	46100	57900	39400	35700	36300	55400	69900
09S14E	46100	41300	40800	46100	46500	48400	37700	46200	41600	46300	48500	61300	46700	44500	44600	63700	68100
09S15E	43300	38800	38300	43300	43700	45500	35400	43400	39000	43500	45600	57600	43900	41800	41900	59800	64000
09S16E	20000	18000	17700	20000	20200	21000	16400	20000	18000	20100	21100	26600	20300	19300	19400	27700	29600
09S17E	11400	10400	9750	11000	10900	11100	8860	10700	9270	10200	10400	14400	10600	9770	10300	14800	15600
09S18E	241	222	207	234	232	237	188	228	197	218	221	305	226	207	220	316	331
10S08E	360	347	328	334	327	337	351	317	294	347	361	335	326	319	299	342	364
10S09E	5560	5360	5060	5150	5040	5200	5420	4890	4530	5350	5570	5180	5020	4930	4620	5280	5620
10S10E	25600	24700	23300	23700	23200	23900	24900	22500	20900	24600	25600	23800	23100	22700	21300	24300	25800
10S11E	15200	14700	13900	14100	13800	14200	14800	13400	12400	14600	15200	14200	13700	13500	12600	14400	15400
10S12E	14000	13500	12700	13000	12700	13100	13600	12300	11400	13500	14000	13000	12600	12400	11600	13300	14100
10S13E	38200	34300	33900	38200	38600	40200	31200	38300	34500	38400	40300	50900	38700	36900	37000	52800	56500
10S14E	71100	63800	63000	71200	71800	74800	58200	71300	64200	71500	74900	94700	72100	68800	68800	98400	105000
10S15E	58100	52100	51500	58100	58600	61100	47500	58200	52400	58400	61200	77400	58900	56200	56200	80300	86000
10S16E	33600	30900	28900	32600	32300	33000	26200	31800	27500	30400	30800	42500	31400	29000	30600	43900	46100
10S17E	15400	14200	13300	15000	14800	15100	12000	14600	12600	13900	14200	19500	14400	13300	14000	20200	21200
10S18E	5500	5060	4720	5320	5280	5390	4290	5200	4490	4960	5040	6950	5130	4730	5000	7180	7530
10S19E	2750	2530	2360	2660	2640	2700	2150	2600	2250	2480	2520	3480	2570	2370	2500	3590	3770
10S20E	181	167	156	176	174	178	141	172	148	164	166	229	169	156	165	237	249
11S10E	25600	24700	23300	23700	23200	24000	25000	22500	20900	24700	25700	23800	23100	22700	21300	24300	25900
11S11E	3710	3570	3380	3440	3360	3470	3620	3260	3020	3570	3710	3450	3350	3290	3080	3520	3750
11S12E	6060	5850	5520	5620	5500	5670	5910	5340	4940	5840	6080	5650	5480	5380	5040	5760	6130
11S13E	24300	23400	22100	22500	22000	22700	23700	21400	19800	23400	24300	22600	21900	21500	20200	23100	24500
11S14E	55700	50000	49400	55700	56200	58600	45600	55800	50300	56000	58700	74200	56500	53900	53900	77100	82400
11S15E	79000	70900	70000	79000	79700	83100	64600	79200	71300	79400	83200	105000	80100	76400	76500	109000	117000
11S16E	76300	70200	65600	74000	73400	74900	59600	72300	62300	68900	70000	96500	71300	65700	69400	99700	105000
11S17E	30200	27800	25900	29200	29000	29600	23500	28600	24600	27200	27700	38100	28200	26000	27500	39400	41300
11S18E	13900	12800	11900	13500	13400	13600	10800	13200	11300	12500	12700	17600	13000	12000	12600	18200	19000
11S19E	8210	7550	7050	7960	7890	8050	6410	7770	6700	7410	7530	10400	7670	7070	7470	10700	11300
11S20E	5720	5260	4910	5540	5490	5610	4460	5410	4660	5160	5240	7220	5340	4920	5200	7470	7830
11S21E	484	372	334	416	368	404	292	361	319	374	379	396	334	314	309	399	484
12S11E	7080	6840	6460	6570	6430	6630	6910	6240	5780	6830	7100	6600	6410	6290	5890	6740	7160
12S12E	7850	7570	7150	7280	7120	7350	7660	6910	6400	7570	7870	7310	7100	6970	6530	7460	7940
12S13E	8600	8300	7840	7980	7810	8050	8390	7580	7020	8290	8630	8010	7780	7630	7160	8180	8700
12S14E	30400	29300	27700	28200	27600	28400	29600	26800	24800	29300	30500	28300	27500	27000	25300	28900	30700
12S15E	70000	64400	60100	67800	67300	68600	54600	66300	57100	63200	64100	88500	65300	60200	63700	91400	95900

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
12S16E	56200	51700	48300	54500	54000	55100	43900	53200	45900	50800	51500	71100	52500	48400	51100	73500	77000
12S17E	66400	61100	57000	64300	63800	65100	51800	62900	54200	59900	60800	83900	62000	57100	60400	86700	90900
12S18E	37800	34800	32500	36600	36300	37100	29500	35800	30900	34100	34600	47800	35300	32500	34400	49400	51800
12S19E	23300	21400	20000	22500	22400	22800	18100	22000	19000	21000	21300	29400	21700	20000	21200	30400	31900
12S20E	25300	19400	17500	21700	19300	21100	15300	18800	16700	19500	19800	20700	17500	16400	16200	20800	25300
12S21E	21900	16800	15100	18800	16700	18200	13200	16300	14400	16900	17100	17900	15100	14200	14000	18000	21900
12S22E	5400	4150	3730	4640	4120	4500	3270	4020	3570	4170	4220	4430	3740	3500	3450	4450	5400
13S11E	1400	1350	1270	1300	1270	1310	1360	1230	1140	1350	1400	1300	1260	1240	1160	1330	1410
13S12E	14700	14200	13400	13600	13400	13800	14400	13000	12000	14200	14800	13700	13300	13100	12200	14000	17400
13S13E	15600	15000	14200	14400	14100	14600	15200	13700	12700	15000	15600	14500	14100	13800	13000	14800	19600
13S14E	16800	16200	15300	15600	15200	15700	16400	14800	13700	16200	16800	15600	15200	14900	14000	16000	21400
13S15E	55000	53000	50100	51000	49900	51500	53600	48400	44800	53000	55100	51200	49700	48800	45700	52300	55600
13S16E	77000	70800	66100	74600	74000	75500	60100	72900	62800	69500	70600	97300	71900	66300	70000	101000	105000
13S17E	68500	52600	47300	58800	52200	57100	41400	51000	45300	52900	53500	56200	47400	44400	43800	56400	68500
13S18E	32000	24600	22100	27500	24400	26700	19400	23800	21200	24700	25000	26300	22200	20800	20500	26400	32000
13S19E	20900	16100	14500	18000	16000	17500	12700	15600	13800	16200	16400	17200	14500	13600	13400	17200	20900
13S20E	9570	7350	6610	8210	7290	7980	5790	7120	6320	7390	7470	7840	6620	6200	6110	7880	9570
13S21E	26200	20100	18100	22500	20000	21900	15900	19500	17300	20300	20500	21500	18200	17000	16800	21600	26200
13S22E	27100	20800	18700	23300	20700	22600	16400	20200	17900	20900	21200	22200	18800	17600	17300	22300	27100
13S23E	23700	18200	16400	20300	18100	19800	14300	17600	15700	18300	18500	19400	16400	15400	15100	19500	23700
13S24E	6880	5280	4750	5900	5240	5730	4160	5120	4540	5310	5370	5640	4760	4460	4400	5660	6880
14S12E	16500	16100	15300	15800	14000	15900	15000	6620	6590	5180	4260	2740	2970	2550	2110	2150	15100
14S13E	42700	41700	39600	40800	36300	41000	38700	12800	12700	9990	8220	5280	5740	4930	4070	4150	18400
14S14E	39900	39000	37000	38100	33900	38300	36100	10300	10300	8080	6640	4270	4640	3980	3290	3350	19700
14S15E	7420	7160	6760	6880	6730	6950	7240	6530	6050	7150	7440	6910	6710	6580	6170	7050	9040
14S16E	45800	35200	31600	39300	34900	38200	27700	34100	30200	35300	35800	37500	31700	29700	29300	37700	45800
14S17E	85500	65700	59100	73400	65200	71300	51700	63600	56500	66000	66800	70100	59200	55400	54600	70400	85500
14S18E	87800	67500	60700	75400	67000	73200	53100	65400	58000	67800	68600	72000	60800	57000	56100	72300	87800
14S19E	44100	33900	30500	37900	33700	36800	26700	32800	29200	34100	34500	36200	30600	28600	28200	36400	44100
14S20E	20600	15900	14300	17700	15700	17200	12500	15400	13600	15900	16100	16900	14300	13400	13200	17000	20600
14S21E	55700	42800	38500	47800	42400	46400	33700	41400	36800	43000	43500	45600	38500	36100	35600	45800	55600
14S22E	44900	34500	31000	38600	34200	37500	27200	33400	29700	34700	35100	36800	31100	29100	28700	37000	44900
14S23E	20200	15500	14000	17300	15400	16800	12200	15000	13300	15600	15800	16500	14000	13100	12900	16600	20200
14S24E	17900	13700	12400	15400	13600	14900	10800	13300	11800	13800	14000	14700	12400	11600	11400	14700	17900
14S25E	346	265	239	297	263	288	209	257	228	267	270	283	239	224	221	285	346
15S12E	3730	3630	3450	3560	3160	3570	3370	1470	1460	1150	946	608	661	567	469	477	1800

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
15S13E	39800	38900	36900	38000	33800	38200	36000	17800	17700	13900	11400	7350	7990	6860	5670	5770	26300
15S14E	36700	35800	34000	35000	31200	35200	33200	12700	12700	9970	8200	5270	5730	4920	4060	4140	24000
15S15E	25500	24900	23600	24300	21600	24400	23100	12300	12200	9600	7900	5070	5520	4740	3910	3980	20900
15S16E	6460	4960	4460	5540	4920	5380	3910	4800	4270	4980	5040	5290	4470	4190	4130	5320	6460
15S17E	113000	87000	78300	97300	86400	94500	68600	84300	74900	87500	88500	92900	78400	73500	72400	93300	113000
15S18E	96900	74500	67000	83200	73900	80800	58600	72100	64100	74900	75700	79500	67100	62900	62000	79800	96900
15S19E	95200	73100	65800	81700	72600	79400	57600	70800	62900	73500	74400	78000	65900	61700	60800	78400	95200
15S20E	70200	53900	48500	60300	53500	58600	42500	52300	46400	54200	54900	57600	48600	45600	44900	57800	70200
15S21E	48600	37300	33600	41700	37100	40500	29400	36200	32100	37500	38000	39800	33700	31500	31100	40000	48600
15S22E	47600	36600	32900	40900	36300	39700	28800	35500	31400	36800	37200	39100	33000	30900	30500	39300	47600
15S23E	44200	34000	30800	38100	33700	37000	27000	33300	29200	34300	34800	36500	30800	29000	28700	36900	44400
15S24E	41000	31500	28400	35200	31300	34200	24800	30600	27100	31700	32100	33700	28400	26600	26300	33800	41000
15S25E	21300	16300	14700	18300	16200	17700	12900	15800	14000	16400	16600	17400	14700	13800	13600	17500	21300
16S14E	29100	28300	26900	27700	24700	27900	26300	17500	17500	13700	11300	7250	7880	6770	5590	5690	30000
16S15E	46900	45800	43500	44800	39800	45000	42400	17900	17800	14000	11500	7390	8040	6900	5700	5800	40200
16S16E	35400	34500	32800	33800	30000	33900	32000	28200	28100	22100	18100	11700	12700	10900	8990	9150	42600
16S17E	30600	23500	21100	26300	23300	25500	18500	22800	20200	23600	23900	25100	21200	19800	19500	25200	30600
16S18E	60700	46700	42000	52200	46300	50700	36800	45200	40100	46900	47500	49800	42100	39400	38800	50000	60700
16S19E	110000	84600	76100	94600	84000	91900	66600	82000	72800	85100	86100	90300	76300	71500	70400	90700	110000
16S20E	102000	78600	70700	87900	78000	85300	61900	76200	67600	79000	80000	83900	70900	66400	65500	84400	102000
16S21E	102000	78600	70700	87800	78000	85300	61900	76200	67600	79000	79900	83900	70800	66400	65400	84300	102000
16S22E	60200	46200	41600	51700	45900	50200	36400	44800	39800	46500	47000	49400	41700	39100	38500	49600	60200
16S23E	51900	39900	36100	44700	39600	43400	31600	39000	34300	40300	40800	42800	36100	33900	33600	43200	52100
16S24E	59400	45600	41200	51100	45300	49600	36100	44500	39200	46000	46500	48800	41200	38700	38200	49200	59500
16S25E	41400	31900	28900	35800	31600	34700	25400	31300	27400	32200	32600	34300	28900	27300	27000	34700	41700
16S26E	13000	8030	6780	9560	8040	10600	5960	7700	5200	8320	9190	11000	7230	7010	7940	9100	16200
17S14E	4850	4730	4490	4630	4110	4650	4390	2650	2630	2070	1700	1090	1190	1020	842	858	3230
17S15E	52900	51600	49000	50500	44900	50700	47900	31700	31500	24800	20400	13100	14200	12200	10100	10300	48000
17S16E	35700	34900	33100	34100	30300	34300	32300	18300	18200	14300	11800	7550	8210	7050	5830	5930	32600
17S17E	36000	35200	33400	34400	30600	34600	32600	31700	31600	24800	20400	13100	14200	12200	10100	10300	47500
17S18E	31500	24200	21700	27000	24000	26200	19000	23400	20800	24300	24600	25800	21800	20400	20100	25900	31500
17S19E	46800	35900	32300	40200	35600	39000	28300	34900	30900	36100	36600	38400	32400	30400	30000	38600	46800
17S20E	57900	44500	40100	49800	44200	48400	35100	43300	38300	44800	45300	47600	40200	37700	37200	47900	58000
17S21E	90400	69400	62400	77600	68900	75300	54700	67200	59700	69800	70600	74100	62500	58600	57800	74400	90300
17S22E	76600	58800	52900	65800	58400	63900	46300	57000	50600	59100	59800	62800	53000	49700	48900	63100	76600
17S23E	69300	53200	47900	59500	52800	57800	41900	51600	45800	53500	54200	56800	48000	45000	44300	57100	69300
17S24E	65100	45300	42200	53100	45400	48300	33600	44500	34500	42600	42800	45000	36100	34000	34000	44700	52500

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
17S25E	83300	49000	48700	62800	49900	51100	32300	49900	27900	40400	40100	42900	29900	28700	30300	41400	45200
17S26E	96100	56500	53600	71200	57500	63400	38000	56000	32600	49500	51100	57100	38400	36800	40000	51300	69900
17S27E	41000	23600	23600	30500	24200	24200	15000	23700	12800	18800	18500	19700	13400	12800	13500	18800	20100
18S15E	12100	11800	11200	11600	10300	11600	11000	2900	2880	2260	1860	1200	1300	1120	922	939	3540
18S16E	43300	42300	40200	41400	36800	41600	39200	17300	17200	13500	11100	7150	7770	6670	5510	5610	25500
18S17E	48100	47000	44600	46000	40900	46200	43600	21500	21400	16800	13800	8890	9670	8300	6860	6980	33100
18S18E	33400	32600	30900	31900	28300	32000	30200	24500	24400	19200	15800	10100	11000	9470	7820	7960	45700
18S19E	34300	26300	23700	29400	26100	28600	20700	25500	22600	26500	26800	28100	23700	22200	21900	28200	34300
18S20E	92400	43900	34700	48400	40100	41500	27500	34700	14700	25700	29500	35600	21700	17600	20900	31600	51700
18S21E	103000	51400	44000	59800	48800	49800	32200	44100	20400	33300	36200	41900	26400	22700	25800	38000	54900
18S22E	114000	59400	53300	71300	57700	58500	37400	53500	26000	41000	43200	48700	31400	27900	30900	44900	59700
18S23E	69900	40900	40100	52300	41700	43500	26900	41200	23100	34100	34200	37200	25400	24400	26000	34900	41100
18S24E	74800	44100	44100	56600	44900	45700	29200	45100	25200	36300	35900	38200	26800	25700	27000	37200	39500
18S25E	140000	81100	81000	105000	83000	83300	52000	81900	44400	64900	63900	68000	46600	44500	46800	65300	69200
18S26E	146000	84200	84200	109000	86300	86300	53700	84800	45700	67000	66000	70100	47900	45600	47900	67100	71100
18S27E	95100	54700	54700	70900	56100	56100	34900	55100	29700	43500	42800	45600	31100	29600	31100	43600	46200
19S16E	30000	29300	27800	28600	25500	28800	27200	18900	18800	14800	12200	7810	8500	7290	6030	6140	23100
19S17E	65200	63600	60500	62300	55400	62600	59000	27400	27200	21400	17600	11300	12300	10600	8720	8880	35700
19S18E	36100	35200	33500	34500	30700	34600	32700	17800	17700	13900	11400	7350	7990	6860	5670	5770	25300
19S19E	12900	12600	12000	12300	10900	12400	11700	12800	12700	9970	8210	5270	5730	4920	4070	4140	17400
19S20E	26800	12600	9870	13800	11500	11800	7750	9790	3970	7140	8270	10000	6000	4790	5740	8800	14700
19S21E	95100	48700	42600	57300	46700	47700	30900	42800	20500	32800	35100	40200	25800	22600	25300	36900	51300
19S22E	72000	43400	40200	53800	43900	50600	30300	43100	26300	40000	42000	47700	32300	31200	34200	42500	61700
19S23E	72600	41800	41800	54100	42800	42800	26600	42100	22700	33200	32700	34800	23700	22600	23700	33200	35300
19S24E	96900	56100	56100	72500	57400	57700	36100	56700	30800	45000	44300	47200	32400	31000	32500	45300	48100
19S25E	118000	68300	68300	88300	69900	70100	43800	69000	37400	54600	53800	57200	39200	37400	39300	54900	58200
19S26E	111000	64000	64000	82700	65500	65700	41100	64600	35100	51300	50500	53700	36800	35200	37000	51600	54700
19S27E	11300	6500	6490	8410	6660	6660	4140	6540	3520	5170	5090	5410	3690	3520	3690	5170	5480
20S15E	22200	21300	23100	23700	23600	25300	24600	19500	21100	18500	19800	15200	15800	15000	18200	9290	27900
20S16E	18100	17300	18800	19300	19200	20600	20000	10300	11100	9730	10400	8010	8330	7910	9580	4900	14700
20S17E	67700	66000	62800	64600	57500	64900	61300	42200	42000	33000	27100	17400	19000	16300	13400	13700	51600
20S18E	41200	40100	38100	39300	35000	39500	37200	25200	24900	19800	16400	10700	11500	9960	8340	8600	39600
20S19E	23600	22700	21700	22500	19900	22600	21100	17400	16900	13900	11700	8150	8460	7460	6480	6920	26800
20S20E	6870	3230	2540	3550	2950	3030	1990	2520	1030	1840	2130	2590	1550	1240	1490	2270	3780
20S21E	47200	22200	17400	24300	20200	20800	13600	17200	6990	12600	14600	17700	10600	8440	10100	15500	25900
20S22E	139000	66500	52800	73500	60900	62900	41500	52800	22400	39000	44700	53900	32800	26800	31700	47800	77600

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
20S23E	93800	54700	53000	69700	55800	59100	35900	54600	30700	46000	46600	51100	34500	33100	35500	47000	58500
20S24E	87500	52000	52000	66600	52900	54100	34800	53400	30200	43200	42800	45600	32200	31000	32700	44700	47500
20S25E	93000	53700	53700	69400	55000	55200	34500	54300	29400	43000	42300	45000	30900	29500	31000	43200	45800
20S26E	95000	54700	54700	70800	56000	56100	34900	55100	29700	43500	42800	45600	31100	29600	31100	43600	46200
20S27E	89000	51200	51200	66300	52500	52500	32700	51600	27800	40800	40100	42700	29100	27800	29200	40800	43300
20S28E	1010	578	578	748	592	592	368	582	313	459	452	481	328	312	328	460	488
21S15E	11100	10600	11600	11900	11800	12700	12300	11300	12200	10700	11500	8830	9180	8720	10600	5400	16200
21S16E	22800	21900	23700	24400	24200	26000	25200	20300	21900	19200	20600	15800	16400	15600	18900	9650	29000
21S17E	17900	17500	16600	17100	15200	17200	16200	9480	9430	7410	6100	3920	4260	3660	3020	3080	11600
21S18E	43600	42200	40200	41600	36900	41700	39100	28700	28100	22700	19000	12900	13600	11900	10200	10700	49700
21S19E	21200	9920	7770	10900	9050	9310	6100	7710	3130	5620	6520	7920	4730	3780	4520	6930	15000
21S20E	11500	5380	4220	5920	4910	5050	3310	4180	1700	3050	3540	4300	2570	2050	2460	3760	6290
21S21E	17500	8190	6420	9000	7470	7680	5040	6370	2590	4640	5380	6540	3900	3120	3740	5730	9570
21S22E	23500	11100	8680	12200	10100	10400	6830	8630	3530	6310	7300	8860	5310	4260	5090	7780	12900
21S23E	53600	31900	29400	39700	32300	37200	21900	31400	18900	29100	30600	34800	23300	22400	24600	30600	45200
21S24E	44500	30100	29800	37600	28800	35100	24300	39700	22400	33500	34800	38900	28600	28700	31700	45500	50700
21S25E	60300	40700	40400	51100	38900	47600	32900	54200	30300	45700	47300	52800	38800	39000	42900	62000	69000
21S26E	87400	59200	58900	74300	56700	69200	48100	78700	44300	66500	68900	76700	56500	56900	62600	90000	100000
21S27E	75800	51100	50800	64200	49000	59800	41400	68100	38100	57500	59500	66400	48800	49100	54000	78000	86700
21S28E	21000	14100	14000	17800	13500	16500	11400	18900	10500	15900	16500	18400	13400	13500	14900	21600	24000
22S18E	6470	6200	6730	6910	6870	7380	7150	5020	5420	4750	5090	3910	4070	3860	4670	2390	8640
22S19E	7960	3730	2930	4100	3410	3500	2300	2900	1180	2120	2450	2980	1780	1420	1700	2610	4360
22S20E	530	248	194	272	226	233	153	193	78	140	162	197	118	94	112	172	289
22S21E	978	457	359	503	417	429	281	356	143	259	300	365	217	173	208	320	535
22S22E	5990	2810	2200	3090	2560	2640	1730	2180	885	1590	1840	2240	1340	1070	1280	1960	3280
22S23E	58900	34000	26500	34700	33500	31800	20000	22700	14800	15300	24000	37500	25100	18300	26400	27800	48000
22S24E	41700	28100	27900	35300	26800	32800	22700	37500	20800	31500	32700	36500	26700	26900	29600	42900	47800
22S25E	58200	39200	38900	49300	37500	45800	31700	52300	29100	44000	45600	50900	37300	37600	41400	59900	66600
22S26E	53400	36400	36200	45500	34900	42500	29700	48100	27400	40800	42300	47000	34800	35000	38500	55000	61100
22S27E	46600	31500	31400	39600	30200	36900	25600	41900	23600	35400	36700	40900	30100	30300	33300	48000	53300
22S28E	16100	10800	10700	13600	10300	12600	8730	14400	8020	12100	12600	14100	10300	10400	11400	16500	18400
23S18E	647	620	673	691	687	738	715	813	878	769	825	632	658	625	757	387	1160
23S19E	1710	1640	1780	1830	1820	1960	1890	1850	2000	1750	1880	1440	1500	1420	1720	881	2650
23S20E	2110	990	776	1090	904	929	610	770	312	561	650	790	472	376	451	692	1160
23S21E	3950	1850	1450	2040	1690	1740	1140	1440	585	1050	1220	1480	883	705	845	1300	2170
23S22E	2010	941	737	1030	858	882	578	731	297	533	617	750	448	358	429	657	1100

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
23S23E	18300	10600	8240	10800	10400	9870	6210	7060	4600	4740	7450	11600	7800	5690	8190	8640	14900
23S24E	36500	22800	20100	25700	22100	23800	15900	22300	13400	17600	21000	27100	19200	16900	20700	26200	35000
23S25E	60000	40500	40300	50900	38800	47400	32800	54000	30200	45500	47200	52600	38600	38900	42800	61800	68700
23S26E	35100	23600	23500	29700	22600	27600	19100	31600	17500	26500	27500	30700	22500	22600	24900	36100	40200
23S27E	18500	12500	12400	15700	11900	14600	10100	16700	9250	14000	14500	16200	11900	11900	13200	19100	21200
23S28E	1810	1220	1210	1530	1160	1420	983	1630	904	1370	1420	1580	1160	1170	1290	1860	2070
24S17E	359	344	374	384	382	410	397	440	475	416	446	342	356	338	409	209	630
24S18E	8980	8590	9340	9580	9530	10200	9920	7060	7630	6680	7170	5500	5720	5430	6570	3360	10100
24S19E	7970	7630	8290	8500	8460	9080	8800	2390	2580	2260	2430	1860	1940	1840	2230	1140	3430
24S20E	11600	5440	4260	5980	4960	5100	3350	4230	1720	3080	3570	4340	2590	2070	2480	3800	6350
24S21E	222	104	81	114	95	97	64	81	32	59	68	83	49	39	47	72	121
24S22E	20600	9630	7550	10600	8790	9040	5930	7490	3040	5460	6330	7690	4590	3670	4400	6740	11300
24S23E	17500	11300	9780	12200	11100	11500	8060	9810	6790	7930	9810	12900	9510	8160	10100	11500	16000
24S24E	24300	14400	11900	15400	14100	14100	9120	11500	7160	8350	11500	16500	11300	8960	12000	13800	21100
24S25E	59300	40500	40300	50600	38900	47400	33200	53500	30600	45500	47100	52300	38800	39100	42900	61100	67800
24S26E	47800	32200	32000	40500	30800	37600	26000	43000	23900	36100	37500	41800	30600	30800	34000	49200	54800
24S27E	8570	5760	5730	7250	5520	6750	4660	7700	4280	6480	6720	7500	5490	5520	6090	8820	9820
24S28E	1640	1100	1090	1390	1050	1290	888	1470	815	1240	1280	1430	1050	1050	1160	1680	1870
25S18E	2820	2070	2290	2320	2390	2150	1610	714	645	794	1010	1120	1270	1460	1600	2000	2050
25S19E	17600	12900	14300	14400	14900	13400	10000	5130	4640	5710	7230	8020	9100	10400	11500	14300	14700
25S20E	11300	8260	9160	9260	9560	8600	6430	5320	4810	5910	7500	8310	9440	10800	11900	14900	15200
25S21E	3960	2890	3210	3250	3350	3020	2260	1990	1800	2210	2800	3110	3520	4040	4440	5550	5690
25S22E	23800	19200	18300	22100	19500	22900	17200	17800	18400	19000	21300	21900	19200	18200	17400	21700	24300
25S23E	23700	19200	18000	21900	19800	23200	17100	16400	19000	18300	21200	21500	19200	17900	16400	20500	23500
25S24E	65400	52600	49700	60400	53600	63000	46800	47300	50900	51200	58100	59500	52500	49400	46400	58200	66000
25S25E	47200	34300	33300	41400	33800	40600	29000	38800	29100	36200	39100	41900	33400	32600	33400	45700	51300
25S26E	87600	65100	62700	77700	64700	77300	55600	69700	57000	67100	73500	78100	63700	61400	61600	83000	93500
25S27E	29000	21700	20800	25800	21700	25800	18600	22800	19200	22200	24500	25900	21300	20400	20300	27300	30800
25S28E	2	1	1	2	1	2	1	2	1	2	2	2	1	1	1	2	3
26S17E	1310	958	1060	1080	1110	999	747	947	856	1050	1340	1480	1680	1930	2120	2650	2710
26S18E	7130	5220	5790	5860	6040	5440	4070	5460	4940	6070	7700	8530	9690	11100	12200	15300	15600
26S19E	28300	20700	23000	23200	24000	21600	16100	12100	10900	13500	17100	18900	21500	24600	27000	33800	34700
26S20E	11400	8330	9240	9350	9640	8680	6490	4460	4030	4960	6290	6970	7910	9080	9970	12500	12800
26S21E	5250	3840	4270	4310	4450	4010	3000	2680	2420	2980	3780	4190	4760	5460	5990	7490	7680
26S22E	13600	11000	10300	12600	11300	13300	9830	9400	10900	10500	12200	12300	11000	10300	9440	11800	13500

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
26S23E	45700	37100	34800	42300	38100	44700	33000	31600	36600	35400	40900	41500	37100	34500	31700	39600	45300
26S24E	69100	55900	52700	64000	57100	67000	49900	49400	54500	54100	61700	62900	55900	52400	48900	61000	69300
26S25E	37400	30000	28300	34400	30500	35900	26600	27000	28900	29200	33200	34000	29900	28100	26400	33200	37700
26S26E	57400	43000	41300	51100	42900	51200	36800	45000	38200	43900	48400	51200	42200	40500	40200	53800	60800
26S27E	15000	11900	11200	13700	12200	14300	10500	10700	11500	11500	13200	13500	11900	11100	10400	13200	15100
27S20E	3320	2430	2700	2730	2810	2530	1890	1430	1290	1590	2020	2230	2540	2910	3190	3990	4100
27S21E	28200	20700	22900	23200	23900	21500	16100	10500	9530	11700	14900	16500	18700	21500	23500	29400	30200
27S22E	25000	20300	19000	23100	20800	24400	18100	17300	20000	19300	22300	22700	20300	18900	17300	21600	24700
27S23E	78700	63900	59900	72900	65500	76800	56900	54700	62900	61000	70300	71500	63900	59500	54800	68300	78100
27S24E	62200	50400	47300	57600	51600	60600	44900	43500	49500	48300	55500	56500	50400	47000	43500	54200	61800
27S25E	53000	43000	40300	49000	44100	51700	38300	36700	42300	41000	47300	48100	43000	40000	36800	45900	52500
27S26E	70700	57400	53700	65400	58900	69000	51100	48800	56600	54700	63200	64100	57300	53300	49000	61100	70000
27S27E	5350	4340	4070	4950	4460	5230	3870	3700	4280	4140	4780	4860	4340	4040	3710	4630	5300
28S21E	4230	3100	3440	3480	3590	3230	2410	1140	1030	1260	1600	1780	2020	2310	2540	3180	3260
28S22E	21800	15900	17700	17900	18400	16600	12400	12900	11600	14300	18100	20100	22800	26200	28700	35900	36800
28S23E	52100	42300	39600	48300	43400	50900	37700	36000	41700	40400	46600	47300	42300	39300	36200	45100	51600
28S24E	66500	53800	50800	61600	54800	64400	48000	47800	52200	52200	59400	60600	53800	50500	47300	59000	66800
28S25E	57500	46700	43800	53300	47800	56100	41600	40200	45800	44700	51400	52300	46600	43500	40200	50200	57200
28S26E	72300	58600	54900	66900	60200	70600	52200	49900	57800	55900	64600	65600	58600	54500	50100	62500	71500
28S27E	25300	20500	19200	23400	21100	24700	18300	17500	20200	19600	22600	22900	20500	19100	17500	21900	25000
28S28E	266	215	201	246	222	259	192	184	212	205	237	241	215	200	184	230	263
29S22E	24100	17700	19600	19800	20400	18400	13800	13500	12200	15100	19100	21200	24000	27600	30200	37800	38800
29S23E	45000	33000	36500	37000	38100	34400	25700	21200	19100	23500	29700	32900	37200	42700	46800	58500	60000
29S24E	62500	51800	51100	53100	48300	52200	45400	40700	38300	37400	37200	49900	45100	39000	47400	38700	59600
29S25E	95200	78900	77800	81100	73600	79700	69200	62500	58500	57600	57300	76300	68800	59800	72300	59800	91100
29S26E	145000	119000	118000	125000	112000	122000	105000	99800	90100	92100	92100	119000	106000	93800	111000	98300	141000
29S27E	52300	42900	42400	45400	40300	44600	37900	37500	32900	34600	34800	43600	38600	34800	40700	37700	51900
29S28E	3680	3010	2980	3200	2830	3140	2660	2670	2320	2470	2480	3080	2720	2470	2870	2710	3670
29S29E	11300	10000	8870	8160	8070	8600	6850	5350	6610	5080	4720	6250	5890	4510	4420	4340	6010
29S30E	75	67	59	54	54	57	45	35	44	34	31	41	39	30	29	29	40
30S23E	2000	1460	1620	1640	1700	1530	1140	1190	1080	1330	1680	1860	2120	2430	2670	3330	3420
30S24E	53500	39200	43400	43900	45300	40800	30500	17200	15600	19100	24300	26900	30500	35000	38400	48000	49300
30S25E	58800	48500	47900	50500	45400	49600	42700	40100	36500	37000	37000	47900	42900	37900	45100	39300	57200
30S26E	41900	34800	34300	35600	32400	35000	30500	27300	25700	25100	25000	33400	30200	26200	31800	26000	39900
30S27E	60000	49800	49100	51000	46400	50200	43600	39100	36800	36000	35700	47900	43300	37500	45500	37200	57200

Appendix C.--Continued

TOWN-SHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
30S28E	39300	32600	32100	33400	30400	32800	28500	25600	24100	23500	23400	31300	28300	24500	29800	24300	37400
30S29E	106000	94200	83600	77900	76300	81700	65100	52600	62700	49900	46700	60800	56800	44500	43900	44100	59500
30S30E	22800	20300	17900	16500	16300	17400	13800	10800	13400	10300	9540	12600	11900	9120	8950	8770	12100
31S24E	6620	4840	5370	5430	5610	5050	3770	2190	1980	2430	3080	3420	3880	4450	4890	6110	6270
31S25E	28600	23700	23400	24300	22100	23900	20800	18600	17500	17100	17000	22800	20600	17800	21600	17700	27200
31S26E	26200	21700	21400	22300	20300	21900	19100	17100	16100	15700	15600	20900	18900	16400	19900	16200	25000
31S27E	108000	89900	88600	92100	83800	90600	78800	70500	66500	64900	64600	86500	78100	67700	82100	67100	103000
31S28E	60900	50500	49800	51800	47100	51000	44300	39800	37400	36600	36400	48700	44000	38100	46200	37900	58100
31S29E	117000	103000	91600	85200	83600	89400	71200	57400	68600	54300	50900	66400	62100	48400	47800	47900	64800
31S30E	36400	32300	28600	26600	26100	27900	22200	17800	21400	16900	15800	20700	19300	15100	14900	14800	20100
32S23E	76	56	62	62	64	58	43	32	29	36	46	51	58	67	73	92	94
32S24E	5900	4320	4800	4850	5000	4500	3370	2090	1890	2330	2950	3270	3710	4260	4670	5840	5990
32S25E	24200	21500	19000	17500	17300	18400	14700	11500	14100	10900	10100	13400	12600	9660	9470	9280	12900
32S26E	52900	46600	41600	39200	38100	41000	32600	27300	31400	25800	24400	31200	28900	23100	23000	23600	31100
32S27E	31800	26400	26000	27000	24600	26600	23100	20700	19500	19000	18900	25400	22900	19900	24100	19700	30300
32S28E	66200	55000	54200	56300	51200	55400	48100	43100	40600	39700	39500	52900	47800	41400	50200	41000	63100
32S29E	89600	79600	70400	64800	64100	68300	54400	42700	52400	40500	37700	49800	46900	36000	35300	34700	47900
32S30E	1570	1390	1230	1130	1120	1190	949	741	915	702	653	866	817	625	612	600	832
12N23WS	1100	978	863	794	786	837	666	521	643	494	459	608	573	439	430	422	584
12N22WS	5810	5170	4560	4200	4150	4420	3520	2750	3400	2610	2430	3220	3030	2320	2280	2230	3090
12N21WS	22800	20300	17900	16500	16300	17300	13800	10800	13300	10200	9520	12600	11900	9100	8930	8750	12100
12N20WS	19700	17600	15500	14300	14100	15000	12000	9350	11500	8870	8250	10900	10300	7890	7730	7580	10500
12N19WS	21600	19300	17000	15600	15500	16500	13100	10300	12700	9730	9040	12000	11300	8650	8480	8310	11500
12N18WS	7790	6930	6120	5620	5570	5930	4720	3690	4550	3500	3250	4310	4060	3110	3050	2990	4140
11N23WS	1080	965	852	783	775	825	657	513	634	487	453	600	566	433	424	416	576
11N22WS	12900	11400	10100	9470	9240	9920	7900	6490	7600	6140	5780	7460	6940	5480	5430	5520	7350
11N21WS	24200	21200	19000	18200	17500	18900	15000	12900	14500	12200	11600	14700	13500	10900	10900	11400	14800
11N20WS	31700	28200	24900	22900	22700	24100	19200	15000	18600	14300	13300	17600	16600	12700	12400	12200	16900
11N19WS	82700	72300	65000	62200	59700	64700	51500	44600	49500	42100	40100	50500	46400	37800	37800	39700	51000
11N18WS	13900	12400	10900	10000	9950	10600	8440	6590	8140	6250	5810	7700	7260	5560	5450	5340	7400

Appendix D.-- Municipal ground-water pumpage synthesized from regression for townships in the Central Valley

[Pumpage, in acre-feet, rounded to three significant figures. Township: Townships are on the Mount Diablo baseline and meridian, except where followed by an "S" which are on the San Bernardino baseline and meridian. , no data]

TOWNSHIP	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
27N03W	3730	3780	3820	3870	3920	4050	4030	3880	4110	4280	4200	4270	4320	4370	4410	4460	4510
24N03W	258	594	674	1020	1080	1180	1080	1050	1200	1230	1250	1460	1550	1630	1710	1800	1880
22N01W	204	215	211	264	250	272	244	269	285	298	331	323	334	345	356	367	378
22N01E	10600	10800	9780	11700	11600	13300	12200	12900	13100	14300	13800	14500	14900	15300	15700	16100	16500
22N02E	1040	1070	966	1150	1150	1310	1200	1280	1290	1290	1490	1440	1480	1520	1560	1600	1640
19N03W	1230	1170	1170	1410	1300	1470	1420	1430	1460	1540	1500	1580	1620	1650	1690	1720	1760
19N03E	0	0	0	0	0	336	789	959	1890	2600	2230	3050	3500	3960	4410	4860	5320
19N04E	471	449	319	470	291	508	453	607	708	549	897	746	783	821	858	896	933
18N02W	5770	5770	5770	5770	5770	5770	5770	5770	5770	5870	5680	5770	5770	5770	5770	5770	5770
18N02E	1090	1030	663	337	416	477	1080	1090	1030	1000	1270	1080	1120	1160	1200	1230	1270
18N03E	141	141	141	141	141	141	141	141	134	147	141	141	141	141	141	141	141
17N02E	423	461	669	772	703	756	748	526	597	576	622	666	673	681	688	695	702
16N01W	915	986	1060	1130	1200	1270	1270	1490	1500	1580	1580	1700	1770	1840	1910	1980	2060
15N03E	2320	2150	1950	2150	2100	2310	2210	2290	2290	2140	2070	2190	2190	2190	2190	2190	2200
15N04E	2850	2770	2680	2770	2750	2840	2800	2830	2830	2960	2750	2860	2870	2880	2880	2890	2900
15N05E	1830	1830	1830	1830	1830	1830	1830	1830	1830	1820	1840	1830	1830	1830	1830	1830	1830
11N06E	1610	1600	1600	1440	1720	1910	1240	1240	1810	2120	1140	1560	1550	1550	1540	1540	1530
10N02E	5920	7390	5540	6840	5970	7130	7070	7980	7700	8340	8660	8630	8880	9130	9380	9630	9880
10N05E	2180	2150	2120	2080	2050	2010	2000	2000	1670	1880	2010	1810	1780	1740	1710	1670	1640
10N06E	503	503	503	503	503	503	503	503	503	499	506	503	503	503	503	503	503
09N04E	5630	5470	5510	6370	6520	7250	6560	7240	7500	7770	8030	8300	8560	8820	9090	9350	9610
09N05E	22200	22900	23700	28100	27500	36500	34400	38600	39800	42300	42600	46800	49200	51600	54000	56300	58700
09N06E	7880	8440	8880	10200	9320	10700	10100	17400	18000	12800	12700	16100	16800	17600	18400	19100	19900
08N01W	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1400	1390	1390	1390	1390	1390	1390
08N02E	2840	2760	2750	3640	3740	4530	4790	5230	6120	6430	6790	7170	7620	8060	8500	8950	9390
08N03E	89	89	89	89	89	137	63	67	89	89	89	89	89	89	89	89	89
08N04E	221	207	177	213	190	218	183	190	187	184	182	179	176	173	170	167	165
08N05E	128	178	228	279	329	355	422	593	448	569	649	683	733	784	834	884	935
08N06E	4110	4110	4110	4110	4110	4110	4110	4110	4010	4320	4000	4110	4110	4110	4110	4110	4110
07N01E	681	673	641	787	803	927	908	978	991	1040	1030	1120	1160	1200	1250	1290	1330
07N05E	630	630	630	630	476	628	620	738	601	697	648	630	630	630	630	630	630
07N06E	652	608	629	774	752	896	841	912	960	1000	1050	1090	1140	1180	1230	1270	1320
06N01W	5430	5580	5010	4960	4900	5190	5820	5870	4700	4500	4680	4800	4740	4690	4630	4570	4510
05N02W	115	115	115	115	115	115	115	120	71	156	116	116	116	116	116	116	116
05N01W	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
04N03E	1410	1380	1340	1310	1270	1210	1260	1210	963	1180	1060	1020	986	950	915	879	843
02S05E	4450	4750	4860	5120	5380	5660	5860	6090	6320	6560	6790	7030	7260	7490	7730	7960	8200
02S08E	958	958	958	958	958	958	958	958	958	958	958	958	958	958	958	958	958
02S09E	853	853	853	853	853	853	853	893	893	893	933	925	937	1040	1050	1080	1040
02S10E	1360	1380	3870	4200	3990	4600	4180	4420	4460	4800	4850	5030	3960	5000	4860	5440	4850