ESTIMATED USE OF GROUND WATER IN THE UNITED STATES - 1945

By

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About three years ago the writer began to compile figures on the use of ground water for various purposes in the United States. The results were to be used in a paper on the industrial use of water, to be a part of a symposium on ground water sponsored by the Committee on the Economic Importance of Ground Water of the American Society of Civil Engineers. Unfortunately, it has required much longer than originally contemplated to finish the compilation, and in the meantime the committee, which performed valuable service under the chairmanship of E. W. Bennison, has been abolished. It now appears desirable to release the figures so that they may be used and referred to by others interested in the subject.

First reference to the figures was made in a talk given by the writer at a meeting of the Geological Society of Washington on January 8, 1947. Since that time, some of the figures have been published in a number of general papers on ground water. These and other papers have met a large part of the pressing need for general discussion of our over-all ground-water problems. The need for detailed discussion of the various factors involved in the use of ground water by industries--the processes, quantity and quality requirements, etc.--is still pressing, but is gradually being met by industrial engineers and other qualified persons as more and more of them become aware of the need and find the time to prepare contributions.

The first step in the compilation of the data on ground-water use was to contact all ground-water field offices of the Geological Survey and various State agencies, requesting estimates and data on the use of ground water in their areas. These offices were very cooperative and furnished many estimates, together with data from their files and from various Survey, State, and local publications. Concurrently, a thorough study was made of the large number of reports and data available in the Washington office dealing with inventories or estimates of ground water use. Later the results of another set of field correspondence, begun by O. E. Meinzer, late chief of the Ground Water Branch, were incorporated in the estimates, and a study was made of publications of the Bureau of the Census. In connection with municipal use, studies were made of data compiled by James C. Harding, Consulting Engineer, and of publications of the Public Health Service and the American Water Works Association. Next, all the gaps, of which there were many, were filled in by estimates of the writer, made on the basis of general knowledge of ground-water conditions, and the locations, populations, and types of areas concerned. A complete set of tables was then sent to the field with the request that the field men check them insofar as possible. Upon receipt of the replies, the tables were revised, taking into account the field men's comments and miscellaneous information that had become available in the meantime.

The attached tables, maps, and graph represent the best possible figures the writer could obtain or estimate. It has not been thought desirable to attempt to give the source of each figure, for in many cases a single figure was derived in several different ways, and neither time nor space permits detailed explanations. However, upon request, the writer is prepared to discuss any particular figure.

The total daily use of ground water in the United States during 1945 has been estimated as follows:

	Million gallons a day
Irrigation	10,000
Industrial (excluding water from municipal systems)	5,000
Municipal	3,000
Rural (excluding irrigation)	2,000
Total	20,000

It is hoped that the information in the attached tables will be helpful and that similar estimates will be kept up to date by ground-water offices so that new tables can be prepared from time to time. The year 1950 is suggested as a good year for which another compilation might be made.

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ESTIMATED USE OF GROUND WATER - 1945
(million gallons per day)

State	Irrigation	Industrial	Municipal	(Excluding irrigation) Rural	Total
Alabama	--	80	55	30	165
Arizona	1,760	30	60	15	1,865
Arkansas	420	50	25	30	525
California	5,000	300	400	100	5,800
Colorado	400	25	20	25	470
Connecticut	--	60	5	20	85
Delaware	--	15	10	5	30
District of Columbia	--	10	--	--	10
Florida	100	175	100	20	395
Georgia	--	150	45	50	245
Idaho	125	10	25	20	180
Illinois	--	265	115	60	440
Indiana	--	350	100	45	495
Iowa	--	150	100	75	325
Kansas	100	100	55	55	310
Kentucky	--	100	20	40	160
Louisiana	380	250	50	30	710
Maine	--	15	10	15	40
Maryland	--	50	20	20	90
Massachusetts	--	100	60	15	175
Michigan	5	165	100	50	320
Minnesota	--	100	50	65	215
Mississippi	--	25	35	35	95
Missouri	--	130	40	45	215
Montana	25	15	10	25	75
Nebraska	450	35	85	80	650
Nevada	150	20	10	5	185
New Hampshire	--	15	10	5	30
New Jersey	5	400	150	20	575
New Mexico	360	20	35	20	435
New York	25	310	250	70	655
North Carolina	5	40	20	50	115
North Dakota	--	5	10	25	40
Ohio	--	400	150	60	610
Oklahoma	10	15	30	35	90
Oregon	75	35	25	25	160
Pennsylvania	--	250	135	90	475
Rhode Island	--	20	10	5	35
South Carolina	5	20	15	25	65
South Dakota	5	15	20	35	75
Tennessee	--	110	60	40	210
Texas	740	300	270	140	1,450
Utah	200	20	35	10	265
Vermont	--	5	10	10	25
Virginia	--	50	15	40	105
Washington	125	100	100	30	355
West Virginia	--	35	20	25	80
Wisconsin	--	100	90	55	245
Wyoming	25	10	10	10	55
Total	10,495	5,050	3,075	1,800	20,420

ESTIMATED USE OF GROUND WATER IN AREAS WHERE LARGE AMOUNTS ARE USED FOR INDUSTRIAL OR MUNICIPAL PURPOSES--1945

(million gallons per day)

Area	Total use	Industrial use	Municipal use
Los Angeles, Calif.	360[1]	60	80
Long Island, N.Y.	280[1]	100	150
Houston, Texas	170	102	68
Memphis, Tenn.	105	74	31
San Antonio, Texas	100[2]	15	38
East St. Louis, Ill.	89	85	4
Peoria, Ill.	85	66	19
(Philadelphia, Pa.-Camden, N.J.)	85	55	30
Dayton, Ohio	85[3]	50	35
Chicago, Ill.	84	48	36
Pittsburgh, Pa.	84[4]	68	16
Clinton, Ind.	80	80	--
Spokane, Wash.	67[1]	7	39
Baton Rouge, La.	63	59	4
Charlestown, Ind.	60	60	--
Kansas City, Mo.-Kan.	60	60	--
Kalamazoo, Mich.	52	44	8
Indianapolis, Ind.	48	45	3
Savannah, Ga.	47	32	15
St. Paul-Minneapolis, Minn.	47[5]	47	--
Cincinnati, Ohio	45	40	5
Louisville, Ky.	45	45	--
Phoenix, Ariz.	45	10	35
Des Moines, Iowa	44	24	20
Jacksonville, Fla.	41	22	19
Baltimore, Md.	40	40	--
Canton, Ohio	38	23	15
Brunswick, Ga.	37	37	--
Middlesex Co., N.J.	37[6]	22	15
Miami, Fla.	34	11	23

[1] Includes use for irrigation.
[2] Includes uses for irrigation and recreation.
[3] Estimated for 1946 instead of 1945.
[4] Estimated for 1947 instead of 1945.
[5] Estimated for 1937 instead of 1945.
[6] Estimated for 1941 instead of 1945.

ESTIMATED USE OF GROUND WATER IN AREAS WHERE LARGE AMOUNTS ARE USED FOR INDUSTRIAL OR MUNICIPAL PURPOSES--1945 (Continued)

(million gallons per day)

Area	Total use	Industrial use	Municipal use
Fernandina, Fla.	33	33	--
Terre Haute, Ind.	33	33	--
Middletown, Ohio	33	29	4
Mobile, Ala.	32	32	--
South Bend, Ind.	29	16	13
Columbus, Ohio	28	28	--
New Orleans, La.	27	27	--
Lake Charles, La.	27	25	2
Akron, Ohio	27	25	2
Milwaukee, Wis.	27	23	4
Rockford, Ill.	26	13	13
Sioux City, Iowa	25	18	7
Pensacola, Fla.	25	19	6
Binghamton, N.Y.	25	8	17
Wichita, Kan.	25	7	18
Las Vegas, Nev.	24[1]	8	12
Chillicothe, Ohio	22	21	1
El Paso, Texas	21	11	10
Schenectady, N.Y.	20	6	14
Tacoma, Wash.	20	10	10
Boston, Mass.	20	7	13
Hamilton, Ohio	20	15	5
Massillon, Ohio	20	20	--
Total for 53 areas	3,046	1,865	859

[1] Includes use for irrigation.

USE OF GROUND WATER--BY TYPE OF INDUSTRY--IN 20 AREAS WHERE INVENTORIES HAVE BEEN MADE

(million gallons per day)

Type of industry	Houston, Texas 1945	E. St. Louis, Ill. 1945	Pitts-burgh, Pa. 1947	Peoria, Ill. 1945	Dayton, Ohio 1946
Oil refining	45.8	14.8	1.7	--	--
Paper manufacturing	18.1	--	1.5	1.0	11.5
Metal working	9.6	16.0	15.1	10.0	6.5
Chemical manufacturing	4.0	30.6	7.2	--	0.9
Building, air conditioning, and refrigerating	1.7	0.6	9.9	3.5	1.7
Distilling	--	--	--	26.0	--
Ice manufacturing and cold storage	4.4	--	6.2	--	2.2
Food processing	--	--	2.7	9.5	2.5
Rubber manufacturing	6.4	--	--	--	2.3
Meat packing	1.1	11.4	3.2	--	0.3
Brewing	2.0	--	1.4	1.2	0.5
Railroad yards	2.5	6.2	6.0	--	0.3
Gas and electricity	2.1	--	6.8	--	5.7
Dairying	--	0.2	2.0	0.5	0.8
Electric equipment manufacturing	--	--	--	--	10.4
Aircraft assembling	--	--	--	--	--
Resinous products manufacturing	--	--	--	--	--
Soap manufacturing	--	--	--	--	0.3
Laundering	0.8	--	--	0.3	0.6
Glass manufacturing	--	--	2.3	--	--
Rope milling	--	--	--	--	--
Ship yards	1.2	--	--	--	--
Tobacco processing	--	--	--	--	--
Miscellaneous	2.2	5.5	1.8	14.0	3.5
Total	101.9	85.3	67.8	66.0	50.0

USE OF GROUND WATER--BY TYPE OF INDUSTRY--IN 20 AREAS WHERE INVENTORIES HAVE BEEN MADE

(million gallons per day)

Type of Industry	Chicago, Ill. 1945	Louisville, Ky. 1945	Minneapolis, St. Paul, Minn. (85%) 1937	Philadelphia, Pa. 1945	Kansas City, Kan. 1943
Oil refining	--	3.0	--	1.4	9.6
Paper manufacturing	--	--	--	--	--
Metal working	9.3	3.5	--	--	--
Chemical manufacturing	6.7	--	--	2.4	--
Building, air conditioning, and refrigerating	1.6	3.7	9.7	3.0	--
Distilling	--	9.2	--	12.0	--
Ice manufacturing and cold storage	--	2.6	3.3	2.7	3.1
Food processing	19.3	0.6	0.2	1.2	--
Rubber manufacturing	--	11.4	--	--	--
Meat packing	5.0	2.0	--	1.1	8.1
Brewing	--	3.1	10.2	--	--
Railroad yards	1.6	--	0.6	1.5	0.3
Gas and electricity	--	0.8	--	3.0	--
Dairying	0.5	2.2	4.3	1.1	--
Electric equipment manufacturing	--	--	--	--	--
Aircraft assembling	--	--	--	--	8.0
Resinous products manufacturing	--	--	--	--	--
Soap manufacturing	--	--	--	--	4.0
Laundering	0.3	--	--	--	--
Glass manufacturing	--	--	--	--	--
Rope milling	--	--	--	2.0	--
Ship yards	--	--	--	--	--
Tobacco processing	--	0.9	--	--	--
Miscellaneous	3.9	1.9	12.5	9.2	2.0
Total	48.2	44.9	40.8	40.6	35.1

USE OF GROUND WATER--BY TYPE OF INDUSTRY--IN
20 AREAS WHERE INVENTORIES HAVE BEEN MADE

(million gallons per day)

Type of industry	Mobile, Ala. 1945	Akron, Ohio 1944	Jackson-ville, Fla. 1945	Chilli-cothe, Ohio 1945	Pensa-cola, Fla. 1945	Smith Rand, Ind. 1945
Oil refining	--	--	--	--	--	--
Paper manufacturing	15.0	2.0	4.1	20.0	3.2	--
Metal working	--	0.4	--	--	--	7.2
Chemical manufacturing	--	5.0	--	--	--	--
Building, air conditioning, and refrigerating	11.0	--	2.7	--	--	2.3
Distilling	--	--	--	--	--	--
Ice manufacturing and cold storage	--	--	8.2	--	--	0.7
Food processing	--	--	--	--	--	--
Rubber manufacturing	--	16.0	--	--	--	--
Meat packing	--	0.3	--	--	--	--
Brewing	--	--	0.5	--	--	1.6
Railroad yards	--	--	1.4	--	--	0.8
Gas and electricity	--	--	0.8	--	--	--
Dairying	--	0.8	--	--	--	0.3
Electric equipment manufacturing	--	--	--	--	--	--
Aircraft assembling	--	--	--	--	--	--
Resinous products manufacturing	--	--	--	--	8.2	--
Soap manufacturing	--	--	--	--	--	--
Laundering	--	--	--	--	--	0.3
Glass manufacturing	--	--	--	--	--	--
Rope milling	--	--	--	--	--	--
Ship yards	--	--	--	--	--	--
Tobacco processing	--	--	--	--	--	--
Miscellaneous	6.0	0.5	4.1	1.0	2.7	2.5
Total	32.0	25.0	21.8	21.0	19.1	15.7

USE OF GROUND WATER--BY TYPE OF INDUSTRY--IN 20 AREAS WHERE INVENTORIES HAVE BEEN MADE

(million gallons per day)

Type of industry	Milwaukee, Wis. (60%) 1944	Miami, Fla. 1945	El Dorado, Ark. 1945	Oklahoma, City, Okla. 1945	Total	Number of areas
Oil refining	--	--	6.2	1.0	83.5	8
Paper manufacturing	--	--	--	--	81.4	9
Metal working	3.2	--	--	--	80.8	10
Chemical manufacturing	--	--	3.1	--	59.9	8
Building, air conditioning, and refrigerating	2.3	1.6	--	0.6	55.9	15
Distilling	--	--	--	--	47.2	3
Ice manufacturing and cold storage	--	4.7	--	0.7	38.8	11
Food processing	1.2	--	--	--	37.2	8
Rubber manufacturing	--	--	--	--	36.1	4
Meat packing	1.1	--	--	1.0	34.6	11
Brewing	4.1	--	--	0.3	24.9	10
Railroad yards	--	--	--	0.2	21.4	11
Gas and electricity	--	1.2	--	--	20.4	7
Dairying	--	2.2	--	--	14.9	11
Electric equipment manufacturing	--	--	--	--	10.4	1
Aircraft assembling	--	--	--	0.5	8.5	2
Resinous products manufacturing	--	--	--	--	8.2	1
Soap manufacturing	--	--	--	--	4.3	2
Laundering	--	--	--	0.2	2.5	6
Glass manufacturing	--	--	--	--	2.3	1
Rope milling	--	--	--	--	2.0	1
Ship yards	--	--	--	--	1.2	1
Tobacco processing	--	--	--	--	0.9	1
Miscellaneous	3.0	1.4	--	0.1	77.8	19
Total	14.9	11.1	9.3	4.6	755.1	20

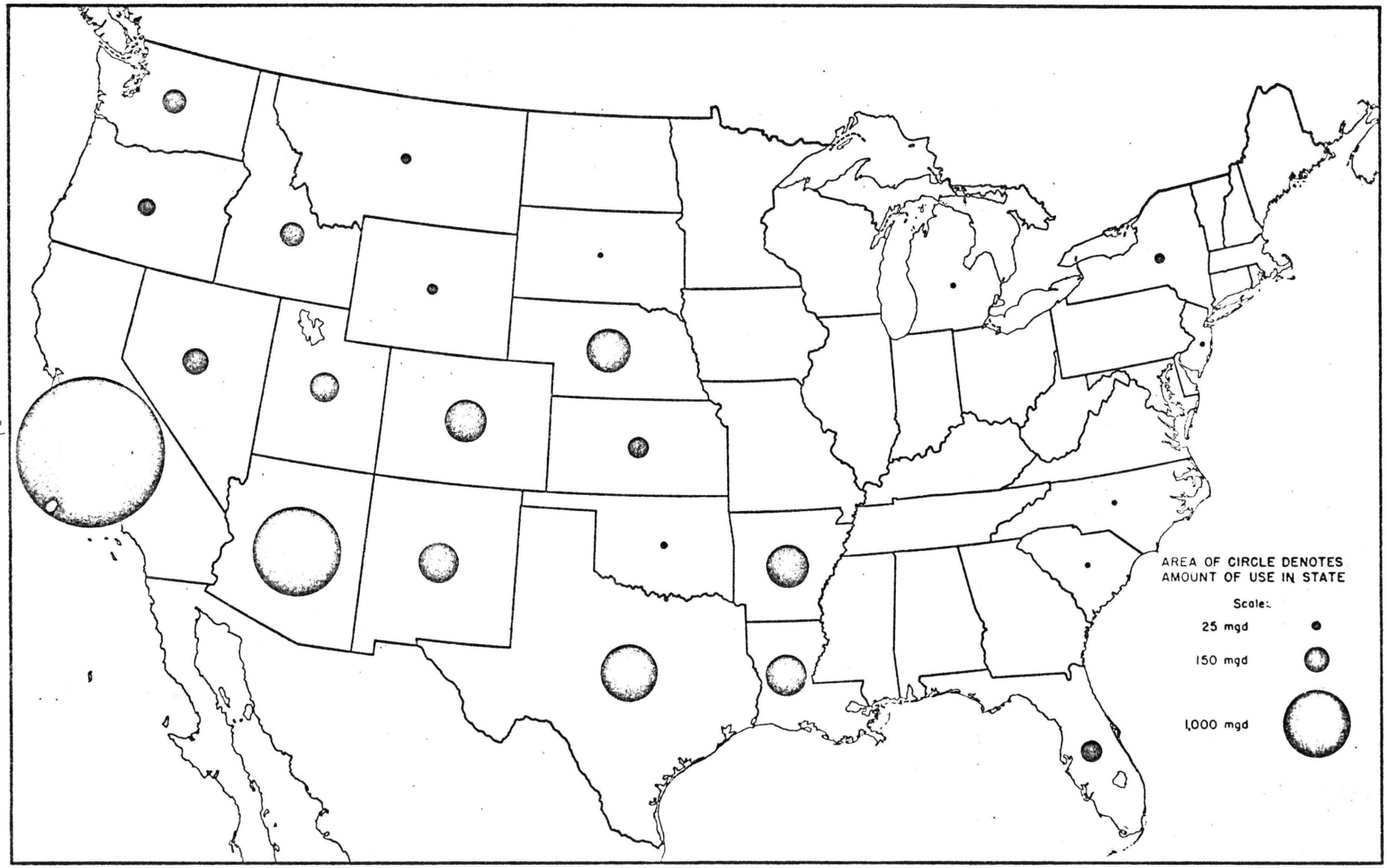

FIGURE 1 — USE OF GROUND WATER FOR IRRIGATION — 1945

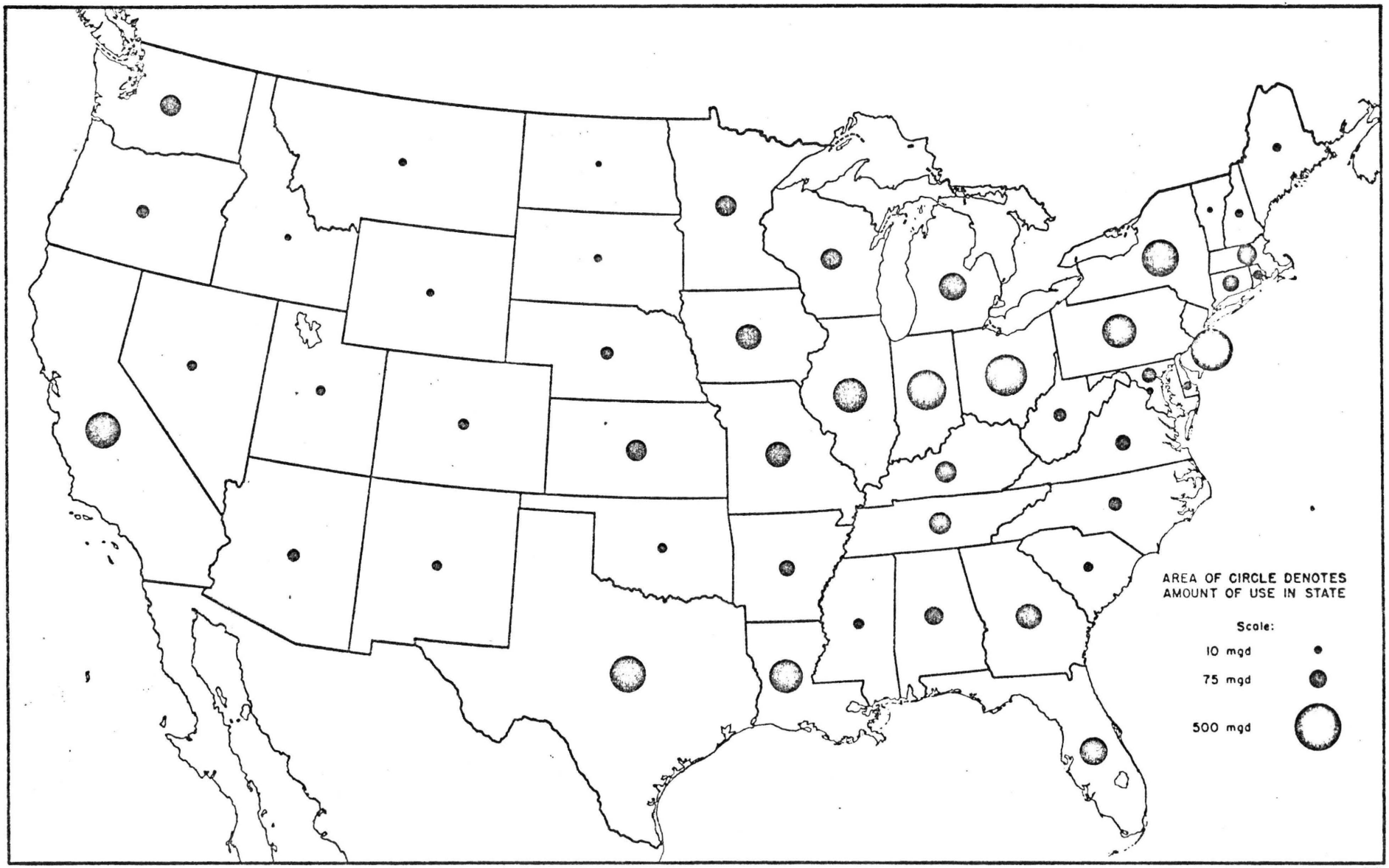

FIGURE 2 — INDUSTRIAL USE OF GROUND WATER — 1945
(not including water supplied from municipal systems)

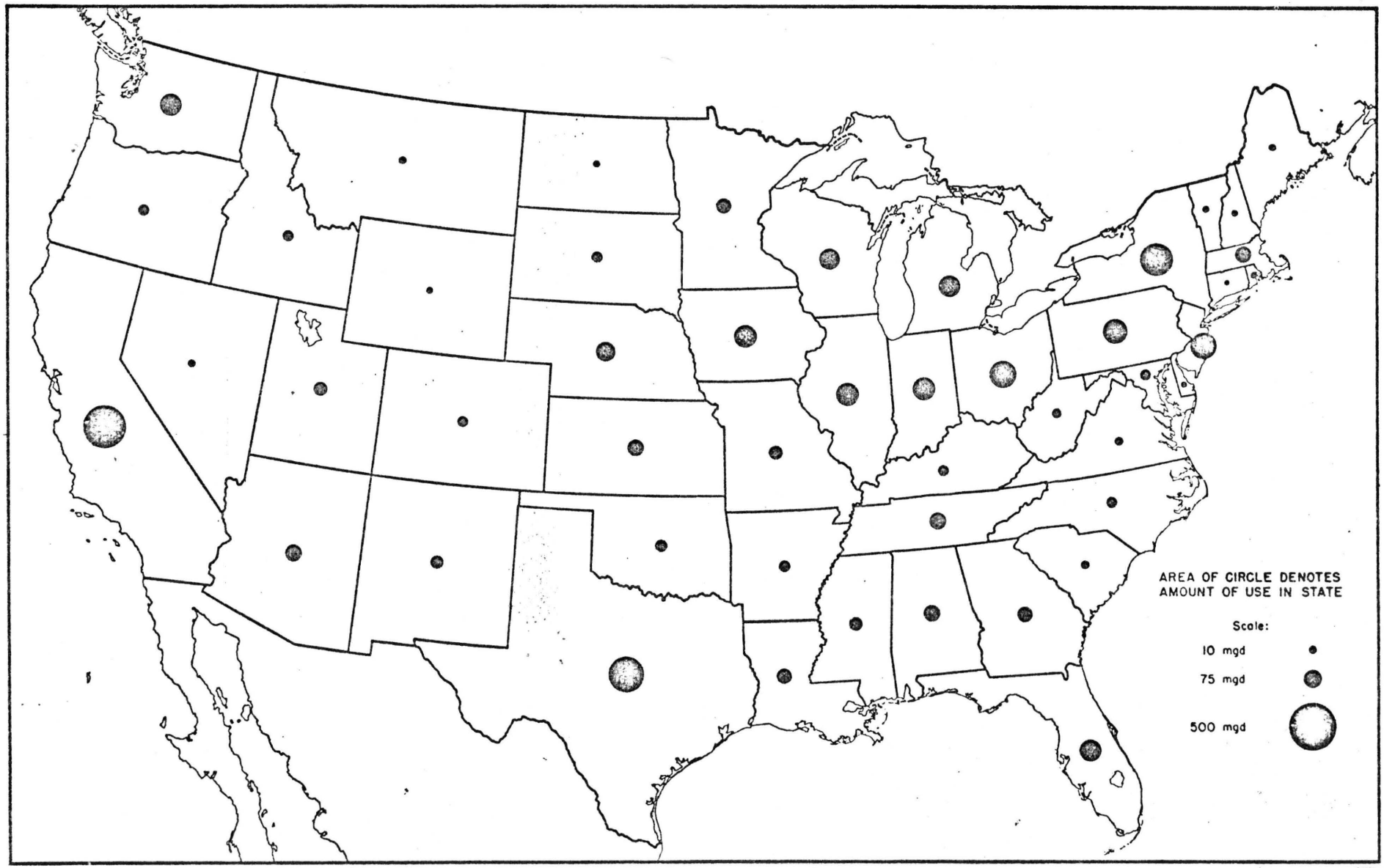

FIGURE 3 — MUNICIPAL USE OF GROUND WATER — 1945

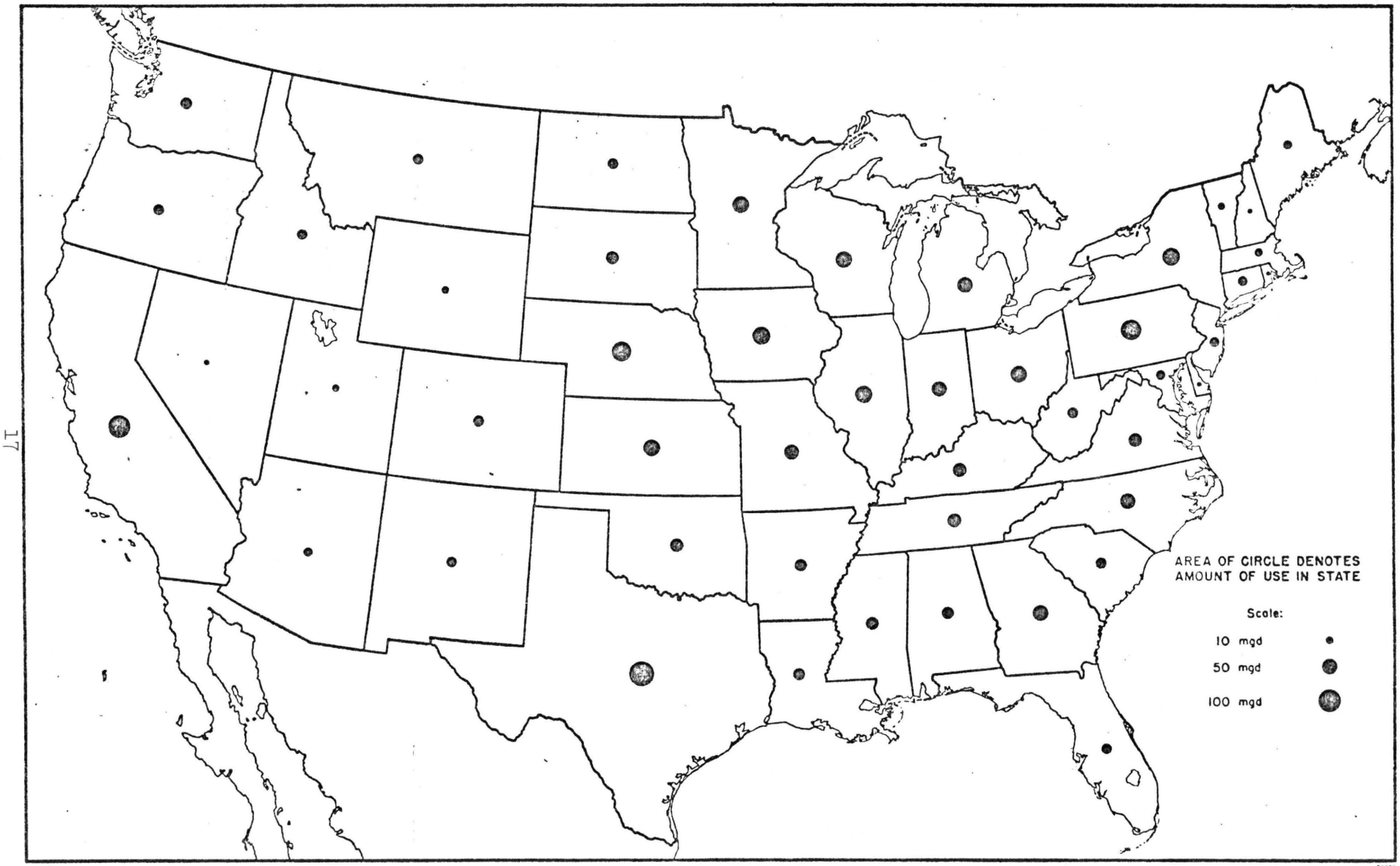

FIGURE 4 — RURAL USE OF GROUND WATER — 1945
(not including use for irrigation)

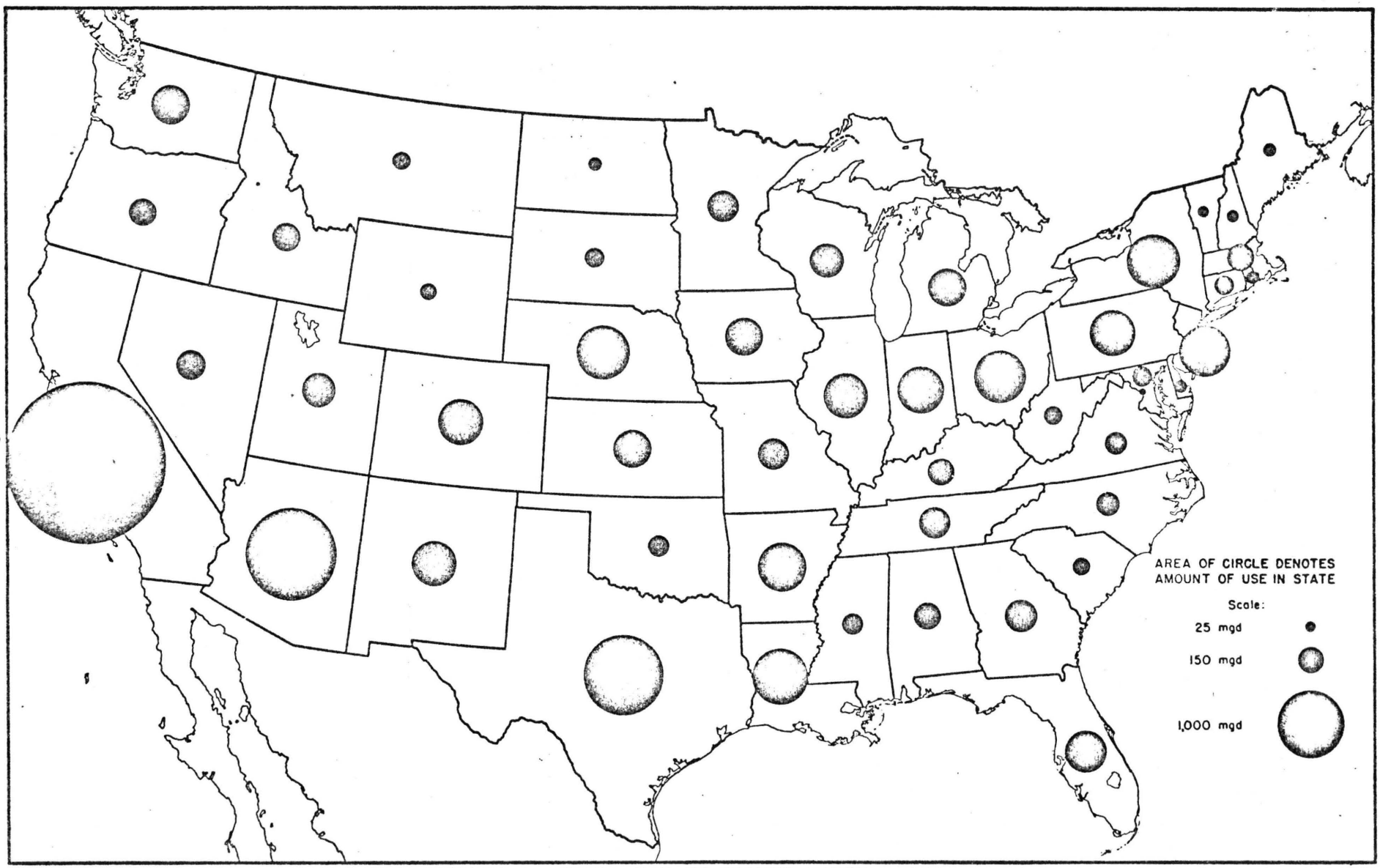

FIGURE 5 — TOTAL USE OF GROUND WATER — 1945

FIGURE 6 — USE OF GROUND WATER IN METROPOLITAN AREAS — 1945
(only areas with 20 mgd or more total use are included)

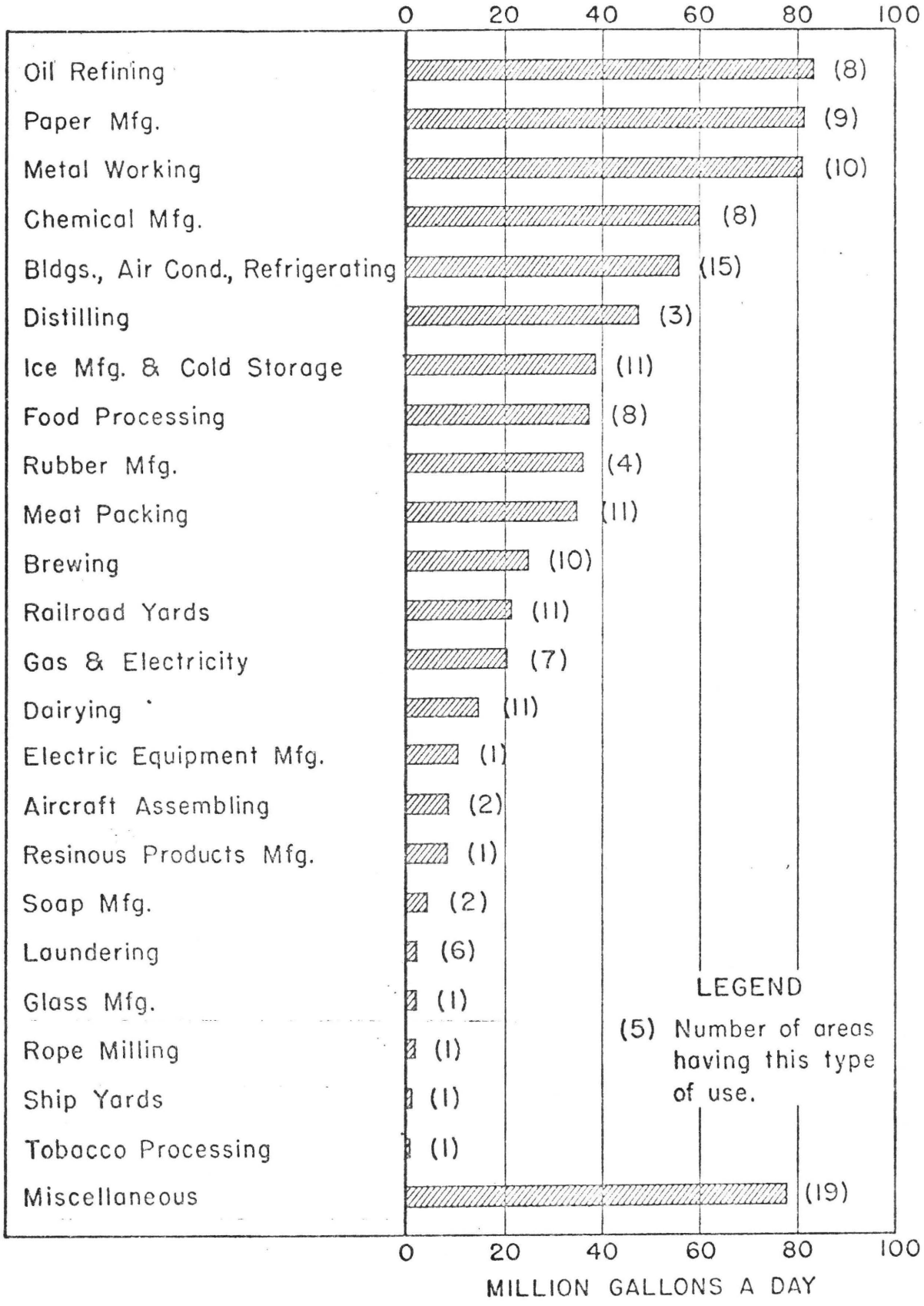

FIGURE 7 — USE OF GROUND WATER BY INDUSTRIES IN 20 SELECTED METROPOLITAN AREAS.
(Not including water from municipal supplies)