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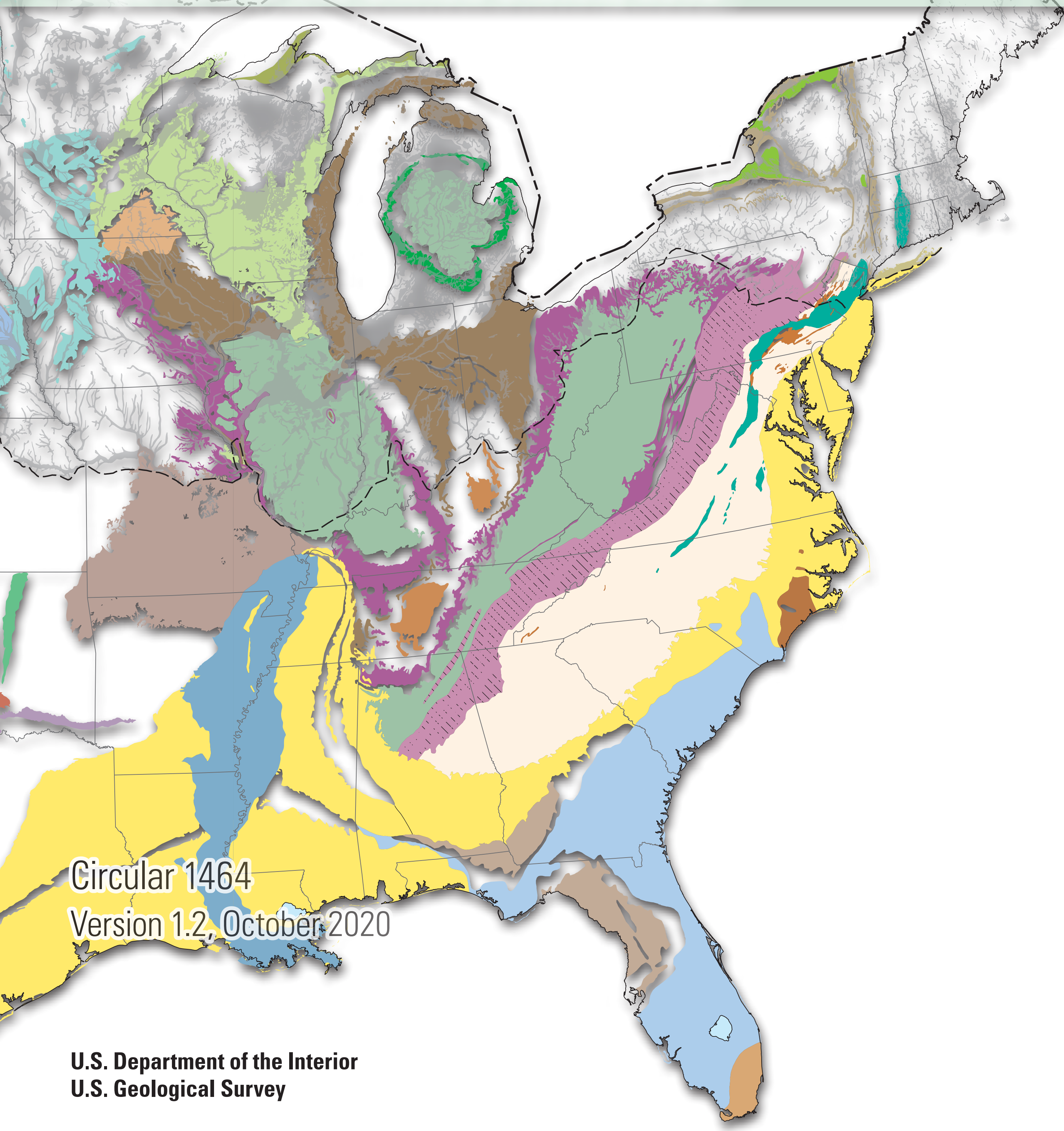
Estimated Groundwater Withdrawals from Principal Aquifers in the United States, 2015



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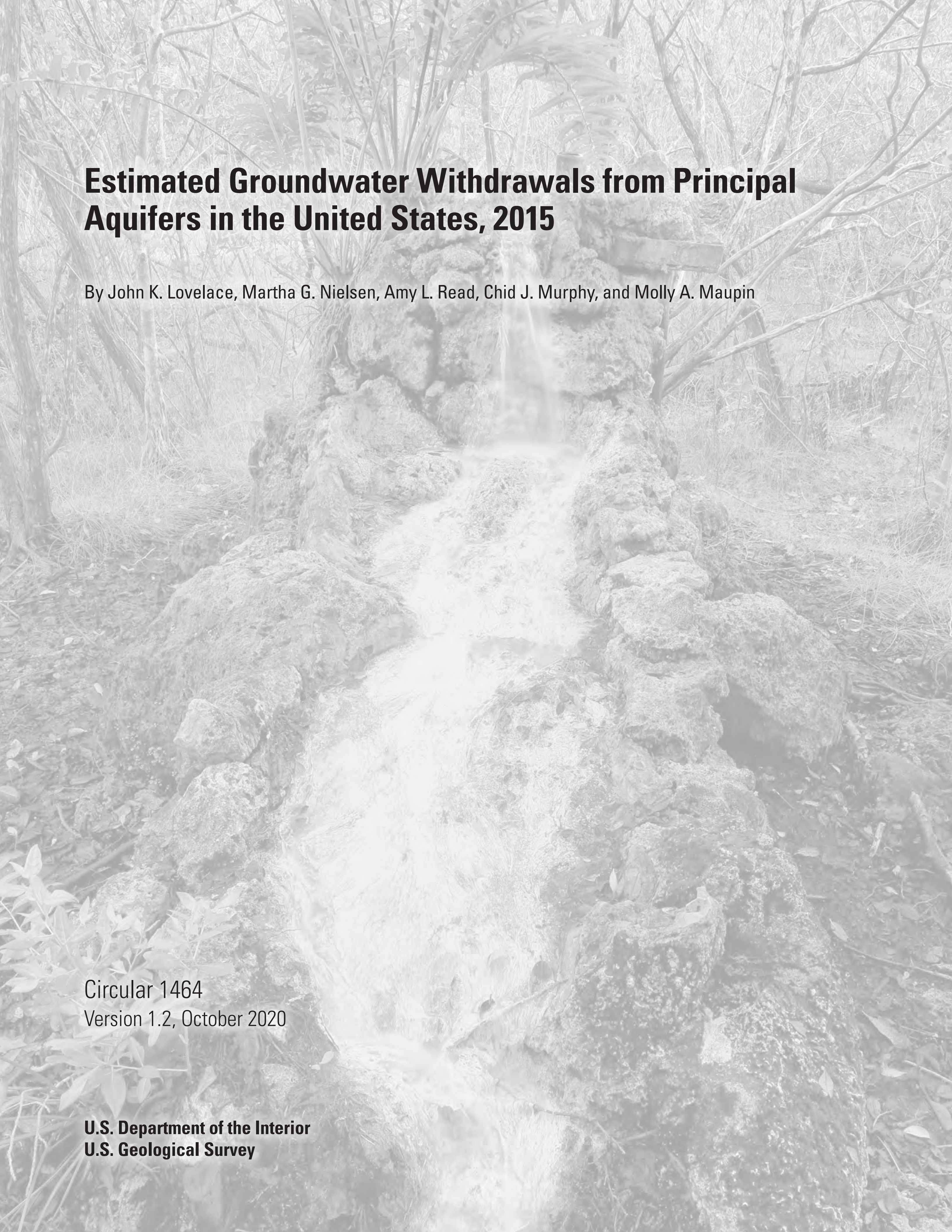
Title page: Cascade of water flowing from an artesian well at the John Pennekamp Coral Reef State Park, Key Largo, Monroe County, Florida. Photograph by Alan M. Cressler, U.S. Geological Survey.



Estimated Groundwater Withdrawals from Principal Aquifers in the United States, 2015

By John K. Lovelace, Martha G. Nielsen, Amy L. Read, Chid J. Murphy, and Molly A. Maupin

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Contents

Figures

Tables

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	0.003785	cubic meter (m^3)
	Flow rate	
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Supplemental Information

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Abbreviations

AWUDS	Aggregate Water-Use Data System (USGS)
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
NWIS	National Water Information System (USGS)
USGS	U.S. Geological Survey

Water tower in downtown Baton Rouge, Louisiana, with Mississippi River bridge in background. Photograph by John K. Lovelace, U.S. Geological Survey.

Estimated Groundwater Withdrawals from Principal Aquifers in the United States, 2015

By John K. Lovelace, Martha G. Nielsen, Amy L. Read, Chid J. Murphy, and Molly A. Maupin

Abstract

In 2015, about 84,600 million gallons per day (Mgal/d) of groundwater were withdrawn in the United States for various uses including public supply, self-supplied domestic, industrial, mining, thermoelectric power, aquaculture, livestock, and irrigation. Of this total, about 94 percent (79,200 Mgal/d) was withdrawn from principal aquifers, which are defined as regionally extensive aquifers or aquifer systems that have the potential to be used as sources of water of suitable quality and quantity to meet various needs. The remaining 6 percent (5,400 Mgal/d) was withdrawn from other, nonprincipal aquifers in the United States.

Sixty-six principal aquifers belonging to 5 major lithologic groups have been identified and delineated in the United States, including Puerto Rico and the U.S. Virgin Islands. Of the water withdrawn from principal aquifers in 2015, 81 percent (63,900 Mgal/d) was from the unconsolidated and semiconsolidated sand and gravel lithologic group, 7.1 percent (5,630 Mgal/d) was from the igneous and metamorphic-rock lithologic group, 6.8 percent (5,360 Mgal/d) was from the carbonate-rock lithologic group, 3.4 percent (2,680 Mgal/d) was from the sandstone lithologic group, and 2.2 percent (1,710 Mgal/d) was from the sandstone and carbonate-rock lithologic group.

The most heavily pumped of the 24 principal aquifers and aquifer systems within the unconsolidated and semiconsolidated sand and gravel lithologic group were the High Plains aquifer (12,300 Mgal/d), Mississippi River Valley alluvial aquifer (12,100 Mgal/d), Central Valley aquifer system (11,100 Mgal/d), and Basin and Range basin-fill aquifers (7,390 Mgal/d). Withdrawals for irrigation were 48,100 Mgal/d and accounted for 75 percent of the total withdrawals from this lithologic group. Although unconsolidated sand and gravel aquifers are widely distributed and were used as sources of water in all States except Hawaii and the U.S. Virgin Islands, 56 percent of the total withdrawn from unconsolidated and semiconsolidated sand and gravel aquifers was in just four States: California (15,600 Mgal/d), Arkansas (9,560 Mgal/d), Nebraska (5,570 Mgal/d), and Texas (4,830 Mgal/d).

The most heavily pumped of the seven principal aquifers within the igneous and metamorphic-rock lithologic group were the Snake River Plain (2,930 Mgal/d) and Columbia Plateau basaltic-rock aquifers (1,080 Mgal/d), which are located in the northwestern United States and together accounted for 71 percent of the water withdrawn from this lithologic group. Withdrawals for irrigation were 4,190 Mgal/d and accounted for more than 74 percent of the total withdrawals from this lithologic group. Seventy-eight percent of the withdrawals from igneous and metamorphic-rock aquifers were in three States: Idaho (3,230 Mgal/d), Washington (614 Mgal/d), and Oregon (528 Mgal/d).

The most heavily pumped of the 15 principal aquifers and aquifer systems within the carbonate-rock lithologic group were the Floridan aquifer system (3,180 Mgal/d) and the Biscayne aquifer (679 Mgal/d), which are in the southeastern United States and together accounted for almost 72 percent of the withdrawals from this lithologic group. Withdrawals for public supply (2,440 Mgal/d) and irrigation (1,610 Mgal/d) together accounted for almost 76 percent of the total withdrawals from this lithologic group. Although water was withdrawn from carbonate-rock aquifers in 35 States, 71 percent of the total withdrawn was in Florida (3,020 Mgal/d) and Georgia (785 Mgal/d).

The most heavily pumped of the 15 principal aquifers within the sandstone lithologic group was the Cambrian-Ordovician aquifer system (921 Mgal/d), which is in the north-central United States and accounted for 34 percent of the water withdrawn from this lithologic group. Withdrawals for public supply were 1,030 Mgal/d and accounted for 38 percent of the total withdrawals from this lithologic group. Although sandstone aquifers were used as sources of water in 32 States, 45 percent of the total withdrawn from sandstone aquifers was in five States: Minnesota (321 Mgal/d), Wisconsin (319 Mgal/d), Kansas (193 Mgal/d), Illinois (187 Mgal/d), and Pennsylvania (179 Mgal/d).

The most heavily pumped of the five principal aquifers and aquifer systems within the sandstone and carbonate-rock lithologic group were the Edwards-Trinity aquifer system (661 Mgal/d) in the south-central United States and the Valley and Ridge aquifers (551 Mgal/d) of the eastern

United States, which together accounted for 71 percent of total withdrawals from this lithologic group. Withdrawals from sandstone and carbonate-rock aquifers for public-supply (713 Mgal/d), irrigation (469 Mgal/d), and self-supplied domestic (253 Mgal/d) uses accounted for about 84 percent of the total withdrawals from this lithologic group. Although water was withdrawn from sandstone and carbonate-rock aquifers in 25 States, 65 percent of the total withdrawn was in Texas (651 Mgal/d), Pennsylvania (238 Mgal/d), and Florida (223 Mgal/d).

Introduction

Water withdrawals from principal aquifers during 2015 were estimated for various categories of use in each county or county equivalent in the United States, including the District of Columbia, Puerto Rico and the U.S. Virgin Islands. Principal aquifers are defined as regionally extensive aquifers or aquifer systems that have the potential to be used as sources of water of suitable quality and quantity to meet various needs (U.S. Geological Survey [USGS], 2017a). Sixty-six principal aquifers have been identified and delineated in the 50 States, Puerto Rico, and the U.S. Virgin Islands, hereinafter referred to as “States” for brevity (fig. 1; table 1) (Miller, 2000a). Because the intensity of groundwater withdrawals can change from year to year in response to changing populations, land uses, climate conditions, and the availability of surface-water supplies, enumeration and documentation of withdrawals from principal aquifers in the United States are necessary to better understand how groundwater is used, to estimate water budgets and availability, and ultimately to help manage these resources.

In 2015, estimated groundwater withdrawals in the United States totaled 84,600 million gallons per day (Mgal/d) for various uses including irrigation (57,200 Mgal/d), public supply (15,200 Mgal/d), self-supplied domestic (3,200 Mgal/d), mining (2,860 Mgal/d), industrial (2,710 Mgal/d), aquaculture (1,600 Mgal/d), livestock (1,240 Mgal/d), and thermoelectric power (597 Mgal/d) (modified from Dieter and others, 2018a). The USGS has summarized water withdrawals on a 5-year basis for various categories of use in each State since 1950 and in each county and county equivalent in the United States since 1985. Many of these withdrawal values have been obtained from facilities, State agencies, or other organizations that monitor water withdrawals and use. Other withdrawal values have been estimated by using a variety of methods, often employing ancillary data and coefficients. Reported and estimated groundwater withdrawals often do not indicate the aquifer from which the water was withdrawn. To better understand the primary sources of groundwater used in the United States, Maupin and Barber (2005) estimated fresh groundwater withdrawals during 2000 for public supply, industry, and irrigation from principal aquifers in each State.

Purpose and Scope

This report summarizes estimated fresh and saline groundwater withdrawals during 2015 from principal aquifers in the States for various categories of use, which include public supply, self-supplied domestic, industrial, mining, thermoelectric power, irrigation, livestock, and aquaculture. The water withdrawal data summarized in this report are published by county-aquifer combinations in Lovelace and others (2020). Saline withdrawals from principal aquifers are estimated for public-supply, industrial, thermoelectric-power, and mining uses in each State. Saline water is defined as water containing dissolved solids of 1,000 milligrams per liter or more and may be treated to reduce salinity for some uses. Estimated withdrawals from 66 principal aquifers or aquifer systems are tabulated by major lithologic group, State, and category of use. Estimated withdrawals from “other” aquifers that are not part of a principal aquifer also are tabulated. Withdrawals from 10 selected principal aquifers that together accounted for more than 72 percent of the groundwater withdrawals in the United States in 2015 also are discussed. In addition, estimated fresh groundwater withdrawals from principal aquifers for public supply, industry, and irrigation during 2000 and 2015 are compared and discussed. This report complements the report, “Estimated Use of Water in the United States in 2015,” by Dieter and others (2018a).

Water-Use Terminology

Water-use terminology used in this report is described in the glossary at the back of the report and is available online at http://water.usgs.gov/watuse/wuglossary.html. Withdrawal for each category of use represents the total amount of groundwater removed for a particular use. Additional water may be used for the category from public-supply deliveries or from reclaimed wastewater. In many cases, some fraction of the total withdrawal will be returned to a water source after use and will be available for other subsequent uses.

Rates of water use presented in this report generally are expressed in terms of million gallons per day. Units of million gallons per day do not represent actual daily rates but are used to express total withdrawals over a single year as an average daily rate. Because water demands often fluctuate seasonally (Shaffer, 2009), the withdrawal estimates in this report represent the total annual withdrawals averaged over 365 days.

Water-use values presented in the report are rounded to three significant figures in the text and on figures and to two decimal places in the tables. Because all values are rounded independently, the sums of individual rounded numbers may not equal the totals. Percentages in the text and on figures are calculated from the nonrounded data, are presented to two significant figures, and may not sum to 100 percent due to independent rounding.

Sources of Data and Methods

Withdrawals from principal aquifers were estimated on a State-by-State basis. Withdrawals in many States were estimated by the authors of this report, but for some States, withdrawals were estimated by a local USGS water-use specialist, often the same person who had compiled the county-level withdrawals published by Dieter and others (2018a). A brief description of data sources and compilation or estimation methods for each State is provided in the appendix.

Withdrawals from principal aquifers were estimated by using data originating from many sources. These data include recorded and estimated withdrawal rates, estimated populations using groundwater, and geographic, geologic, and hydrogeologic maps and references. A primary source of groundwater withdrawal and population data was the USGS Aggregate Water-Use Data System (AWUDS) (Nawyn and others, 2017), which stores the 2015 estimated groundwater withdrawals for each category of use in each U.S. county and county equivalent that were published in Dieter and others (2018a). The 2015 groundwater withdrawal totals for each water-use category in each county were obtained from AWUDS and set as target values for principal-aquifer estimates to ensure that the data presented herein are consistent with the data presented in Dieter and others (2018b). Other sources of withdrawal data included local USGS and State water-use databases and many State and local agencies and organizations that maintain information about water wells or water users. Most of these data sources also were used to compile and estimate groundwater withdrawals in each county and county equivalent for Dieter and others (2018b).

Sources of geographic, geologic, and hydrogeologic data primarily included spatial datasets, websites, and publications. Descriptions of the principal aquifers and spatial data are available from the USGS National Aquifer Code Reference List (USGS, 2017b). The USGS National Ground Water Atlas (Miller, 2000a) was a primary reference for descriptions of principal and local aquifers. Chapters of the atlas and additional information are available at https://water.usgs.gov/ogw/aquifer/atlas.html. Additional spatial data for many of the principal aquifers were obtained from the USGS National Spatial Data Infrastructure Node website (USGS, 2018). Sources of geologic maps and descriptions of geologic units in each State included “Geologic Maps of the United States” (Horton, 2017) and Geolex, the National Geologic Map Database and Geologic Names Lexicon (USGS, 2019). Maps and reports describing local geology also were obtained from the USGS Publications Warehouse (USGS, 2020) as well as various State agencies and academic publications.

A major source of water-well information, including well location, use, and local or principal aquifers in which each well was completed, was the USGS National Water Information System (NWIS) (USGS, 2017c). A list of local aquifer codes used in NWIS also was used to help correlate local aquifers to principal aquifers (USGS, 2011). Other sources of water-well information included many State agencies that register, permit, or regulate water withdrawals and water-well construction. Water-well datasets often did not include a complete inventory of a State’s wells for various reasons, including the longevity of a State’s water-well registration program and data-collection biases towards areas or aquifers of greater stakeholder concern. For States with more than one source of well data, professional judgment often was used to determine which dataset was more complete and representative of the total population of wells in that State. In some cases, well datasets were combined to create a more complete set.

Methods used to estimate withdrawals from principal aquifers in each State generally depended on the availability of withdrawal and water-well data for the State. Water-withdrawal data for various categories of use were often available from a State agency or local USGS office; however, completeness of the datasets and inclusion of aquifer assignments varied from State to State, and aquifers often had to be assigned to withdrawals. Withdrawal data were considered “complete sets” when withdrawals for each category of use could be subtotaled by principal aquifer, county, and water-use category and those subtotals matched 2015 withdrawal totals by county and water-use category that were in AWUDS or published in Dieter and others (2018b).

Often, withdrawal datasets for a State were incomplete, lacking data for one or more categories of use and lacking aquifer information. In these cases, withdrawals by county and category of use generally were disaggregated and assigned to principal aquifers by using one of three methods: withdrawal weighted, well weighted, and area weighted.

For the withdrawal-weighted method, percentages of withdrawals by county, category of use, and principal aquifer were calculated from a partial set of withdrawal data, which was assumed to be a representative subset of all the withdrawals in a State. These percentages were then used to disaggregate withdrawal totals by county and water-use category from AWUDS and assign the resulting withdrawals to principal aquifers.

For the well-weighted method, percentages of water wells in each county completed in each principal aquifer (or other, nonprincipal aquifers) for each category of use were calculated and used to disaggregate and assign the withdrawal totals by county and water-use category from AWUDS to principal aquifers. Major assumptions of this method are that water-well data used to develop these percentages are representative of the total population of water wells in the State and that well counts are correlative to withdrawal rates. Consideration of additional data such as well yields, aquifer properties, and water quality could have been used to refine the percentages, but these added steps were beyond the scope of this effort. When water-well data were unavailable or insufficient for a water-use category in a county, percentages developed for another use category in the county generally were used.

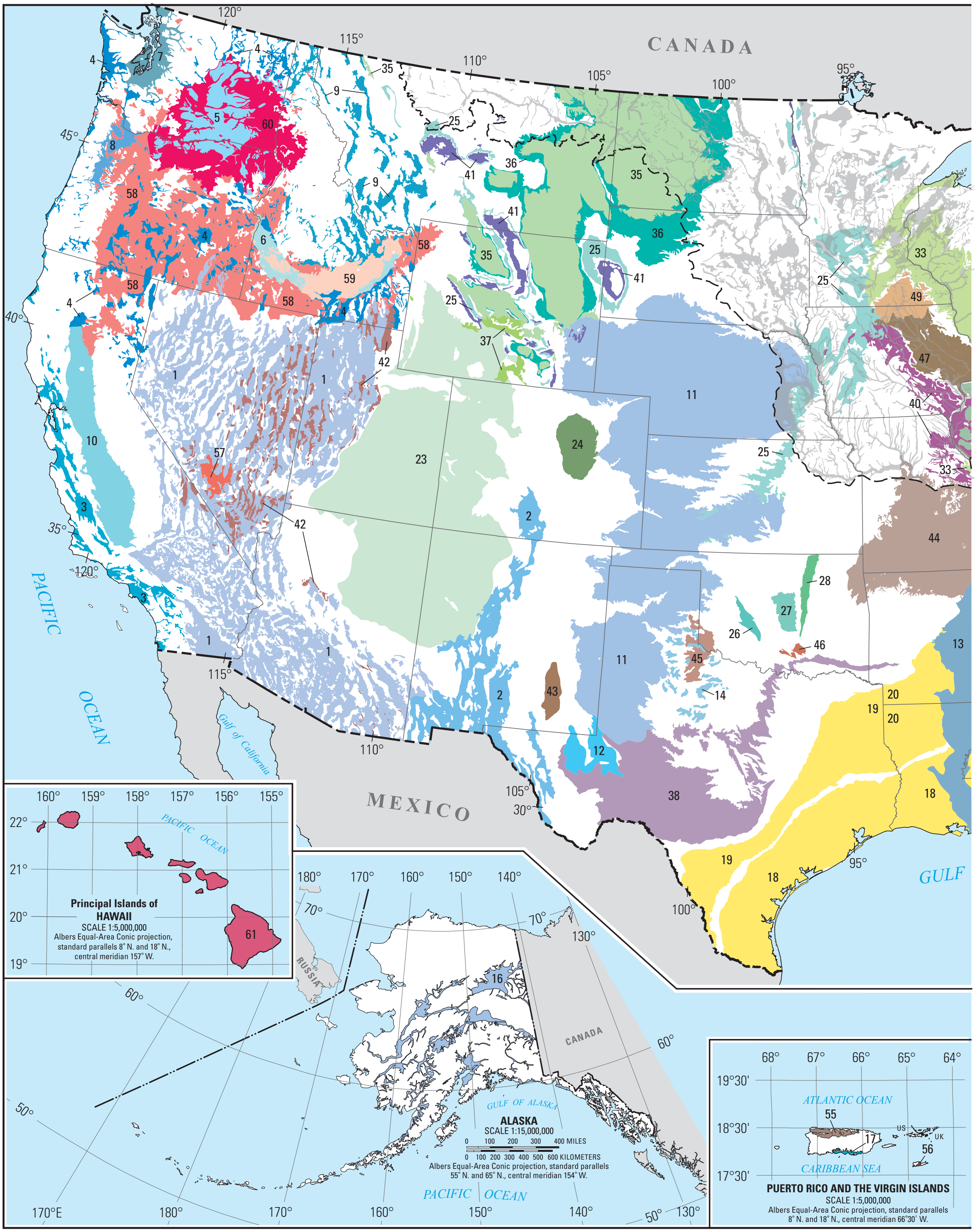


Figure 1. Freshwater extent of shallowest principal aquifers of the United States (modified from Miller, 2000a). Extents of two deeper aquifers, including the New York and New England crystalline-rock aquifers and the intermediate aquifer system, are overlain by shallow aquifers and are not shown. The extents of alluvial aquifers also are not shown because they are too small to distinguish at this map scale.

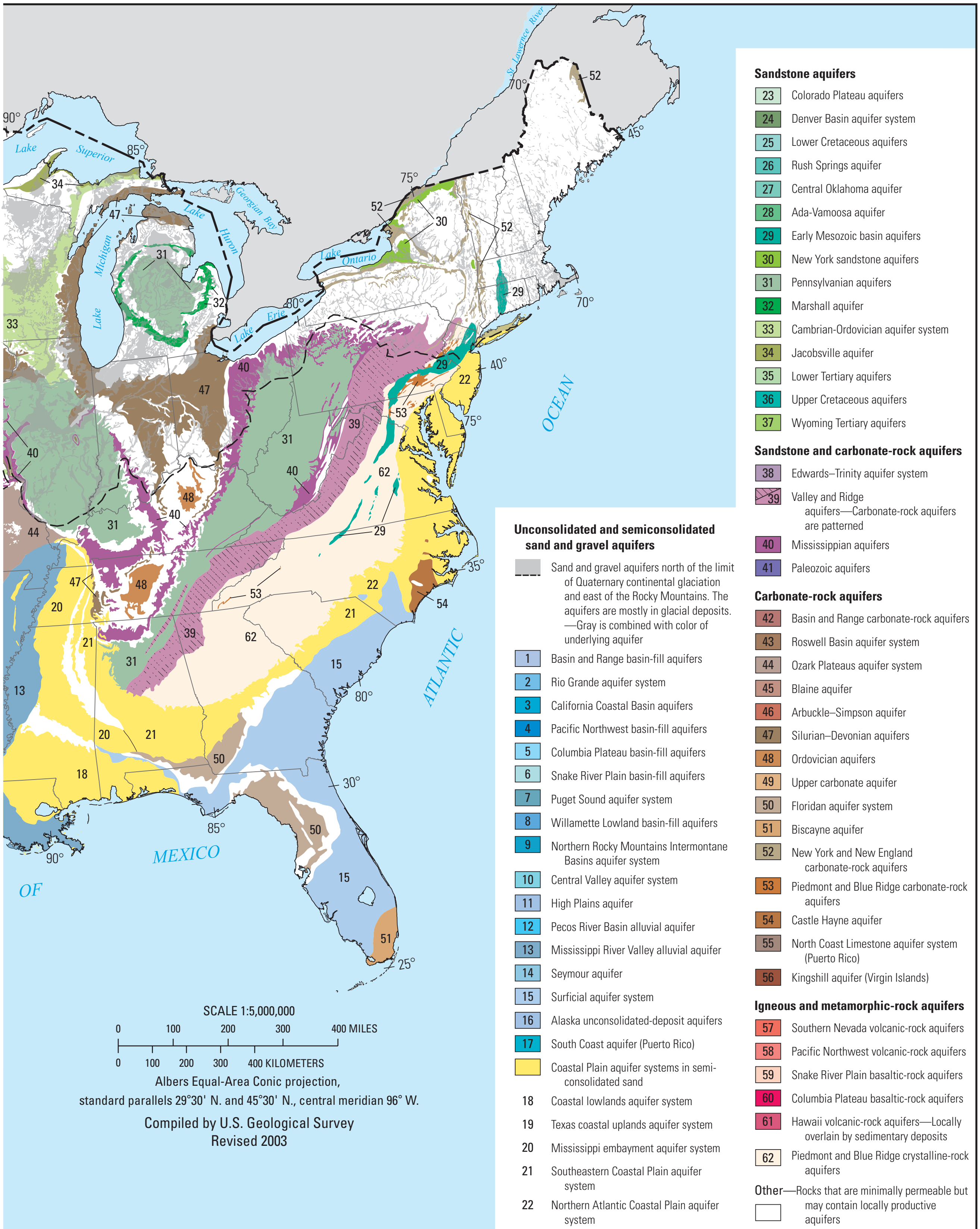

Lake Superior
Lake Michigan
Lake Huron
Georgian Bay
Lake Erie
Lake Ontario
St. Lawrence River
ATLANTIC
OCEAN
OF
MEXICO
90°
85°
80°
75°
70°
45°
40°
35°
30°
25°
Sandstone aquifers
23 Colorado Plateau aquifers
24 Denver Basin aquifer system
25 Lower Cretaceous aquifers
26 Rush Springs aquifer
27 Central Oklahoma aquifer
28 Ada-Vamoosa aquifer
29 Early Mesozoic basin aquifers
30 New York sandstone aquifers
31 Pennsylvanian aquifers
32 Marshall aquifer
33 Cambrian-Ordovician aquifer system
34 Jacobsville aquifer
35 Lower Tertiary aquifers
36 Upper Cretaceous aquifers
37 Wyoming Tertiary aquifers
Sandstone and carbonate-rock aquifers
38 Edwards–Trinity aquifer system
39 Valley and Ridge aquifers—Carbonate-rock aquifers are patterned
40 Mississippian aquifers
41 Paleozoic aquifers
Carbonate-rock aquifers
42 Basin and Range carbonate-rock aquifers
43 Roswell Basin aquifer system
44 Ozark Plateaus aquifer system
45 Blaine aquifer
46 Arbuckle–Simpson aquifer
47 Silurian–Devonian aquifers
48 Ordovician aquifers
49 Upper carbonate aquifer
50 Floridan aquifer system
51 Biscayne aquifer
52 New York and New England carbonate-rock aquifers
53 Piedmont and Blue Ridge carbonate-rock aquifers
54 Castle Hayne aquifer
55 North Coast Limestone aquifer system (Puerto Rico)
56 Kingshill aquifer (Virgin Islands)
Igneous and metamorphic-rock aquifers
57 Southern Nevada volcanic-rock aquifers
58 Pacific Northwest volcanic-rock aquifers
59 Snake River Plain basaltic-rock aquifers
60 Columbia Plateau basaltic-rock aquifers
61 Hawaii volcanic-rock aquifers—Locally overlain by sedimentary deposits
62 Piedmont and Blue Ridge crystalline-rock aquifers
Other—Rocks that are minimally permeable but may contain locally productive aquifers
Unconsolidated and semiconsolidated sand and gravel aquifers
Sand and gravel aquifers north of the limit of Quaternary continental glaciation and east of the Rocky Mountains. The aquifers are mostly in glacial deposits. —Gray is combined with color of underlying aquifer
1 Basin and Range basin-fill aquifers
2 Rio Grande aquifer system
3 California Coastal Basin aquifers
4 Pacific Northwest basin-fill aquifers
5 Columbia Plateau basin-fill aquifers
6 Snake River Plain basin-fill aquifers
7 Puget Sound aquifer system
8 Willamette Lowland basin-fill aquifers
9 Northern Rocky Mountains Intermontane Basins aquifer system
10 Central Valley aquifer system
11 High Plains aquifer
12 Pecos River Basin alluvial aquifer
13 Mississippi River Valley alluvial aquifer
14 Seymour aquifer
15 Surficial aquifer system
16 Alaska unconsolidated-deposit aquifers
17 South Coast aquifer (Puerto Rico)
Coastal Plain aquifer systems in semi-consolidated sand
18 Coastal lowlands aquifer system
19 Texas coastal uplands aquifer system
20 Mississippi embayment aquifer system
21 Southeastern Coastal Plain aquifer system
22 Northern Atlantic Coastal Plain aquifer system
SCALE 1:5,000,000
0 100 200 300 400 MILES
0 100 200 300 400 KILOMETERS
Albers Equal-Area Conic projection, standard parallels 29°30' N. and 45°30' N., central meridian 96° W.
Compiled by U.S. Geological Survey
Revised 2003

Table 1. Estimated groundwater withdrawals in the United States during 2015 by major lithologic group, principal aquifer, and water-use category.

[No., aquifer number as shown in figure 1; bold denotes withdrawal totals by major lithologic group and use category; *, aquifer not shown in figure 1]

No.	Aquifer name	Withdrawals, in million gallons per day			
		Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh
	Unconsolidated and semiconsolidated sand and gravel aquifers				
16	Alaska unconsolidated-deposit aquifers	36.87	0.00	9.71	6.63
*	Alluvial aquifers	624.23	3.04	65.28	161.09
1	Basin and Range basin-fill aquifers	1,284.43	19.43	58.59	37.74
3	California Coastal Basin aquifers	932.96	29.83	16.77	225.41
10	Central Valley aquifer system	523.80	0.09	49.06	123.47
18	Coastal lowlands aquifer system	739.15	5.08	99.41	321.28
5	Columbia Plateau basin-fill aquifers	136.04	0.00	6.95	11.18
Gray	Glacial sand and gravel aquifers	1,995.31	0.00	598.46	395.02
11	High Plains aquifer	253.82	3.82	40.06	65.09
20	Mississippi embayment aquifer system	498.25	0.00	32.38	126.95
13	Mississippi River Valley alluvial aquifer	30.69	0.00	7.34	36.25
22	Northern Atlantic Coastal Plain aquifer system	756.48	10.85	178.50	88.91
9	Northern Rocky Mountains Intermontane Basins aquifer system	90.21	0.00	27.41	3.78
4	Pacific Northwest basin-fill aquifers	137.46	0.00	36.41	15.02
12	Pecos River Basin alluvial aquifer	10.71	0.11	0.46	0.15
7	Puget Sound aquifer system	156.87	0.00	40.80	16.79
2	Rio Grande aquifer system	188.32	9.12	15.67	2.35
14	Seymour aquifer	4.41	0.73	0.55	0.14
6	Snake River Plain basin-fill aquifers	16.04	0.00	6.59	32.18
17	South Coast aquifer (Puerto Rico)	13.82	0.00	0.01	0.28
21	Southeastern Coastal Plain aquifer system	308.43	0.00	62.03	100.34
15	Surficial aquifer system	271.12	0.00	57.43	4.47
19	Texas coastal uplands aquifer system	175.16	0.63	17.62	6.82
8	Willamette Lowland basin-fill aquifers	84.97	0.00	22.17	15.84
	Unconsolidated and semiconsolidated sand and gravel aquifers, total	**9,269.55**	**82.73**	**1,449.66**	**1,797.18**
	Carbonate-rock aquifers				
46	Arbuckle-Simpson aquifer	3.52	0.00	0.20	0.01
42	Basin and Range carbonate-rock aquifers	61.78	0.00	1.08	3.84
51	Biscayne aquifer	591.57	0.00	3.02	3.07
45	Blaine aquifer	0.19	0.00	0.01	0.20
54	Castle Hayne aquifer	38.42	0.00	5.28	0.45
50	Floridan aquifer system	1,151.37	169.14	182.19	296.91
56	Kingshill aquifer (Virgin Islands)	0.09	0.00	0.15	0.08
52	New York and New England carbonate-rock aquifers	38.71	0.00	30.43	12.05
55	North Coast Limestone aquifer system (Puerto Rico)	29.47	0.00	0.25	2.29
48	Ordovician aquifers	2.40	0.00	5.80	0.49
44	Ozark Plateaus aquifer system	141.72	0.00	55.22	25.26
53	Piedmont and Blue Ridge carbonate-rock aquifers	36.98	0.00	20.15	4.09
43	Roswell Basin aquifer system	16.17	0.00	1.00	0.74

Table 1. Estimated groundwater withdrawals in the United States during 2015 by major lithologic group, principal aquifer, and water-use category.—Continued

[No., aquifer number as shown in figure 1; bold denotes withdrawal totals by major lithologic group and use category; *, aquifer not shown in figure 1]

Withdrawals, in million gallons per day										
Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Unconsolidated and semiconsolidated sand and gravel aquifers										
0.00	0.63	0.00	0.00	5.20	0.03	169.25	1.49	224.61	5.20	229.81
0.00	28.30	0.00	24.77	1.39	78.44	21.04	1,952.17	2,955.32	4.43	2,959.75
22.51	59.81	79.39	143.54	100.28	47.08	89.36	5,447.67	7,168.22	221.61	7,389.83
0.00	4.42	0.00	0.79	61.37	5.06	5.76	751.14	1,942.31	91.20	2,033.51
0.00	3.63	0.00	4.90	63.94	52.31	175.52	10,120.08	11,052.77	64.03	11,116.80
0.77	52.53	0.00	12.17	0.00	21.01	276.24	760.32	2,282.11	5.85	2,287.96
0.00	0.00	0.00	0.43	0.00	4.26	21.42	210.98	391.26	0.00	391.26
0.00	49.70	0.00	87.41	0.57	204.65	88.65	1,271.74	4,690.94	0.57	4,691.51
0.19	21.77	0.00	7.70	43.93	221.03	11.16	11,632.34	12,252.97	47.94	12,300.91
0.00	14.36	0.00	5.66	0.00	6.07	11.38	233.58	928.63	0.00	928.63
0.00	27.39	0.00	1.26	0.00	1.90	290.59	11,745.61	12,141.03	0.00	12,141.03
0.00	10.48	2.72	16.35	0.00	38.62	12.95	228.77	1,331.06	13.57	1,344.63
0.00	0.78	0.00	0.21	1.31	3.29	9.55	473.45	608.68	1.31	609.99
0.00	3.71	0.00	2.48	0.00	8.08	13.93	1,173.71	1,390.80	0.00	1,390.80
0.00	0.00	0.00	0.06	10.40	0.55	0.00	65.89	77.82	10.51	88.33
0.00	0.00	0.00	7.96	0.00	3.97	35.88	57.05	319.32	0.00	319.32
2.19	4.05	0.00	3.65	1.13	5.85	18.56	698.19	936.64	12.44	949.08
0.00	0.00	0.00	0.00	0.00	0.53	0.00	92.98	98.61	0.73	99.34
0.00	1.01	0.00	0.37	0.00	4.65	21.16	342.86	424.86	0.00	424.86
0.00	0.83	0.00	0.63	0.00	0.07	0.00	19.47	35.11	0.00	35.11
0.00	5.28	0.00	23.90	0.00	11.88	31.52	181.72	725.10	0.00	725.10
0.00	2.52	0.00	11.93	0.00	5.23	2.60	201.97	557.27	0.00	557.27
0.11	8.03	0.00	14.48	0.00	23.95	0.41	128.98	375.45	0.74	376.19
0.00	4.15	0.00	1.01	0.00	1.01	0.15	336.31	465.61	0.00	465.61
25.77	**303.38**	**82.11**	**371.66**	**289.52**	**749.52**	**1,307.08**	**48,128.47**	**63,376.50**	**480.13**	**63,856.63**
Carbonate-rock aquifers										
0.00	0.00	0.00	0.79	0.00	0.07	0.00	0.08	4.67	0.00	4.67
13.76	0.00	0.00	30.67	18.02	1.39	3.80	6.13	108.69	31.78	140.47
0.00	1.28	0.00	28.66	0.00	0.04	0.70	50.99	679.33	0.00	679.33
0.00	0.00	0.00	0.00	0.00	0.79	0.00	63.11	64.30	0.00	64.30
0.00	0.00	0.00	7.25	0.00	3.35	0.44	9.33	64.52	0.00	64.52
0.00	24.09	28.53	53.91	0.00	35.31	24.96	1,218.53	2,987.27	197.67	3,184.94
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.32
0.00	0.71	0.00	4.47	0.00	4.09	0.69	1.47	92.62	0.00	92.62
0.00	0.00	0.00	0.68	0.00	2.05	0.00	1.30	36.04	0.00	36.04
0.00	0.00	0.00	4.49	0.00	3.05	0.00	4.40	20.63	0.00	20.63
0.00	2.26	0.00	13.37	0.00	14.99	4.70	47.27	304.79	0.00	304.79
0.00	0.25	0.00	9.73	0.00	4.58	4.40	2.59	82.77	0.00	82.77
0.00	0.00	0.00	0.07	1.42	2.54	1.59	175.66	197.77	1.42	199.19

Table 1. Estimated groundwater withdrawals in the United States during 2015 by major lithologic group, principal aquifer, and water-use category.—Continued

[No., aquifer number as shown in figure 1; bold denotes withdrawal totals by major lithologic group and use category; *, aquifer not shown in figure 1]

No.	Aquifer name	Withdrawals, in million gallons per day: Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh
	Carbonate-rock aquifers—Continued				
47	Silurian-Devonian aquifers	151.79	0.00	90.87	80.55
49	Upper carbonate aquifer	6.41	0.00	1.54	0.57
	Carbonate-rock aquifers, total	**2,270.59**	**169.14**	**397.19**	**430.60**
	Igneous and metamorphic-rock aquifers				
60	Columbia Plateau basaltic-rock aquifers	129.46	0.00	36.37	20.01
61	Hawaii volcanic-rock aquifers	236.33	0.00	0.63	0.24
*	New York and New England crystalline-rock aquifers	37.34	0.00	140.25	12.06
58	Pacific Northwest volcanic-rock aquifers	54.50	0.00	13.68	3.00
62	Piedmont and Blue Ridge crystalline-rock aquifers	95.23	0.00	370.37	16.32
59	Snake River Plain basaltic-rock aquifers	79.11	0.00	27.87	1.97
57	Southern Nevada volcanic-rock aquifers	0.05	0.00	0.00	0.00
	Igneous and metamorphic-rock aquifers, total	**632.02**	**0.00**	**589.17**	**53.60**
	Sandstone aquifers				
28	Ada-Vamoosa aquifer	4.49	0.00	1.53	0.00
33	Cambrian-Ordovician aquifer system	560.82	0.00	61.51	109.05
27	Central Oklahoma aquifer	23.40	0.00	7.75	2.34
23	Colorado Plateaus aquifers	77.89	0.00	17.95	8.30
24	Denver Basin aquifer system	41.53	0.00	9.21	1.71
29	Early Mesozoic basin aquifers	92.82	0.00	70.79	17.02
34	Jacobsville aquifer	2.67	0.00	1.33	0.08
25	Lower Cretaceous aquifers	64.92	0.00	7.40	20.22
35	Lower Tertiary aquifers	8.47	0.00	2.92	0.81
32	Marshall aquifer	32.02	0.00	28.42	3.17
30	New York sandstone aquifers	2.37	0.00	5.91	1.44
31	Pennsylvanian aquifers	102.81	0.00	117.99	31.05
26	Rush Springs aquifer	5.72	0.00	1.39	0.37
36	Upper Cretaceous aquifers	6.34	0.00	1.89	0.86
37	Wyoming Tertiary aquifers	0.86	0.00	0.09	0.09
	Sandstone aquifers, total	**1,027.13**	**0.00**	**336.08**	**196.51**
	Sandstone and carbonate-rock aquifers				
38	Edwards-Trinity aquifer system	335.87	0.77	46.69	11.54
*	Intermediate aquifer system	24.78	0.00	16.67	0.33
40	Mississippian aquifers	99.67	0.00	60.32	14.56
41	Paleozoic aquifers	9.27	0.00	1.10	1.44
39	Valley and Ridge aquifers	242.40	0.00	128.24	55.23
	Sandstone and carbonate-rock aquifers, total	**711.99**	**0.77**	**253.02**	**83.10**
	Other aquifers				
	Other aquifers, total	**1,039.35**	**10.50**	**178.23**	**109.37**
	Grand total	**14,950.63**	**263.14**	**3,203.35**	**2,670.36**

Table 1. Estimated groundwater withdrawals in the United States during 2015 by major lithologic group, principal aquifer, and water-use category.—Continued

[No., aquifer number as shown in figure 1; bold denotes withdrawal totals by major lithologic group and use category; *, aquifer not shown in figure 1]

Withdrawals, in million gallons per day										
Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Carbonate-rock aquifers—Continued										
0.00	7.22	0.00	60.69	0.07	48.15	5.85	28.75	473.87	0.07	473.94
0.00	0.00	0.00	0.00	0.00	2.82	0.00	1.02	12.36	0.00	12.36
13.76	**35.81**	**28.53**	**214.78**	**19.51**	**123.22**	**47.13**	**1,610.63**	**5,129.95**	**230.94**	**5,360.89**
Igneous and metamorphic-rock aquifers										
0.00	1.19	0.00	2.29	0.00	11.18	2.02	876.20	1,078.72	0.00	1,078.72
0.00	1.48	15.90	0.85	0.00	0.49	8.39	71.73	320.14	15.90	336.04
0.00	0.21	0.00	4.76	0.00	6.42	1.17	19.63	221.84	0.00	221.84
0.00	0.00	0.00	3.70	0.37	1.09	1.59	394.81	472.37	0.37	472.74
0.00	0.09	0.00	28.21	0.00	32.44	1.39	47.63	591.68	0.00	591.68
0.00	0.00	0.00	0.12	0.00	27.14	13.42	2,779.18	2,928.81	0.00	2,928.81
0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.28	0.34	0.00	0.34
0.00	**2.97**	**15.90**	**39.93**	**0.37**	**78.77**	**27.98**	**4,189.46**	**5,613.90**	**16.27**	**5,630.17**
Sandstone aquifers										
0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.05	6.22	0.00	6.22
0.00	3.61	0.00	2.12	0.00	58.10	16.46	109.64	921.31	0.00	921.31
0.00	0.00	0.00	0.01	0.00	0.31	0.00	5.08	38.89	0.00	38.89
0.30	39.38	0.00	5.83	26.77	5.91	59.33	123.33	337.92	27.07	364.99
0.00	1.10	0.00	0.16	0.20	1.89	0.18	8.61	64.39	0.20	64.59
0.00	0.34	0.00	10.48	0.00	5.22	0.49	7.85	205.01	0.00	205.01
0.00	0.00	0.00	0.26	0.00	0.09	2.03	0.07	6.53	0.00	6.53
0.00	12.58	0.00	1.17	0.73	35.21	4.45	299.15	445.10	0.73	445.83
0.00	1.92	0.00	29.43	10.92	6.11	0.09	6.52	56.27	10.92	67.19
0.00	1.07	0.00	0.35	0.18	4.66	0.01	13.53	83.23	0.18	83.41
0.00	0.00	0.00	0.07	0.00	1.05	0.64	0.13	11.61	0.00	11.61
3.05	2.10	0.00	36.08	1.50	15.42	4.87	36.48	346.80	4.55	351.35
0.00	0.00	0.00	0.41	0.00	1.32	0.00	81.73	90.94	0.00	90.94
0.00	0.00	0.00	2.41	1.47	4.33	0.01	3.78	19.62	1.47	21.09
0.00	0.00	0.00	0.02	0.00	0.09	0.45	2.16	3.76	0.00	3.76
3.35	**62.10**	**0.00**	**88.80**	**41.77**	**139.86**	**89.01**	**698.11**	**2,637.60**	**45.12**	**2,682.72**
Sandstone and carbonate-rock aquifers										
0.01	0.00	0.00	10.37	0.02	11.81	0.83	243.19	660.30	0.80	661.10
0.00	0.00	0.00	3.80	0.00	0.49	0.31	177.06	223.44	0.00	223.44
0.00	4.68	0.00	11.92	0.02	19.11	11.91	25.09	247.26	0.02	247.28
0.00	0.00	0.00	0.14	0.03	0.83	1.14	10.10	24.02	0.03	24.05
0.00	4.48	0.00	29.82	0.00	26.68	51.08	13.31	551.24	0.00	551.24
0.01	**9.16**	**0.00**	**56.05**	**0.07**	**58.92**	**65.27**	**468.75**	**1,706.26**	**0.85**	**1,707.11**
Other aquifers										
0.00	**10.95**	**45.81**	**234.69**	**1,504.06**	**88.54**	**64.13**	**2,109.76**	**3,835.02**	**1,560.37**	**5,395.39**
42.89	**424.37**	**172.35**	**1,005.91**	**1,855.30**	**1,238.83**	**1,600.60**	**57,205.18**	**82,299.23**	**2,333.68**	**84,632.91**

For example, when a county had estimated withdrawals for livestock, but no wells designated for that use in that county's water-well records, records for irrigation wells often were used to disaggregate and assign county livestock withdrawals to principal aquifers, under the assumption that irrigation wells are probably screened in the same source aquifers as livestock wells.

The area-weighted method was used when representative withdrawals and well-construction data were unavailable. Percentages of county area underlain by each principal aquifer (or other, nonprincipal aquifers) were calculated and used to disaggregate and assign to principal aquifers the withdrawal totals by county and water-use category from AWUDS. This method was confounded when aquifers overlaid one another. Where this occurred, previous publications and local knowledge of water use and wells were consulted to determine which aquifers were the most likely water sources for specific uses.

Geographic information systems (GIS) and spatial datasets of groundwater withdrawal data, water-well construction data, and aquifer extents generally were used to varying degrees for these methods. Withdrawal and water-well data that lacked aquifer information but included locations, usually latitudes and longitudes or other geographic coordinates, could be plotted with aquifer extents to determine the most likely source aquifer. In many cases, water-well depths and spatial data including the depths to tops and bottoms of aquifers were used to determine which aquifers wells were completed in. County extents and aquifer extents also were used to calculate the percentages used for the area-weighted method.

Aquifer Terminology

An *aquifer* is a geologic formation, a group of formations, or a part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs (Lohman, 1972). A *principal aquifer* is defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS, 2017a). Principal aquifers in the United States have been classified by rock type into five lithologic groups: unconsolidated and semiconsolidated sand and gravel, sandstone, sandstone and carbonate rock, carbonate rock, and igneous and metamorphic rock (table 1). Detailed descriptions of these lithologic groups, as well as "other rocks" that are not part of a principal aquifer, are in Miller (2000a) and online at https://water.usgs.gov/ogw/aquiferbasics/index.html (USGS, 2016).

Unconsolidated sand and gravel aquifers can be further subdivided into four categories: basin-fill aquifers, which also are called valley-fill aquifers; blanket sand and gravel aquifers; glacial-deposit aquifers; and stream-valley aquifers (Miller, 2000a). Basin-fill or valley-fill aquifers were formed in depressions created by faulting or erosion or both. Examples of basin-fill aquifers include the Basin and Range basin-fill aquifers of the southwestern United States and the Central Valley aquifer system of California. Widespread, blanket-like deposits of sand and gravel form aquifers in lowland areas of Alaska, atop lava plateaus in Washington, along the Atlantic and eastern gulf coasts, along part of the lower reaches of the Mississippi River, and in the High Plains. These aquifers mostly consist of alluvial deposits. An example is the High Plains aquifer, which extends across a large area of the central United States. Glacial-deposit aquifers form numerous local, and some regional, highly productive aquifers in the north-central and northeastern United States. These aquifers are present north of the southern extent of Quaternary continental glaciation (fig. 1), consist of outwash, terrace, or ice-contact deposits, and mostly occupy bedrock valleys or areas of interlobate ice-margin deposition (USGS, 2016). Stream-valley aquifers are present in and near major rivers and consist of sediments deposited by the rivers and typically are of limited spatial extent (Sargent and others, 2008).

Semiconsolidated sand aquifers consist of semiconsolidated sand interbedded with silt, clay, and minor carbonate rocks. These aquifers underlie the Coastal Plains of the eastern and southern United States (fig. 1) and are of fluvial, deltaic, and shallow marine origin (Miller, 2000a).

Sandstone aquifers consist of consolidated and cemented sand grains and have retained sufficient porosity, fractures, and permeability to transmit water. Sandstone aquifers are present across large areas of the eastern, midwestern, and central United States, and examples include the Cambrian-Ordovician aquifer system and Colorado Plateaus aquifers (Miller, 2000a).

Sandstone and carbonate-rock aquifers consist of carbonate rocks interbedded with almost equal amounts of water-bearing sandstone. The Edwards-Trinity aquifer system of the south-central United States and the Valley and Ridge aquifers of the eastern United States are examples of this type of aquifer (Miller, 2000a).

Carbonate-rock aquifers typically consist of limestone, but dolomite and marble also are sources of water in some areas. Examples of these aquifers include the Biscayne aquifer and the Floridan aquifer system of the southeastern United States and the Silurian-Devonian aquifers and the Ozark Plateaus aquifer system of the Midwest (Miller, 2000a).

Igneous and metamorphic-rock aquifers can be divided into two categories: crystalline-rock aquifers and volcanic-rock aquifers. Although crystalline rocks underlie much of the eastern and north-central parts of the United States, these rocks only yield water in areas where they are fractured, usually in relatively small amounts (Miller, 2000a). However, because these aquifers extend over large areas, large volumes of groundwater are withdrawn from them (Maupin and Barber, 2005). Examples include the Piedmont and Blue Ridge crystalline-rock aquifers and New England crystalline-rock aquifers. Volcanic-rock aquifers are present in the northwestern United States and in Hawaii. Most of these aquifers are composed of basaltic rocks. The Columbia Plateau and Snake River Plain basaltic-rock aquifers of the northwest and the volcanic-rock aquifers of Hawaii are examples of this category of aquifers (Miller, 2000a).

Estimated Groundwater Withdrawals from Principal Aquifers

An estimated 79,200 Mgal/d were withdrawn from 66 principal aquifers in the United States during 2015 (table 1). These withdrawals accounted for about 94 percent of total groundwater withdrawals and about 25 percent of the total surface water and groundwater withdrawn during 2015 (Dieter and others, 2018a). In addition, about 5,400 Mgal/d were withdrawn from other, nonprincipal aquifers in the United States, and these withdrawals accounted for the remaining 6.4 percent of the total groundwater withdrawn during 2015.

Withdrawals by Major Lithologic Group

Withdrawals from principal aquifers are summarized by five major lithologic groups: unconsolidated and semiconsolidated sand and gravel aquifers, sandstone aquifers, sandstone and carbonate-rock aquifers, carbonate-rock aquifers, and igneous and metamorphic-rock aquifers (fig. 2). Withdrawals from other, nonprincipal aquifers, are not included in these totals.

Unconsolidated and Semiconsolidated Sand and Gravel Aquifers (63,900 Mgal/d)

Withdrawals from 24 unconsolidated and semiconsolidated sand and gravel aquifers were 63,900 Mgal/d, which included 480 Mgal/d of saline water, and accounted for about 81 percent of the total withdrawals from principal aquifers in 2015 (table 1; fig. 2). Withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers for irrigation were 48,100 Mgal/d and accounted for 75 percent of the total withdrawals from this lithologic group. Withdrawals for public supply were 9,350 Mgal/d and accounted for an additional 15 percent of the withdrawals from this lithologic group. The most heavily pumped principal aquifers in this lithologic group include the High Plains aquifer (12,300 Mgal/d), the Mississippi River Valley alluvial aquifer (12,100 Mgal/d), the Central Valley aquifer system (11,100 Mgal/d), and the Basin and Range basin-fill aquifers (7,390 Mgal/d), which together accounted for 67 percent of the water withdrawn from unconsolidated and semiconsolidated sand and gravel aquifers. Unconsolidated sand and gravel aquifers are widely distributed across the United States and were used as sources of water in all States except Hawaii and the U.S. Virgin Islands. Fifty-six percent of the total groundwater withdrawn from unconsolidated and semiconsolidated sand and gravel aquifers was in four States: California (15,600 Mgal/d),

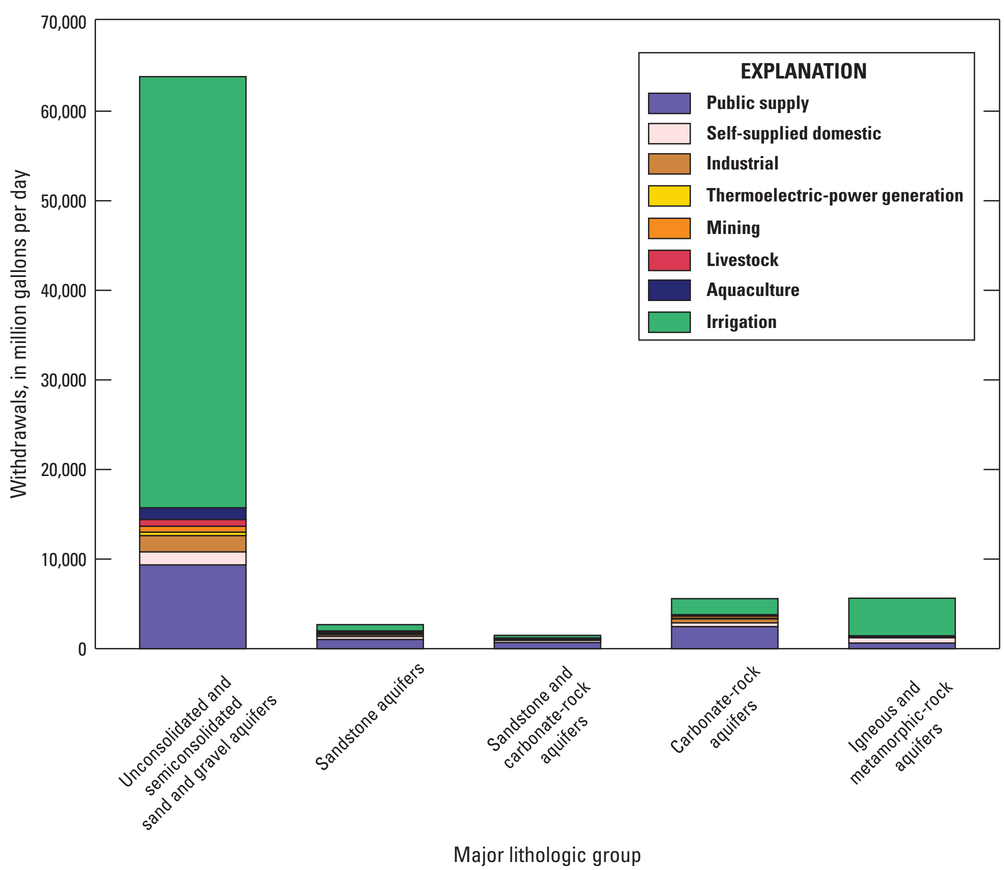


Figure 2. Groundwater withdrawals by category of use from principal aquifers in five major lithologic groups in the United States, 2015.

Arkansas (9,560 Mgal/d), Nebraska (5,570 Mgal/d), and Texas (4,830 Mgal/d) (table 2, shown at back of report). Eighty-seven percent of the water withdrawn from unconsolidated and semiconsolidated sand and gravel aquifers in these four States was used for irrigation. Saline water was withdrawn for mining (290 Mgal/d), public-supply (82.7 Mgal/d), thermoelectric-power (82.1 Mgal/d), and industrial (25.8 Mgal/d) uses in the United States in 2015 (table 1).

Igneous and Metamorphic-Rock Aquifers (5,630 Mgal/d)

Withdrawals from seven igneous and metamorphic-rock aquifers were 5,630 Mgal/d, which included 16.3 Mgal/d of saline water, and accounted for 7.1 percent of the total withdrawals from principal aquifers in 2015 (table 1; fig. 2). Withdrawals from igneous and metamorphic-rock aquifers for irrigation were 4,190 Mgal/d and accounted for more than 74 percent of the total withdrawals from this lithologic group. Other major uses of withdrawals from igneous and metamorphic-rock aquifers included public supply (632 Mgal/d) and self-supplied domestic (589 Mgal/d), which together accounted for another 22 percent of the total withdrawn. The most heavily pumped principal aquifers in this lithologic group include the Snake River Plain (2,930 Mgal/d) and the Columbia Plateau basaltic-rock aquifers (1,080 Mgal/d), which are in the northwestern United States (fig. 1) and together accounted for 71 percent of the water withdrawn from igneous and metamorphic-rock aquifers. Although water was withdrawn from igneous and metamorphic rocks in 28 States, 78 percent of the withdrawals were in 3 States: Idaho (3,230 Mgal/d), Washington (614 Mgal/d), and Oregon (528 Mgal/d) (table 2). Saline water was withdrawn for thermoelectric-power (15.9 Mgal/d) and mining (0.37 Mgal/d) uses in the United States in 2015 (table 1).

Carbonate-Rock Aquifers (5,360 Mgal/d)

Withdrawals from 15 carbonate-rock aquifers were 5,360 Mgal/d, which included 231 Mgal/d of saline water, and accounted for 6.8 percent of the total withdrawals from principal aquifers in 2015 (table 1; fig. 2). Withdrawals from carbonate-rock aquifers for public supply (2,440 Mgal/d) and irrigation (1,610 Mgal/d) together accounted for almost 76 percent of the total withdrawals from this lithologic group. The most heavily pumped principal aquifers in this lithologic group were the Floridan aquifer system (3,180 Mgal/d) and the Biscayne aquifer (679 Mgal/d), which are in the southeastern United States (fig. 1) and together accounted for almost 72 percent of the withdrawals from carbonate-rock aquifers. Although water was withdrawn from carbonate-rock aquifers in 35 States (table 2), 71 percent of the total withdrawn was in Florida (3,020 Mgal/d) and Georgia (785 Mgal/d). Saline water was withdrawn for public-supply (169 Mgal/d), thermoelectric-power (28.5 Mgal/d), mining (19.5 Mgal/d), and industrial (13.8 Mgal/d) uses in the United States in 2015 (table 1).

Sandstone Aquifers (2,680 Mgal/d)

Withdrawals from 15 sandstone aquifers were 2,680 Mgal/d, which included 45.1 Mgal/d of saline water, and accounted for 3.4 percent of the total withdrawals from principal aquifers in 2015 (table 1; fig. 2). Withdrawals from sandstone aquifers for public supply were 1,030 Mgal/d and accounted for 38 percent of the total withdrawals from this lithologic group. Other major uses of withdrawals from sandstone aquifers included irrigation (698 Mgal/d), self-supplied domestic (336 Mgal/d), and industrial (200 Mgal/d), which together accounted for another 46 percent of the total. The most heavily pumped principal aquifer in this lithologic group was the Cambrian-Ordovician aquifer system (921 Mgal/d), which is in the north-central United States (fig. 1) and accounted for 34 percent of the water withdrawn from this lithologic group. Although sandstone aquifers were used as sources of water in 32 States (table 2), 45 percent of the total withdrawn from sandstone aquifers was in 5 States: Minnesota (321 Mgal/d), Wisconsin (319 Mgal/d), Kansas (193 Mgal/d), Illinois (187 Mgal/d), and Pennsylvania (179 Mgal/d). Of the total withdrawn from sandstone aquifers in these States, 48 percent was used for public supply, and 25 percent was used for irrigation. Saline water was withdrawn for mining (41.8 Mgal/d) and industrial (3.35 Mgal/d) uses in the United States in 2015 (table 1).

Sandstone and Carbonate-Rock Aquifers (1,710 Mgal/d)

Withdrawals from five sandstone and carbonate-rock aquifers were 1,710 Mgal/d, which included 0.85 Mgal/d of saline water, and accounted for 2.2 percent of the total withdrawals from principal aquifers in 2015 (table 1; fig. 2). Withdrawals from sandstone and carbonate-rock aquifers for public-supply (713 Mgal/d), irrigation (469 Mgal/d), and self-supplied domestic (253 Mgal/d) uses accounted for about 84 percent of the total withdrawals from this lithologic group. The most heavily pumped principal aquifers in this lithologic group were the Edwards-Trinity aquifer system (661 Mgal/d) in the south-central United States and the Valley and Ridge aquifers (551 Mgal/d) of the eastern United States, which together accounted for 71 percent of total withdrawals from sandstone and carbonate-rock aquifers. Although water was withdrawn from sandstone and carbonate-rock aquifers in 25 States, 65 percent of the total withdrawn was in Texas (651 Mgal/d), Pennsylvania (238 Mgal/d), and Florida (223 Mgal/d) (table 2). Saline water was withdrawn for public-supply (0.77 Mgal/d), mining (0.07 Mgal/d), and industrial (0.01 Mgal/d) uses in the United States in 2015 (table 1).

Withdrawals by Category of Use

Withdrawals from major lithologic groups and principal aquifers are summarized by eight categories of use, including public supply, self-supplied domestic, industrial, thermoelectric power, mining, livestock, aquaculture, and irrigation (fig. 3). Withdrawals from other aquifers are included in withdrawal totals by category of use unless otherwise indicated.

Public Supply (15,200 Mgal/d)

Public-supply water use includes water that is delivered by public or private water systems to residential and commercial customers. Public-supply water also includes water used for purposes such as fire protection, flushing of distribution lines, sewage treatment, and other public needs, as well as water lost through leaks in the distribution system. Public-supply systems are generally defined as providing water to at least 25 people or having at least 15 connections.

In 2015, groundwater withdrawals in the United States for public supply were 15,200 Mgal/d and accounted for 18 percent of total groundwater withdrawals (table 1). Saline groundwater withdrawals were 263 Mgal/d and accounted for 1.7 percent of the groundwater withdrawn for public supply. Unconsolidated and semiconsolidated sand and gravel aquifers provided 61 percent (9,350 Mgal/d) of the total groundwater withdrawn for public supply (fig. 4). Carbonate-rock aquifers provided another 16 percent (2,440 Mgal/d) of the total. Other public-supply withdrawals were from sandstone aquifers (1,030 Mgal/d), sandstone and carbonate-rock aquifers (713 Mgal/d), igneous and metamorphic-rock aquifers (632 Mgal/d), and other aquifers (1,050 Mgal/d).

Although all 66 principal aquifers provided water for public supply (table 1), the 11 aquifers discussed below provided 65 percent of the total (fig. 5), primarily because they supplied water to populations across very large spatial extents or to very densely populated areas. Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for public supply included the

- Glacial sand and gravel aquifers (2,000 Mgal/d), which supplied water to cities and towns in the upper Midwest, Great Lakes, and New England States;
- Basin and Range basin-fill aquifers (1,300 Mgal/d), which supplied water to much of the southwestern United States;
- California Coastal Basin aquifers (963 Mgal/d) and Central Valley aquifer system (524 Mgal/d), which supplied water to large cities in California;

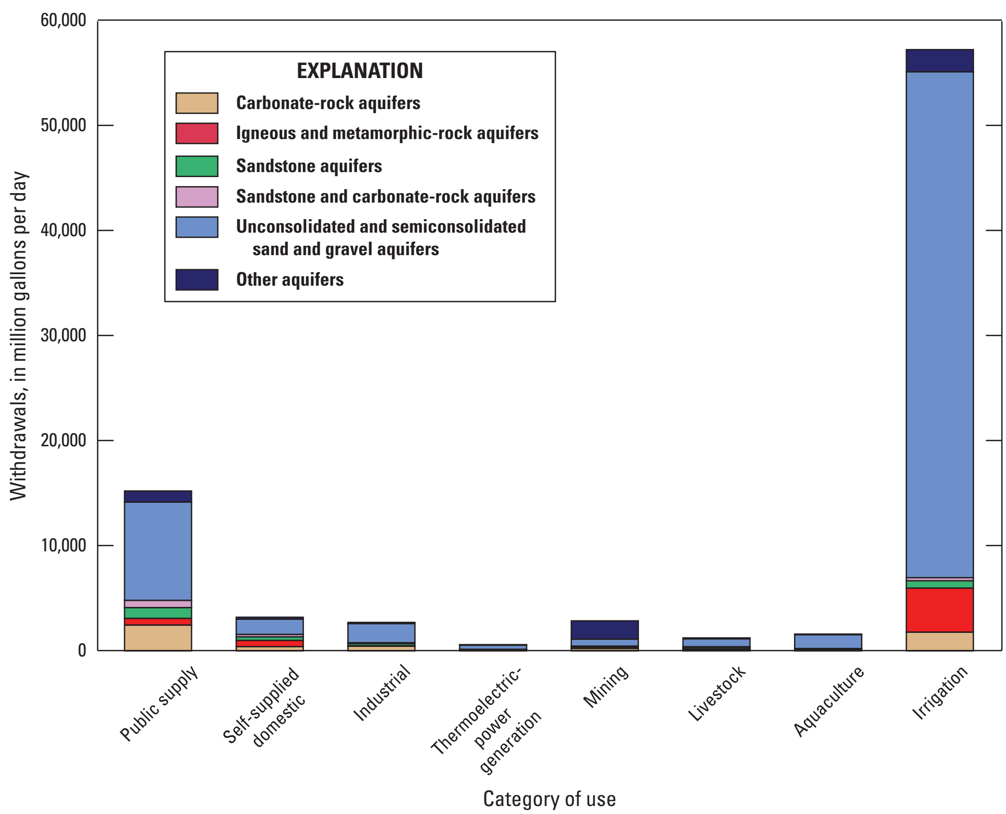


Figure 3. Total groundwater withdrawals from principal aquifers in five major lithologic groups and other nonprincipal aquifers for various categories of use in the United States, 2015.

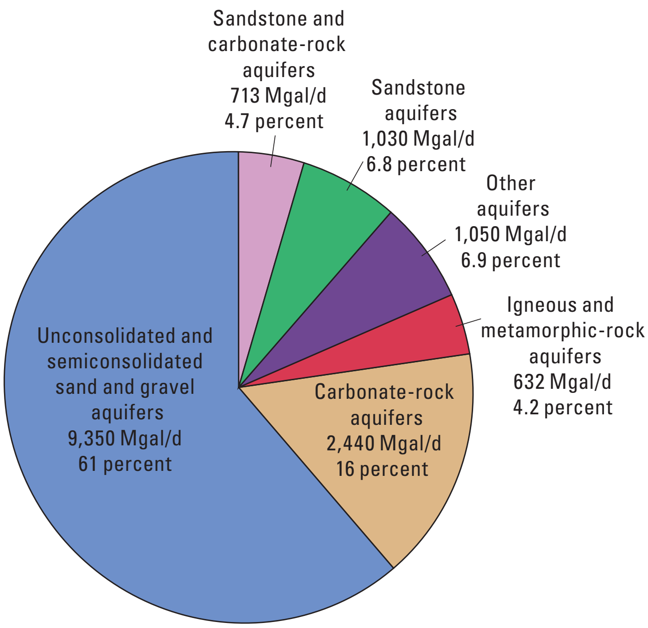


Figure 4. Groundwater withdrawals for public supply by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

- Northern Atlantic Coastal Plain aquifer system (767 Mgal/d), which supplied water to population centers in the east-central United States;
- Coastal lowlands aquifer system (744 Mgal/d), which supplied water to cities and towns near the gulf coast in Texas, Louisiana, Mississippi, and Alabama;
- Alluvial aquifers (627 Mgal/d), which are spread across much of the United States; and
- Mississippi embayment aquifer system (498 Mgal/d) in the south-central United States (table 1).

Within the carbonate-rock lithologic group, major sources of groundwater withdrawn for public supply included the Floridan aquifer system (1,320 Mgal/d) and Biscayne aquifer (592 Mgal/d), which supplied water to population centers in coastal areas of Alabama, Florida, Georgia, and South Carolina. Within the sandstone lithologic group, the Cambrian-Ordovician aquifer system (561 Mgal/d) supplied water to cities and towns in several midwestern States.

From 2000 to 2015, fresh groundwater withdrawals for public supply decreased 6.5 percent, from about 16,000 Mgal/d to about 15,000 Mgal/d (Maupin and Barber, 2005; Dieter and others, 2018). The largest decreases were in California Coastal Basin aquifers (−644 Mg/d), the Central Valley aquifer system (−315 Mgal/d), and the Coastal lowlands aquifer system (−272 Mgal/d). The largest increases of fresh groundwater withdrawals for public supply from 2000 to 2015 were from other aquifers (+682 Mgal/d), Valley and Ridge aquifers (+194 Mgal/d), and Basin and Range basin-fill aquifers (+187 Mgal/d).

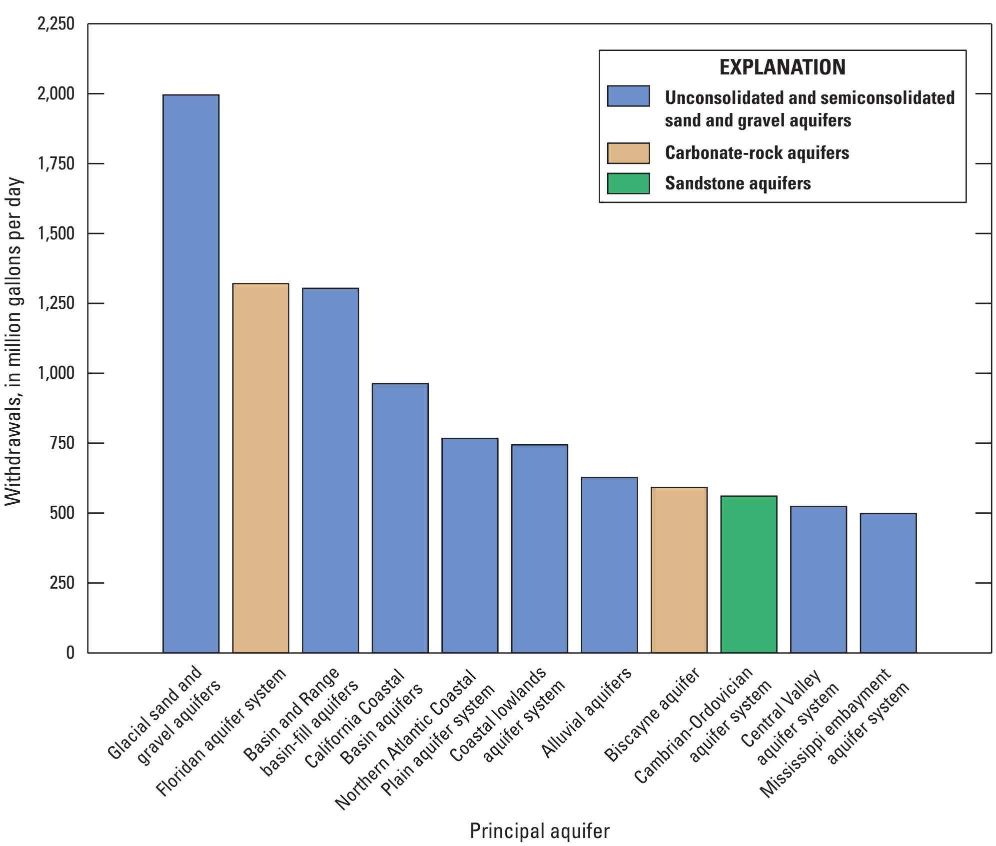


Figure 5. Withdrawals for public-supply use from 11 principal aquifers that provided the most groundwater for public-supply use in the United States during 2015.

Self-Supplied Domestic (3,200 Mgal/d)

Self-supplied domestic use includes water from private sources, such as wells, that are used for various needs at individual residences. The wells typically are owned by the homeowner and supply a single residence, often located in a rural area where public-supply water is unavailable. Common indoor uses include drinking, food preparation, washing clothes and dishes, bathing, and flushing toilets. Common outdoor uses are watering lawns and gardens or maintaining pools, ponds, or other features in an outdoor environment. Approximately 12 percent of all water used for domestic purposes in the United States in 2015 was self-supplied, and the other 88 percent was provided by a public supplier. Groundwater was the source of more than 98 percent of self-supplied domestic water used (Dieter and others, 2018a).

In 2015, groundwater withdrawals in the United States for self-supplied domestic use were 3,200 Mgal/d and accounted for 3.8 percent of the groundwater withdrawn for all uses (table 1). Unconsolidated and semiconsolidated sand and gravel aquifers provided 45 percent (1,450 Mgal/d) of the total groundwater withdrawn for self-supplied domestic use (fig. 6). Igneous and metamorphic-rock aquifers provided another 18 percent (589 Mgal/d) of the total. Other self-supplied domestic withdrawals were from carbonate-rock aquifers (397 Mgal/d), sandstone aquifers (336 Mgal/d), sandstone and carbonate-rock aquifers (253 Mgal/d), and other aquifers (178 Mgal/d).

Although all but one of the 66 principal aquifers provided water for self-supplied domestic use in 2015 (table 1), the nine aquifers discussed below provided 60 percent of the total (fig. 7). Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for self-supplied domestic use included Glacial sand and gravel aquifers (598 Mgal/d) in the upper Midwest, Great Lakes, and New England States; the Northern Atlantic Coastal Plain aquifer system (178 Mgal/d) in the east-central United States, and the Coastal lowlands aquifer system (99.4 Mgal/d) along the gulf coast (table 1). Within the igneous and metamorphic-rock lithologic group, major sources of groundwater withdrawn for self-supplied domestic use included the Piedmont and Blue Ridge crystalline-rock aquifers (370 Mgal/d) and the New York and New England crystalline-rock aquifers (140 Mgal/d), which supplied water to populations in the northeastern and east-central United States. Within the carbonate-rock lithologic group, major sources were the Floridan aquifer system (182 Mgal/d) in the southeastern United States and Silurian-Devonian aquifers (90.9 Mgal/d) in the midwestern United States. Within the sandstone and carbonate-rock lithologic group, the Valley and Ridge aquifers (128 Mgal/d) were a major source of water to self-supplied residences in the eastern United States, and within the sandstone lithologic group, the Pennsylvanian aquifers (118 Mgal/d) were major sources of water to populations in many eastern and midwestern States.

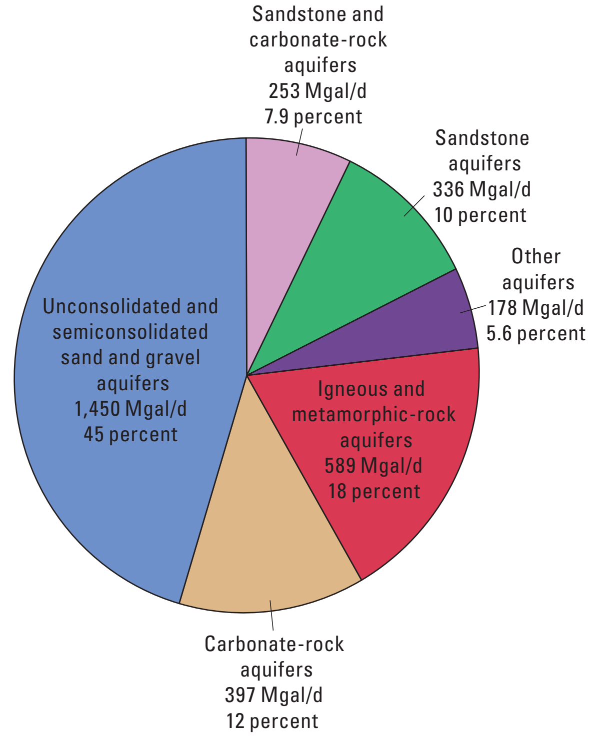


Figure 6. Groundwater withdrawals for self-supplied domestic use by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

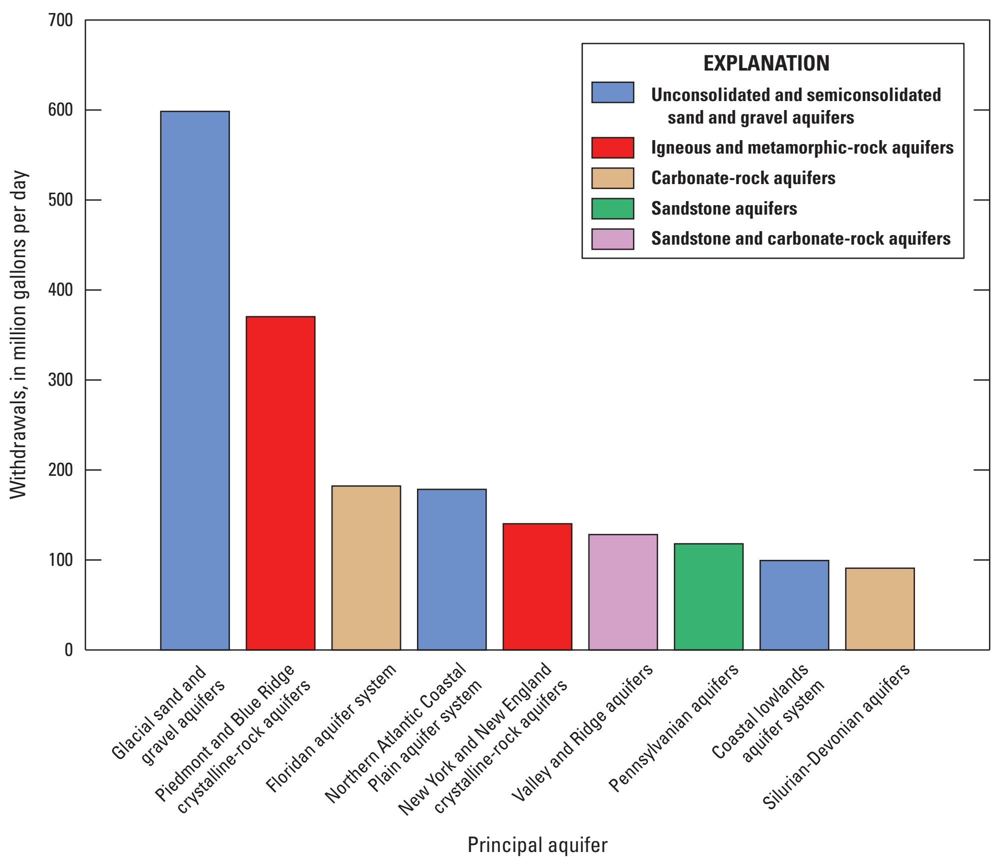


Figure 7. Withdrawals for self-supplied domestic use from nine principal aquifers that provided the most groundwater for self-supplied domestic use in the United States during 2015.

Irrigation (57,200 Mgal/d)

Irrigation water use includes self-supplied water applied by an irrigation system on farms, at horticultural facilities, in recreational areas such as parks and golf courses, and in other places where water is needed to sustain plant growth. Irrigation water often is applied during growing seasons, but also may be applied during field preparation, planting, and harvesting or for weed control, frost protection, chemical application, dust suppression, and leaching of salts from the root zone. All irrigation withdrawals are assumed to be self-supplied.

In 2015, groundwater withdrawals in the United States for irrigation were 57,200 Mgal/d and accounted for 68 percent of groundwater withdrawn for all uses (table 1). Unconsolidated and semiconsolidated sand and gravel aquifers provided 84 percent (48,100 Mgal/d) of the groundwater withdrawn for irrigation (fig. 8). Igneous and metamorphic-rock aquifers provided another 7.3 percent (4,190 Mgal/d) of the total. Other irrigation withdrawals were from carbonate-rock aquifers (1,610 Mgal/d), sandstone aquifers (698 Mgal/d), sandstone and carbonate-rock aquifers (469 Mgal/d), and other aquifers (2,110 Mgal/d).

Although all but 1 of the 66 principal aquifers provided water for irrigation in 2015 (table 1), the 9 aquifers discussed below each provided more than 1,000 Mgal/d and together accounted for 83 percent of the total (fig. 9). Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for irrigation included the Mississippi River Valley alluvial aquifer (11,700 Mgal/d) in the south-central United States, the High Plains aquifer (11,600 Mgal/d) in the central United States, the Central Valley aquifer system (10,100 Mgal/d) in California, the Basin and Range basin-fill aquifers (5,450 Mgal/d) in the southwestern United States, alluvial aquifers across the United States (1,950 Mgal/d), Glacial sand and gravel aquifers in the north-central and northeastern United States (1,270 Mgal/d), and the Pacific Northwest basin-fill aquifers (1,170 Mgal/d). Within the igneous and metamorphic-rock lithologic group, a major source of groundwater withdrawn for irrigation was the Snake River Plain basaltic-rock aquifers (2,780 Mgal/d), located mainly in

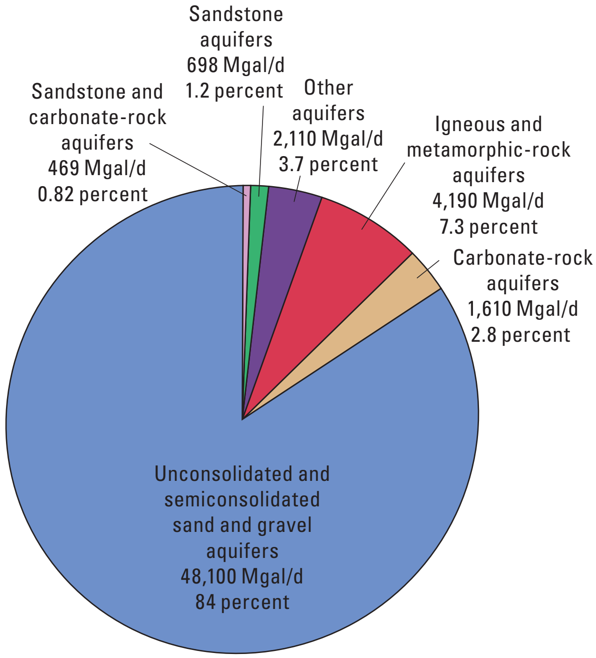


Figure 8. Groundwater withdrawals for irrigation by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

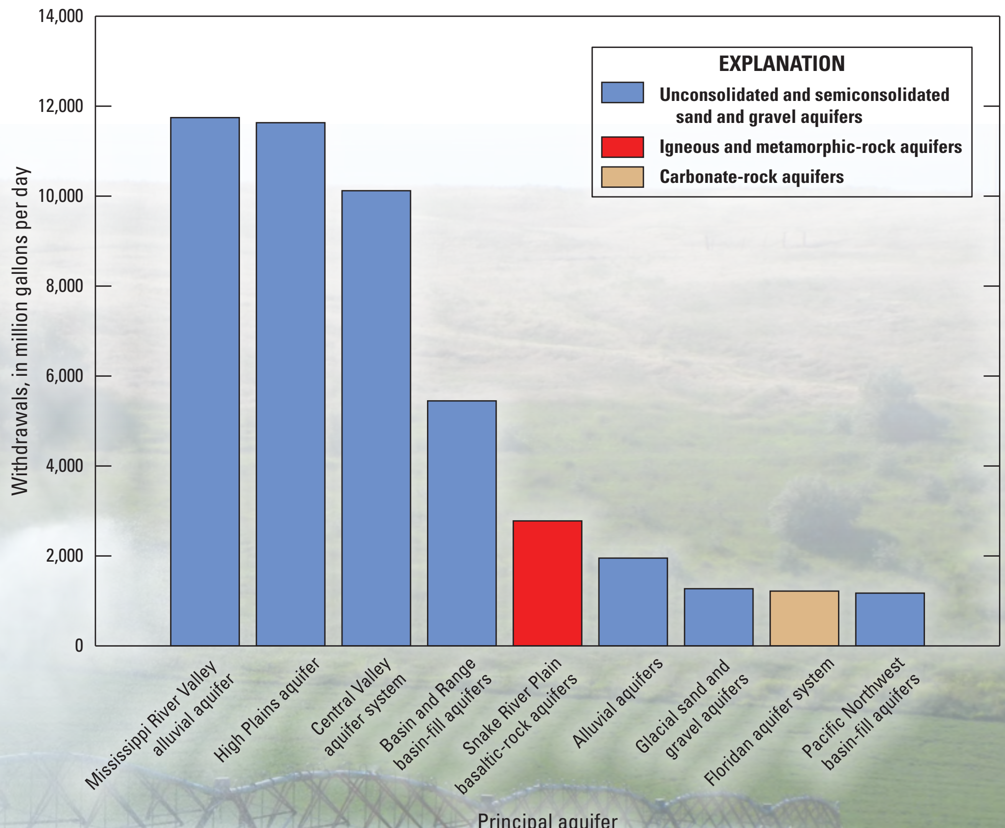


Figure 9. Withdrawals for irrigation from nine principal aquifers that provided the most groundwater for irrigation in the United States during 2015.

Traveling sprinkler watering a field in Idaho. Photograph by John K. Lovelace, U.S. Geological Survey.

Idaho (fig. 1). The Floridan aquifer system (1,220 Mgal/d), within the carbonate-rock lithologic group, was a major source of water for irrigation in the southeastern United States.

From 2000 to 2015, groundwater withdrawals for irrigation increased 1.2 percent, from about 56,600 Mgal/d to about 57,200 Mgal/d (Maupin and Barber, 2005; Dieter and others, 2018). The largest increases were from the Mississippi River Valley alluvial aquifer (+2,600 Mgal/d), other aquifers (+1,450 Mgal/d), Basin and Range basin-fill aquifers (+1,250 Mgal/d), and the Central Valley aquifer system (+1,210 Mgal/d). The largest decreases in irrigation withdrawals from 2000 to 2015 were in the High Plains aquifer (−5,360 Mgal/d), California Coastal Basin aquifers (−1,010 Mgal/d), and Floridan aquifer system (−707 Mgal/d).

Livestock (1,240 Mgal/d)

Livestock water use includes groundwater and surface water associated with livestock watering, feedlots, dairy operations, and other on-farm needs. The water may be used for drinking, cooling, sanitation, waste disposal, and other needs related to the animals. All livestock withdrawals are assumed to be self-supplied.

In 2015, fresh groundwater withdrawals in the United States for livestock were 1,240 Mgal/d and accounted for 1.5 percent of groundwater withdrawn for all uses (table 1). Unconsolidated and semiconsolidated sand and gravel aquifers provided 61 percent (750 Mgal/d) of the groundwater withdrawn for livestock (fig. 10). Other livestock withdrawals were from sandstone aquifers (140 Mgal/d), carbonate-rock aquifers (123 Mgal/d), igneous and metamorphic-rock aquifers (78.8 Mgal/d), sandstone and carbonate-rock aquifer (58.9 Mgal/d), and other aquifers (88.5 Mgal/d).

Although all but 1 of the 66 principal aquifers provided water for livestock (table 1), the 2 aquifers discussed below provided more than twice as much as any other principal aquifer and together accounted for 34 percent of the total (fig. 11). Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for livestock included the High Plains aquifer (221 Mgal/d) in the central United States and the Glacial sand and gravel aquifers (205 Mgal/d) in the northeastern and north-central United States (fig. 11).

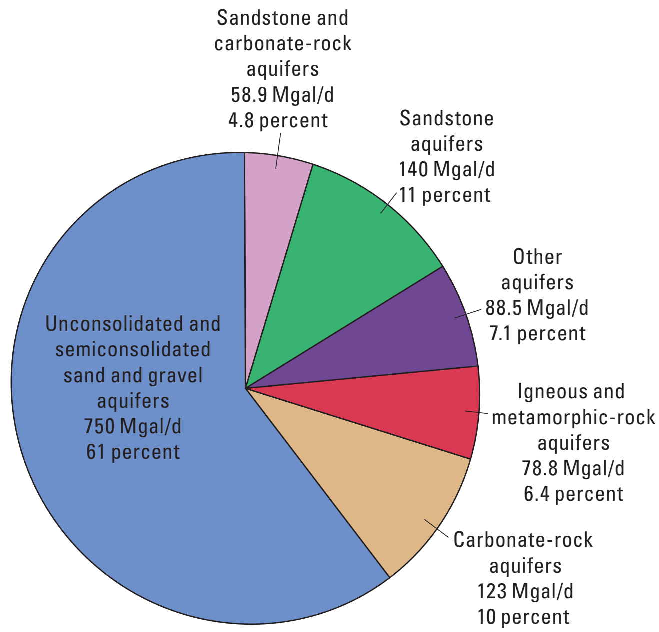


Figure 10. Groundwater withdrawals for livestock by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

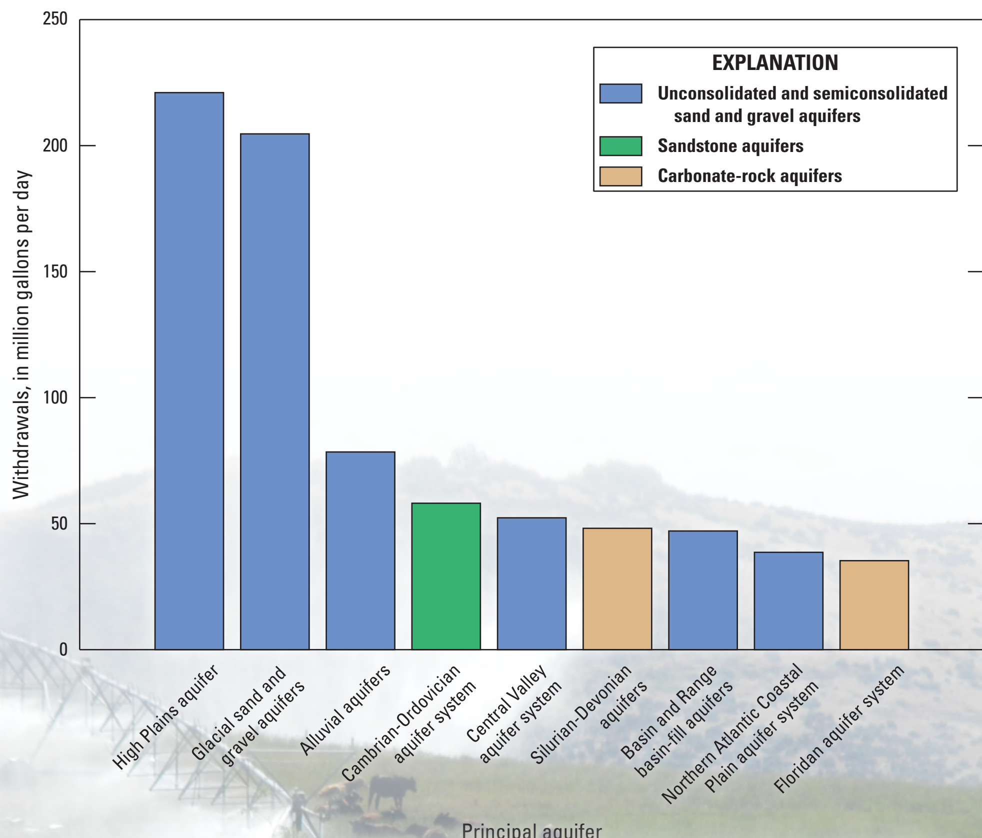


Figure 11. Withdrawals for livestock from nine principal aquifers that provided the most groundwater for livestock use in the United States during 2015.

Traveling sprinkler watering a field with cows in Idaho. Photograph by John K. Lovelace, U.S. Geological Survey.

Aquaculture (1,600 Mgal/d)

Aquaculture water use includes groundwater and surface water associated with raising organisms that live in water, such as finfish and shellfish, for food, restoration, conservation, or sport. Aquaculture production occurs under controlled feeding, sanitation, and harvesting procedures primarily in ponds, flow-through raceways, and, to a lesser extent, cages, net pens, and tanks. All aquaculture withdrawals are assumed to be self-supplied.

In 2015, fresh groundwater withdrawals for aquaculture in the United States were 1,600 Mgal/d and accounted for 1.9 percent of groundwater withdrawn for all uses (table 1). Unconsolidated and semiconsolidated sand and gravel aquifers provided 82 percent (1,310 Mgal/d) of the total groundwater withdrawn for aquaculture (fig. 12). Other aquaculture withdrawals were from sandstone aquifers (89.0 Mgal/d), sandstone and carbonate-rock aquifers (65.3 Mgal/d), carbonate-rock aquifers (47.1 Mgal/d), igneous and metamorphic-rock aquifers (28.0 Mgal/d), and other aquifers (64.1 Mgal/d).

Although most principal aquifers provided water for aquaculture (table 1), the four aquifers discussed below provided 57 percent of the total. Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for aquaculture included the Mississippi River Valley alluvial aquifer (291 Mgal/d) and the Coastal lowlands aquifer system (276 Mgal/d) in the south-central United States, the Central Valley aquifer system (176 Mgal/d) in California, and the Alaska unconsolidated-deposit aquifers (169 Mgal/d) (fig. 13).

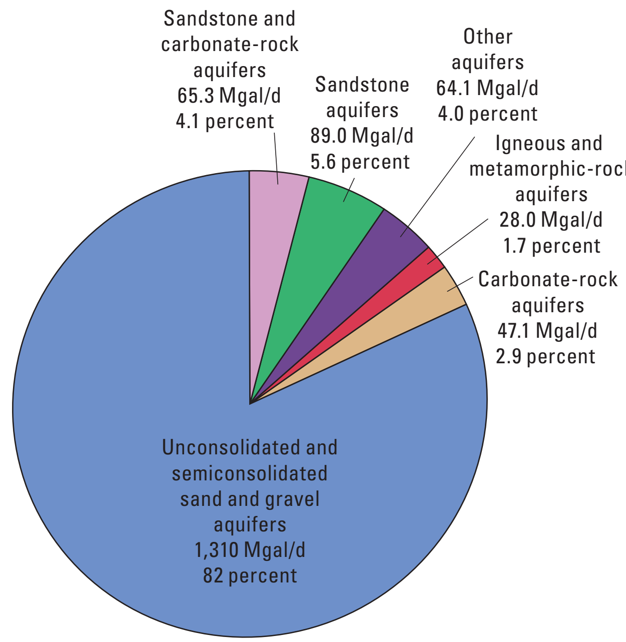


Figure 12. Groundwater withdrawals for aquaculture by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

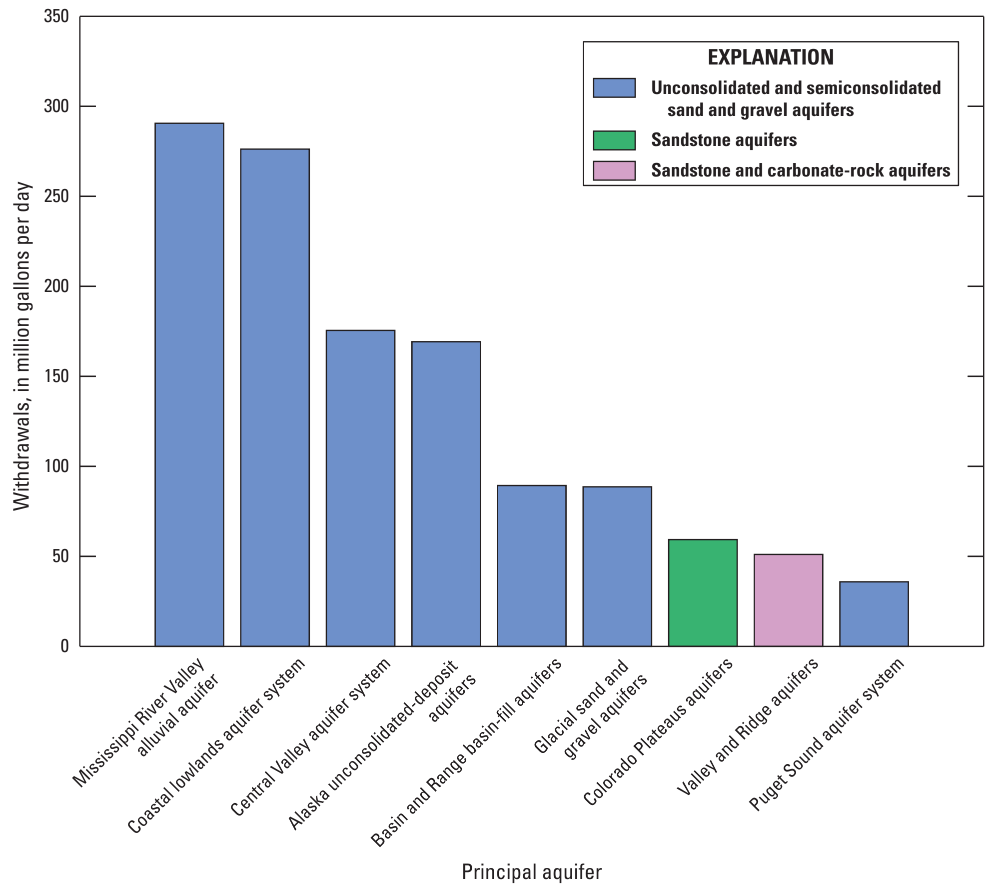


Figure 13. Withdrawals for aquaculture from nine principal aquifers that provided the most groundwater for aquaculture in the United States during 2015.

Industrial (2,710 Mgal/d)

Industrial water use includes groundwater and surface water associated with fabricating, processing, washing, diluting, cooling, and other processes used in the development of products, as well as water used for consumption, maintenance, and other needs at manufacturing facilities. Industries that typically use large amounts of water include food, paper, chemical, and primary metal manufacturers and petroleum refineries. Water used at industrial facilities may be delivered by a public supplier or self-supplied, but only self-supplied industrial withdrawals are included in this report.

In 2015, groundwater withdrawals for industrial use in the United States were 2,710 Mgal/d and accounted for 3.2 percent of the groundwater withdrawal for all uses (table 1). Saline groundwater withdrawals were 42.9 Mgal/d and accounted for 1.6 percent of the groundwater withdrawn for industrial use. Unconsolidated and semiconsolidated sand and gravel aquifers provided 67 percent (1,820 Mgal/d) of the groundwater withdrawn for industrial use (fig. 14). Other industrial withdrawals were from carbonate-rock aquifers (444 Mgal/d), sandstone aquifers (200 Mgal/d), sandstone and carbonate-rock aquifers (83.1 Mgal/d), igneous and metamorphic-rock aquifers (53.6 Mgal/d), and other aquifers (109 Mgal/d).

Although all but 2 of the 66 principal aquifers provided water for industry (table 1), the 4 aquifers discussed below accounted for 46 percent of the total (fig. 15). Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for industry included the Glacial sand and gravel aquifers (395 Mgal/d) in the northeastern and north-central United States, the Coastal lowlands aquifer system (322 Mgal/d) along the gulf coast in the south-central United States, and the California Coastal Basin aquifers (225 Mgal/d) (fig. 15). Within the carbonate-rock lithologic group, the Floridan aquifer system (297 Mgal/d) was a major source of groundwater for industry.

From 2000 to 2015, fresh groundwater withdrawals for industrial use decreased 25 percent, from about 3,570 Mgal/d to about 2,670 Mgal/d (Maupin and Barber, 2005; Dieter and others, 2018). The largest decreases occurred in Glacial sand and gravel aquifers (−188 Mgal/d), Cambrian-Ordovician aquifer system (−141 Mgal/d), and the Coastal lowlands aquifer system (−103 Mgal/d). The largest increases in fresh groundwater withdrawals for industry from 2000 to 2015 were from the California Coastal Basin aquifers (+119 Mgal/d), the Central Valley aquifer system (+64.6 Mgal/d), and other aquifers (+41.6 Mgal/d).

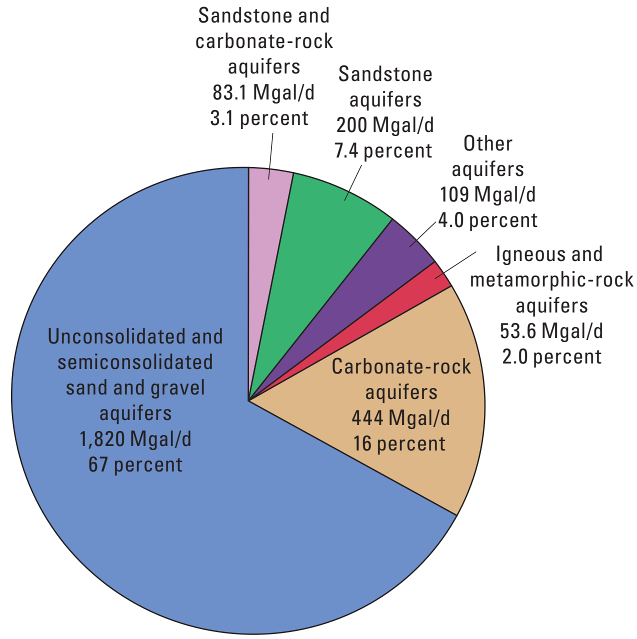


Figure 14. Groundwater withdrawals for industry by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

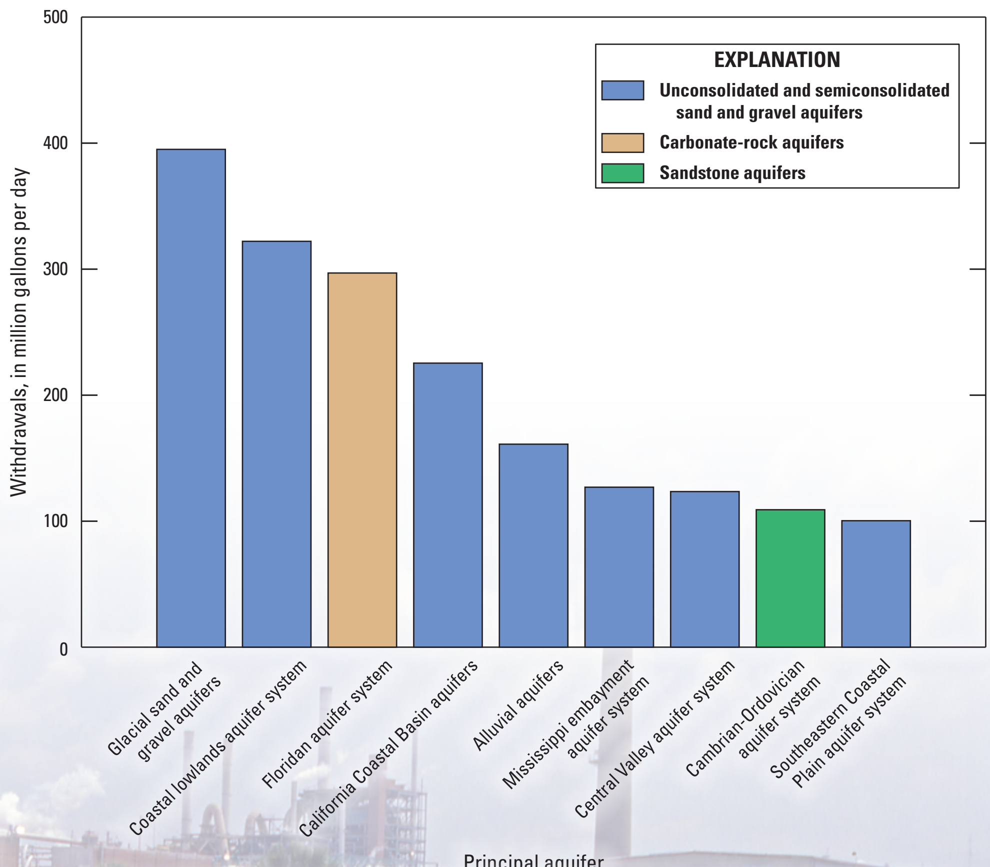


Figure 15. Withdrawals for industry from nine principal aquifers that provided the most groundwater for industry in the United States during 2015.

Paper mill in St. Marys, Georgia, with turbine pump for water well visible in foreground. Photograph by Alan M. Cressler, U.S. Geological Survey.

Mining (2,860 Mgal/d)

The mining water-use category includes groundwater and surface water that is withdrawn and used for the extraction of ores, stone, sand, gravel, coal, petroleum, and natural gas. Water can be used during the extraction, but also for quarrying, milling (crushing, screening, washing, and flotation of mined materials), and other activities directly associated with mining. For petroleum and natural gas mining, water extracted as a byproduct of the mining often is reinjected for secondary oil or gas recovery. Extracted water that is reinjected for secondary recovery is being used beneficially and is considered a mining withdrawal; extracted water reinjected for disposal is not considered a mining withdrawal. Water produced through dewatering activities also is not considered a mining withdrawal unless the water is used beneficially, such as for dampening roads for dust control (Hutson and others, 2004).

In 2015, groundwater withdrawals in the United States for mining use were 2,860 Mgal/d and accounted for 3.4 percent of groundwater withdrawals for all uses (table 1). Saline withdrawals were 1,860 Mgal/d and accounted for about 65 percent of the total withdrawn for mining. Unconsolidated and semiconsolidated sand and gravel aquifers provided 23 percent (661 Mgal/d) of the groundwater withdrawn for mining (fig. 16). Other mining withdrawals were from carbonate-rock aquifers (234 Mgal/d), sandstone aquifers (131 Mgal/d), sandstone and carbonate-rock aquifers (56.1 Mgal/d), and igneous and metamorphic-rock aquifers (40.3 Mgal/d). Other aquifers provided 61 percent (1,740 Mgal/d) of the water used for mining. About 87 percent (1,500 Mgal/d) of the water withdrawn from other aquifers was saline water, much of which probably originated as a byproduct of oil and gas extraction.

Although all but 6 of the 66 principal aquifers provided water for mining (table 1), the 7 aquifers discussed below provided 22 percent of the total. Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for mining included the Basin and Range basin-fill aquifers (244 Mgal/d) in the southwestern United States; the Glacial sand and gravel aquifers (88.0 Mgal/d), the Central Valley aquifer system (68.8 Mgal/d), and California Coastal Basin aquifers (62.2 Mgal/d) in California; and the High Plains aquifer (51.6 Mgal/d) in the central United States (fig. 17). Within the carbonate-rock lithologic group, the Silurian-Devonian aquifers (60.8 Mgal/d) in the upper midwestern United States and the Floridan aquifer system (53.9 Mgal/d) in the southeastern United States were major sources of groundwater for mining.

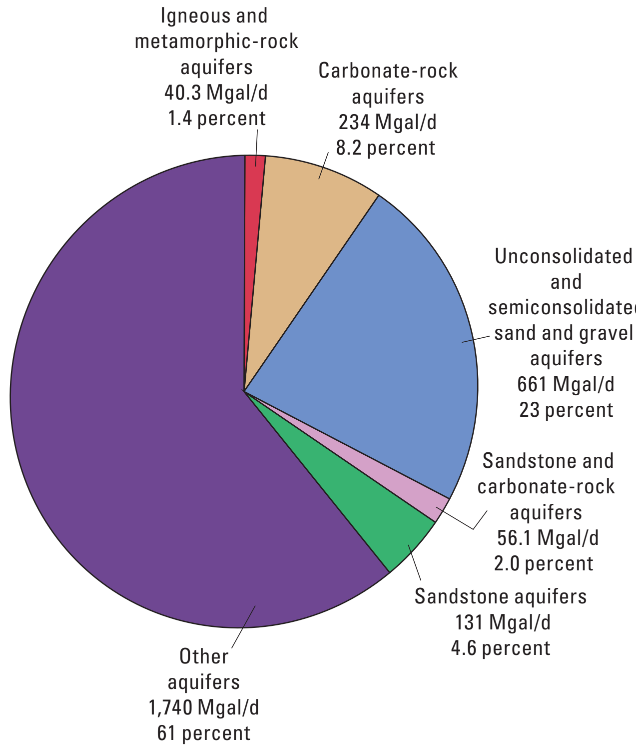


Figure 16. Groundwater withdrawals for mining by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

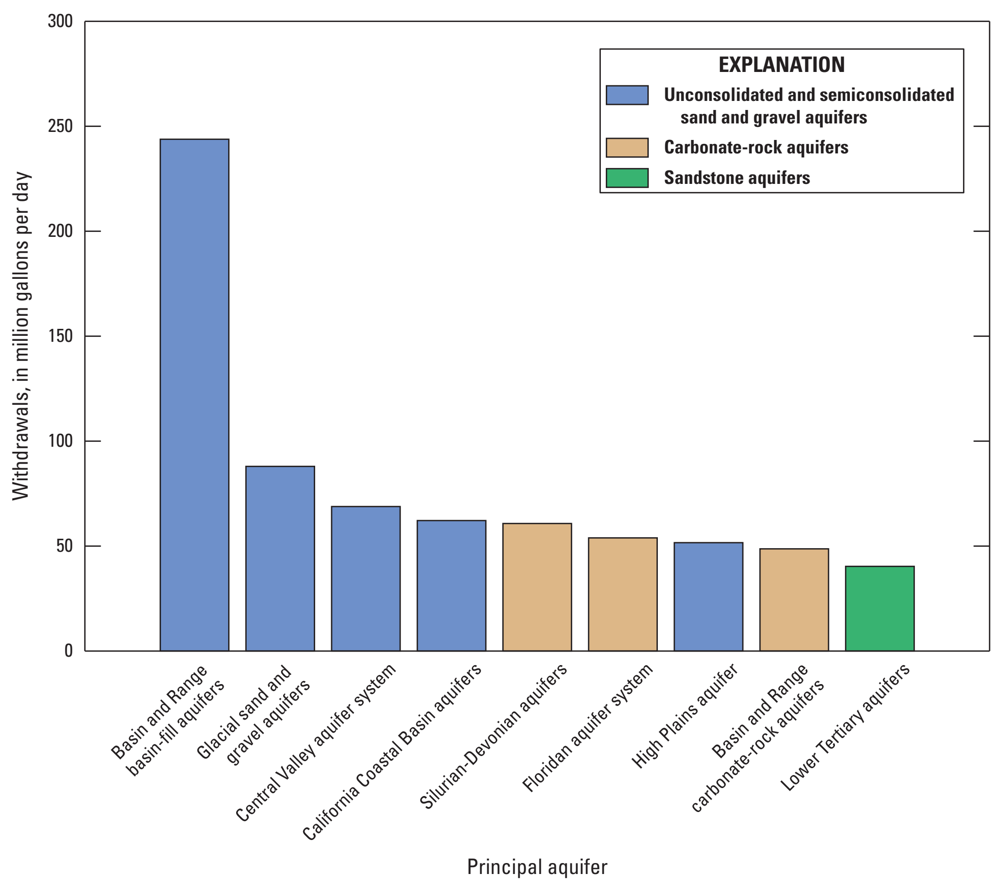


Figure 17. Withdrawals for mining from nine principal aquifers that provided the most groundwater for mining in the United States during 2015.

Thermoelectric Power (597 Mgal/d)

Water used for thermoelectric-power generation is primarily used to condense, or cool, the steam used to drive thermoelectric generators. Cooling systems may be once-through, which use relatively large volumes of water, or recirculating, which use relatively smaller volumes of water. Thermoelectric-power water use also includes water used for consumption, maintenance, and other needs at the plants. Water used at thermoelectric powerplants may be delivered by a public supplier or may be self-supplied, but only self-supplied withdrawals for thermoelectric power are included in this report.

In 2015, groundwater withdrawals in the United States for thermoelectric power were 597 Mgal/d and accounted for 0.71 percent of groundwater withdrawn for all uses (table 1). Saline withdrawals were 172 Mgal/d and accounted for 29 percent of the groundwater withdrawn for thermoelectric power. Unconsolidated and semiconsolidated sand and gravel aquifers provided 65 percent (385 Mgal/d) of the total groundwater withdrawn for thermoelectric power in 2015 (fig. 18). Other thermoelectric-power withdrawals were from carbonate-rock aquifers (64.3 Mgal/d), sandstone aquifers (62.1 Mgal/d), igneous and metamorphic-rock aquifers (18.9 Mgal/d), sandstone and carbonate-rock aquifers (9.16 Mgal/d), and other aquifers (56.8 Mgal/d).

Although many principal aquifers provided water for thermoelectric power (table 1), the four aquifers discussed below provided 49 percent of the total. Within the unconsolidated and semiconsolidated sand and gravel lithologic group, major sources of groundwater withdrawn for industry included the Basin and Range basin-fill aquifers (139 Mgal/d) in the southeastern United States, the Coastal lowlands aquifer system (52.5 Mgal/d) in the south-central United States, and Glacial sand and gravel aquifers in the north-central and northeastern United States (49.7 Mgal/d) (fig. 19). Within the carbonate-rock lithologic group, the Floridan aquifer system (52.6 Mgal/d) in the southeastern United States also was a major source of groundwater for thermoelectric power.

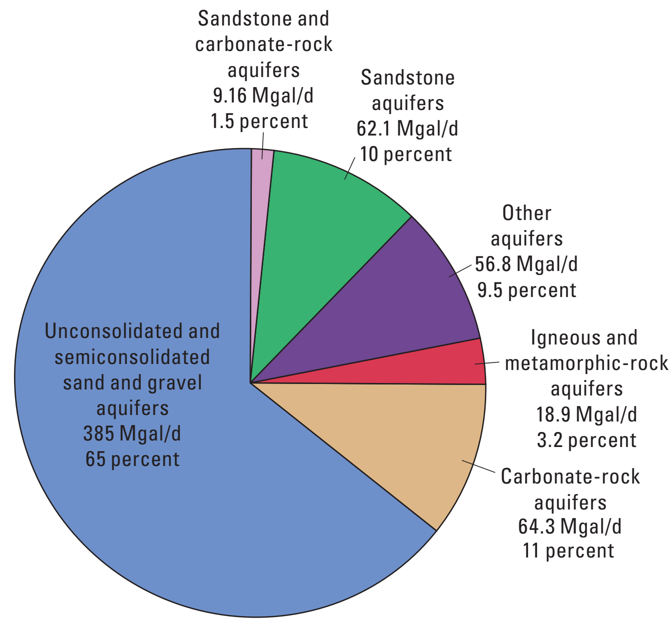


Figure 18. Groundwater withdrawals for thermoelectric power by major lithologic group in the United States, 2015. [Mgal/d, million gallons per day]

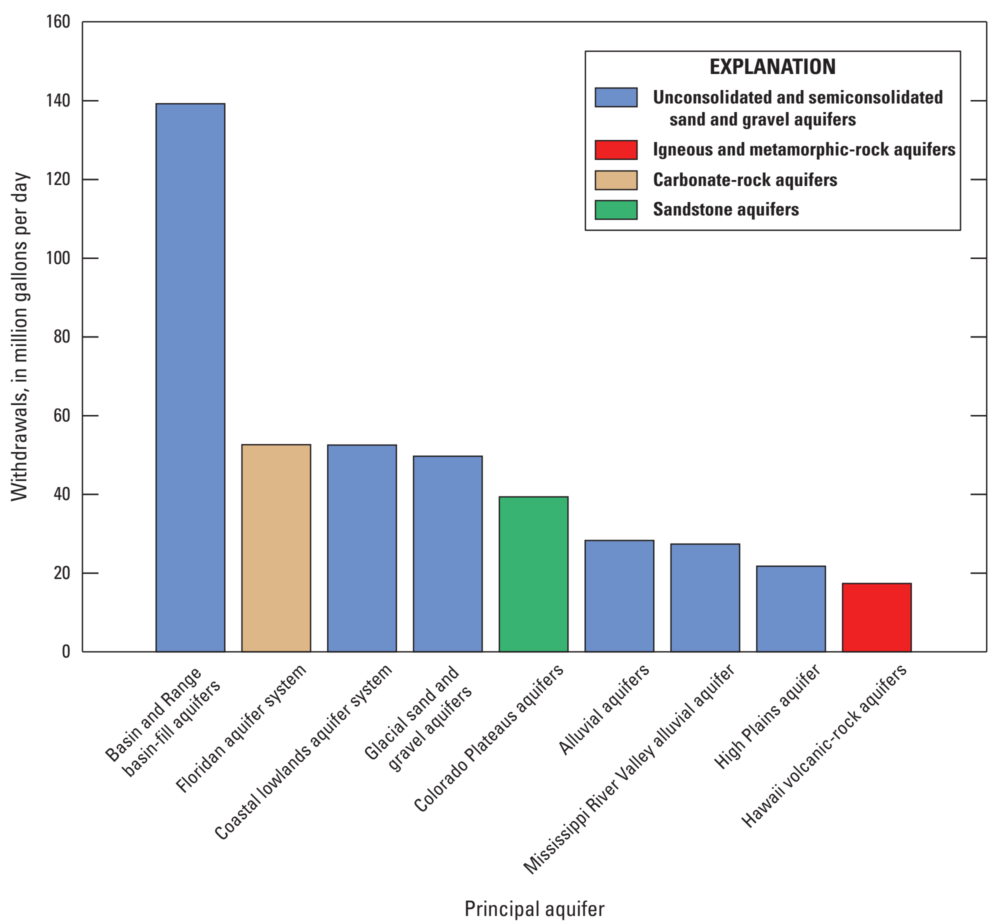


Figure 19. Withdrawals for thermoelectric power from nine principal aquifers that provided the most groundwater for thermoelectric power in the United States during 2015.

Estimated Withdrawals from Selected Principal Aquifers

Withdrawals from 10 aquifers or aquifer systems accounted for 72 percent of the total groundwater withdrawn in the United States during 2015 (table 1). Eight of these aquifers are unconsolidated and semiconsolidated sand and gravel aquifers, one is a carbonate-rock aquifer, and one is an igneous and metamorphic-rock aquifer. The following sections provide brief descriptions of these aquifers and estimated withdrawals for the various categories of use. Additional information about these and other principal aquifers is available at the USGS Aquifer Basics website (USGS, 2016).

High Plains Aquifer (12,300 Mgal/d)

The High Plains aquifer extends across an area of about 174,000 square miles (mi^2) of the central United States and underlies parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming (fig. 20) (Robson and Banta, 1995; Ryder, 1996; Whitehead, 1996; Miller and Appel, 1997). The aquifer generally is unconfined and consists of unconsolidated and semiconsolidated gravel, sand, silt, and clay. In most areas, the aquifer overlies low-permeability sediments and bedrock.

The High Plains aquifer was the most heavily pumped principal aquifer in the Nation in 2015, and withdrawals of 12,300 Mgal/d from the aquifer accounted for almost 15 percent of all groundwater withdrawals and 19 percent of withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers (table 1). Almost 95 percent (11,600 Mgal/d) of the withdrawals were for irrigation. Withdrawals for public supply (258 Mgal/d) and livestock (221 Mgal/d) together accounted for another 3.9 percent, and withdrawals for all other uses accounted for 1.5 percent of the total. Withdrawals from the High Plains aquifer

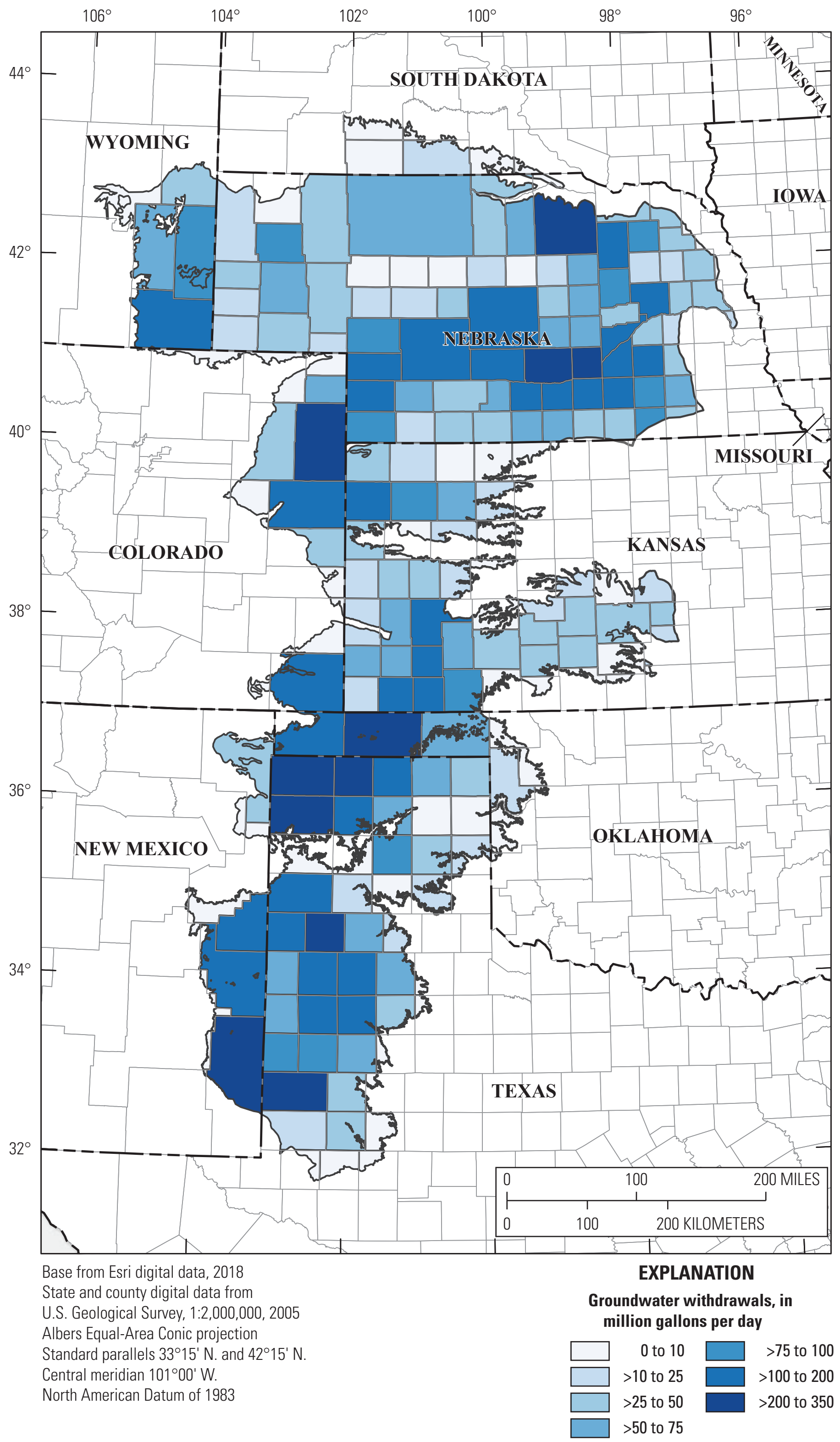


Figure 20. Total withdrawals from the High Plains aquifer by county, 2015.

in Nebraska (5,100 Mgal/d), Texas (3,440 Mgal/d), and Kansas (1,690 Mgal/d) accounted for 83 percent of the total withdrawals from the aquifer (fig. 21; table 2). Of the total withdrawals from the High Plains aquifer in 2015, 47.9 Mgal/d were saline water used for mining (43.9 Mgal/d), public supply (3.82 Mgal/d), and industry (0.19 Mgal/d) (table 1). About 87 percent (41.8 Mgal/d) of the saline withdrawals were in New Mexico (table 2).

From 2000 to 2015, fresh groundwater withdrawals from the High Plains aquifer for public supply, irrigation, and industry decreased about 32 percent, from 17,500 Mgal/d (Maupin and Barber, 2005) to 12,000 Mgal/d. Most of the decrease was attributed to irrigation withdrawals, which decreased from 17,000 Mgal/d in 2000 to 11,600 Mgal/d in 2015, and occurred primarily in three States: Nebraska (−2,180 Mgal/d), Texas (−1,830 Mgal/d), and Kansas (−1,250 Mgal/d). In addition, withdrawals from the aquifer for public supply decreased from 389 Mgal/d to 254 Mgal/d, and withdrawals for industry decreased from 99.3 Mgal/d to 65.1 Mgal/d over the same period.

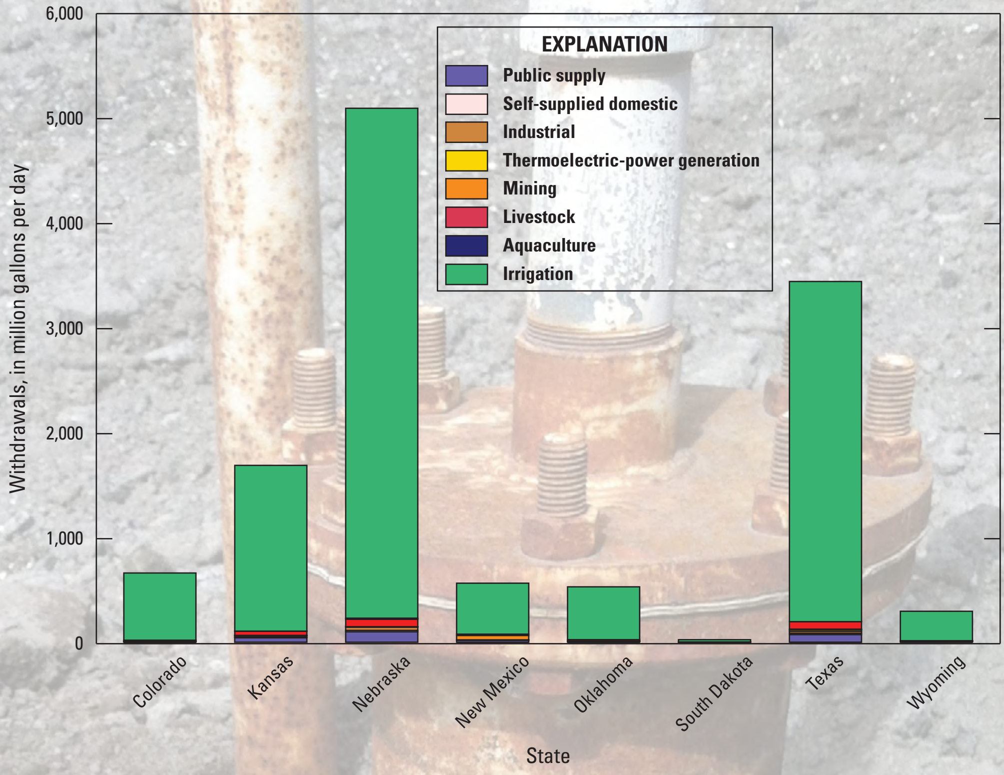


Figure 21. Withdrawals from the High Plains aquifer by State and category of use, 2015.

Mississippi River Valley Alluvial Aquifer (12,100 Mgal/d)

The Mississippi River Valley alluvial aquifer is at or near the surface across an area of about 43,800 mi^2 along the Mississippi River in the south-central United States, underlying parts of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee (fig. 22) (Painter and Westerman, 2018). The aquifer consists of flood-plain sediments that generally grade downward from fine sand, silt, or clay at the top to coarse sand or gravel at the base (Lloyd and Lyke, 1995). An overlying clay confining unit is missing in some areas (Renken, 1998).

The Mississippi River Valley alluvial aquifer was the second most heavily pumped principal aquifer in the Nation in 2015, and withdrawals of 12,100 Mgal/d from the aquifer accounted for about 14 percent of all groundwater withdrawals and 19 percent of withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers (table 1). Ninety-seven percent (11,700 Mgal/d) of the withdrawals were for irrigation. Withdrawals in Arkansas were 8,880 Mgal/d and accounted for 73 percent of the total water withdrawn from the aquifer. Mississippi (1,710 Mgal/d) and Missouri (1,170 Mgal/d) together accounted for another 24 percent of the withdrawals (fig. 23; table 2). All the withdrawals from the Mississippi River Valley alluvial aquifer in 2015 were freshwater; no saline water was withdrawn (table 1).

From 2000 to 2015, fresh groundwater withdrawals from the Mississippi River Valley alluvial aquifer for public supply, irrigation, and industry increased about 27 percent, from 9,290 Mgal/d (Maupin and Barber, 2005) to 11,800 Mgal/d. Withdrawals for public supply decreased from 69.8 Mgal/d in 2000 to 30.7 Mgal/d in 2015. Withdrawals for industry also decreased from 70.4 Mgal/d to 36.2 Mgal/d over the same timeframe. However, withdrawals for irrigation increased from 9,150 Mgal/d to 11,700 Mgal/d. Withdrawals for irrigation in Arkansas increased from 6,320 Mgal/d in 2000 to 8,720 Mgal/d in 2015 and accounted for 92 percent of the total increase in irrigation withdrawals from the Mississippi River Valley alluvial aquifer.

Water leaking from a plug in a flowing artesian well completed in the Coastal lowlands aquifer system in St. John the Baptist Parish, Louisiana. Photograph by Jason M. Griffith, U.S. Geological Survey.

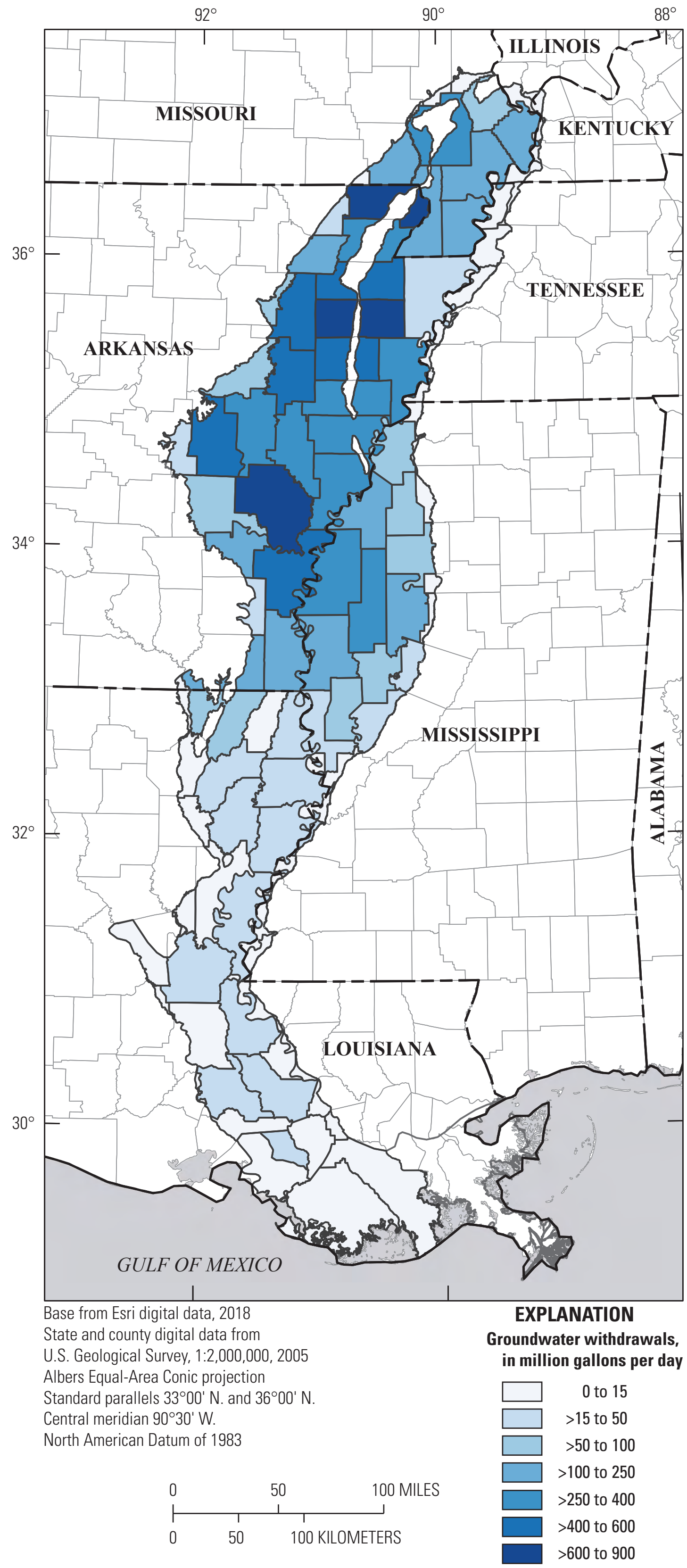


Figure 22. Total withdrawals from the Mississippi River Valley alluvial aquifer by county, 2015.

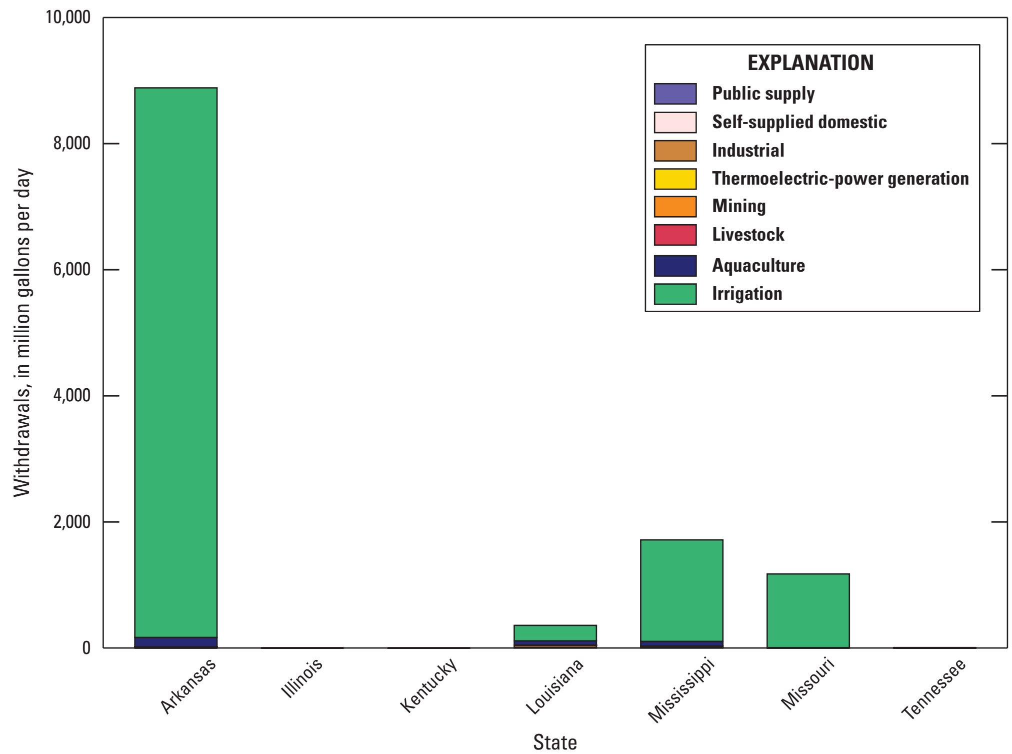


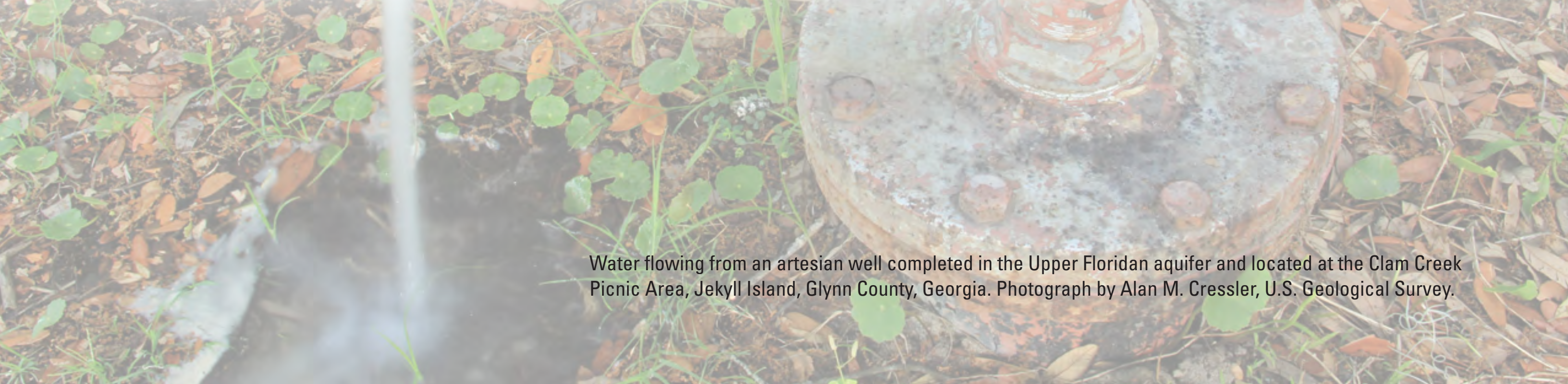
Figure 23. Withdrawals from the Mississippi River Valley alluvial aquifer by State and category of use, 2015.

Central Valley Aquifer System (11,100 Mgal/d)

The Central Valley aquifer system is about 550 miles (mi) long and 30 to 80 mi wide, extending from north to south across more than 30,000 mi^2 of central California (fig. 24). The aquifer is unconfined, semiconfined, and confined in parts and consists primarily of a thick sequence of sand and gravel beds separated by semiconfining and confining layers of overlying low-permeability volcanic and metamorphic rocks (Planert and Williams, 1995; Faunt, 2009).

The Central Valley aquifer system was the third most heavily pumped principal aquifer in the Nation in 2015, and withdrawals of 11,100 Mgal/d from the aquifer accounted for 13 percent of all groundwater withdrawals and 17 percent of withdrawals from the unconsolidated and semiconsolidated sand and gravel aquifers (table 1). Ninety-one percent (10,100 Mgal/d) of the withdrawals were for irrigation. Withdrawals for public supply accounted for another 4.7 percent, and withdrawals for all other uses accounted for 4.3 percent of the total. Of the total withdrawals from the Central Valley aquifer system, 64.0 Mgal/d were saline and used for mining (63.9 Mgal/d) and public supply (0.09 Mgal/d). All withdrawals from the Central Valley aquifer system were in California (fig. 25; table 2).

From 2000 to 2015, fresh groundwater withdrawals from the Central Valley aquifer system for public supply, irrigation, and industry increased almost 9.8 percent, from about 9,810 Mgal/d (Maupin and Barber, 2005) to 10,800 Mgal/d. A 38-percent decrease in public-supply withdrawals, from 839 Mgal/d in 2000 to 524 Mgal/d in 2015, was more than offset by the 14-percent increase in withdrawals for irrigation, from 8,910 in 2000 to 10,100 Mgal/d in 2015. Industrial withdrawals also increased from 58.9 Mgal/d in 2000 to 123 Mgal/d in 2015.



Water flowing from an artesian well completed in the Upper Floridan aquifer and located at the Clam Creek Picnic Area, Jekyll Island, Glynn County, Georgia. Photograph by Alan M. Cressler, U.S. Geological Survey.

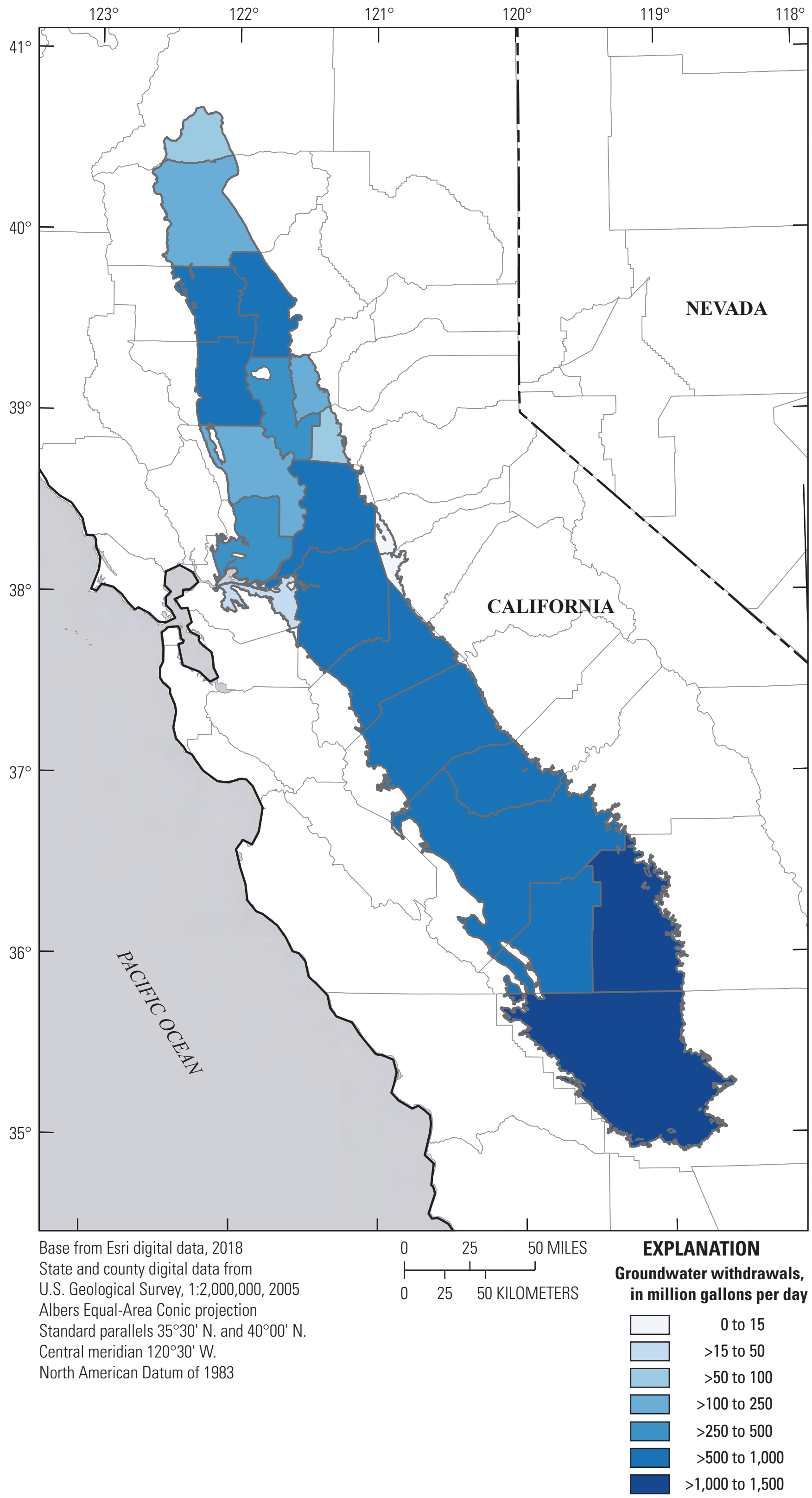


Figure 24. Total withdrawals from the Central Valley aquifer system by county, 2015.

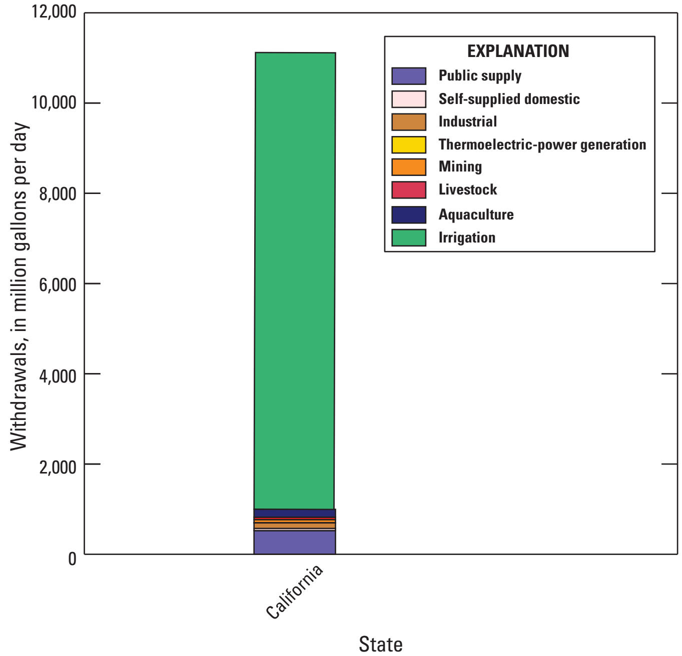


Figure 25. Withdrawals from the Central Valley aquifer system by category of use, 2015.

Basin and Range Basin-Fill Aquifers (7,390 Mgal/d)

The Basin and Range basin-fill aquifers extend through about 200,000 mi^2 of the southwestern United States and underlie most of Nevada and parts of eastern California, southern Oregon and Idaho, western Utah, southern Arizona, and southwestern New Mexico (fig. 26) (Robson and Banta, 1995). The aquifers generally are unconfined and are present as thick deposits of basin fill in valleys bounded by mountain ranges formed mostly of relatively impermeable bedrock (Planert and Williams, 1995; Robson and Banta, 1995). The deposits primarily consist of unconsolidated to moderately consolidated, well-sorted to poorly sorted beds of gravel, sand, silt, and clay (Robson and Banta, 1995).

About 7,390 Mgal/d were withdrawn from the Basin and Range basin-fill aquifers in 2015 (table 1). These withdrawals accounted for 8.7 percent of all groundwater withdrawals and almost 12 percent of all withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers. Withdrawals for irrigation (5,450 Mgal/d) and for public supply (1,300 Mgal/d) accounted for 74 and 18 percent, respectively, of the total withdrawals from the Basin and Range basin-fill aquifers. Withdrawals in Arizona (2,580 Mgal/d) and California (2,220 Mgal/d) together accounted for 65 percent of the total water withdrawn from the aquifer (fig. 27; table 2). Nevada (1,200 Mgal/d) and Utah (825 Mgal/d) together accounted for another 27 percent of the withdrawals. Of the total withdrawals from the Basin and Range basin-fill aquifers in 2015, about 222 Mgal/d were saline water and used for mining (100 Mgal/d), thermoelectric power (79.4 Mgal/d), industry (22.5 Mgal/d), and public supply (19.4 Mgal/d) (table 1). Withdrawals of saline water from the Basin and Range basin-fill aquifers were in California (87.7 Mgal/d), Nevada (82.2 Mgal/d), and Utah (51.7 Mgal/d) (table 2).

Public-supply well in East Baton Rouge Parish, Louisiana. Photograph by Frank R. Glass, U.S. Geological Survey.

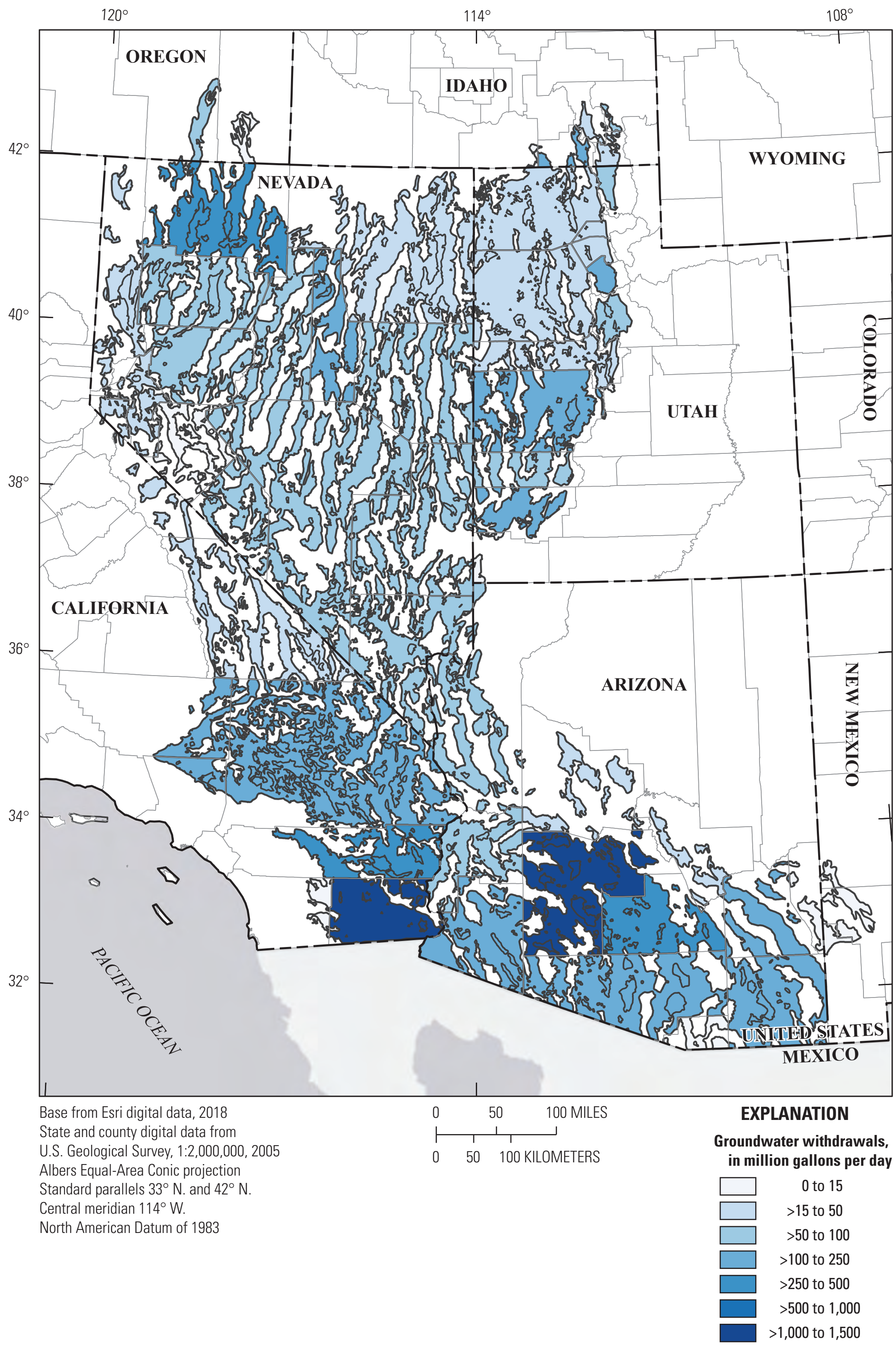


Figure 26. Total withdrawals from the Basin and Range basin-fill aquifers by county, 2015.

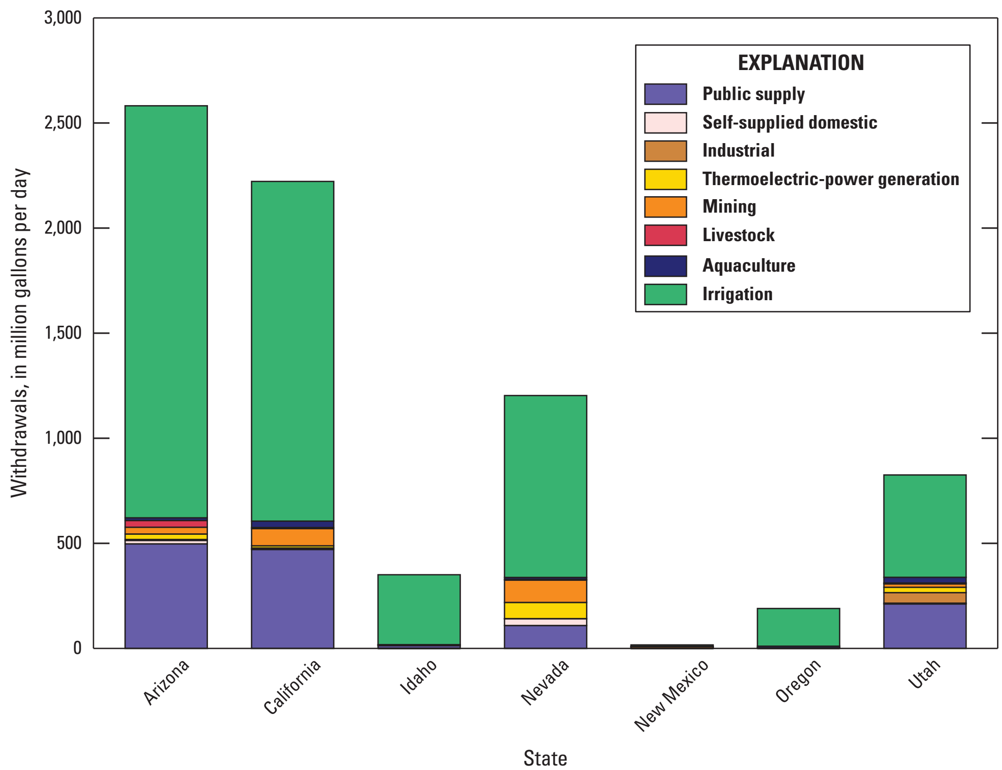


Figure 27. Withdrawals from the Basin and Range basin-fill aquifers by State and category of use, 2015.

From 2000 to 2015, fresh groundwater withdrawals from Basin and Range basin-fill aquifers for public supply, irrigation, and industry increased about 26 percent, from 5,360 Mgal/d (Maupin and Barber, 2005) to 6,770 Mgal/d. Although withdrawals from these aquifers decreased in States such as Arizona (−343 Mgal/d) and New Mexico (−174 Mgal/d), withdrawals increased by larger amounts in California (+1,440 Mgal/d) and in Nevada (+257 Mgal/d). Withdrawals for irrigation increased by 30 percent, and withdrawals for public supply increased by 17 percent. Fresh groundwater withdrawals for industry, which accounted for less than 1 percent of the total withdrawals from Basin and Range basin-fill aquifers during 2015, decreased by 3.5 percent from 2000 to 2015.

Glacial Sand and Gravel Aquifers (4,690 Mgal/d)

Glacial sand and gravel aquifers, which are present in much of the northern United States (fig. 28), generally were formed by glacial outwash deposits and alluvium derived from reworked glacial deposits laid down in stream valleys over a bedrock surface during periods of Pleistocene glaciation (Olcott, 1995; Trapp and Horn, 1997). The aquifers generally consist of well-sorted and stratified unconsolidated beds of coarse sand and gravel that range in thickness from 50 to 400 feet (ft) but can be as much as 1,000 ft thick (Olcott, 1992). Glacial sand and gravel aquifers are buried and under confined conditions in some areas but are exposed at land surface and under mostly unconfined conditions in other areas (Olcott, 1992; Trapp and Horn, 1997).

About 4,690 Mgal/d were withdrawn from the Glacial sand and gravel aquifers in 2015 (table 1). These withdrawals accounted for 5.5 percent of all groundwater withdrawals and 7.3 percent of all withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers. Withdrawals for public supply (2,000 Mgal/d) and irrigation (1,270 Mgal/d) together accounted for 70 percent of the total withdrawals from the Glacial sand and gravel aquifers, and withdrawals for self-supplied domestic use (598 Mgal/d) and industry (395 Mgal/d) together accounted for an additional 21 percent. The Glacial sand and gravel aquifers supplied more water for public-supply, self-supplied domestic, and industrial uses than any other principal aquifer and accounted for 13 percent, 19 percent, and 15 percent, respectively, of the total groundwater withdrawn for these uses in the United States in 2015. Water was withdrawn from Glacial sand and gravel aquifers in 23 States (table 2), but withdrawals in 9 states—Michigan (576 Mgal/d), Illinois (565 Mgal/d), Ohio (513 Mgal/d), Indiana (477 Mgal/d), New York (466 Mgal/d), Minnesota (433 Mgal/d), Wisconsin (380 Mgal/d), Iowa (354 Mgal/d), and Massachusetts (314 Mgal/d)—accounted for 87 percent of the withdrawals (fig. 29; table 2). Of the total water withdrawn from the Glacial sand and gravel aquifers, 0.57 Mgal/d was saline water used for mining in Michigan (0.33 Mgal/d) and Montana (0.24 Mgal/d).

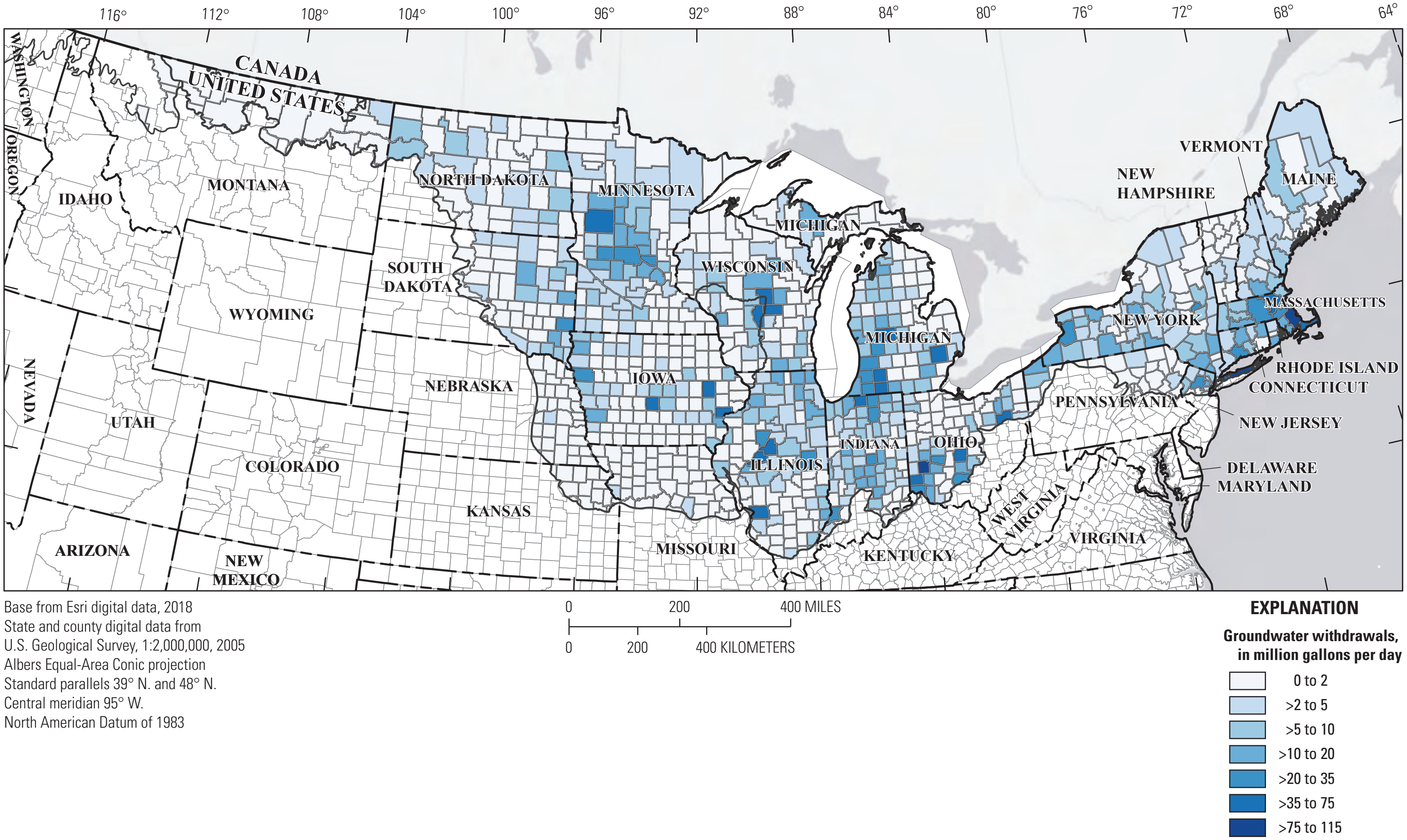


Figure 28. Total withdrawals from Glacial sand and gravel aquifers by county, 2015.

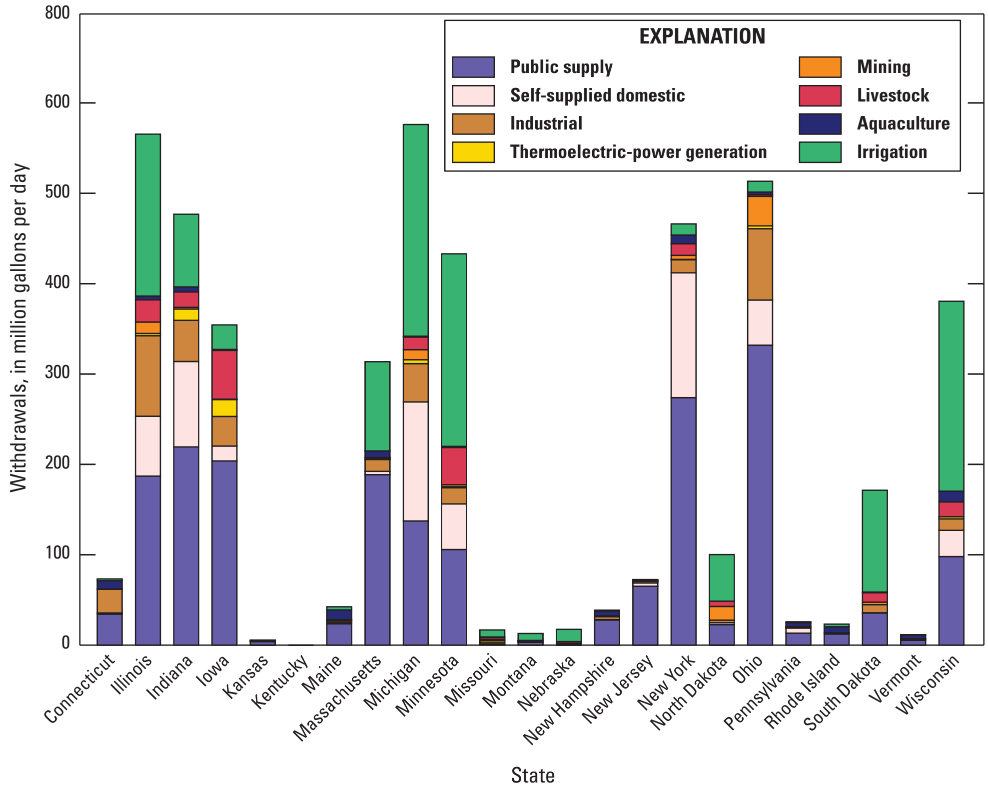


Figure 29. Withdrawals from Glacial sand and gravel aquifers by State and category of use, 2015.

From 2000 to 2015, fresh groundwater withdrawals from Glacial sand and gravel aquifers for public supply, irrigation, and industry increased by 3.0 percent, from 3,560 Mgal/d (Maupin and Barber, 2005) to 3,660 Mgal/d. Although there were relatively large decreases in withdrawals from these aquifers in a few States, such as Nebraska (−187 Mgal/d) and Indiana (−110 Mgal/d), withdrawals increased by smaller amounts in many other States, such as Michigan (+75.8 Mgal/d) and Massachusetts (+74.1 Mgal/d). Withdrawals from the Glacial sand and gravel aquifers for irrigation increased about 25 percent, from 1,020 Mgal/d to 1,270 Mgal/d. Withdrawals for public supply increased 2.2 percent from 2000 to 2015, and withdrawals for industry decreased 32 percent.

Floridan Aquifer System (3,180 Mgal/d)

The Floridan aquifer system extends across an area of about 100,000 mi^2 of southern Alabama, southeastern Mississippi, southern Georgia, southern South Carolina, and all of Florida (fig. 30). The aquifer system consists of a sequence of carbonate rocks that generally thickens from north to south, ranging from less than 200 ft thick along its northern edge to more than 3,400 ft thick in parts of south Florida (Miller, 2000b). Much of the Floridan aquifer system is confined, but along much of its northern edge and in west-central Florida, the aquifer is unconfined or only thinly confined, resulting in karst topography in these areas (Miller, 2000b).

About 3,180 Mgal/d was withdrawn from the Floridan aquifer system in 2015 (table 1). These withdrawals accounted for 59 percent of all withdrawals from carbonate-rock aquifers but only 3.8 of the total groundwater withdrawn in the United States that year. Withdrawals for public supply (1,320 Mgal/d) and irrigation (1,220 Mgal/d) accounted for 80 percent of this total. Withdrawals for industry (297 Mgal/d) and self-supplied domestic use (182 Mgal/d) accounted for an additional 15 percent of the total withdrawals. Almost 73 percent (2,340 Mgal/d) of the water withdrawn from the Floridan aquifer system was withdrawn in Florida (fig. 31; table 2). Of the total withdrawals from the Floridan aquifer system in 2015, about 198 Mgal/d were saline water and used for public supply (169 Mgal/d) and thermoelectric power (28.5 Mgal/d) (table 1). All the saline withdrawals from the Floridan aquifer system were in Florida, except for 0.01 Mgal/d that was withdrawn in Georgia (table 2).

From 2000 to 2015, fresh groundwater withdrawals from the Floridan aquifer system for public supply, irrigation, and industry decreased about 27 percent, from 3,640 Mgal/d (Maupin and Barber, 2005) to 2,670 Mgal/d. Seventy-three percent of that decrease was due to reduced withdrawals for irrigation in Florida (−707 Mgal/d). Withdrawals from the Floridan aquifer system also decreased for public supply by 178 Mgal/d and for industry by 87.1 Mgal/d. Withdrawals from the Floridan aquifer system for public supply, irrigation, and industry decreased in Florida (−883 Mgal/d), Georgia (−62.8 Mgal/d), and South Carolina (−29.7 Mgal/d) and increased slightly in Alabama (+3.62 Mgal/d) from 2000 to 2015.

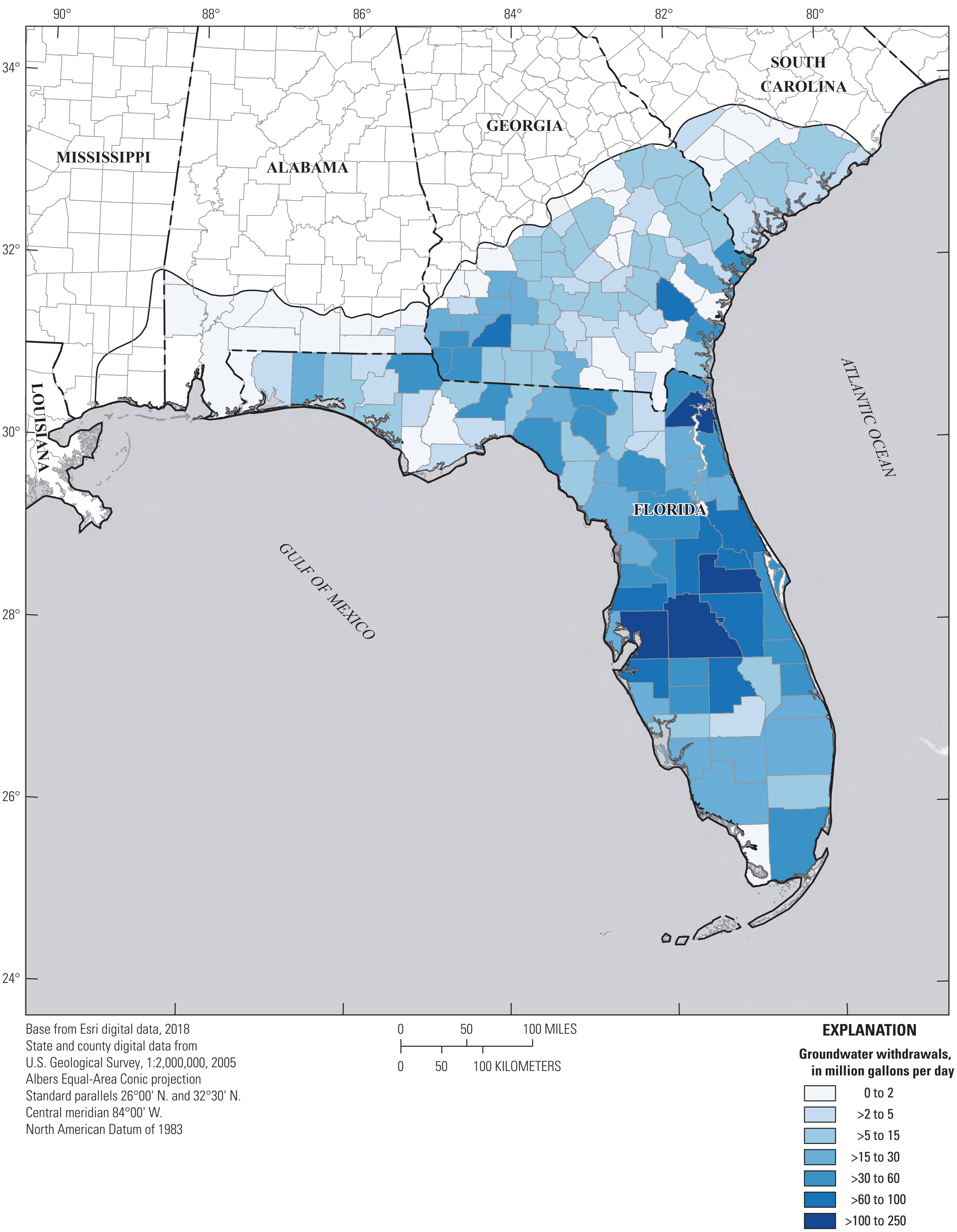


Figure 30. Total withdrawals from the Floridan aquifer system by county, 2015.

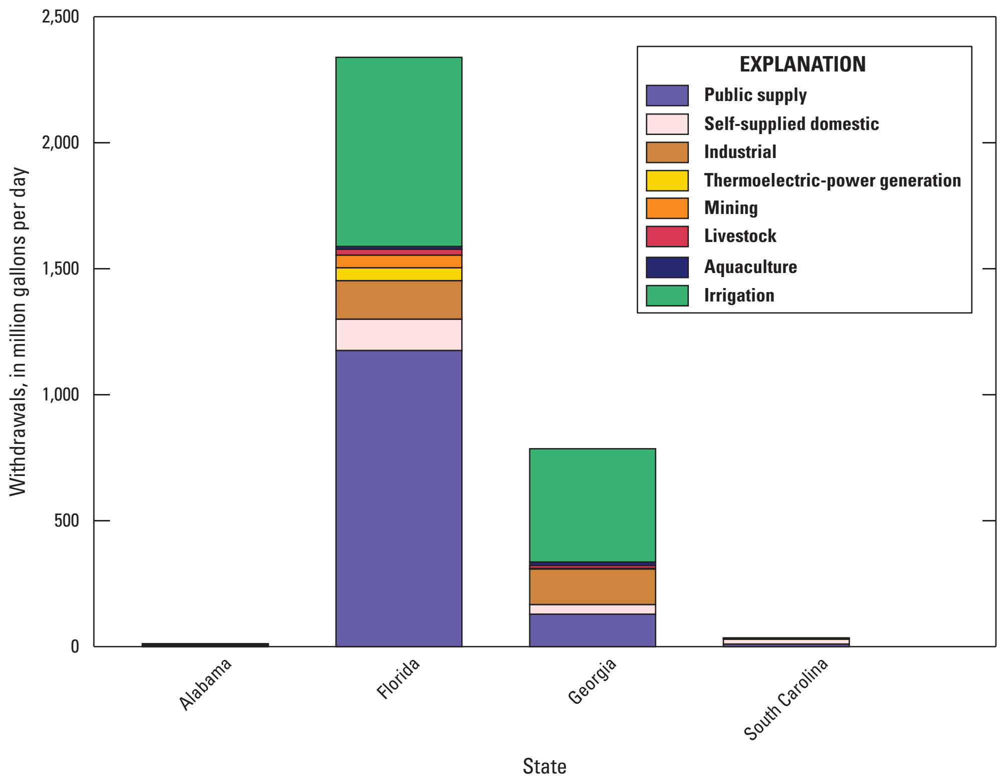


Figure 31. Withdrawals from the Floridan aquifer system by State and category of use, 2015.

Snake River Plain Basaltic-Rock Aquifers (2,930 Mgal/d)

The Snake River Plain basaltic-rock aquifers underlie about 9,600 mi^2 of Idaho and eastern Oregon (fig. 32). The basaltic rocks that encompass the aquifers are of volcanic origin and range in thickness from less than 100 ft along the margins of the Snake River Plain to more than 3,000 ft within the central part of the plain. The basaltic-rock aquifers comprise fractured rubble zones that range from 1 to 10 ft thick and are located between individual basalt flows that average about 25 ft in thickness (Whitehead, 1994; De Grey and Link, undated). The basaltic rocks generally are underlain, overlain, and interbedded with unconsolidated sediments made up of sand, silt, clay, and volcanic ash.

About 2,930 Mgal/d of water was withdrawn from the Snake River Plain basaltic-rock aquifers during 2015 (table 1). These withdrawals accounted for 52 percent of withdrawals from igneous and metamorphic rocks, but only 3.5 percent of total groundwater withdrawals in the United States. Ninety-five percent of the withdrawals (2,780 Mgal/d) from the Snake River Plain basaltic-rock aquifers were for irrigation, and 2.7 percent of the withdrawals (79.1 Mgal/d) were for public supply. The aquifers accounted for 4.9 percent of all groundwater withdrawn for irrigation in the United States. More than 99.9 percent of the total withdrawals from the Snake River Plain basaltic-rock aquifers were in Idaho; only 2.5 Mgal/d were withdrawn in Oregon (fig. 33; table 2). All the withdrawals from the Snake River Plain basaltic-rock aquifers in 2015 were freshwater; no saline water was withdrawn (table 1).

From 2000 to 2015, fresh groundwater withdrawals from the Snake River Plain basaltic-rock aquifer for public supply, irrigation, and industry increased 9.5 percent, from 2,610 Mgal/d (Maupin and Barber, 2005) to 2,860 Mgal/d. This increase was almost entirely due to increased irrigation withdrawals in Idaho (+283 Mgal/d). Withdrawals for public supply increased 9.10 Mgal/d, and withdrawals for industry decreased 12.4 Mgal/d.

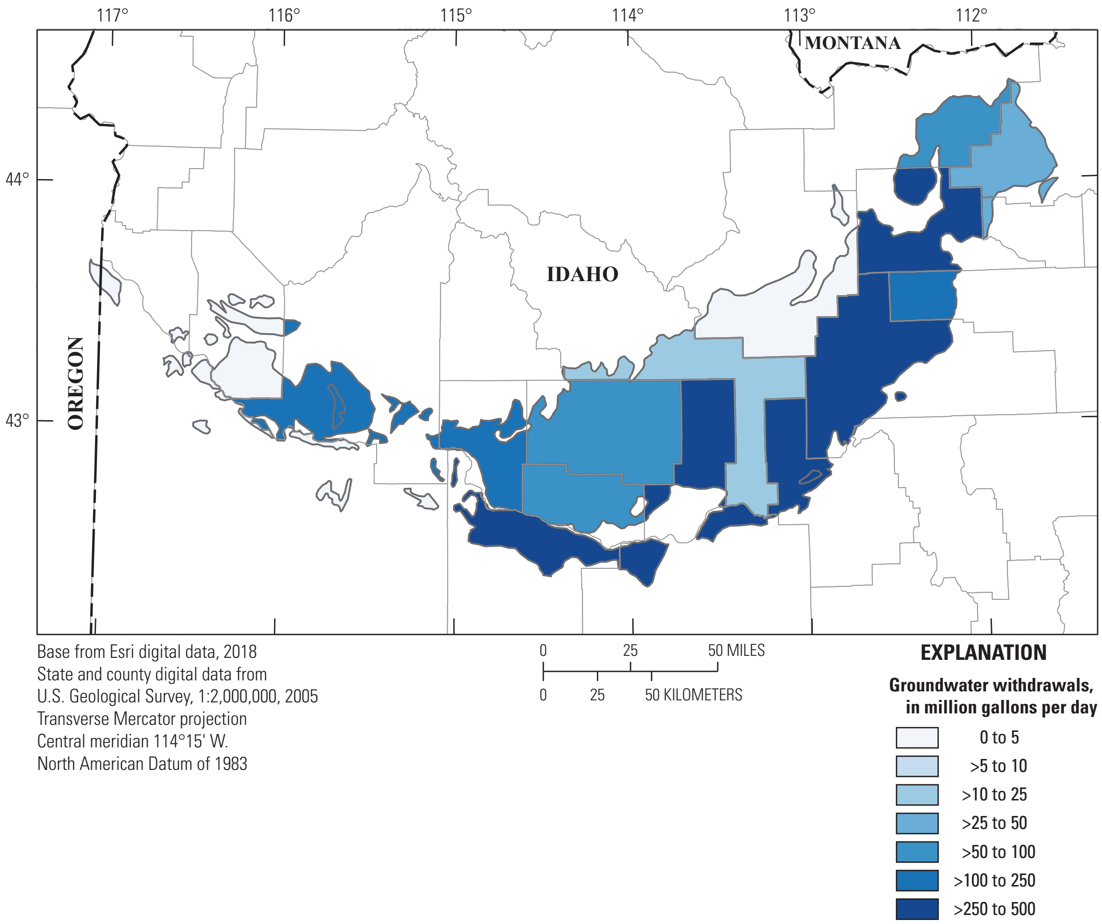


Figure 32. Total withdrawals from Snake River Plain basaltic-rock aquifers by county, 2015.

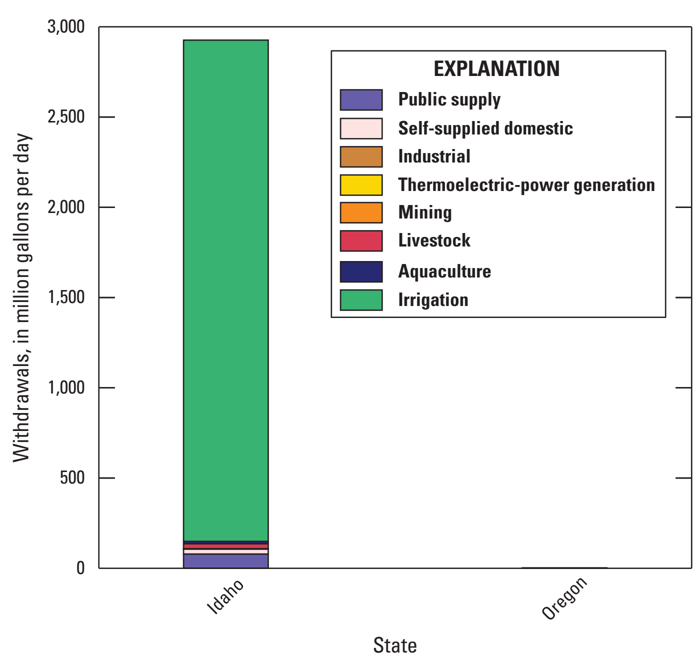


Figure 33. Withdrawals from Snake River Plain basaltic-rock aquifers, 2015.

Alluvial Aquifers (2,960 Mgal/d)

Alluvial aquifers generally consist of sediments deposited by rivers and streams that are present in or near existing major streams and are not included in another named principal aquifer. Alluvial aquifers also can include terrace deposits and unconsolidated sediments deposited by ancient streams (Maupin and Barber, 2005). Alluvial aquifers primarily are composed of unconsolidated sand and gravel and usually are unconfined or semiconfined. Alluvial aquifers are not shown on figure 1 because they generally are too small and narrow to map accurately at the scale of that figure.

About 2,960 Mgal/d were withdrawn from alluvial aquifers in the United States in 2015 (table 1). These withdrawals accounted for 3.5 percent of total groundwater withdrawals and 4.6 percent of water withdrawn from unconsolidated and semiconsolidated sand and gravel aquifers. Of the total water withdrawn from alluvial aquifers, 66 percent was withdrawn for irrigation, and about 21 percent was withdrawn for public supply. Water was withdrawn from alluvial aquifers in 21 States, but 49 percent of the total withdrawals were in just three States—Kansas (602 Mgal/d), Nebraska (458 Mgal/d), and Arkansas (384 Mgal/d)—where the water was primarily used for irrigation (fig. 34; table 2). Of the total withdrawals from the alluvial aquifers in 2015, 4.43 Mgal/d were saline water (table 1) and used for public supply in Kansas (3.04 Mgal/d) and mining in Montana (1.11 Mgal/d), Nebraska (0.27 Mgal/d), and Colorado (0.01 Mgal/d) (table 2).

From 2000 to 2015, fresh groundwater withdrawals from alluvial aquifers for public supply, irrigation, and industry increased 52 percent, from 1,800 Mgal/d (Maupin and Barber, 2005) to 2,740 Mgal/d. Although withdrawals from these aquifers decreased substantially in a few States, such as Colorado (−220 Mgal/d) and South Dakota (−40.1 Mgal/d), withdrawals increased in many other States, including Arkansas (+378 Mgal/d), Nebraska (+293 Mgal/d), Wyoming (+124 Mgal/d), Indiana (+118 Mgal/d), and Kansas (+111 Mgal/d). Withdrawals from alluvial aquifers for irrigation increased about 64 percent, from 1,190 Mgal/d to 1,950 Mgal/d. Withdrawals for public supply and industry also increased by 37 and 5.0 percent, respectively, from 2000 to 2015.

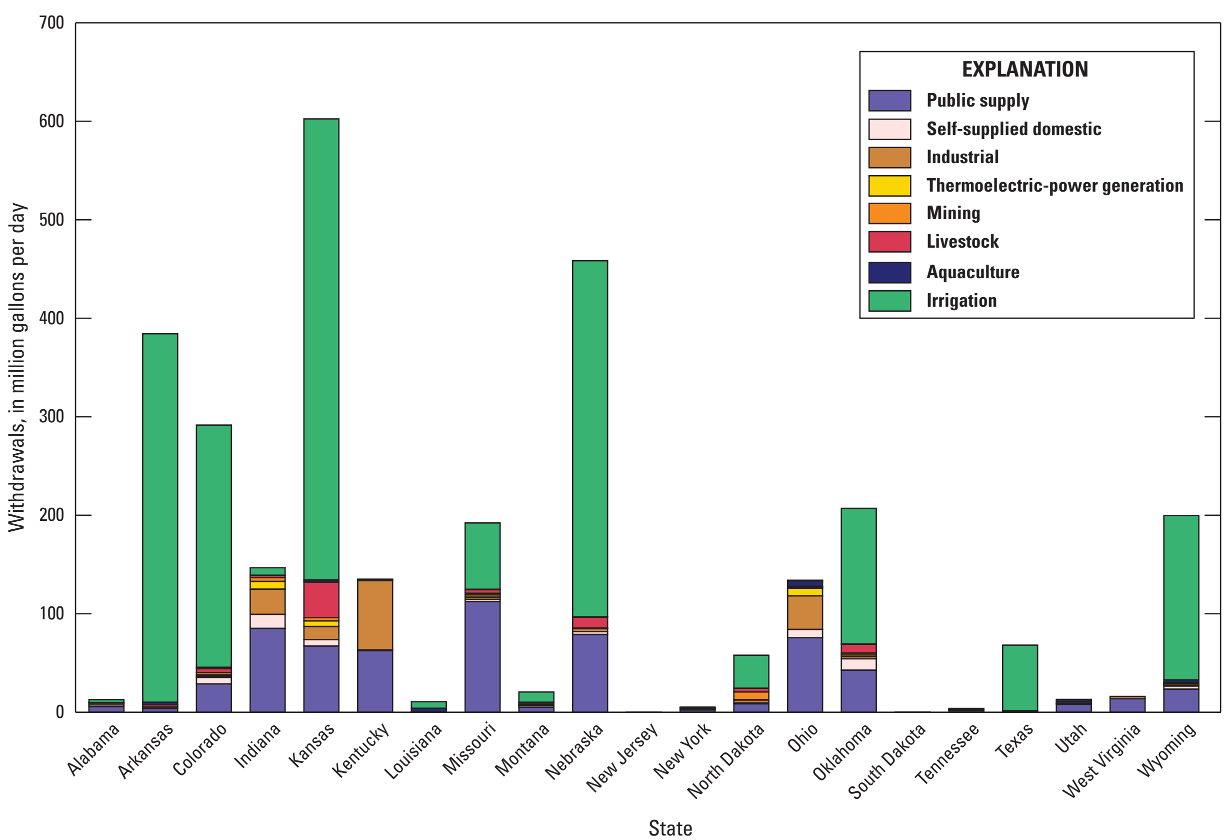


Figure 34. Withdrawals from alluvial aquifers by State and category of use, 2015.

Coastal Lowlands Aquifer System (2,290 Mgal/d)

The Coastal lowlands aquifer system underlies an area of 99,000 mi^2 along the gulf coast in Texas, Louisiana, Mississippi, Alabama, and western Florida (fig. 35) (Ryder, 1996; Renken, 1998; Miller, 2000b). The aquifer system generally consists of unconsolidated or semiconsolidated beds of sand, silt, and clay that dip and thicken from outcrop and subcrop areas along its northern and western borders towards the Gulf of Mexico to the south and east. The thickness of the aquifer system ranges from less than 100 ft in outcrop and subcrop areas to more than 14,000 ft off the coast of Louisiana where it contains only saltwater. The aquifer system contains freshwater to maximum depths of about 2,500 ft in areas of Texas (Ryder, 1996) and about 3,000 ft in areas of Louisiana (Renken, 1998). The aquifer system generally is confined except where it outcrops along its updip limit.

About 2,290 Mgal/d were withdrawn from the Coastal lowlands aquifer system in 2015 (table 1). These withdrawals accounted for 2.7 percent of total groundwater withdrawals and 3.6 percent of water withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers. Sixty-six percent of the water withdrawn from the Coastal lowlands aquifer system was used for irrigation (760 Mgal/d) and public supply (744 Mgal/d). Withdrawals for industry (322 Mgal/d) and aquaculture (276 Mgal/d) together accounted for another 26 percent of withdrawals from the aquifer system. Withdrawals in Louisiana (1,280 Mgal/d) and Texas (637 Mgal/d) accounted for almost 84 percent of the withdrawals (fig. 36; table 2). Of the total withdrawn from the Coastal lowlands aquifer system in 2015, 5.85 Mgal/d was saline water used for public supply (5.08 Mgal/d) and industry (0.77 Mgal/d) in Texas.

From 2000 to 2015, fresh groundwater withdrawals from the Coastal lowlands aquifer system for public supply, irrigation, and industry decreased 23 percent, from 2,370 Mgal/d (Maupin and Barber, 2005) to 1,820 Mgal/d. Withdrawals decreased for public supply by 272 Mgal/d, for irrigation by 173 Mgal/d, and for industry by 103 Mgal/d. Decreased withdrawals from the Coastal lowlands aquifer system in Texas for public supply (−289 Mgal/d) and irrigation (−113 Mgal/d) accounted for much of the total decrease. Withdrawals also declined in Louisiana (−94.4 Mgal/d), Mississippi (−29.9 Mgal/d), and Florida (−27.5 Mgal/d). Withdrawals from the Coastal lowlands aquifer system increased by 30.9 Mgal/d in Alabama from 2000 to 2015.

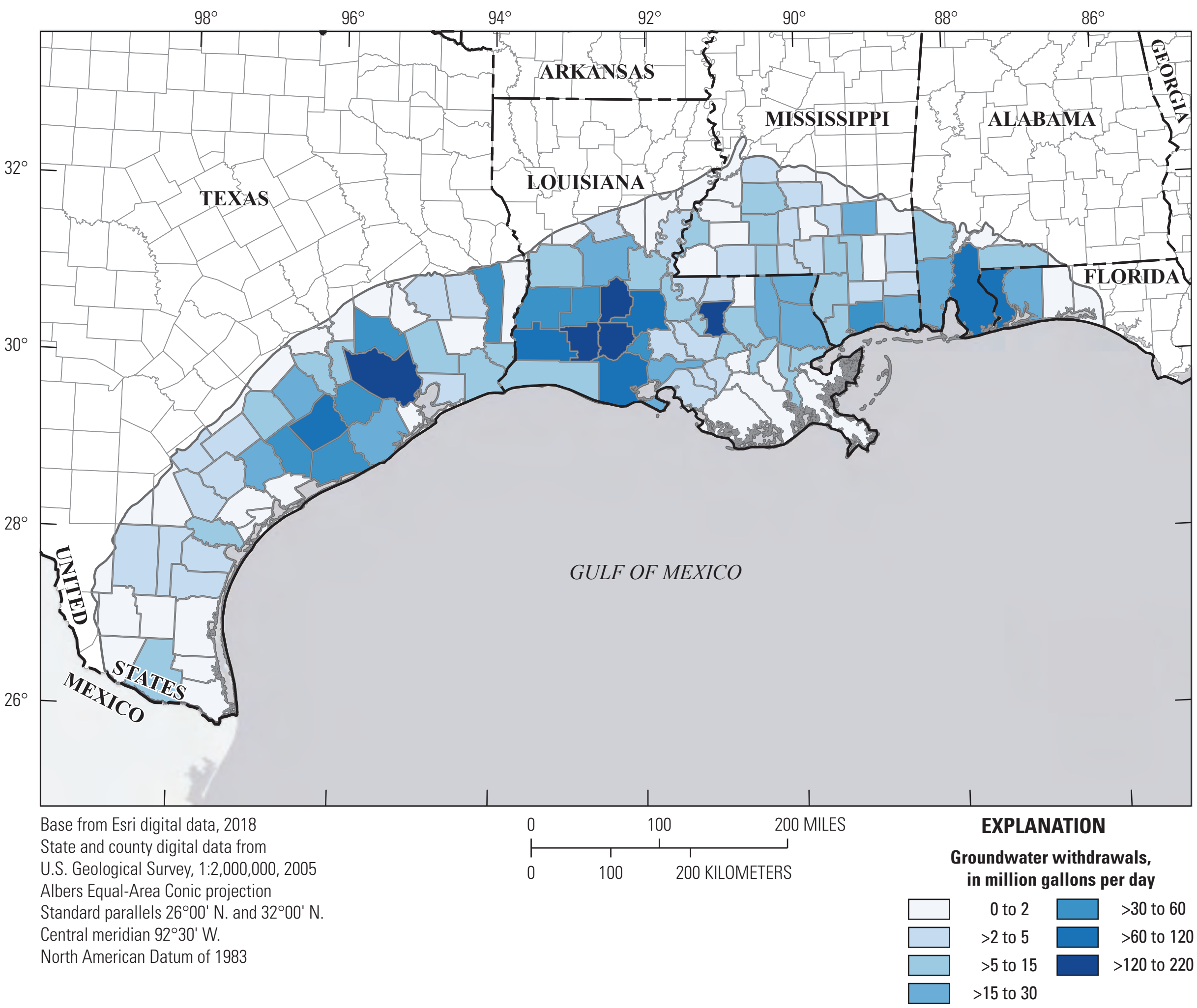


Figure 35. Total withdrawals from the Coastal lowlands aquifer system by county, 2015.

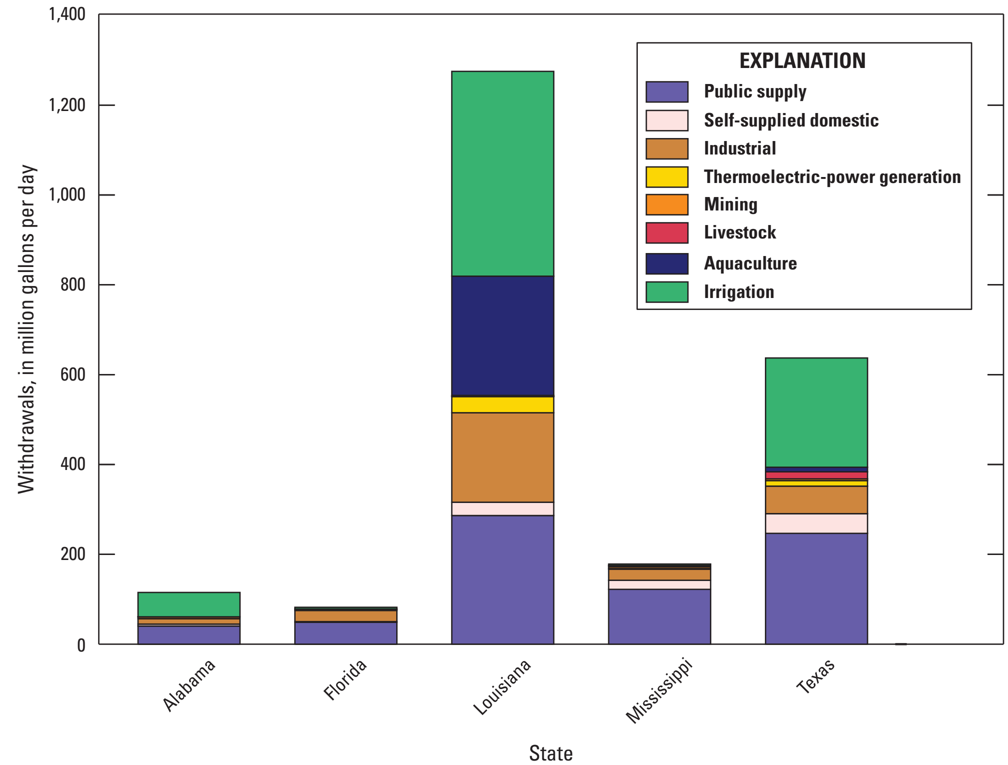


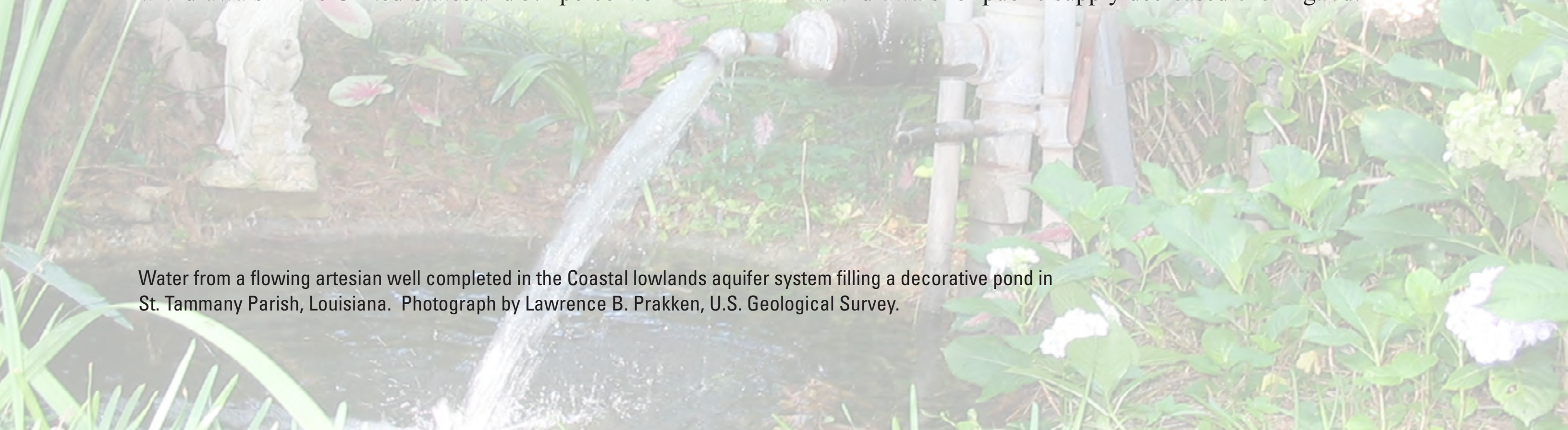
Figure 36. Withdrawals from the Coastal lowlands aquifer system by State and category of use, 2015.

California Coastal Basin Aquifers (2,030 Mgal/d)

The California Coastal Basin aquifers comprise more than 100 individual basin-fill aquifers located in intermontane depressions that have resulted from folding and faulting along California's western coast (fig. 37) (Planert and Williams, 1995). The aquifers may be confined or unconfined and typically are composed of unconsolidated deposits of sand and gravel interbedded with deposits of silt and clay. Each coastal basin has its own characteristics and hydrology (Planert and Williams, 1995), but many include two or more aquifers separated by confining units of variable thickness and extent (California Department of Water Resources, 2015).

About 2,030 Mgal/d were withdrawn from California Coastal Basin aquifers during 2015 (table 1). These withdrawals accounted for 2.4 percent of all groundwater withdrawals in the United States and 3.2 percent of withdrawals from unconsolidated and semiconsolidated sand and gravel aquifers. Withdrawals for public supply (963 Mgal/d), irrigation (751 Mgal/d), and industry (225 Mgal/d) together accounted for more than 95 percent of the water withdrawn from California Coastal Basin aquifers. Of the total water withdrawn from the California Coastal Basin aquifers in 2015, 91.2 Mgal/d of saline water were used for mining (61.4 Mgal/d) and public supply (29.8 Mgal/d). All the water withdrawn from these aquifers was withdrawn in California (fig. 38; table 2).

From 2000 to 2015, fresh groundwater withdrawals from the California Coastal Basin aquifers for public supply, irrigation, and industry decreased about 45 percent, from 3,450 Mgal/d (Maupin and Barber, 2005) to 1,910 Mgal/d. Although withdrawals for industry increased by 119 Mgal/d, withdrawals for irrigation decreased 1,010 Mgal/d, and withdrawals for public supply decreased 645 Mgal/d.



Water from a flowing artesian well completed in the Coastal lowlands aquifer system filling a decorative pond in St. Tammany Parish, Louisiana. Photograph by Lawrence B. Prakken, U.S. Geological Survey.

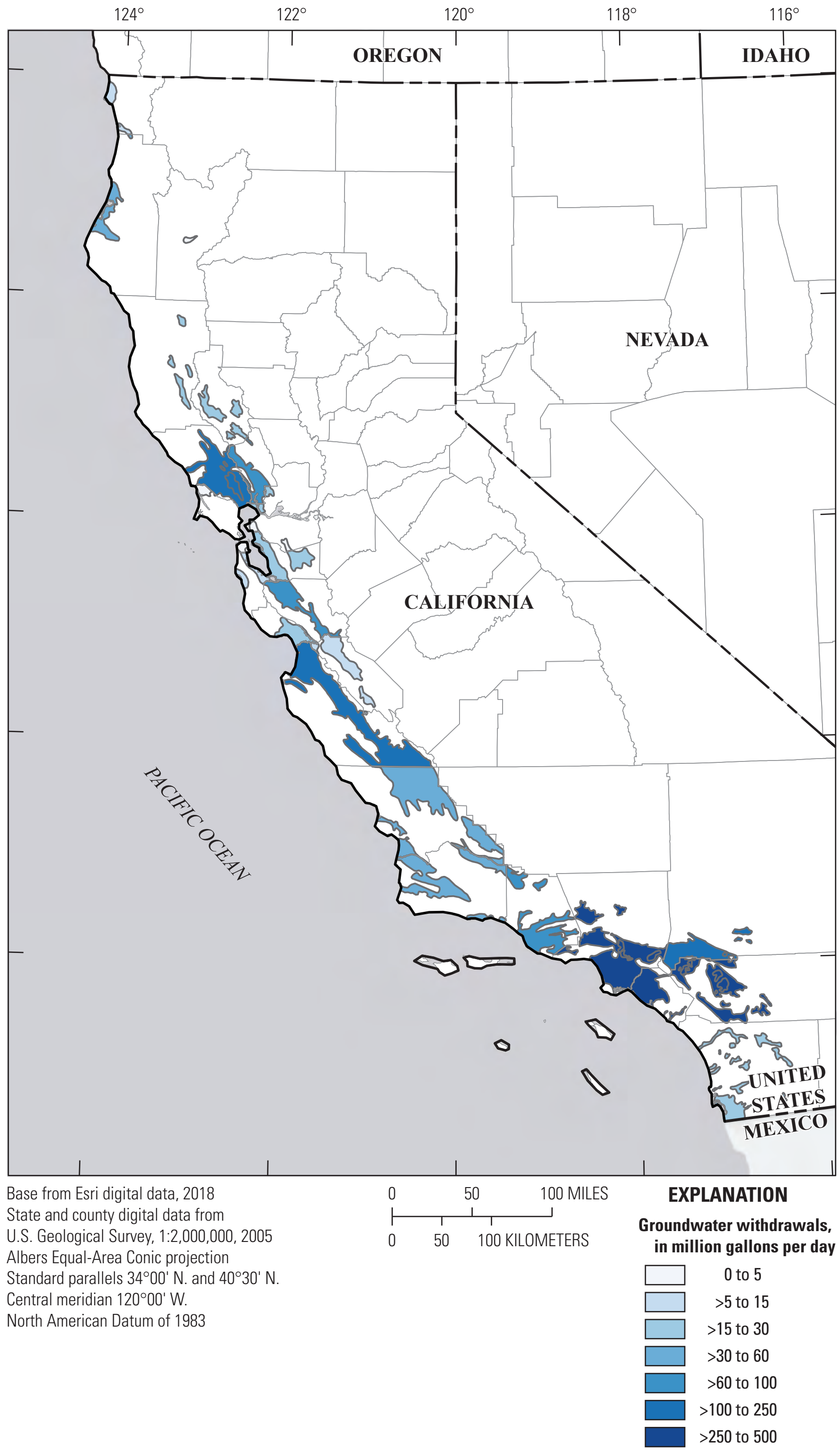


Figure 37. Total withdrawals from the California Coastal Basin aquifers by county, 2015.

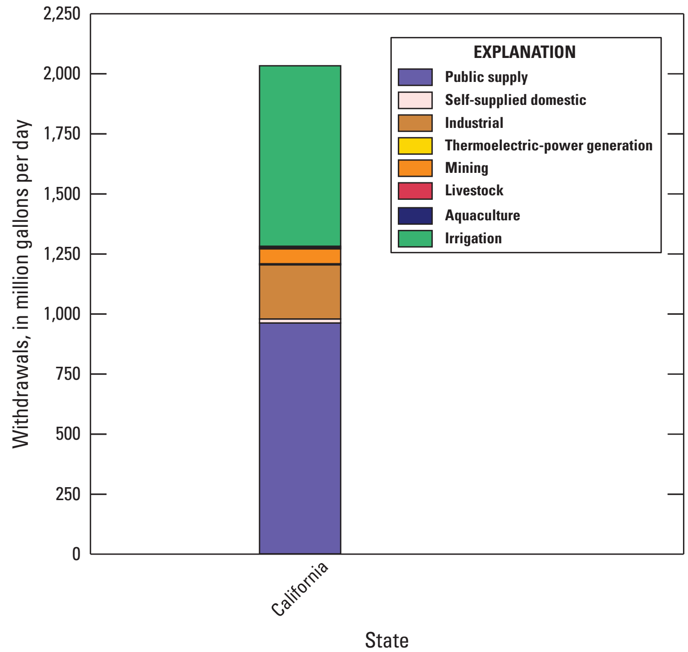


Figure 38. Withdrawals from California Coastal Basin aquifers by category of use, 2015.

References Cited

California Department of Water Resources, 2015, California's groundwater update 2013—A compilation of enhanced content for California water plan update 2013: State of California, Natural Resources Agency, 90 p., accessed December 20, 2019, at https://cawaterlibrary.net/document/californias-groundwater-update-2013-a-compilation-of-enhanced-content-for-california-water-plan-update-2013/.

De Grey, L., and Link, P.K., [undated], Digital geology of Idaho—Snake River Plain aquifer: Idaho State University, Digital Atlas of Idaho, accessed March 27, 2019, at http://geology.isu.edu/Digital_Geology_Idaho/Module15/mod15.htm.

Dieter, C.A., Maupin, M.A., Caldwell, R.R., Harris, M.A., Ivahnenko, T.I., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2018a, Estimated use of water in the United States in 2015: U.S. Geological Survey Circular 1441, 65 p. [Supersedes USGS Open-File Report 2017–1131], accessed December 20, 2019, at https://doi.org/10.3133/cir1441.

Dieter, C.A., Linsey, K.S., Caldwell, R.R., Harris, M.A., Ivahnenko, T.I., Lovelace, J.K., Maupin, M.A., and Barber, N.L., 2018b, Estimated use of water in the United States county-level data for 2015 (ver. 2.0, June 2018): U.S. Geological Survey data release, https://doi.org/10.5066/F7TB15V5.

Esri, 2018, Esri demographics, accessed January 10, 2020, at https://www.esri.com/en-us/arcgis/products/esri-demographics/overview.

Faunt, C.C., ed., 2009, Groundwater availability of the Central Valley aquifer, California: U.S. Geological Survey Professional Paper 1766, 225 p.

Horton, J.D., 2017, The State Geologic Map Compilation (SGMC) geodatabase of the conterminous United States (ver. 1.1, August 2017): U.S. Geological Survey data release, accessed April 18, 2019, at https://doi.org/10.5066/F7WH2N65.

Hutson, S.S., Barber, N.L., Kenny, J.F., Linsey, K.S., Lumia, D.S., and Maupin, M.A., 2004, Estimated use of water in the United States in 2000: Reston, Va., U.S. Geological Survey Circular 1268, 46 p., accessed December 20, 2019, at https://pubs.usgs.gov/circ/2004/circ1268/pdf/circular1268.pdf.

Lloyd, O.B., and Lyke, W.L., 1995, Ground water atlas of the United States—Segment 10, Illinois, Indiana, Kentucky, Ohio, Tennessee: U.S. Geological Survey Hydrologic Atlas 730–K, 30 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730k/report.pdf.

Lohman, S.W., 1972, Definitions of selected ground-water terms—Revisions and conceptual refinements: U.S. Geological Survey Water Supply Paper 1988, 21 p., accessed July 3, 2019, at https://pubs.er.usgs.gov/publication/wsp1988.

Lovelace, J.K., Nielsen, M.G., Read, A.L., and Murphy, C.J., 2020, Estimated groundwater withdrawals from principal aquifers in the United States—County-level data for 2015: U.S. Geological Survey data release, https://doi.org/10.5066/P9EI0KMR.

Maupin, M.A., and Barber, N.L., 2005, Estimated withdrawals from principal aquifers in the United States, 2000: U.S. Geological Survey Circular 1279, 46 p. [Also available at https://pubs.usgs.gov/circ/2005/1279.]

Miller, J.A., 2000a, Ground water atlas of the United States—Introduction and national summary: U.S. Geological Survey Hydrologic Atlas 730–A, 15 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730a/report.pdf.

Miller, J.A., 2000b, Ground water atlas of the United States—Segment 6, Alabama, Florida, Georgia, South Carolina: U.S. Geological Survey Hydrologic Atlas 730–G, 28 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730g/report.pdf.

Miller, J.A., and Appel, C.L., 1997, Ground water atlas of the United States—Segment 3, Kansas, Missouri, Nebraska: U.S. Geological Survey Hydrologic Atlas 730–D, 24 p., accessed October 23, 2018, at https://pubs.usgs.gov/ha/730d/report.pdf.

Nawyn, J.P., Sargent, B.P., Hoopes, B.C., Augenstein, T.W., Rowland, K.M., and Barber, N.L., 2017, User's Manual for the National Water Information System of the U.S. Geological Survey—Aggregate Water-Use Data System, version 3.2: U.S. Geological Survey Open-File Report 2017–1114, 29 p., accessed February 15, 2019, at https://doi.org/10.3133/ofr20171114.]

Olcott, P.G., 1992, Ground water atlas of the United States—Segment 9, Iowa, Michigan, Minnesota, Wisconsin: U.S. Geological Survey Hydrologic Atlas 730–J, 31 p., accessed March 27, 2019, at https://pubs.er.usgs.gov/publication/ha730J.

Olcott, P.G., 1995, Ground water atlas of the United States—Segment 12, Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont: U.S. Geological Survey Hydrologic Atlas 730–M, 28 p., accessed March 27, 2019, at https://pubs.er.usgs.gov/publication/ha730M.

Painter, J.A., and Westerman, D.A., 2018, Mississippi Alluvial Plain Extent, November 2017: U.S. Geological Survey data release, accessed October 10, 2018, at https://doi.org/10.5066/F70R9NMJ.

Planert, M., and Williams, J.S., 1995, Ground water atlas of the United States—Segment 1, California, Nevada: U.S. Geological Survey Hydrologic Investigations Atlas 730–B, 28 p.

Renken, R.A., 1998, Ground water atlas of the United States—Segment 5, Arkansas, Louisiana, Mississippi: U.S. Geological Survey Hydrologic Atlas 730–F, 28 p.

Robson, S.G., and Banta, E.R., 1995, Ground water atlas of the United States—Segment 2, Arizona, Colorado, New Mexico, Utah: U.S. Geological Survey Hydrologic Atlas 730–C, 32 p., accessed October 23, 2018, at https://pubs.usgs.gov/ha/730c/report.pdf.

Ryder, P.D., 1996, Ground water atlas of the United States—Segment 3, Oklahoma, Texas: U.S. Geological Survey Hydrologic Atlas 730–E, 30 p., accessed October 23, 2018, at https://pubs.usgs.gov/ha/730e/report.pdf.

Sargent, B.P., Maupin, M.A., and Hinkle, S.R., 2008, Estimated withdrawals from stream-valley aquifers and refined estimated withdrawals from selected aquifers in the United States, 2000: U.S. Geological Survey Scientific Investigations Report 2008–5003, 71 p.

Shaffer, K.H., 2009, Variations in withdrawal, return flow, and consumptive use of water in Ohio and Indiana, with selected data from Wisconsin, 1999–2004: U.S. Geological Survey Scientific Investigations Report 2009–5096, 93 p.

Trapp, H., Jr., and Horn, M.A., 1997, Ground water atlas of the United States—Segment 11, Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, West Virginia: U.S. Geological Survey Hydrologic Atlas 730–L, 24 p., accessed March 27, 2019, at https://pubs.usgs.gov/ha/730l/report.pdf.

U.S. Geological Survey [USGS], 2005, The National Map—State and county boundaries, 1:2,000,000, accessed June 2, 2005, at http://nationalmap.gov/small_scale/atlasftp.html.

U.S. Geological Survey [USGS], 2011, National Water Information System—Help system—Aquifer codes, accessed April 18, 2019, at https://help.waterdata.usgs.gov/code/aqfr_cd_query?fmt=html.

U.S. Geological Survey [USGS], 2016, Aquifer basics—Principal aquifers by rock type, accessed July 17, 2018, at https://water.usgs.gov/ogw/aquiferbasics/index.html.

U.S. Geological Survey [USGS], 2017a, Aquifers—Map of the principal aquifers of the United States, accessed July 3, 2019, at https://water.usgs.gov/ogw/aquifer/map.html.

U.S. Geological Survey [USGS], 2017b, National aquifer code reference list, accessed April 18, 2019, at https://water.usgs.gov/ogw/NatlAqCode-reflist.html.

U.S. Geological Survey [USGS], 2017c, USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed July 9, 2019, at https://doi.org/10.5066/F7P55KJN.

U.S. Geological Survey [USGS], 2018, USGS Water Resources NSDI Node—Spatial data sets available on the WRD NSDI Node, accessed April 18, 2019, at https://water.usgs.gov/lookup/getgislist.

U.S. Geological Survey [USGS], 2019, The National Geologic Map Database, accessed April 18, 2019, at https://ngmdb.usgs.gov/ngmdb/ngmdb_home.html.

U.S. Geological Survey [USGS], 2020, USGS Publications Warehouse, accessed April 18, 2019, at https://pubs.er.usgs.gov/.

Whitehead, R.L., 1994, Ground water atlas of the United States—Segment 7, Idaho, Oregon, Washington: U.S. Geological Survey Hydrologic Atlas 730–H, 31 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730h/report.pdf.

Whitehead, R.L., 1996, Ground water atlas of the United States—Segment 8, Montana, North Dakota, South Dakota, Wyoming: U.S. Geological Survey Hydrologic Atlas 730–I, 24 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730i/report.pdf.

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Alabama															
Alluvial aquifers	5.83	0.00	1.68	1.85	0.00	0.00	0.00	0.37	0.00	0.07	0.09	2.95	12.84	0.00	12.84
Coastal lowlands aquifer system	40.35	0.00	4.38	11.98	0.00	0.00	0.00	3.77	0.00	0.35	0.09	54.20	115.12	0.00	115.12
Floridan aquifer system	5.53	0.00	0.90	0.26	0.00	0.00	0.00	1.06	0.00	0.19	0.04	3.77	11.75	0.00	11.75
Mississippi embayment aquifer system	2.02	0.00	0.31	0.00	0.00	0.00	0.00	0.69	0.00	0.02	0.00	0.02	3.06	0.00	3.06
Mississippian aquifers	35.62	0.00	4.43	0.01	0.00	0.00	0.00	0.73	0.00	1.66	0.01	9.26	51.72	0.00	51.72
Other aquifers	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.11
Pennsylvanian aquifers	3.71	0.00	4.35	1.03	0.00	0.00	0.00	1.51	0.00	2.76	0.00	1.54	14.90	0.00	14.90
Piedmont and Blue Ridge crystalline-rock aquifers	5.06	0.00	4.09	0.08	0.00	0.00	0.00	0.61	0.00	0.76	0.01	0.43	11.04	0.00	11.04
Southeastern Coastal Plain aquifer system	100.09	0.00	11.59	15.03	0.00	0.00	0.00	8.29	0.00	4.32	26.39	25.35	191.06	0.00	191.06
Surficial aquifer system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Valley and Ridge aquifers	73.71	0.00	4.83	2.43	0.00	0.00	0.00	4.75	0.00	1.41	0.63	1.25	89.01	0.00	89.01
Alabama total	**271.92**	**0.00**	**36.67**	**32.67**	**0.00**	**0.00**	**0.00**	**21.78**	**0.00**	**11.54**	**27.26**	**98.77**	**500.61**	**0.00**	**500.61**
Alaska															
Alaska unconsolidated-deposit aquifers	36.87	0.00	9.71	6.63	0.00	0.63	0.00	0.00	5.20	0.03	169.25	1.49	224.61	5.20	229.81
Other aquifers	0.96	0.00	0.12	0.07	0.00	0.00	0.00	0.00	83.99	0.01	0.00	0.01	1.17	83.99	85.16
Alaska total	**37.83**	**0.00**	**9.83**	**6.70**	**0.00**	**0.63**	**0.00**	**0.00**	**89.19**	**0.04**	**169.25**	**1.50**	**225.78**	**89.19**	**314.97**
Arizona															
Basin and Range basin-fill aquifers	497.58	0.00	16.18	4.67	0.00	25.97	0.00	32.13	0.00	32.33	12.61	1,960.53	2,582.00	0.00	2,582.00
Basin and Range carbonate-rock aquifers	3.21	0.00	0.05	0.06	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	3.35	0.00	3.35
Colorado Plateaus aquifers	27.33	0.00	3.40	0.24	0.00	31.74	0.00	1.44	0.00	2.00	1.46	5.00	72.61	0.00	72.61
Other aquifers	40.80	0.00	4.37	1.15	0.00	0.00	0.00	34.77	0.00	4.51	9.74	5.71	101.05	0.00	101.05
Arizona total	**568.92**	**0.00**	**24.00**	**6.12**	**0.00**	**57.71**	**0.00**	**68.34**	**0.00**	**38.87**	**23.81**	**1,971.24**	**2,759.01**	**0.00**	**2,759.01**
Arkansas															
Alluvial aquifers	3.97	0.00	1.47	0.00	0.00	0.00	0.00	0.02	0.00	2.17	2.57	374.08	384.28	0.00	384.28
Edwards-Trinity aquifer system	2.33	0.00	0.50	0.19	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	3.18	0.00	3.18
Mississippi embayment aquifer system	66.02	0.00	2.12	27.84	0.00	3.13	0.00	0.12	0.00	1.07	1.25	185.53	287.08	0.00	287.08
Mississippi River Valley alluvial aquifer	15.41	0.00	1.92	1.50	0.00	0.00	0.00	0.00	0.00	0.79	148.29	8,716.63	8,884.54	0.00	8,884.54
Other aquifers	0.09	0.00	3.49	0.00	0.00	0.00	0.00	0.00	0.00	4.82	0.01	0.05	8.46	0.00	8.46
Ozark Plateaus aquifer system	6.40	0.00	3.36	0.00	0.00	0.00	0.00	0.00	0.00	4.60	0.32	2.85	17.53	0.00	17.53
Arkansas total	**94.22**	**0.00**	**12.86**	**29.53**	**0.00**	**3.13**	**0.00**	**0.14**	**0.00**	**13.61**	**152.44**	**9,279.14**	**9,585.07**	**0.00**	**9,585.07**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermoelectric power, fresh	Thermoelectric power, saline	Mining, fresh	Mining, saline	Livestock	Aquaculture	Irrigation	Total, fresh	Total, saline	Total
California															
Basin and Range basin-fill aquifers	455.86	14.90	2.46	4.31	0.00	10.70	0.00	8.96	72.77	5.40	30.32	1,616.30	2,134.31	87.67	2,221.98
Basin and Range carbonate-rock aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.80	0.00	3.80	0.00	3.80
California Coastal Basin aquifers	932.96	29.83	16.77	225.41	0.00	4.42	0.00	0.79	61.37	5.06	5.76	751.14	1,942.31	91.20	2,033.51
Central Valley aquifer system	523.80	0.09	49.06	123.47	0.00	3.63	0.00	4.90	63.94	52.31	175.52	10,120.08	11,052.77	64.03	11,116.80
Other aquifers	387.68	7.22	37.46	40.69	0.00	0.49	35.12	15.21	73.74	18.39	31.19	1,035.96	1,567.07	116.08	1,683.15
Pacific Northwest basin-fill aquifers	5.63	0.00	1.33	3.08	0.00	0.38	0.00	0.19	0.00	0.61	0.00	240.80	252.02	0.00	252.02
Pacific Northwest volcanic-rock aquifers	7.12	0.00	1.15	0.46	0.00	0.00	0.00	0.20	0.37	0.27	0.04	91.28	100.52	0.37	100.89
California total	**2,313.05**	**52.04**	**108.23**	**397.42**	**0.00**	**19.62**	**35.12**	**30.25**	**272.19**	**82.04**	**246.63**	**13,855.56**	**17,052.80**	**359.35**	**17,412.15**
Colorado															
Alluvial aquifers	28.86	0.00	6.56	1.38	0.00	1.29	0.00	2.21	0.01	3.95	1.42	245.88	291.55	0.01	291.56
Colorado Plateaus aquifers	6.03	0.00	4.70	0.00	0.00	0.00	0.00	0.38	12.54	0.81	0.22	0.52	12.66	12.54	25.20
Denver Basin aquifer system	41.53	0.00	9.21	1.71	0.00	1.10	0.00	0.16	0.20	1.89	0.18	8.61	64.39	0.20	64.59
High Plains aquifer	6.02	0.00	2.26	0.00	0.00	0.00	0.00	0.62	2.04	8.01	0.00	641.60	658.51	2.04	660.55
Other aquifers	20.20	0.00	10.06	1.13	0.00	0.64	0.00	1.66	9.42	7.64	5.38	27.79	74.50	9.42	83.92
Rio Grande aquifer system	6.41	0.00	2.58	0.00	0.00	0.00	0.00	0.21	0.00	0.40	8.77	382.45	400.82	0.00	400.82
Colorado total	**109.05**	**0.00**	**35.37**	**4.22**	**0.00**	**3.03**	**0.00**	**5.24**	**24.21**	**22.70**	**15.97**	**1,306.85**	**1,502.43**	**24.21**	**1,526.64**
Connecticut															
Early Mesozoic basin aquifers	0.73	0.00	4.76	8.37	0.00	0.00	0.00	0.11	0.00	0.08	0.00	0.03	14.08	0.00	14.08
Glacial sand and gravel aquifers	34.32	0.00	1.32	26.41	0.00	0.00	0.00	0.02	0.00	0.06	9.15	2.01	73.29	0.00	73.29
New York and New England carbonate-rock aquifers	0.54	0.00	0.92	0.02	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.07	1.59	0.00	1.59
New York and New England crystalline-rock aquifers	7.42	0.00	23.83	5.28	0.00	0.00	0.00	0.68	0.00	0.99	0.00	0.91	39.11	0.00	39.11
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Connecticut total	**43.01**	**0.00**	**30.83**	**40.08**	**0.00**	**0.00**	**0.00**	**0.82**	**0.00**	**1.16**	**9.15**	**3.02**	**128.07**	**0.00**	**128.07**
Delaware															
Northern Atlantic Coastal Plain aquifer system	42.63		13.53	10.59		0.13	0.00	0.34		1.23	1.98	94.64	165.07	0.00	165.07
Other aquifers	0.00		0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Piedmont and Blue Ridge crystalline-rock aquifers	3.12		1.00	0.14		0.00	0.00	0.00		0.11	0.00	0.79	5.16	0.00	5.16
Delaware total	**45.75**		**14.53**	**10.73**		**0.13**	**0.00**	**0.34**		**1.34**	**1.98**	**95.43**	**170.23**	**0.00**	**170.23**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
District of Columbia															
Northern Atlantic Coastal Plain aquifer system	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other aquifers	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Piedmont and Blue Ridge crystalline-rock aquifers	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
District of Columbia total	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Florida															
Biscayne aquifer	591.57	0.00	3.02	3.07	0.00	1.28	0.00	28.66	0.00	0.04	0.70	50.99	679.33	0.00	679.33
Coastal lowlands aquifer system	48.74	0.00	1.49	24.78	0.00	2.57	0.00	0.00	0.00	0.23	0.54	3.77	82.12	0.00	82.12
Floridan aquifer system	1,006.41	169.14	124.24	152.83	0.00	22.41	28.52	50.50	0.00	23.24	11.03	750.46	2,141.12	197.66	2,338.78
Intermediate aquifer system	24.78	0.00	16.67	0.33	0.00	0.00	0.00	3.80	0.00	0.49	0.31	177.06	223.44	0.00	223.44
Other aquifers	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.98
Surficial aquifer system	237.17	0.00	30.52	0.29	0.00	1.57	0.00	6.16	0.00	1.73	0.27	171.73	449.44	0.00	449.44
Florida total	**1,908.67**	**169.14**	**176.92**	**181.30**	**0.00**	**27.83**	**28.52**	**89.12**	**0.00**	**25.73**	**12.85**	**1,154.01**	**3,576.43**	**197.66**	**3,774.09**
Georgia															
Floridan aquifer system	129.05	0.00	38.03	141.13	0.00	1.24	0.01	1.44	0.00	11.22	13.80	449.47	785.38	0.01	785.39
Other aquifers	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.01	0.01	1.20	3.06	0.00	3.06
Pennsylvanian aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Piedmont and Blue Ridge crystalline-rock aquifers	15.55	0.00	47.03	5.25	0.00	0.06	0.00	5.77	0.00	12.26	0.24	14.07	100.23	0.00	100.23
Southeastern Coastal Plain aquifer system	70.26	0.00	15.49	42.96	0.00	1.21	0.00	7.73	0.00	3.09	0.09	92.97	233.80	0.00	233.80
Surficial aquifer system	0.69	0.00	0.74	0.21	0.00	0.91	0.00	0.06	0.00	0.07	0.00	2.10	4.78	0.00	4.78
Valley and Ridge aquifers	13.99	0.00	3.19	3.16	0.00	0.00	0.00	0.44	0.00	0.89	0.40	1.24	23.31	0.00	23.31
Georgia Total	**230.89**	**0.00**	**104.48**	**192.71**	**0.00**	**3.42**	**0.01**	**15.93**	**0.00**	**27.54**	**14.54**	**561.05**	**1,150.56**	**0.01**	**1,150.57**
Hawaii															
Hawaii volcanic-rock aquifers	236.33	0.00	0.63	0.24	0.00	1.48	15.90	0.85	0.00	0.49	8.39	71.73	320.14	15.90	336.04
Other aquifers	15.98	0.00	0.03	0.00	0.00	0.00	4.34	0.04	0.00	0.02	0.19	2.07	18.33	4.34	22.67
Hawaii Total	**252.31**	**0.00**	**0.66**	**0.24**	**0.00**	**1.48**	**20.24**	**0.89**	**0.00**	**0.51**	**8.58**	**73.80**	**338.47**	**20.24**	**358.71**
Idaho															
Basin and Range basin-fill aquifers	12.66	0.00	3.45	0.39	0.00	0.00	0.00	0.00	0.00	1.55	0.00	332.51	350.56	0.00	350.56
Basin and Range carbonate-rock aquifers	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.78
Columbia Plateau basaltic-rock aquifers	9.32	0.00	3.05	0.45	0.00	0.00	0.00	0.00	0.00	0.50	0.04	147.68	161.04	0.00	161.04

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
Idaho—Continued															
Columbia Plateau basin-fill aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Rocky Mountains Intermontane Basins aquifer systems	44.49	0.00	16.85	0.28	0.00	0.78	0.00	0.00	0.00	0.98	9.01	446.18	518.57	0.00	518.57
Other aquifers	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.09
Pacific Northwest basin-fill aquifers	83.69	0.00	11.84	7.22	0.00	0.00	0.00	0.86	0.00	6.19	2.55	726.94	839.29	0.00	839.29
Pacific Northwest volcanic-rock aquifers	0.53	0.00	1.29	2.47	0.00	0.00	0.00	0.00	0.00	0.19	0.00	142.18	146.66	0.00	146.66
Snake River Plain basaltic-rock aquifers	79.11	0.00	27.34	1.97	0.00	0.00	0.00	0.12	0.00	27.14	13.42	2,777.21	2,926.31	0.00	2,926.31
Snake River Plain basin-fill aquifers	15.92	0.00	6.33	32.18	0.00	1.01	0.00	0.37	0.00	4.65	21.16	328.06	409.68	0.00	409.68
Idaho total	**246.59**	**0.00**	**70.15**	**44.96**	**0.00**	**1.79**	**0.00**	**1.35**	**0.00**	**41.20**	**46.18**	**4,900.76**	**5,352.98**	**0.00**	**5,352.98**
Illinois															
Cambrian-Ordovician aquifer system	124.93	0.00	1.52	22.94	0.00	0.65	0.00	0.01	0.00	0.53	0.11	3.42	154.11	0.00	154.11
Glacial sand and gravel aquifers	187.07	0.00	66.21	89.13	0.00	2.48	0.00	12.64	0.00	24.55	4.24	179.12	565.44	0.00	565.44
Mississippi embayment aquifer system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mississippi River Valley alluvial aquifer	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.96
Mississippian aquifers	1.51	0.00	6.50	3.75	0.00	1.08	0.00	0.00	0.00	4.17	0.00	7.86	24.87	0.00	24.87
Other aquifers	18.24	0.00	0.00	13.96	0.00	0.00	0.00	0.73	21.00	0.00	0.76	0.00	33.69	21.00	54.69
Ozark Plateaus aquifer system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pennsylvanian aquifers	1.55	0.00	6.21	0.00	0.00	0.00	0.00	0.22	0.00	4.98	0.08	19.62	32.66	0.00	32.66
Silurian-Devonian aquifers	32.74	0.00	11.43	2.08	0.00	0.00	0.00	1.00	0.00	1.94	0.04	8.94	58.17	0.00	58.17
Southeastern Coastal Plain aquifer system	0.02	0.00	0.19	0.00	0.00	0.00	0.00	0.02	0.00	0.05	0.00	0.03	0.31	0.00	0.31
Illinois total	**367.02**	**0.00**	**92.06**	**131.86**	**0.00**	**4.21**	**0.00**	**14.62**	**21.00**	**36.22**	**5.23**	**218.99**	**870.21**	**21.00**	**891.21**
Indiana															
Alluvial aquifers	85.20	0.00	14.24	25.58	0.00	7.89	0.00	3.70	0.00	2.54	0.00	7.57	146.72	0.00	146.72
Glacial sand and gravel aquifers	219.36	0.00	94.53	45.51	0.00	12.56	0.00	1.81	0.00	17.08	5.58	80.39	476.82	0.00	476.82

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Indiana—Continued															
Mississippian aquifers	0.27	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	1.46	0.00	1.46
Other aquifers	1.77	0.00	0.59	0.00	0.00	0.01	0.00	0.00	0.00	0.33	0.00	0.37	3.07	0.00	3.07
Pennsylvanian aquifers	0.12	0.00	0.09	0.30	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.03	0.64	0.00	0.64
Silurian-Devonian aquifers	32.66	0.00	17.15	8.54	0.00	0.25	0.00	0.01	0.00	5.90	0.88	4.72	70.11	0.00	70.11
Indiana total	**339.38**	**0.00**	**127.45**	**79.93**	**0.00**	**20.81**	**0.00**	**5.52**	**0.00**	**26.19**	**6.46**	**93.08**	**698.82**	**0.00**	**698.82**
Iowa															
Cambrian-Ordovician aquifer system	53.30	0.00	3.07	27.32	0.00	1.41	0.00	0.39	0.00	11.36	5.41	0.13	102.39	0.00	102.39
Glacial sand and gravel aquifers	203.83	0.00	16.48	32.76	0.00	18.71	0.00	0.42	0.00	53.95	1.08	27.13	354.36	0.00	354.36
Lower Cretaceous aquifers	15.89	0.00	1.92	4.13	0.00	0.00	0.00	0.00	0.00	19.22	0.92	1.54	43.62	0.00	43.62
Mississippian aquifers	9.90	0.00	1.08	2.33	0.00	0.00	0.00	0.00	0.00	7.04	0.00	0.35	20.70	0.00	20.70
Other aquifers	0.50	0.00	0.69	1.39	0.00	0.00	0.00	0.00	0.00	6.17	0.00	0.20	8.95	0.00	8.95
Silurian-Devonian aquifers	30.15	0.00	8.73	24.85	0.00	6.83	0.00	0.27	0.00	26.11	0.05	2.82	99.81	0.00	99.81
Upper carbonate aquifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iowa total	**313.57**	**0.00**	**31.97**	**92.78**	**0.00**	**26.95**	**0.00**	**1.08**	**0.00**	**123.85**	**7.46**	**32.17**	**629.83**	**0.00**	**629.83**
Kansas															
Alluvial aquifers	64.25	3.04	6.53	13.31	0.00	5.67	0.00	3.20	0.00	36.25	2.14	468.05	599.40	3.04	602.44
Glacial sand and gravel aquifers	3.96	0.00	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.71	5.64	0.00	5.64
High Plains aquifer	39.70	3.14	6.12	14.27	0.00	0.89	0.00	1.03	0.00	39.78	1.01	1,582.21	1,685.01	3.14	1,688.15
Lower Cretaceous aquifers	8.28	0.00	1.02	0.35	0.00	0.00	0.00	0.58	0.00	6.33	0.00	176.38	192.94	0.00	192.94
Other aquifers	8.83	0.00	3.78	2.41	0.00	1.25	0.00	0.63	0.00	0.37	0.01	329.79	347.07	0.00	347.07
Ozark Plateaus aquifer system	5.63	0.00	0.02	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	5.95	0.00	5.95
Kansas total	**130.65**	**6.18**	**17.68**	**30.49**	**0.00**	**7.81**	**0.00**	**5.44**	**0.00**	**83.48**	**3.16**	**2,557.30**	**2,836.01**	**6.18**	**2,842.19**
Kentucky															
Alluvial aquifers	62.58	0.00	0.74	70.25	0.00	0.00	0.00	1.13	0.00	0.10	0.00	0.26	135.06	0.00	135.06
Glacial sand and gravel aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mississippi embayment aquifer system	10.49	0.00	1.37	5.90	0.00	0.00	0.00	0.04	0.00	0.16	0.51	0.40	18.87	0.00	18.87
Mississippi River Valley alluvial aquifer	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04
Mississippian aquifers	6.03	0.00	2.12	1.12	0.00	0.00	0.00	6.69	0.00	0.49	0.01	0.17	16.63	0.00	16.63

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
Kentucky—Continued															
Ordovician aquifers	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.30	0.00	0.18	0.00	0.15	0.92	0.00	0.92
Other aquifers	0.00	0.00	2.52	0.00	0.00	4.96	0.00	0.36	0.00	0.81	0.00	1.62	10.27	0.00	10.27
Pennsylvanian aquifers	4.39	0.00	7.15	0.00	0.00	0.00	0.00	9.10	0.00	0.24	0.06	0.21	21.15	0.00	21.15
Silurian-Devonian aquifers	3.93	0.00	0.25	0.00	0.00	0.00	0.00	0.01	0.00	0.09	0.00	0.03	4.31	0.00	4.31
Kentucky total	**87.42**	**0.00**	**14.48**	**77.27**	**0.00**	**4.96**	**0.00**	**17.63**	**0.00**	**2.07**	**0.58**	**2.84**	**207.25**	**0.00**	**207.25**
Louisiana															
Alluvial aquifers	0.17	0.00	0.11	0.02	0.00	0.00	0.00	0.05	0.00	0.26	3.45	6.65	10.71	0.00	10.71
Coastal lowlands aquifer system	286.39	0.00	29.56	199.22	0.00	35.99	0.00	0.82	0.00	1.83	265.43	455.95	1,275.19	0.00	1,275.19
Mississippi embayment aquifer system	48.26	0.00	6.20	21.36	0.00	0.00	0.00	0.23	0.00	0.35	0.07	5.38	81.85	0.00	81.85
Mississippi River Valley alluvial aquifer	8.65	0.00	2.72	32.83	0.00	0.99	0.00	0.53	0.00	0.67	67.38	245.17	358.94	0.00	358.94
Other aquifers	9.36	0.00	0.75	0.46	0.00	0.00	0.00	0.02	0.00	0.05	0.89	6.52	18.05	0.00	18.05
Louisiana total	**352.83**	**0.00**	**39.34**	**253.89**	**0.00**	**36.98**	**0.00**	**1.65**	**0.00**	**3.16**	**337.22**	**719.67**	**1,744.74**	**0.00**	**1,744.74**
Maine															
Glacial sand and gravel aquifers	23.54	0.00	1.27	1.79	0.00	0.92	0.00	0.53	0.00	0.05	10.90	3.46	42.46	0.00	42.46
New York and New England carbonate-rock aquifers	0.11	0.00	0.49	0.21	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.11	0.96	0.00	0.96
New York and New England crystalline-rock aquifers	3.81	0.00	29.87	3.83	0.00	0.00	0.00	0.91	0.00	1.46	0.00	1.49	41.37	0.00	41.37
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maine total	**27.46**	**0.00**	**31.63**	**5.83**	**0.00**	**0.92**	**0.00**	**1.45**	**0.00**	**1.54**	**10.90**	**5.06**	**84.79**	**0.00**	**84.79**
Maryland															
Early Mesozoic basin aquifers	0.52	0.00	0.79	0.01	0.00	0.01	0.00	0.02	0.00	0.03	0.00	0.05	1.43	0.00	1.43
Mississippian aquifers	1.03	0.00	0.32	0.04	0.00	0.00	0.00	0.10	0.00	0.03	0.00	0.00	1.52	0.00	1.52
Northern Atlantic Coastal Plain aquifer system	85.12	0.00	67.03	6.05	0.00	2.29	0.00	6.52	0.00	4.19	0.00	46.75	217.95	0.00	217.95
Other aquifers	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.00	0.07
Pennsylvanian aquifers	0.15	0.00	1.52	0.00	0.00	0.00	0.00	0.01	0.00	0.12	0.00	0.00	1.80	0.00	1.80
Piedmont and Blue Ridge carbonate-rock aquifers	2.02	0.00	4.66	0.01	0.00	0.00	0.00	2.05	0.00	0.32	0.05	0.14	9.25	0.00	9.25
Piedmont and Blue Ridge crystalline-rock aquifers	4.74	0.00	36.46	4.72	0.00	0.00	0.00	4.37	0.00	0.82	0.00	1.20	52.31	0.00	52.31
Valley and Ridge aquifers	0.31	0.00	3.13	0.02	0.00	0.00	0.00	0.58	0.00	0.34	5.86	0.10	10.34	0.00	10.34
Maryland total	**93.90**	**0.00**	**113.93**	**10.85**	**0.00**	**2.30**	**0.00**	**13.65**	**0.00**	**5.85**	**5.91**	**48.28**	**294.67**	**0.00**	**294.67**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Massachusetts															
Early Mesozoic basin aquifers	0.08	0.00	1.50	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.33	1.97	0.00	1.97
Glacial sand and gravel aquifers	188.65	0.00	3.65	13.16	0.00	0.31	0.00	1.76	0.00	0.02	7.33	98.77	313.65	0.00	313.65
New York and New England carbonate-rock aquifers	0.08	0.00	0.41	0.87	0.00	0.00	0.00	3.60	0.00	0.06	0.00	0.11	5.13	0.00	5.13
New York and New England crystalline-rock aquifers	7.85	0.00	29.56	1.13	0.00	0.06	0.00	0.15	0.00	0.53	0.02	15.27	54.57	0.00	54.57
Northern Atlantic Coastal Plain aquifer system	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Massachusetts total	**196.66**	**0.00**	**35.14**	**15.19**	**0.00**	**0.37**	**0.00**	**5.51**	**0.00**	**0.64**	**7.35**	**114.48**	**375.34**	**0.00**	**375.34**
Michigan															
Cambrian-Ordovician aquifer system	0.43	0.00	2.32	0.17	0.00	0.00	0.00	0.17	0.00	0.34	0.00	0.19	3.62	0.00	3.62
Glacial sand and gravel aquifers	137.41	0.00	131.73	42.37	0.00	4.34	0.00	10.77	0.33	13.97	0.95	234.24	575.78	0.33	576.11
Jacobsville aquifer	2.43	0.00	1.15	0.06	0.00	0.00	0.00	0.26	0.00	0.04	0.03	0.00	3.97	0.00	3.97
Marshall aquifer	32.02	0.00	28.42	3.17	0.00	1.07	0.00	0.35	0.18	4.66	0.01	13.53	83.23	0.18	83.41
Other aquifers	0.33	0.00	1.40	0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.89	2.68	0.00	2.68
Pennsylvanian aquifers	33.01	0.00	16.49	3.00	0.00	0.06	0.00	0.08	0.00	1.99	0.01	10.09	64.73	0.00	64.73
Silurian-Devonian aquifers	3.68	0.00	5.50	15.77	0.00	0.13	0.00	4.38	0.07	0.35	0.07	2.42	32.30	0.07	32.37
Michigan total	**209.31**	**0.00**	**187.01**	**64.55**	**0.00**	**5.60**	**0.00**	**16.01**	**0.58**	**21.40**	**1.07**	**261.36**	**766.31**	**0.58**	**766.89**
Minnesota															
Cambrian-Ordovician aquifer system	218.40	0.00	27.11	29.75	0.00	0.71	0.00	1.36	0.00	12.72	0.49	26.73	317.27	0.00	317.27
Glacial sand and gravel aquifers	105.81	0.00	50.47	17.93	0.00	1.06	0.00	2.26	0.00	41.21	1.22	213.07	433.03	0.00	433.03
Lower Cretaceous aquifers	0.90	0.00	0.53	0.38	0.00	0.00	0.00	0.00	0.00	1.19	0.00	1.05	4.05	0.00	4.05
Other aquifers	4.79	0.00	2.58	0.36	0.00	0.00	0.00	0.01	0.00	0.98	0.01	0.33	9.06	0.00	9.06
Paleozoic aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper carbonate aquifer	6.41	0.00	1.54	0.57	0.00	0.00	0.00	0.00	0.00	2.82	0.00	1.02	12.36	0.00	12.36
Minnesota total	**336.31**	**0.00**	**82.23**	**48.99**	**0.00**	**1.77**	**0.00**	**3.63**	**0.00**	**58.92**	**1.72**	**242.20**	**775.77**	**0.00**	**775.77**
Mississippi															
Coastal lowlands aquifer system	122.05	0.00	20.16	24.75	0.00	1.63	0.00	3.73	0.00	2.92	0.01	3.15	178.40	0.00	178.40
Mississippi embayment aquifer system	168.23	0.00	15.59	23.98	0.00	7.62	0.00	3.08	0.00	2.88	8.87	26.65	256.90	0.00	256.90

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
Mississippi—Continued															
Mississippi River Valley alluvial aquifer	5.67	0.00	1.09	0.20	0.00	24.49	0.00	0.06	0.00	0.05	73.63	1,609.64	1,714.83	0.00	1,714.83
Other aquifers	0.00	0.00	0.07	0.17	0.00	0.00	6.35	0.03	6.58	0.01	0.00	0.00	0.28	12.93	13.21
Southeastern Coastal Plain aquifer system	51.04	0.00	6.56	23.68	0.00	0.00	0.00	1.31	0.00	1.00	5.01	0.46	89.06	0.00	89.06
Mississippi total	**346.99**	**0.00**	**43.47**	**72.78**	**0.00**	**33.74**	**6.35**	**8.21**	**6.58**	**6.86**	**87.52**	**1,639.90**	**2,239.47**	**12.93**	**2,252.40**
Missouri															
Alluvial aquifers	112.45	0.00	2.18	2.32	0.00	2.23	0.00	1.63	0.00	3.60	0.47	67.31	192.19	0.00	192.19
Cambrian-Ordovician aquifer system	17.69	0.00	0.00	0.89	0.00	0.02	0.00	0.00	0.00	0.46	0.00	8.91	27.97	0.00	27.97
Glacial sand and gravel aquifers	0.68	0.00	0.77	1.96	0.00	1.94	0.00	0.96	0.00	2.13	0.63	7.74	16.81	0.00	16.81
Mississippi embayment aquifer system	14.72	0.00	0.00	3.73	0.00	1.43	0.00	0.00	0.00	0.00	0.00	2.42	22.30	0.00	22.30
Mississippi River Valley alluvial aquifer	0.00	0.00	1.26	1.72	0.00	1.91	0.00	0.67	0.00	0.27	1.29	1,167.37	1,174.49	0.00	1,174.49
Mississippian aquifers	10.28	0.00	2.80	5.61	0.00	3.54	0.00	3.35	0.00	0.08	0.00	0.41	26.07	0.00	26.07
Other aquifers	0.00	0.00	1.34	1.03	0.00	0.42	0.00	1.12	0.00	0.00	0.00	0.00	3.91	0.00	3.91
Ozark Plateaus aquifer system	125.77	0.00	49.11	25.12	0.00	2.26	0.00	13.36	0.00	9.58	4.38	44.16	273.74	0.00	273.74
Silurian-Devonian aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Missouri total	**281.59**	**0.00**	**57.46**	**42.38**	**0.00**	**13.75**	**0.00**	**21.09**	**0.00**	**16.12**	**6.77**	**1,298.32**	**1,737.48**	**0.00**	**1,737.48**
Montana															
Alluvial aquifers	5.15	0.00	1.85	0.31	0.00	0.00	0.00	0.09	1.11	1.62	0.02	10.41	19.45	1.11	20.56
Glacial sand and gravel aquifers	3.17	0.00	0.83	0.07	0.00	0.00	0.00	0.23	0.24	0.57	0.11	7.67	12.65	0.24	12.89
Lower Cretaceous aquifers	2.83	0.00	0.40	0.13	0.00	0.00	0.00	0.04	0.73	1.48	1.17	2.60	8.65	0.73	9.38
Lower Tertiary aquifers	1.44	0.00	1.45	0.15	0.00	0.80	0.00	0.19	10.92	3.66	0.01	3.26	10.96	10.92	21.88
Northern Rocky Mountains Intermontane Basins aquifer systems	45.72	0.00	10.56	3.50	0.00	0.00	0.00	0.21	1.31	2.31	0.54	27.27	90.11	1.31	91.42
Other aquifers	22.21	0.00	6.34	0.86	0.00	0.00	0.00	0.26	0.50	1.43	1.64	5.80	38.54	0.50	39.04
Pacific Northwest volcanic-rock aquifers	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Paleozoic aquifers	0.76	0.00	0.22	0.05	0.00	0.00	0.00	0.00	0.03	0.17	0.00	0.41	1.61	0.03	1.64
Upper Cretaceous aquifers	2.03	0.00	0.93	0.15	0.00	0.00	0.00	0.06	1.47	1.06	0.00	2.15	6.38	1.47	7.85
Montana total	**83.32**	**0.00**	**22.58**	**5.22**	**0.00**	**0.80**	**0.00**	**1.08**	**16.31**	**12.30**	**3.49**	**59.57**	**188.36**	**16.31**	**204.67**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
Nebraska															
Alluvial aquifers	79.03	0.00	2.90	2.87	0.00	0.36	0.00	0.05	0.27	11.11	0.39	361.44	458.15	0.27	458.42
Glacial sand and gravel aquifers	1.53	0.00	0.50	0.01	0.00	0.00	0.00	0.00	0.00	1.90	0.00	13.52	17.46	0.00	17.46
High Plains aquifer	99.15	0.00	13.56	31.06	0.00	3.95	0.00	0.01	0.07	71.56	10.15	4,867.90	5,097.34	0.07	5,097.41
Lower Cretaceous aquifers	23.01	0.00	1.39	6.97	0.00	12.52	0.00	0.00	0.00	2.35	0.00	111.56	157.80	0.00	157.80
Other aquifers	15.22	0.00	0.69	1.06	0.00	0.00	0.00	0.00	6.86	2.79	0.00	62.40	82.16	6.86	89.02
Nebraska total	**217.94**	**0.00**	**19.04**	**41.97**	**0.00**	**16.83**	**0.00**	**0.06**	**7.20**	**89.71**	**10.54**	**5,416.82**	**5,812.91**	**7.20**	**5,820.11**
Nevada															
Basin and Range basin-fill aquifers	109.14	0.00	31.70	0.96	0.00	6.08	70.93	95.01	11.28	3.45	9.23	865.44	1,121.01	82.21	1,203.22
Basin and Range carbonate-rock aquifers	6.62	0.00	0.88	0.00	0.00	0.00	0.00	30.67	0.00	0.83	0.00	4.35	43.35	0.00	43.35
Other aquifers	24.16	0.00	3.06	0.06	0.00	0.96	0.00	61.63	0.00	0.54	2.40	99.29	192.10	0.00	192.10
Pacific Northwest basin-fill aquifers	0.94	0.00	0.10	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.00	0.20	1.29	0.00	1.29
Pacific Northwest volcanic-rock aquifers	0.64	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	2.66	3.42	0.00	3.42
Southern Nevada volcanic-rock aquifers	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.28	0.34	0.00	0.34
Nevada total	**141.55**	**0.00**	**35.77**	**1.02**	**0.00**	**7.04**	**70.93**	**187.34**	**11.28**	**4.94**	**11.63**	**972.22**	**1,361.51**	**82.21**	**1,443.72**
New Hampshire															
Glacial sand and gravel aquifers	27.78	0.00	0.49	3.26	0.00	0.96	0.00	0.02	0.00	0.00	5.32	0.89	38.72	0.00	38.72
New York and New England crystalline-rock aquifers	7.64	0.00	29.25	0.95	0.00	0.14	0.00	1.74	0.00	0.63	1.14	0.21	41.70	0.00	41.70
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New Hampshire total	**35.42**	**0.00**	**29.74**	**4.21**	**0.00**	**1.10**	**0.00**	**1.76**	**0.00**	**0.63**	**6.46**	**1.10**	**80.42**	**0.00**	**80.42**
New Jersey															
Alluvial aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
Early Mesozoic basin aquifers	47.64	0.00	15.01	4.09	0.00	0.25	0.00	0.00	0.00	0.15	0.02	3.10	70.26	0.00	70.26
Glacial sand and gravel aquifers	65.18	0.00	3.61	1.75	0.00	0.00	0.00	0.06	0.00	0.03	1.58	0.37	72.58	0.00	72.58
New York and New England carbonate-rock aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Atlantic Coastal Plain aquifer system	247.63	0.00	50.82	20.91	0.00	1.58	0.00	1.35	0.00	0.44	0.06	51.13	373.92	0.00	373.92

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
New Jersey—Continued															
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Piedmont and Blue Ridge carbonate-rock aquifers	10.77	0.00	4.80	1.12	0.00	0.25	0.00	0.00	0.00	0.09	3.96	0.18	21.17	0.00	21.17
Piedmont and Blue Ridge crystalline-rock aquifers	5.36	0.00	9.78	0.45	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.14	15.81	0.00	15.81
Valley and Ridge aquifers	2.00	0.00	6.64	0.57	0.00	0.00	0.00	0.07	0.00	0.09	4.16	0.18	13.71	0.00	13.71
New Jersey total	**378.58**	**0.00**	**90.66**	**28.89**	**0.00**	**2.08**	**0.00**	**1.48**	**0.00**	**0.88**	**9.78**	**55.11**	**567.46**	**0.00**	**567.46**
New Mexico															
Basin and Range basin-fill aquifers	0.50	0.00	0.10	0.00	0.00	0.00	0.00	7.34	0.00	0.04	2.16	6.59	16.73	0.00	16.73
Colorado Plateaus aquifers	8.14	0.00	5.36	0.82	0.00	2.05	0.00	2.00	4.79	1.08	3.17	3.95	26.57	4.79	31.36
High Plains aquifer	18.69	0.00	2.03	0.01	0.00	1.63	0.00	0.20	41.82	12.55	0.00	486.50	521.61	41.82	563.43
Other aquifers	32.13	0.00	3.93	0.22	0.00	0.00	0.00	26.26	29.88	8.29	1.96	96.47	169.26	29.88	199.14
Pecos River Basin alluvial aquifer	0.54	0.00	0.01	0.03	0.00	0.00	0.00	0.04	10.40	0.16	0.00	0.11	0.89	10.40	11.29
Rio Grande aquifer system	107.34	0.00	12.21	1.58	0.00	2.45	0.00	3.44	1.11	5.11	9.79	279.17	421.09	1.11	422.20
Roswell Basin aquifer system	16.17	0.00	1.00	0.74	0.00	0.00	0.00	0.07	1.42	2.54	1.59	175.66	197.77	1.42	199.19
New Mexico total	**183.51**	**0.00**	**24.64**	**3.40**	**0.00**	**6.13**	**0.00**	**39.35**	**89.42**	**29.77**	**18.67**	**1,048.45**	**1,353.92**	**89.42**	**1,443.34**
New York															
Alluvial aquifers	2.41	0.00	0.92	0.30	0.00	0.97	0.00	0.14	0.00	0.22	0.00	0.03	4.99	0.00	4.99
Early Mesozoic basin aquifers	6.48	0.00	1.04	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	8.46	0.00	8.46
Glacial sand and gravel aquifers	273.88	0.00	138.11	14.54	0.00	0.34	0.00	4.44	0.00	12.89	9.64	12.30	466.14	0.00	466.14
New York and New England carbonate-rock aquifers	33.94	0.00	25.53	10.75	0.00	0.71	0.00	0.85	0.00	2.43	0.69	0.86	75.76	0.00	75.76
New York and New England crystalline-rock aquifers	2.79	0.00	14.00	0.00	0.00	0.00	0.00	0.03	0.00	0.08	0.00	0.36	17.26	0.00	17.26
New York sandstone aquifers	2.37	0.00	5.91	1.44	0.00	0.00	0.00	0.07	0.00	1.05	0.64	0.13	11.61	0.00	11.61
Northern Atlantic Coastal Plain aquifer system	282.83	0.00	0.74	0.00	0.00	5.28	0.00	0.00	0.00	0.10	0.00	3.94	292.89	0.00	292.89
Other aquifers	9.39	0.00	0.00	1.51	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	10.90	0.95	11.85
Valley and Ridge aquifers	0.08	0.00	1.22	0.00	0.00	0.00	0.00	0.11	0.00	0.04	0.00	0.09	1.54	0.00	1.54
New York total	**614.17**	**0.00**	**187.47**	**29.35**	**0.00**	**7.30**	**0.00**	**5.64**	**0.95**	**16.81**	**10.97**	**17.84**	**889.55**	**0.95**	**890.50**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
North Carolina															
Castle Hayne aquifer	38.42	0.00	5.28	0.45	0.00	0.00	0.00	7.25	0.00	3.35	0.44	9.33	64.52	0.00	64.52
Early Mesozoic basin aquifers	1.10	0.00	5.86	0.00	0.00	0.00	0.00	1.77	0.00	0.94	0.00	1.72	11.39	0.00	11.39
Northern Atlantic Coastal Plain aquifer system	73.68	0.00	16.76	12.39	0.00	0.15	0.00	7.26	0.00	32.03	10.91	27.68	180.86	0.00	180.86
Other aquifers	0.19	0.00	7.23	0.00	0.00	0.00	0.00	0.19	0.00	0.50	0.00	1.00	9.11	0.00	9.11
Piedmont and Blue Ridge carbonate-rock aquifers	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16
Piedmont and Blue Ridge crystalline-rock aquifers	29.78	0.00	127.28	1.65	0.00	0.00	0.00	9.64	0.00	12.41	0.07	25.32	206.15	0.00	206.15
Surficial aquifer system	14.37	0.00	6.15	0.55	0.00	0.03	0.00	3.93	0.00	2.69	1.86	18.74	48.32	0.00	48.32
Valley and Ridge aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Carolina total	**157.70**	**0.00**	**168.56**	**15.04**	**0.00**	**0.18**	**0.00**	**30.04**	**0.00**	**51.92**	**13.28**	**83.79**	**520.51**	**0.00**	**520.51**
North Dakota															
Alluvial aquifers	8.57	0.00	0.91	2.97	0.00	0.42	0.00	7.79	0.00	3.77	0.00	33.46	57.89	0.00	57.89
Glacial sand and gravel aquifers	22.70	0.00	2.14	2.81	0.00	0.00	0.00	15.16	0.00	5.84	0.00	51.56	100.21	0.00	100.21
Lower Cretaceous aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower Tertiary aquifers	0.02	0.00	0.08	0.06	0.00	0.00	0.00	0.39	0.00	0.69	0.00	0.24	1.48	0.00	1.48
Other aquifers	2.00	0.00	0.22	0.25	0.00	0.00	0.00	1.20	15.10	0.81	0.00	16.77	21.25	15.10	36.35
Paleozoic aquifers	1.60	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.62	0.00	1.62
Upper Cretaceous aquifers	0.46	0.00	0.32	0.09	0.00	0.00	0.00	1.63	0.00	1.36	0.00	0.37	4.23	0.00	4.23
North Dakota total	**35.35**	**0.00**	**3.69**	**6.18**	**0.00**	**0.42**	**0.00**	**26.17**	**15.10**	**12.47**	**0.00**	**102.40**	**186.68**	**15.10**	**201.78**
Ohio															
Alluvial aquifers	75.74	0.00	8.43	34.06	0.00	7.83	0.00	0.72	0.00	1.13	5.57	0.55	134.03	0.00	134.03
Glacial sand and gravel aquifers	331.91	0.00	49.97	78.94	0.00	3.15	0.00	32.61	0.00	1.89	2.93	11.93	513.33	0.00	513.33
Mississippian aquifers	6.74	0.00	26.15	0.35	0.00	0.00	0.00	0.02	0.00	1.22	1.01	1.19	36.68	0.00	36.68
Other aquifers	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.42	0.00	0.42
Pennsylvanian aquifers	7.35	0.00	19.21	0.70	0.00	0.00	0.00	3.49	0.00	0.67	0.02	0.72	32.16	0.00	32.16
Silurian-Devonian aquifers	27.84	0.00	33.00	23.59	0.00	0.01	0.00	54.50	0.00	2.86	3.79	3.49	149.08	0.00	149.08
Ohio total	**449.58**	**0.00**	**136.76**	**138.01**	**0.00**	**10.99**	**0.00**	**91.34**	**0.00**	**7.82**	**13.32**	**17.88**	**865.70**	**0.00**	**865.70**
Oklahoma															
Ada-Vamoosa aquifer	4.49	0.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.05	6.22	0.00	6.22
Alluvial aquifers	42.78	0.00	11.51	2.37	0.00	1.59	0.00	1.89	0.00	9.14	0.06	137.69	207.03	0.00	207.03

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
Oklahoma—Continued															
Arbuckle-Simpson aquifer	3.52	0.00	0.20	0.01	0.00	0.00	0.00	0.79	0.00	0.07	0.00	0.08	4.67	0.00	4.67
Blaine aquifer	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.14	0.00	30.38	30.61	0.00	30.61
Central Oklahoma aquifer	23.40	0.00	7.75	2.34	0.00	0.00	0.00	0.01	0.00	0.31	0.00	5.08	38.89	0.00	38.89
Edwards-Trinity aquifer system	2.36	0.00	0.69	1.66	0.00	0.00	0.00	1.02	0.00	0.38	0.00	0.97	7.08	0.00	7.08
High Plains aquifer	9.45	0.00	0.48	0.41	0.00	0.00	0.00	0.02	0.00	13.97	0.00	504.18	528.51	0.00	528.51
Other aquifers	6.47	0.00	4.05	0.02	0.00	0.00	0.00	0.06	154.71	1.06	0.00	26.86	38.52	154.71	193.23
Ozark Plateaus aquifer system	3.92	0.00	2.73	0.00	0.00	0.00	0.00	0.01	0.00	0.81	0.00	0.10	7.57	0.00	7.57
Rush Springs aquifer	5.72	0.00	1.39	0.37	0.00	0.00	0.00	0.41	0.00	1.32	0.00	81.73	90.94	0.00	90.94
Oklahoma total	**102.11**	**0.00**	**30.33**	**7.27**	**0.00**	**1.59**	**0.00**	**4.21**	**154.71**	**27.35**	**0.06**	**787.12**	**960.04**	**154.71**	**1,114.75**
Oregon															
Basin and Range basin-fill aquifers	1.54	0.00	0.94	0.00	0.00	0.00	0.00	0.10	0.00	0.14	7.92	179.37	190.01	0.00	190.01
Columbia Plateau basaltic-rock aquifers	16.95	0.00	5.11	2.35	0.00	1.19	0.00	0.51	0.00	0.88	0.00	279.31	306.30	0.00	306.30
Columbia Plateau basin-fill aquifers	6.87	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.02	21.38	49.13	77.86	0.00	77.86
Other aquifers	2.87	0.00	15.47	0.10	0.00	0.00	0.00	3.40	0.00	0.26	0.13	25.25	47.48	0.00	47.48
Pacific Northwest basin-fill aquifers	23.17	0.00	12.57	0.00	0.00	0.00	0.00	0.32	0.00	0.31	1.73	174.76	212.86	0.00	212.86
Pacific Northwest volcanic-rock aquifers	44.92	0.00	10.78	0.04	0.00	0.00	0.00	3.40	0.00	0.49	1.51	158.31	219.45	0.00	219.45
Snake River Plain basaltic-rock aquifers	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.97	2.50	0.00	2.50
Snake River Plain basin-fill aquifers	0.12	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.80	15.18	0.00	15.18
Willamette Lowland basin-fill aquifers	50.54	0.00	20.23	0.96	0.00	0.38	0.00	0.72	0.00	0.92	0.15	332.40	406.30	0.00	406.30
Oregon total	**146.98**	**0.00**	**66.35**	**3.45**	**0.00**	**1.57**	**0.00**	**8.45**	**0.00**	**3.02**	**32.82**	**1,215.30**	**1,477.94**	**0.00**	**1,477.94**
Pennsylvania															
Alluvial aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Early Mesozoic basin aquifers	35.08	0.00	31.46	3.53	0.00	0.08	0.00	8.50	0.00	3.91	0.47	2.13	85.16	0.00	85.16
Glacial sand and gravel aquifers	13.25	0.00	5.75	0.00	0.00	0.01	0.00	0.77	0.00	0.71	4.46	0.91	25.86	0.00	25.86
Mississippian aquifers	10.09	0.00	6.47	0.21	0.00	0.06	0.00	0.04	0.00	1.17	0.85	0.34	19.23	0.00	19.23

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
							Pennsylvania—Continued								
New York and New England carbonate-rock aquifers	1.95	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.08	2.44	0.00	2.44
Northern Atlantic Coastal Plain aquifer system	1.07	0.00	0.08	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	1.26	0.00	1.26
Other aquifers	18.41	0.00	22.06	17.46	0.00	0.00	0.00	0.22	0.00	2.85	3.82	0.84	65.66	0.00	65.66
Pennsylvanian aquifers	35.20	0.00	39.70	2.94	0.00	0.75	0.00	5.48	0.00	3.67	2.41	3.49	93.64	0.00	93.64
Piedmont and Blue Ridge carbonate-rock aquifers	24.03	0.00	10.69	2.96	0.00	0.00	0.00	7.68	0.00	4.17	0.39	2.27	52.19	0.00	52.19
Piedmont and Blue Ridge crystalline-rock aquifers	15.44	0.00	30.87	1.82	0.00	0.00	0.00	2.97	0.00	4.34	0.60	2.24	58.28	0.00	58.28
Valley and Ridge aquifers	72.88	0.00	60.79	16.92	0.00	4.48	0.00	7.23	0.00	15.49	35.82	5.14	218.75	0.00	218.75
Pennsylvania total	**227.40**	**0.00**	**208.27**	**45.93**	**0.00**	**5.38**	**0.00**	**32.89**	**0.00**	**36.32**	**48.82**	**17.46**	**622.47**	**0.00**	**622.47**
							Puerto Rico								
North Coast Limestone aquifer system (Puerto Rico)	29.47	0.00	0.25	2.29	0.00	0.00	0.00	0.68	0.00	2.05	0.00	1.30	36.04	0.00	36.04
Other aquifers	23.33	0.00	0.26	1.10	0.00	0.99	0.00	0.53	0.00	2.11	0.00	20.80	49.12	0.00	49.12
South Coast aquifer (Puerto Rico)	13.82	0.00	0.01	0.28	0.00	0.83	0.00	0.63	0.00	0.07	0.00	19.47	35.11	0.00	35.11
Puerto Rico total	**66.62**	**0.00**	**0.52**	**3.67**	**0.00**	**1.82**	**0.00**	**1.84**	**0.00**	**4.23**	**0.00**	**41.57**	**120.27**	**0.00**	**120.27**
							Rhode Island								
Glacial sand and gravel aquifers	12.31	0.00	0.71	0.38	0.00	0.00	0.00	0.16	0.00	0.08	6.72	2.89	23.25	0.00	23.25
New York and New England crystalline-rock aquifers	1.45	0.00	5.86	0.16	0.00	0.00	0.00	1.02	0.00	0.03	0.00	0.89	9.41	0.00	9.41
Northern Atlantic Coastal Plain aquifer system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhode Island total	**13.76**	**0.00**	**6.57**	**0.54**	**0.00**	**0.00**	**0.00**	**1.18**	**0.00**	**0.11**	**6.72**	**3.78**	**32.66**	**0.00**	**32.66**
							South Carolina								
Floridan aquifer system	10.38	0.00	19.02	2.69	0.00	0.44	0.00	0.91	0.00	0.66	0.09	14.83	49.02	0.00	49.02
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Piedmont and Blue Ridge crystalline-rock aquifers	5.17	0.00	52.72	1.51	0.00	0.00	0.00	2.08	0.00	0.04	0.02	1.84	63.38	0.00	63.38
Southeastern Coastal Plain aquifer system	80.07	0.00	26.52	18.67	0.00	4.07	0.00	3.51	0.00	2.91	0.03	61.82	197.60	0.00	197.60
Surficial aquifer system	18.89	0.00	20.02	3.42	0.00	0.01	0.00	1.78	0.00	0.74	0.47	9.40	54.73	0.00	54.73
South Carolina total	**114.51**	**0.00**	**118.28**	**26.29**	**0.00**	**4.52**	**0.00**	**8.28**	**0.00**	**4.35**	**0.61**	**87.89**	**364.73**	**0.00**	**364.73**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
	Withdrawals, in million gallons per day														
South Dakota															
Alluvial aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.08	0.22	0.00	0.22
Glacial sand and gravel aquifers	35.55	0.00	0.28	8.99	0.00	0.00	0.00	2.74	0.00	10.43	0.76	112.65	171.40	0.00	171.40
High Plains aquifer	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	1.37	0.00	21.39	23.95	0.00	23.95
Lower Cretaceous aquifers	9.37	0.00	1.73	7.92	0.00	0.00	0.00	0.36	0.00	4.41	2.36	4.58	30.73	0.00	30.73
Lower Tertiary aquifers	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.05	0.37	0.00	0.37
Other aquifers	0.64	0.00	0.16	0.31	0.00	0.00	0.00	0.47	0.00	0.80	0.31	0.19	2.88	0.00	2.88
Paleozoic aquifers	1.04	0.00	0.11	0.90	0.00	0.00	0.00	0.00	0.00	0.24	0.14	0.27	2.70	0.00	2.70
Upper Cretaceous aquifers	0.16	0.00	0.29	0.28	0.00	0.00	0.00	0.00	0.00	1.64	0.00	0.30	2.67	0.00	2.67
South Dakota total	**47.98**	**0.00**	**2.58**	**18.40**	**0.00**	**0.00**	**0.00**	**3.59**	**0.00**	**19.29**	**3.57**	**139.51**	**234.92**	**0.00**	**234.92**
Tennessee															
Alluvial aquifers	1.87	0.00	0.66	0.00	0.00	0.00	0.00	0.08	0.00	0.22	0.00	1.01	3.84	0.00	3.84
Mississippi embayment aquifer system	188.51	0.00	6.79	44.14	0.00	2.18	0.00	1.50	0.00	1.59	0.68	13.18	258.57	0.00	258.57
Mississippi River Valley alluvial aquifer	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	6.80	7.23	0.00	7.23
Mississippian aquifers	16.63	0.00	6.65	0.99	0.00	0.00	0.00	0.56	0.00	2.76	7.25	5.44	40.28	0.00	40.28
Ordovician aquifers	2.40	0.00	5.51	0.49	0.00	0.00	0.00	4.19	0.00	2.87	0.00	4.25	19.71	0.00	19.71
Other aquifers	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.29	0.00	0.02	0.00	0.00	0.41	0.00	0.41
Pennsylvanian aquifers	0.37	0.00	2.41	0.00	0.00	0.00	0.00	0.25	0.00	0.63	0.00	0.70	4.36	0.00	4.36
Piedmont and Blue Ridge crystalline-rock aquifers	0.24	0.00	2.92	0.18	0.00	0.00	0.00	0.02	0.00	0.23	0.33	0.12	4.04	0.00	4.04
Silurian-Devonian aquifers	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.34	0.00	0.06	0.00	0.18	0.94	0.00	0.94
Southeastern Coastal Plain aquifer system	6.95	0.00	1.68	0.00	0.00	0.00	0.00	3.04	0.00	0.51	0.00	1.09	13.27	0.00	13.27
Valley and Ridge aquifers	38.90	0.00	15.47	5.77	0.00	0.00	0.00	6.84	0.00	2.95	3.43	3.67	77.03	0.00	77.03
Tennessee total	**255.87**	**0.00**	**42.86**	**51.57**	**0.00**	**2.18**	**0.00**	**17.11**	**0.00**	**11.96**	**11.69**	**36.44**	**429.68**	**0.00**	**429.68**
Texas															
Alluvial aquifers	0.03	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00	66.40	68.12	0.00	68.12
Blaine aquifer	0.19	0.00	0.01	0.11	0.00	0.00	0.00	0.00	0.00	0.65	0.00	32.73	33.69	0.00	33.69
Coastal lowlands aquifer system	241.62	5.08	43.82	60.55	0.77	12.34	0.00	3.85	0.00	15.68	10.17	243.25	631.28	5.85	637.13
Edwards-Trinity aquifer system	331.18	0.77	45.50	9.69	0.01	0.00	0.00	9.35	0.02	11.27	0.83	242.22	650.04	0.80	650.84
High Plains aquifer	72.41	0.68	13.27	18.23	0.19	15.22	0.00	4.65	0.00	71.49	0.00	3,247.55	3,442.82	0.87	3,443.69

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Texas—Continued															
Other aquifers	243.24	2.59	14.00	2.91	0.00	0.49	0.00	83.19	1,004.57	12.80	0.20	320.08	676.91	1,007.16	1,684.07
Pecos River Basin alluvial aquifer	10.17	0.11	0.45	0.12	0.00	0.00	0.00	0.02	0.00	0.39	0.00	65.78	76.93	0.11	77.04
Rio Grande aquifer system	74.57	9.12	0.88	0.77	2.19	1.60	0.00	0.00	0.02	0.34	0.00	36.57	114.73	11.33	126.06
Seymour aquifer	4.41	0.73	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.53	0.00	92.98	98.61	0.73	99.34
Texas coastal uplands aquifer system	175.16	0.63	17.62	6.82	0.11	8.03	0.00	14.48	0.00	23.95	0.41	128.98	375.45	0.74	376.19
Texas total	**1,152.98**	**19.71**	**136.69**	**99.34**	**3.27**	**37.68**	**0.00**	**115.54**	**1,004.61**	**138.20**	**11.61**	**4,476.54**	**6,168.58**	**1,027.59**	**7,196.17**
U.S. Virgin Islands															
Kingshill aquifer (Virgin Islands)	0.09	0.00	0.15	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.32
Other aquifers	0.82	0.00	1.08	0.44	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	2.35	0.00	2.35
U.S. Virgin Islands total	**0.91**	**0.00**	**1.23**	**0.52**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**2.67**	**0.00**	**2.67**
Utah															
Alluvial aquifers	8.09	0.00	0.86	0.15	0.00	0.00	0.00	0.00	0.00	0.12	2.32	1.49	13.03	0.00	13.03
Basin and Range basin-fill aquifers	207.15	4.53	3.76	27.41	22.51	17.06	8.46	0.00	16.23	4.17	27.12	486.93	773.60	51.73	825.33
Basin and Range carbonate-rock aquifers	51.17	0.00	0.15	3.78	13.76	0.00	0.00	0.00	18.02	0.53	0.00	1.78	57.41	31.78	89.19
Colorado Plateaus aquifers	34.64	0.00	4.02	5.43	0.30	5.59	0.00	1.67	9.44	1.59	53.64	41.74	148.32	9.74	158.06
Other aquifers	53.76	0.00	1.56	0.63	0.00	0.07	0.00	0.00	0.00	1.04	0.00	2.97	60.03	0.00	60.03
Pacific Northwest basin-fill aquifers	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.92	1.94	0.00	1.94
Pacific Northwest volcanic-rock aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Utah total	**354.81**	**4.53**	**10.36**	**37.40**	**36.57**	**22.72**	**8.46**	**1.67**	**43.69**	**7.46**	**83.08**	**536.83**	**1,054.33**	**93.25**	**1,147.58**
Vermont															
Glacial sand and gravel aquifers	5.41	0.00	0.40	0.59	0.00	0.53	0.00	0.00	0.00	0.18	4.16	0.28	11.55	0.00	11.55
New York and New England carbonate-rock aquifers	2.09	0.00	2.68	0.20	0.00	0.00	0.00	0.00	0.00	1.53	0.00	0.24	6.74	0.00	6.74
New York and New England crystalline-rock aquifers	6.38	0.00	7.88	0.71	0.00	0.01	0.00	0.23	0.00	2.70	0.01	0.50	18.42	0.00	18.42
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vermont total	**13.88**	**0.00**	**10.96**	**1.50**	**0.00**	**0.54**	**0.00**	**0.23**	**0.00**	**4.41**	**4.17**	**1.02**	**36.71**	**0.00**	**36.71**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day														
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Virginia															
Early Mesozoic basin aquifers	1.19	0.00	10.37	0.18		0.00	0.00	0.08	0.00	0.08	0.00	0.36	12.26	0.00	12.26
Mississippian aquifers	0.02	0.00	0.12	0.13		0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.31	0.00	0.31
Northern Atlantic Coastal Plain aquifer system	23.52	10.85	29.52	38.88		1.05	2.72	0.88	0.00	0.63	0.00	4.61	99.09	13.57	112.66
Other aquifers	0.08	0.69	0.06	0.11		0.00	0.00	0.00	0.00	0.04	0.00	0.07	0.36	0.69	1.05
Pennsylvanian aquifers	0.19	0.00	0.91	0.00		0.00	0.00	0.85	0.00	0.05	0.00	0.02	2.02	0.00	2.02
Piedmont and Blue Ridge crystalline-rock aquifers	10.68	0.00	58.04	0.52		0.03	0.00	2.74	0.00	1.37	0.12	1.46	74.96	0.00	74.96
Valley and Ridge aquifers	35.60	0.00	25.75	26.16		0.00	0.00	1.61	0.00	4.34	0.03	1.42	94.91	0.00	94.91
Virginia total	**71.28**	**11.54**	**124.77**	**65.98**		**1.08**	**2.72**	**6.20**	**0.00**	**6.51**	**0.15**	**7.94**	**283.91**	**14.26**	**298.17**
Washington															
Columbia Plateau basaltic-rock aquifers	103.19		28.21	17.21	0.00	0.00	0.00	1.78	0.00	9.80	1.98	449.21	611.38	0.00	611.38
Columbia Plateau basin-fill aquifers	129.17		6.49	11.18	0.00	0.00	0.00	0.43	0.00	4.24	0.04	161.85	313.40	0.00	313.40
Northern Rocky Mountains Intermontane Basins aquifer systems	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other aquifers	72.22		21.17	18.69	0.00	0.67	0.00	1.80	0.00	1.76	3.04	18.05	137.40	0.00	137.40
Pacific Northwest basin-fill aquifers	24.03		10.56	4.72	0.00	3.33	0.00	1.08	0.00	0.94	9.65	29.09	83.40	0.00	83.40
Pacific Northwest volcanic-rock aquifers	1.28		0.43	0.03	0.00	0.00	0.00	0.10	0.00	0.05	0.04	0.38	2.31	0.00	2.31
Puget Sound aquifer system	156.87		40.80	16.79	0.00	0.00	0.00	7.96	0.00	3.97	35.88	57.05	319.32	0.00	319.32
Willamette Lowland basin-fill aquifers	34.43		1.94	14.88	0.00	3.77	0.00	0.29	0.00	0.09	0.00	3.91	59.31	0.00	59.31
Washington total	**521.19**		**109.60**	**83.50**	**0.00**	**7.77**	**0.00**	**13.44**	**0.00**	**20.85**	**50.63**	**719.54**	**1,526.52**	**0.00**	**1,526.52**
West Virginia															
Alluvial aquifers	13.74	0.00	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.04	0.00	16.04
Mississippian aquifers	1.55	0.00	2.83	0.02	0.00	0.00	0.00	0.39	0.02	0.15	2.78	0.07	7.79	0.02	7.81
Other aquifers	0.59	0.00	1.14	0.04	0.00	0.00	0.00	0.12	0.00	0.11	2.28	0.03	4.31	0.00	4.31
Pennsylvanian aquifers	16.77	0.00	19.95	23.08	3.05	1.19	0.00	15.09	1.50	0.31	2.29	0.06	78.74	4.55	83.29
Piedmont and Blue Ridge crystalline-rock aquifers	0.09	0.00	0.18	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.02	0.32	0.00	0.32
Valley and Ridge aquifers	4.93	0.00	7.22	0.20	0.00	0.00	0.00	8.19	0.00	1.13	0.75	0.22	22.64	0.00	22.64
West Virginia total	**37.67**	**0.00**	**31.32**	**25.64**	**3.05**	**1.19**	**0.00**	**23.80**	**1.52**	**1.72**	**8.10**	**0.40**	**129.84**	**4.57**	**134.41**

Table 2. Estimated groundwater withdrawals from principal aquifers in the United States during 2015 by State and water-use category.—Continued

Aquifer name	Withdrawals, in million gallons per day													
	Public supply, fresh	Public supply, saline	Self-supplied domestic	Industrial, fresh	Industrial, saline	Thermo-electric power, fresh	Thermo-electric power, saline	Mining, fresh	Mining, saline	Livestock	Aqua-culture	Irrigation	Total, fresh	Total, saline	Total
Wisconsin															
Cambrian-Ordovician aquifer system	146.07	0.00	27.49	27.98	0.00	0.82	0.00	0.19	0.00	32.69	10.45	70.26	315.95	0.00	315.95
Glacial sand and gravel aquifers	98.01	0.00	29.03	12.65	0.00	2.39	0.00	0.05	0.00	16.36	11.89	210.13	380.51	0.00	380.51
Jacobsville aquifer	0.24	0.00	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.05	2.00	0.07	2.56	0.00	2.56
Other aquifers	0.64	0.00	5.29	0.40	0.00	0.00	0.00	0.00	0.00	7.10	0.16	0.34	13.93	0.00	13.93
Silurian-Devonian aquifers	20.79	0.00	14.45	5.72	0.00	0.00	0.00	0.18	0.00	10.84	1.02	6.15	59.15	0.00	59.15
Wisconsin total	**265.75**	**0.00**	**76.44**	**46.77**	**0.00**	**3.21**	**0.00**	**0.42**	**0.00**	**67.04**	**25.52**	**286.95**	**772.10**	**0.00**	**772.10**
Wyoming															
Alluvial aquifers	23.51	0.00	3.14	1.05	0.00	0.05	0.00	1.70	0.00	0.93	2.54	166.85	199.77	0.00	199.77
Colorado Plateaus aquifers	1.75	0.00	0.47	1.81	0.00	0.00	0.00	0.34	0.00	0.43	0.84	72.12	77.76	0.00	77.76
High Plains aquifer	7.23	0.00	2.34	1.11	0.00	0.08	0.00	1.15	0.00	2.30	0.00	281.01	295.22	0.00	295.22
Lower Cretaceous aquifers	4.64	0.00	0.41	0.34	0.00	0.06	0.00	0.19	0.00	0.23	0.00	1.44	7.31	0.00	7.31
Lower Tertiary aquifers	6.96	0.00	1.38	0.60	0.00	1.12	0.00	28.85	0.00	1.50	0.08	2.97	43.46	0.00	43.46
Other aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	96.76	0.00	0.00	0.00	0.00	96.76	96.76
Pacific Northwest basin-fill aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific Northwest volcanic-rock aquifers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paleozoic aquifers	5.87	0.00	0.75	0.49	0.00	0.00	0.00	0.14	0.00	0.42	1.00	9.42	18.09	0.00	18.09
Upper Cretaceous aquifers	3.69	0.00	0.35	0.34	0.00	0.00	0.00	0.72	0.00	0.27	0.01	0.96	6.34	0.00	6.34
Wyoming Tertiary aquifers	0.86	0.00	0.09	0.09	0.00	0.00	0.00	0.02	0.00	0.09	0.45	2.16	3.76	0.00	3.76
Wyoming total	**54.51**	**0.00**	**8.93**	**5.83**	**0.00**	**1.31**	**0.00**	**33.11**	**96.76**	**6.17**	**4.92**	**536.93**	**651.71**	**96.76**	**748.47**
Grand total	**14,950.63**	**263.14**	**3,203.35**	**2,670.36**	**42.89**	**424.37**	**172.35**	**1,005.91**	**1,855.30**	**1,238.83**	**1,600.60**	**57,205.18**	**82,299.23**	**2,333.68**	**84,632.91**

Glossary

The following terms are referenced in the text or are part of the water-use circular series.

aquaculture water use Water use associated with the farming of organisms that live in water (such as finfish and shellfish) and offstream water use associated with fish hatcheries. *See also* livestock water use.

closed-loop cooling system *See* recirculating cooling system.

commercial water use Water for motels, hotels, restaurants, office buildings, other commercial facilities, military and nonmilitary institutions, and (for 1990 and 1995) offstream fish hatcheries. Water may be obtained from a public-supply system or may be self-supplied. Commercial water-use estimates were included in some previous water-use circulars but were omitted beginning in 2000. *See also* public-supply water use, public-supply deliveries, and self-supplied water use.

consumptive use The part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment. Also referred to as water consumed.

cooling system An equipment system that provides water for cooling purposes, such as to condensers at powerplants or at factories. May include water intakes, outlets, cooling towers, ponds, canals, pumps, and pipes. *See also* cooling-system type, industrial water use, and thermoelectric-power water use.

cooling-system type Defined as either once-through or recirculating cooling system. *See also* industrial water use, once-through cooling system, recirculating cooling system, and thermoelectric-power water use.

domestic water use Water used for indoor household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, and flushing toilets, and outdoor purposes, such as watering lawns and gardens. Domestic water use includes water provided to households by a public water supply (domestic deliveries from public suppliers) and self-supplied water. *See also* public-supply deliveries, public-supply water use, rural water use, and self-supplied water use.

freshwater Water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids. Generally, water with more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses. *See also* saline water.

industrial water use Water used for fabrication, processing, washing, and cooling. Includes industries such as chemical and allied products, food, mining, paper and allied products, petroleum refining, and steel. Term used in previous water-use circulars to describe the combined public-supply deliveries to industrial users and self-supplied industrial withdrawals. Since 2000, industrial water use refers only to self-supplied industrial withdrawals. *See also* mining water use, public-supply deliveries, public-supply water use, and self-supplied water use.

instream use Water that is used, but not withdrawn, from a surface-water source for such purposes as hydroelectric-power generation, navigation, water-quality improvement, fish propagation, and recreation. Instream water-use estimates for hydroelectric power were included in some previous water-use circulars but were omitted since 2000.

irrigation water use Water that is applied by an irrigation system to assist crop and pasture growth, or to maintain vegetation on recreational lands such as parks and golf courses. Irrigation includes water that is applied for pre-irrigation, frost protection, chemical application, weed control, field preparation, crop cooling, harvesting, dust suppression, leaching of salts from the root zone, and conveyance losses. Irrigation water use includes self-supplied water and reclaimed wastewater.

livestock water use Water used for livestock watering, feedlots, dairy operations, and other on-farm needs. Types of livestock include dairy cows and heifers, beef cattle and calves, sheep and lambs, goats, hogs and pigs, horses and poultry. *See also* aquaculture water use, and rural water use.

mining water use Water used for the extraction of naturally occurring minerals including solids (such as coal, sand, gravel, and other ores), liquids (such as crude petroleum), and gases (such as natural gas). Also includes uses associated with quarrying, milling of mined materials, injection of water for secondary oil recovery or for unconventional oil and gas recovery (such as hydraulic fracturing), and other operations associated with mining activity. Does not include water associated with dewatering of the aquifer that is not put to beneficial use. Also does not include water used in processing, such as smelting, refining petroleum, or slurry pipeline operations. These processing uses are included in industrial water use. *See also* industrial water use and self-supplied water use.

once-through cooling system Also known as open-loop cooling system. Cooling system in which the water is withdrawn from a source, circulated through the heat exchangers, and then returned to a body of water at a higher temperature. *See also* cooling system, cooling-system type, and thermoelectric-power water use.

public-supply deliveries Amount of water delivered from a public supplier to users for domestic, commercial, industrial, thermoelectric power, or public-use purposes. Estimates of deliveries for each purpose were provided for 1995 and earlier years, but not for 2000. For 2005–2015, only domestic deliveries were estimated nationally. *See also* commercial water use, domestic water use, industrial water use, public-supply water use, public water use, and thermoelectric-power use.

public-supply water use Water withdrawn by public and private water suppliers that furnish water to at least 25 people or have a minimum of 15 connections. Public suppliers provide water for a variety of uses, such as domestic, commercial, industrial, thermoelectric-power, and public water use. *See also* commercial water use, domestic water use, industrial water use, public-supply deliveries, public water use, and thermoelectric-power water use.

public water use Water supplied from a public supplier and used for such purposes as firefighting, street washing, flushing of water lines, and maintaining municipal parks and swimming pools. Generally, public-use water is not billed by the public supplier. *See also* public-supply deliveries and public-supply water use.

recirculating cooling system Also known as closed-loop cooling system. Water is withdrawn from a source, circulated through heat exchangers, cooled, and then reused in the same process. Recirculating cooling systems may use induced-draft cooling towers, forced-draft cooling towers, cooling ponds, or canals. *See also* cooling system, cooling-system type, and thermoelectric-power water use.

reclaimed wastewater Wastewater-treatment plant effluent that has been diverted for beneficial uses such as irrigation, industrial use, or thermoelectric-power cooling instead of being released to a natural waterway or aquifer. *See also* water use.

return flow Water that reaches a groundwater or surface-water source after release from the point of use and thus becomes available for further use. *See also* water use.

rural water use Water used in suburban or farm areas for domestic and livestock needs. The water generally is self-supplied and includes domestic use, drinking water for livestock, and other uses such as dairy sanitation, cleaning, and waste disposal. *See also* domestic water use, livestock water use, and self-supplied water use.

saline water Water that contains 1,000 mg/L or more of dissolved solids. *See also* freshwater.

self-supplied water use Water withdrawn from a groundwater or surface-water source by a user rather than being obtained from a public-supply source.

thermoelectric-power water use Water used in the process of generating electricity with steam-driven turbine generators. Thermoelectric-power water use includes water provided by a public water supply (deliveries from public suppliers), self-supplied water, and reclaimed wastewater. *See also* cooling system, cooling-system type, public-supply water use, reclaimed wastewater, and self-supplied water use.

water use In a restrictive sense, the term refers to water that is withdrawn for a specific purpose, such as for public supply, domestic use, irrigation, thermoelectric-power cooling, or industrial processing. In some previous water-use circulars, water use for the domestic, commercial, industrial, and thermoelectric-power categories included both self-supplied withdrawals and deliveries from public supply, and some categories included reclaimed wastewater use. More broadly, water use pertains to the interaction of humans with and influence on the hydrologic cycle and includes elements such as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, return flow, and instream use. *See also* instream use.

water withdrawal Water removed from a groundwater or surface-water source for use. *See also* self-supplied water use.

Appendix 1. Summary of Sources of Information and Methods Used to Estimate Water Withdrawals from Principal Aquifers for Each Category of Use in Each State

Brief descriptions of primary data sources and methods used to estimate groundwater withdrawals from principal aquifers in each State are summarized in this appendix. These summaries are generalized and may not include all the data sources or methods used for a State. Unless otherwise indicated, geospatial data for principal aquifers used in analyses were obtained from the U.S. Geological Survey (USGS, 2017a; 2018).

Alabama

Withdrawals from principal aquifers in Alabama were estimated by using 2015 county withdrawal data from the USGS Aggregate Water-Use Data System (AWUDS) and the well-weighted method. Construction data for about 2,300 water wells, including well location, category of use, and local aquifer assignment, were obtained from the Geological Survey of Alabama. The local aquifer assignment for each well was correlated to a principal aquifer by using hydrogeologic information from Miller and others (2000b), well locations, and spatial extents of principal aquifers. From these data, the percentages of wells completed in each principal aquifer in each county for each category of use were calculated, then used to disaggregate and assign 2015 withdrawals for each use category in each county to one or more principal aquifers.

Alaska

Withdrawals from principal aquifers in Alaska were estimated by using 2015 county withdrawal data from AWUDS and the well-weighted method. Construction data, including location, depth, use category, and aquifer code, for 3,370 water wells were obtained from the USGS National Water Information System (NWIS; USGS, 2017b). Locations of wells used for thermoelectric power were estimated by using data provided by the U.S. Energy Information Administration and Energy Justice Network. The percentages of wells completed in each principal aquifer in each borough for each category of use were calculated and used to disaggregate and assign 2015 withdrawals in each borough to one or more principal aquifers.

Arizona

Withdrawals from principal aquifers for public-supply, domestic, industrial, and livestock uses were estimated by using the 2015 county withdrawals from NWIS and the well-weighted method. Construction data, including location, depth, use category, and aquifer, for 13,200 water wells were obtained from NWIS. Additional water-well construction data were obtained from the Arizona Department of Water Resources. Geospatial analysis of well locations was used to determine the percentage of wells per county-aquifer combination for public-supply, domestic, industrial, and livestock uses. The percentages of wells completed in each principal aquifer in each county for each category of use were then calculated and used to disaggregate and assign 2015 withdrawals in each county to one or more principal aquifers. Withdrawals for mining, thermoelectric power, irrigation, and aquaculture generally were assigned to principal aquifers based on site-specific data obtained from individual facilities and other sources.

Arkansas

Withdrawals from principal aquifers in Arkansas for public-supply, industrial, mining, aquaculture, and irrigation uses were estimated by using site-specific withdrawal data, including local aquifer assignments, obtained from the USGS Arkansas Water Use Data Program. Withdrawals from principal aquifers for self-supplied domestic and livestock uses were estimated by using 2015 county withdrawals data from AWUDS, construction data for 4,100 domestic water wells and 220 livestock wells, and the well-weighted method. Principal aquifers were correlated with local aquifers by using information from Renken (1998), well locations, and principal-aquifer extents. Percentages of wells in each principal aquifer in each county for each use were calculated and used to disaggregate and assign 2015 county withdrawals to principal aquifers. Withdrawals for thermoelectric power were assigned to principal aquifers by using geospatial analysis of powerplant locations obtained from the U.S. Energy Information Administration (2018) and principal-aquifer extents.

California

Withdrawals from principal aquifers in California were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data, including locations, for public-supply, irrigation, livestock, industrial, and domestic wells were obtained from the California Department of Water Resources (2015) (435,000 wells) and Qi and Harris (2017) (800 wells). Locations of wells used for aquaculture were estimated based on information about aquaculture facilities obtained from the California Department of Fish and Wildlife. Locations of wells used for thermoelectric power were estimated by using data obtained from the U.S. Energy Information Administration. Principal aquifers were assigned to wells by using geospatial analysis of well locations and principal-aquifer extents. Percentages of wells in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals to principal aquifers.

Colorado

Withdrawals from principal aquifers in Colorado were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Documentation from USGS water-use compilations for 2000, 2005, and 2010 were referenced to assign estimated withdrawals to principal aquifers. Surface-water withdrawal locations were obtained from NWIS to identify regions supplied by surface water. Additional geospatial data for aquifer extents in Colorado were obtained from Colorado's Decision Support Systems (https://www.colorado.gov/cdss). Water-well data, including location, use category, aquifer, and other information, were obtained from NWIS (26,100 wells), Qi and Harris (2017) (11,400 wells), and the Colorado Information Marketplace (https://data.colorado.gov/) (7,000 wells). Geospatial analysis of well locations and principal-aquifer extents was used as needed to assign principal aquifers to wells. Percentages for each county, aquifer, and use combination were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers. Thermoelectric-power well locations were estimated and assigned to principal aquifers by using data provided by the U.S. Energy Information Administration and Energy Justice Network.

Connecticut

Data for select public-supply systems and aquaculture facilities were obtained from the Connecticut Department of Energy and Environmental Protection (DEEP) and Public Utilities Regulatory Authority. Aquifers were associated with public-supply systems by matching system identifiers to water-well locations and descriptions obtained from the United States Environmental Protection Agency (EPA). For some public-supply systems, principal aquifers were assigned based on system location and principal-aquifer extents, which were obtained from the USGS and, for glacial aquifers, from the DEEP. Aquaculture withdrawals were assigned to aquifers based on permitted withdrawal volumes for each facility from the DEEP. The area-weighted method was used to assign principal aquifers to self-supplied domestic withdrawals obtained from AWUDS. Geospatial analysis of public-supply service areas, rural housing, and principal aquifer extents was used to develop the area-weighted percentages. The well-weighted method was used to disaggregate and assign principal aquifers to industrial, mining, irrigation, and livestock withdrawals obtained from AWUDS. Percentages of wells in each aquifer in each county were developed by using geospatial analysis of principal-aquifer extents and water-well data obtained from NWIS.

Delaware

The North Atlantic Coastal Plain aquifer system was assumed to be the source of groundwater for all withdrawals in Kent and Sussex Counties. For New Castle County, withdrawals for all use categories except self-supplied domestic were estimated by using 2015 county withdrawals from AWUDS, water-well construction data from NWIS, and the well-weighted method. Percentages of wells screened in each aquifer for each use category were developed by using geospatial analysis of well locations and principal-aquifer extents and used to disaggregate and assign 2015 withdrawals in each county to principal aquifers. Self-supplied domestic withdrawals were estimated by using 2015 county withdrawals from AWUDS, water-well permit data from the Delaware Department of Natural Resources and Environmental Control, Division of Water, and the well-weighted method. Principal aquifers were assigned to permitted domestic wells by using geospatial analysis of well locations and principal-aquifer extents. Percentages of wells screened in each aquifer were then used to disaggregate and assign 2015 domestic withdrawals for each county from NWIS to principal aquifers.

District of Columbia

Although three principal aquifers are present in the District of Columbia, no groundwater withdrawals were reported in the District in 2015 (Dieter and others, 2018). Therefore, withdrawals in the District from principal aquifers were estimated to be 0.00 Mgal/d.

Florida

Withdrawals from principal aquifers in Florida for public-supply, self-supplied domestic, industrial, thermoelectric-power, mining, livestock, and aquaculture uses were estimated from site-specific withdrawal data provided by Florida Water Management Districts. Principal aquifers were assigned to withdrawals primarily based on historical water-use data, information obtained from previous studies, and professional judgment. Withdrawals for irrigation also were provided by some water management districts but were estimated for other areas of Florida by using crop acreage obtained from various agricultural agencies and water-use coefficients. Aquifers were assigned to irrigation withdrawals based on information from previous USGS groundwater and water-use studies.

Georgia

Withdrawals from principal aquifers in Georgia for public supply, industry, thermoelectric power, and golf course irrigation were based on site-specific data provided by the Georgia Department of Natural Resources, Environmental Protection Division. The data included local aquifer codes that subsequently were correlated to principal aquifer codes. Withdrawals for self-supplied domestic use were estimated by using estimates of populations that were not on public water systems and a per capita water-use coefficient. The withdrawals were disaggregated and assigned to principal aquifers by using the well-weighted method and domestic water-well data from the USGS NWIS database. Estimated withdrawals for crop irrigation were provided by the Georgia Soil and Water Conservation District. Many of the irrigation records included the source aquifer, but when the source aquifer was not included, the aquifer was assumed based on farm location and principal-aquifer extents. Estimated withdrawals for livestock and aquaculture in each county were disaggregated and assigned to principal aquifers by using the well-weighted method and water-well data from the USGS NWIS database. Withdrawals for mining primarily were assigned to principal aquifers based on mine locations and principal-aquifer extents.

Hawaii

Withdrawals from principal aquifers in Hawaii were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data for water wells, including location, depth, use category, and aquifer, were obtained from NWIS (7,040 wells) and Qi and Harris (2017) (369 wells). Locations of wells used for thermoelectric power were estimated by using data provided by the U.S. Energy Information Administration and USGS personnel in Hawaii. Principal aquifers were assigned to wells by using geospatial analysis of well locations and depths and principal-aquifer extents. Additional geospatial data of aquifer extents were obtained from the Hawaii State Office of Planning (http://geoportal.hawaii.gov/datasets?group_ids=4ef473112ddd427d844394e44b62dba2). Percentages of wells in each aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers.

Idaho

Withdrawals from principal aquifers in Idaho were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data for about 175,000 water wells were obtained from the Idaho Department of Natural Resources. These data included well location, category of use, and well depth. Surficial geologic maps and geologic contact maps were obtained from the Idaho Geologic Survey. Individual wells were correlated to principal aquifer well locations, spatial extents of principal aquifers, and geologic maps. From these data, the percentages of wells completed in each principal aquifer in each county for each category of use were calculated and then used to disaggregate and assign 2015 withdrawals in each county to one or more principal aquifers.

Illinois

Withdrawals from principal aquifers in Illinois were estimated by using site-specific withdrawal information obtained from Patrick Mills, USGS Central Midwest Water Science Center. These data included facility name, facility type, facility location, local aquifer code, and withdrawal rates for 2015. Patrick Mills also provided data that correlated local aquifer codes to principal aquifers, and these correlations were used to assign withdrawals to principal aquifers.

Indiana

Withdrawals from principal aquifers in Indiana for public-supply and industrial uses were estimated by using site-specific withdrawal rates obtained from the Indiana Department of Natural Resources for about 7,000 high-capacity wells capable of withdrawing more than 100,000 gallons per day. Principal aquifers were assigned to the high-capacity wells, which represented the total population of public-supply and industrial facilities, by using geospatial analysis of well locations and depths and principal-aquifer extents and depths. Withdrawals from principal aquifers for irrigation, livestock, aquaculture, and thermoelectric power were estimated by using 2015 county withdrawals from AWUDS and the withdrawal-weighted method. Percentages of withdrawals from each aquifer in each county for each use category were calculated from the site-specific withdrawal data and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers. Withdrawals from principal aquifers for self-supplied domestic use were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data, including location, depth, and use category, for about 400,000 water wells were obtained from the Indiana Department of Natural Resources. Principal aquifers were assigned to wells by using geospatial analysis of well locations and depths and principal-aquifer extents. The percentages of wells in each aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers.

Iowa

Withdrawals from principal aquifers in Iowa were estimated by using site-specific withdrawal information obtained from Mike Linhart of the USGS Central Midwest Water Science Center. The data included facility name, facility type, facility location, local aquifer codes, and withdrawal rates for 2015. Local aquifers were correlated with principal aquifers, then withdrawals were totaled by county, principal aquifer, and use category.

Kansas

Withdrawals from principal aquifers in Kansas were estimated by using data from the Kansas Department of Agriculture, Division of Water Resources. The data included site locations, facility type, well-construction data, local aquifer codes, use category, and 2015 withdrawal rates. Local aquifer codes were correlated to principal aquifers by using information obtained from Jenny Lanning-Rush of the USGS Kansas Water Science Center and David Engelhaupt of the Kansas Department of Agriculture. Use categories were refined by using Standard Industrial Classification codes provided by Jenny Lanning-Rush. Withdrawals were then totaled by county, principal aquifer, and use category.

Kentucky

Withdrawals from principal aquifers in Kentucky were estimated by using 2015 withdrawals by county from AWUDS for each use category and the well-weighted method. Construction data, including location and use category, for about 17,300 water wells were obtained from the Kentucky Geological Survey. Principal aquifer designations were assigned to wells by using geospatial analysis of well locations and the principal aquifer extents. The percentages of wells completed in each principal aquifer in each county for each category of use were then calculated and used to disaggregate and assign 2015 withdrawals in each county to one or more principal aquifers.

Louisiana

Site-specific groundwater withdrawal data, including local source aquifers, for public-supply, industrial, mining, and thermoelectric-power water-use categories were obtained from Angela Robinson of the USGS Lower Mississippi-Gulf Water Science Center. Estimated withdrawals for self-supplied domestic use, irrigation, livestock, and aquaculture that were aggregated by parish and local aquifers also were provided. The local aquifers in these data were correlated to principal aquifers, then totaled by parish, principal aquifer, and category of use.

Maine

Site-specific public-supply withdrawals obtained from the Maine Public Utilities Commission were assigned to principal aquifers by using data from the EPA's Safe Drinking Water Information System and geospatial analysis to compare facility locations and well depths with principal-aquifer extents. Withdrawals for self-supplied domestic, industrial, livestock, irrigation, and mining uses in each county were obtained from AWUDS and assigned to principal aquifers by using geospatial analysis and the well-weighted method. Well-construction data, including location, use, and depth, for about 121,000 wells were obtained from the Maine Geological Survey. Well-construction data, including location, use, and depth, for an additional 7,300 wells were obtained from the USGS NWIS database. Geospatial analysis was used to assign principal aquifers to wells by comparing well location and depth to principal-aquifer extents. The percentages of wells in each aquifer and county for each use were used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers. Site-specific withdrawals for aquaculture and thermoelectric power in Maine were obtained from personnel in the USGS New England Water Science Center and assigned to principal aquifers based on facility locations relative to principal-aquifer extents. Facility locations were obtained from the Department of Homeland Security's Infrastructure Program database or determined from analysis of aerial photographs.

Maryland

Site-specific withdrawal data, including aquifer designations, for public-supply, industrial, mining, irrigation, and aquaculture uses in Maryland were obtained from personnel in the USGS Maryland-Delaware-District of Columbia Water Science Center and summed by county, principal aquifer, and category of use.

Withdrawals for self-supplied domestic and livestock uses in each county were obtained from AWUDS and assigned to principal aquifers by using water-well construction data, including aquifer designations, for about 17,000 wells from NWIS and the well-weighted method.

Massachusetts

Site-specific withdrawal data for public-supply, industrial, mining, and thermoelectric-power uses in Massachusetts were obtained from the Massachusetts Department of Environmental Protection (DEP). Principal aquifers were assigned to public-supply withdrawals by using facility information and water-well data from the DEP Drinking Water Program and the U.S. Environmental Protection Agency. Principal aquifers were assigned to withdrawals for industrial, mining, and thermoelectric-power uses by using information from a previous USGS study (Levin and Granato, 2018). Withdrawals were then summed by county, principal aquifer, and use category.

Withdrawals from principal aquifers for self-supplied domestic use and irrigation were estimated by using 2015 withdrawals by county from AWUDS and the well-weighted method. Construction data, including locations and depths, for about 30,000 domestic water wells were obtained from the DEP. A principal aquifer was assigned to each well by using geospatial analysis of well location and depth, principal-aquifer extents from the USGS, and detailed data on depth and extent of the Glacial sand and gravel aquifers from the Massachusetts Office of GIS. Construction records for more than 14,000 irrigation wells obtained from the DEP included well depth and depth to bedrock, but did not include specific locations and instead were located by municipality. Percentages of the area of each municipality underlain by each principal aquifer and no principal aquifer were calculated by using geospatial analysis of municipality location and principal-aquifer extents. Irrigation wells with depths less than the depth to bedrock were assigned to the Glacial sand and gravel aquifers. Irrigation wells with depths greater than the depth to bedrock were assigned to principal aquifers by using these percentages. After all wells had been assigned to principal aquifers, the percentages of domestic and irrigation wells completed in each principal aquifer in each county were calculated and used to disaggregate and assign 2015 county withdrawals for self-supplied domestic and irrigation uses from AWUDS to principal aquifers. The results were then summed by county, principal aquifer, and use category.

Michigan

Withdrawals from principal aquifers in Michigan were estimated by using 2015 withdrawals by county and use category from AWUDS, the withdrawal-weighted method, and the well-weighted method. County withdrawals for public supply, industry, and irrigation were disaggregated and assigned to principal aquifers by using percentages of withdrawals from principal aquifers in each county derived from withdrawals presented in Maupin and Barber (2005). Geospatial analysis and principal-aquifer extents were used to assign principal aquifers to water-well data obtained from the

Michigan Department of Environmental Quality. Percentages of wells completed in each principal aquifer in each county for each use category were then used to disaggregate and assign county withdrawals to principal aquifers.

Minnesota

Withdrawals from principal aquifers in Minnesota for all use categories except self-supplied domestic were estimated by using site-specific data from the Minnesota Department of Natural Resources. The dataset included facility name, use type, local aquifer name, and 2015 withdrawal rate. Local aquifers were correlated to principal aquifers through comparison with water-well data from NWIS that included both local and principal aquifer designations and through geospatial analysis of facility locations in relation to principal-aquifer extents. Withdrawals were then summed by county, principal aquifer, and use category. Withdrawals for self-supplied domestic use in each county were obtained from NWIS and disaggregated and assigned to principal aquifers by using geospatial analysis of principal-aquifer extents and the area-weighted method.

Mississippi

Withdrawals from principal aquifers for public-supply and industrial use in Mississippi were estimated by using 2015 county withdrawal estimates from AWUDS and the withdrawal-weighted method. Percentages of withdrawals from each principal aquifer in each county for public-supply and industrial use were determined from reported site-specific withdrawal data obtained from the Mississippi Department of Environmental Quality for a subset of public-supply and industrial facilities. The reported withdrawal data were assumed to be representative of the entire population of withdrawals for public-supply and industrial use and were used to develop percentages of withdrawals from each principal aquifer in each county for those categories. These percentages were then used to disaggregate 2015 county withdrawals from AWUDS and assign them to principal aquifers. Withdrawals from principal aquifers for self-supplied domestic, irrigation, livestock, mining, and thermoelectric power were estimated by disaggregating total withdrawals for these use categories in each county by using water-well construction data for about 60,000 wells from NWIS, 2015 county withdrawal estimates from AWUDS, and the well-weighted method. Because no wells were specified for mining or thermoelectric-power generation in NWIS, percentages developed from livestock and industrial wells were used to disaggregate and assign withdrawals for those two categories to principal aquifers.

Missouri

Withdrawals from principal aquifers in Missouri for all use categories except self-supplied domestic were estimated by using 2015 county withdrawals from AWUDS, construction data for about 200,000 water wells obtained from the Missouri Department of Natural Resources, and the well-weighted method. Principal aquifers were correlated to wells by using geospatial analysis of principal-aquifer extents and well locations, depths, and lithologies. Percentages of wells screened in each aquifer in each county for each use category were determined and used to disaggregate and assign 2015 county totals to principal aquifers. Withdrawals from principal aquifers for self-supplied domestic use were estimated by using 2015 county withdrawals and the area-weighted method. The percentage of each county underlain by each principal aquifer was determined by using geospatial analysis of principal aquifer and county extents. Where principal aquifers overlapped, the shallowest aquifer was assumed to be the primary source for domestic wells.

Montana

Withdrawals from principal aquifers in Montana were estimated by using 2015 county withdrawals from AWUDS, water-well construction data, and the well-weighted method. Construction data for public-supply, domestic, industrial, mining, irrigation, and livestock wells, including location, depth, use category, and local aquifer, were obtained from the Montana Ground Water Information Center. Additional data for aquaculture and thermoelectric-power wells were obtained from Montana Fish, Wildlife, and Parks and the U.S. Energy Information Administration. Principal aquifers generally were assigned to wells by correlating the local aquifers or through geospatial analysis of principal-aquifer extents with well locations and depths. In some areas where aquifers are stacked, well log data were consulted to determine the source aquifer. The percentages of wells in each principal aquifer in each county for each use were calculated and used to disaggregate and assign county withdrawals from AWUDS to principal aquifers.

Nebraska

Withdrawals from principal aquifers in Nebraska were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Water-well construction data for about 235,000 wells, including location, depth, and use category, were obtained from the Nebraska Department of Natural Resources. Principal aquifers were assigned to wells by using geospatial analysis of principal-aquifer extents and well locations and depths. Percentages of wells in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign withdrawals from AWUDS to principal aquifers.

Nevada

Withdrawals from principal aquifers in Nevada primarily were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data for about 11,600 water wells, including location and aquifer, were obtained from NWIS. Percentages of wells completed in each principal aquifer in each county for each use category were used to disaggregate county withdrawals from AWUDS and assign them to principal aquifers. For irrigation, aquaculture, mining, and thermoelectric-power uses, additional information on locations of irrigated areas and aquaculture, mining, and power-generation facilities was obtained from a variety of sources. Geospatial analysis was used to associate water wells with those locations, and only the wells that could be associated to a location were used to calculate the principal-aquifer percentages for the irrigation, aquaculture, mining, and thermoelectric-power use categories.

New Hampshire

Withdrawals from principal aquifers in New Hampshire for all use categories except self-supplied domestic were estimated from site-specific data, including well-construction information, obtained from the New Hampshire Department of Environmental Services. Site-specific data that were not already associated with a specific aquifer were assigned an aquifer by using geospatial analysis of well depth and principal-aquifer extents and additional data for glacial and bedrock aquifers obtained from the USGS office in Maine. Withdrawals from each principal aquifer in each county for each use category were summed and compared to 2015 county totals in AWUDS. Discrepancies between the two sets of estimates were rectified by proportionally increasing or decreasing the withdrawals for each principal aquifer for a use category in a county so that the resulting total matched the total for that use category and county in the data from AWUDS.

Self-supplied domestic withdrawals were estimated by using 2015 county totals from AWUDS and the well-weighted method. Construction data, including location and aquifer, for about 118,000 domestic wells were obtained from the New Hampshire Geological Survey. Percentages of wells in each principal aquifer in each county were calculated and used to disaggregate and assign withdrawals from AWUDS to principal aquifers.

New Jersey

Withdrawals from principal aquifers for all categories of use in New Jersey were estimated by using site-specific withdrawal data for 2015 obtained from the New Jersey Department of Environmental Protection, Division of Water Supply and Geoscience. Most of the withdrawal data were correlated to well data that include aquifer designations from NWIS. Withdrawal data that could not be correlated to wells were investigated and, when possible, assigned aquifers by USGS personnel in New Jersey. Withdrawals that could not positively be associated with an aquifer were divided and assigned to principal aquifers in the county proportionally to the rates of known withdrawals from principal aquifers in the county for the use category. All withdrawals subsequently were summed by county, principal aquifer, and use category.

New Mexico

Withdrawals from principal aquifers in New Mexico were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data, including location, depth, use category, and aquifer designation for most of about 30,000 water wells, were obtained from NWIS. Additional construction data for about 147,000 wells, including location, depth, and use category, were obtained from the New Mexico Office of the State Engineer. Locations of wells used for thermoelectric power were estimated by using data provided by the U.S. Energy Information Administration. Principal aquifers were assigned to wells as needed by using geospatial analysis of well locations and depths, principal-aquifer extents, and geologic maps obtained from the New Mexico Office of Public Planning. Percentages of wells completed in each principal aquifer in each county for each use category were used to disaggregate county withdrawals from AWUDS and assign them to principal aquifers.

New York

Withdrawals from principal aquifers in New York primarily were estimated using site-specific withdrawal data, water-well locations, and principal-aquifer extents. Site-specific withdrawal data, including location, aquifer type, well depth, use category, and withdrawal rate, for all use categories except self-supplied domestic were obtained from the New York State Department of Environmental Conservation. Additional data for facility locations were obtained from the Department of Homeland Security's Infrastructure Program database. Withdrawals that were attributed to the aquifer type "unconsolidated" were assigned to the Glacial sand and gravel aquifer. Withdrawals that were attributed to the aquifer type "bedrock" were assigned to principal aquifers by using geospatial analysis of well location, depth, and principal-aquifer extents. When the aquifer type was unknown, aquifers assigned to nearby wells or facilities generally were used. Withdrawals for principal aquifers for self-supplied domestic use were estimated by using 2015 county withdrawals from AWUDS and the area-weighted method. Geospatial analysis was used to calculate the percentages of each county underlain by principal aquifers and by no principal aquifers. The resulting percentages were used to disaggregate and assign 2015 county withdrawals for self-supplied domestic use to principal aquifers.

North Carolina

Withdrawals from principal aquifers in North Carolina were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data for about 11,200 water wells were obtained from NWIS. These data included well location, use category, and local and national aquifer codes. The percentages of wells completed in each principal aquifer in each county for each category of use were calculated and used to disaggregate and assign 2015 withdrawals in each county to one or more principal aquifers. When a county had estimated withdrawals for a use category, but no wells in the county for that use in the well-construction dataset, percentages developed for another use category were used to disaggregate and assign withdrawals to principal aquifers in the county.

North Dakota

Site-specific 2015 withdrawal data and construction data for about 235,000 water wells were obtained from the North Dakota State Water Commission and Office of the State Engineer. The withdrawal data included county location, use category, local aquifer, and withdrawal rates for public supply and industry. For these use categories, local aquifers in the withdrawal dataset were correlated with principal aquifers, and withdrawals were summed by county, principal aquifer, and use category. Withdrawals for self-supplied domestic, irrigation, livestock, aquaculture, mining, and thermoelectric-power use were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Well-construction data included use category, location, depth, and local aquifer. Wells were correlated to principal aquifer by using the local aquifers associated with each well and geospatial analysis of well locations and principal-aquifer extents. Percentages of wells completed in each principal aquifer in each county for each use category were used to disaggregate 2015 county withdrawals from AWUDS and assign them to principal aquifers.

Ohio

Withdrawals from principal aquifers in Ohio were estimated by using site-specific data obtained from Kimberly Schaffer of the USGS Ohio-Kentucky-Indiana Water Science Center. These data included facility name, facility type, use category, local aquifer, and withdrawal rate. Site-specific withdrawals were correlated to principal aquifer by using the local aquifers associated with the withdrawals and geospatial analysis of withdrawal locations and principal-aquifer extents. Withdrawals subsequently were summed by county, principal aquifer, and use category.

Oklahoma

Withdrawals from principal aquifers for public supply, industry, and irrigation in Oklahoma were estimated by using site specific data provided by Carol Becker of the USGS Oklahoma Water Science Center. The site-specific data included site location, site name, use type, and principal aquifer. Withdrawals for self-supplied domestic, livestock, aquaculture, mining, and thermoelectric power were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data for about 103,000 water wells, including location, depth, and use category, were obtained from the Oklahoma Water Development Board. Principal aquifers were assigned to wells by using geospatial analysis of well locations and depths and principal-aquifer extents. Percentages of wells in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign withdrawals from AWUDS to principal aquifers.

Oregon

Withdrawals from principal aquifers for public supply and aquaculture use in Oregon were estimated by using site-specific withdrawal data, including use category, location, and local aquifer, provided by Jonathan Haynes of the USGS Oregon Water Science Center. Withdrawals from principal aquifers for self-supplied domestic, industrial, irrigation, and livestock uses were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data, including location, use category, and sometimes aquifer, for about 8,900 water wells in Oregon were obtained from NWIS. Additional information about locations of mines, irrigated land, and thermoelectric powerplants were obtained from the Oregon Spatial Data Library, Esri ArcGIS online catalog, and the Energy Information Administration. Principal aquifers were assigned to wells and other locations as needed by using geospatial analysis of locations, well depths, and principal-aquifer extents. Additional geospatial data for the Columbia Plateau Regional Aquifer System were obtained from the USGS Oregon Water Science Center and used where stacked aquifers were present to help determine source aquifers. Percentages of wells completed in each principal aquifer in each county for each use were calculated and used to disaggregate and assign 2015 county withdrawals from NWIS to principal aquifers.

Pennsylvania

Withdrawals from principal aquifers in Pennsylvania for public-supply, industrial, mining, thermoelectric-power, and irrigation uses were estimated by using a combination of withdrawal-weighted and well-weighted methods. Site-specific withdrawal data from the Pennsylvania Department of Environmental Protection, 2015 county withdrawals from AWUDS, and the withdrawal-weighted method were used for most counties. Principal aquifers were assigned to site-specific withdrawals by associating the withdrawals to water-well construction data for 5,700 wells from the USGS Pennsylvania Water Science Center's water-use database, 33,000 wells from NWIS, and 161,000 wells from the Pennsylvania Department of Conservation. Geospatial analysis was used to assign principal aquifers to wells as needed by using well locations and depths and principal-aquifer extents. Percentages of withdrawals from each principal aquifer in each county for each category of use were calculated from the site-specific withdrawals and used to disaggregate and assign county withdrawals from AWUDS to principal aquifers. When a county had no site-specific withdrawals for a use category, but had withdrawals for that use in the county in the AWUDS data, the county withdrawals from AWUDS were disaggregated and assigned to principal aquifers by using the well-construction data and the well-weighted method. Withdrawals from principal aquifers for self-supplied domestic, livestock, and aquaculture also were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method.

Puerto Rico

Withdrawals from principal aquifers in Puerto Rico were estimated by using 2015 county withdrawal data from AWUDS, construction data for about 2,300 water wells from NWIS, and the well-weighted method. Geospatial analysis was used to assign principal aquifers to wells based on the well location and principal-aquifer extents. The percentages of wells completed in each principal aquifer in each municipio for each use category were calculated and used to disaggregate and assign 2015 withdrawals to one or more principal aquifers. When a municipio had estimated withdrawals for a particular category of use, but no wells in the well-construction data for that use, percentages developed for another use category were used.

Rhode Island

Withdrawals from principal aquifers in Rhode Island for public supply were estimated by using site-specific withdrawal estimates, including associated water well names or numbers, obtained from the USGS New England Water Science Center, 2015 county withdrawals from AWUDS, and the withdrawal-weighted method. Principal aquifers were assigned to site-specific withdrawal estimates by using geospatial analysis of associated well locations and principal-aquifer extents. Percentages of withdrawals from each principal aquifer in each county for public-supply use were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers. These same percentages also were used to disaggregate and assign 2015 county withdrawals for industrial and irrigation uses from AWUDS to principal aquifers. Self-supplied populations in each Rhode Island township, obtained from the USGS New England Water Science Center, were assigned to principal aquifers by using geospatial analysis of township areas, principal aquifer extents, and the extents of New England stratified drift aquifers, which also were obtained from the USGS New England Water Science Center. Self-supplied domestic withdrawals from principal aquifers in each county were estimated by multiplying the self-supplied populations assigned to principal aquifers in each county by a water-use coefficient, then summing the results by county and principal aquifer. The percentages of self-supplied withdrawals from principal aquifers in each county were then used to disaggregate and assign 2015 county withdrawals for livestock and mining uses from AWUDS to principal aquifers. Withdrawals for aquaculture were assigned to principal aquifers by using information provided by the USGS New England Water Science Center.

South Carolina

Withdrawals from principal aquifers in South Carolina were estimated by using 2015 county withdrawal data from AWUDS and the well-weighted method. Construction data, including location, use category, and local and national aquifers, for about 6,800 water wells were obtained from NWIS. The percentages of wells completed in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers. When a county had estimated withdrawals in AWUDS for a particular use category, but no wells in the county for that use in the well-construction data, percentages developed for another use category were used to disaggregate and assign withdrawals to principal aquifers in the county.

South Dakota

Withdrawals from principal aquifers in South Dakota were estimated by using 2015 county withdrawal data from AWUDS and the well-weighted method. Construction data, including location, depth, and use category, for about 72,000 water wells were obtained from the South Dakota Department of Environment and Natural Resources, Water Rights Program. Principal aquifers were assigned to wells by using geospatial analysis of well locations and depths and principal-aquifer extents. Percentages of wells completed in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals from NWIS to principal aquifers.

Tennessee

Site-specific withdrawals for public supply and industries were obtained from the Tennessee Department of Environment and Conservation, Division of Water Resources, and assigned to aquifers by using geospatial analysis of withdrawal locations and principal-aquifer extents, previously published water-use reports, and local knowledge of aquifers and water use in Tennessee. Withdrawals from principal aquifers for self-supplied domestic, irrigation, and livestock uses were estimated by using 2015 county withdrawals from AWUDS and the area-weighted method. Where aquifers were stacked, staff in the Nashville office of the USGS Lower Mississippi-Gulf Water Science Center used local knowledge of water use and aquifers to adjust area-weighted percentages and assign withdrawals to aquifers. USGS staff in Nashville also assigned site-specific withdrawals for aquaculture, mining, and thermoelectric-power uses to principal aquifers based on facility locations, identified through aerial photographs and other means, and principal-aquifer extents.

Texas

Withdrawals from principal aquifers in Texas were estimated for all use categories by using data obtained from the Texas Water Development Board. Information in the dataset included site name, facility type, use category, local aquifer name, and annual withdrawal rate. Local aquifers were correlated to principal aquifers by using information from Ryder (1996) and George and others (2011). Withdrawals were then summed by county, principal aquifer, and use category.

U.S. Virgin Islands

Withdrawals from principal aquifers in the U.S. Virgin Islands were estimated by using 2015 county withdrawal data from AWUDS, construction data for about 563 water wells from NWIS, and the well-weighted method. Geospatial analysis was used to assign principal aquifers to wells based on well location and principal-aquifer extents. The percentages of wells completed in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 withdrawals to one or more principal aquifers. When a county had estimated withdrawals for a particular category of use, but no wells in the well-construction data for that use, percentages developed for another use category were used.

Utah

Withdrawals from principal aquifers in Utah were estimated by using geospatial analysis, 2015 county withdrawals from NWIS, and the well-weighted method. Construction data for water wells in Utah were obtained from several sources, including NWIS (22,400 wells), Qi and Harris (2017) (5,100 wells), and the Utah Automated Geographic Reference Center (161,000 wells). Thermoelectric-power well locations were estimated by using data provided by the U.S. Energy Information Administration and Energy Justice Network. Additional geospatial data for the top elevation for the Basin and Range carbonate-rock aquifers were obtained from Virginia McGuire, USGS Nebraska Water Science Center. Geospatial analysis was used to assign principal aquifers to wells based on location and depth and principal-aquifer extents and depths. Percentages of wells in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers.

Vermont

Site-specific withdrawal data for public suppliers in Vermont were obtained from the Vermont Drinking Water and Groundwater Protection Division. Water wells were associated with public suppliers by using well-construction data, including location and aquifer, obtained from Cheryl Buchwald, USGS New England Water Science Center, and from the Vermont Open Geodata Portal. Principal aquifers were assigned to wells as needed by using geospatial analysis of well locations and depths and principal-aquifer extents. Additional geospatial data for sand and gravel deposits were obtained from Ratcliffe and others (2011), and geospatial data for bedrock were obtained from the Vermont Open Geodata Portal. Site-specific withdrawal data also were obtained for aquaculture and thermoelectric-power uses from the USGS New England Water Science Center. Principal aquifers were assigned to these withdrawals by using geospatial analysis of facility locations and principal-aquifer extents.

Withdrawals from principal aquifers for self-supplied domestic, industrial, mining, and irrigation uses were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data for water wells were obtained from NWIS (1,300 wells) and the Vermont Open Geodata Portal (101,000 wells). Principal aquifers were assigned to wells as needed by using geospatial analysis of well locations and depths and principal-aquifer extents. Percentages of wells in each principal aquifer in each county for each use category were calculated and used to disaggregate and assign 2015 county withdrawals to principal aquifers. Because there were too few wells for industry and irrigation, percentages developed from public-supply wells were used. Similarly, because there were too few wells used for livestock, percentages developed from domestic wells were used.

Virginia

Withdrawals from principal aquifers in Virginia for all use categories except thermoelectric power were estimated by using 2015 county withdrawals from AWUDS and the area-weighted method. Geospatial analysis was used to calculate the percentages of each county underlain by principal aquifers and no principal aquifers. The resulting percentages were used to disaggregate and assign 2015 county withdrawals to principal aquifers. Withdrawals for thermoelectric power were assigned to principal aquifers based on facility location and principal-aquifer extent.

Washington

Withdrawals from principal aquifers in Washington were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data, including location and use category, for water wells used for public-supply, domestic, industrial, livestock, aquaculture, and crop irrigation uses, were obtained from NWIS (11,400 wells) and the Washington Department of Ecology (105,000 wells). Locations of wells used for aquaculture were estimated based on information about fish hatcheries obtained from the Washington Department of Fish and Wildlife. Locations of wells used for mining were estimated by using geospatial data for active mines in Washington obtained from the ArcGIS website (https://www.arcgis.com/home/item.html?id=48eaf66e093e41d1af809e782dcbc362). Locations of wells used for thermoelectric power were estimated by using data provided by the U.S. Energy Information Administration. Principal aquifers were assigned to wells by using geospatial analysis of well locations and principal-aquifer extents. Additional geospatial data for the Columbia Plateau Regional Aquifer System were obtained from the USGS Oregon Water Science Center and used where stacked aquifers were present to determine source aquifers. Percentages of wells in each principal aquifer in each county for each category of use were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers.

West Virginia

Withdrawals from principal aquifers in West Virginia for all use categories were estimated by using 2015 county withdrawals from AWUDS and the area-weighted method. Geospatial analysis was used to calculate the percentages of each county underlain by principal aquifers and no principal aquifers. The resulting percentages were used to disaggregate and assign 2015 county withdrawals to principal aquifers.

Wisconsin

Withdrawals from principal aquifers in Wisconsin were estimated by using site-specific data withdrawal, water-well construction data, geospatial analysis, and the well-weighted method. Site-specific withdrawals for public-supply, industry, irrigation, aquaculture, mining, and thermoelectric power were obtained from the Wisconsin Department of Natural Resources and associated with principal aquifers by using geospatial analysis of facility locations, well depths, and spatial extents and depths of principal aquifers. Withdrawals for self-supplied domestic and livestock use from AWUDS were disaggregated and assigned to principal aquifers by using the well-weighted method. Water-well construction data were obtained from NWIS and the Wisconsin Department of Natural Resources. Principal aquifers were associated with wells as needed by using geospatial analysis of well locations and depths and principal-aquifer extents. Percentages of wells in each principal aquifer in each county for each use were calculated and used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers.

Wyoming

Withdrawals from principal aquifers in Wyoming for all use categories were estimated by using 2015 county withdrawals from AWUDS and the well-weighted method. Construction data, including location, depth, and use category, for 98,000 wells were obtained from the Wyoming State Engineer's Office (http://seo.wyo.gov/ground-water). Principal aquifers were assigned to wells by using geospatial analysis of well location and depths and principal-aquifer extents. The percentages of wells in each principal aquifer in each county for each use were used to disaggregate and assign 2015 county withdrawals from AWUDS to principal aquifers.

References

California Department of Water Resources, 2015, California's groundwater update 2013—A compilation of enhanced content for California water plan update 2013: State of California, Natural Resources Agency, 90 p., accessed December 20, 2019, at https://cawaterlibrary.net/document/californias-groundwater-update-2013-a-compilation-of-enhanced-content-for-california-water-plan-update-2013/.

George, P.G., Mace, R.E., and Petrossian, R., 2011, Aquifers of Texas: Texas Water Development Board Report 380, 172 p., accessed June 4, 2019, at http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R380_AquifersofTexas.pdf.

Levin, S.B., and Granato, G.E., 2018, Methods used to estimate daily streamflow and water availability in the Massachusetts Sustainable-Yield Estimator version 2.0: U.S. Geological Survey Scientific Investigations Report 2018–5146, 16 p. [Also available at https://doi.org/10.3133/sir20185146.]

Maupin, M.A., and Barber, N.L., 2005, Estimated withdrawals from principal aquifers in the United States, 2000: U.S. Geological Survey Circular 1279, 46 p. [Also available at https://pubs.usgs.gov/circ/2005/1279.]

Miller, J.A., 2000, Ground water atlas of the United States—Segment 6, Alabama, Florida, Georgia, South Carolina: U.S. Geological Survey Hydrologic Atlas 730–G, 28 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730g/report.pdf.

Qi, S.L., and Harris, A.C., 2017, Geochemical database for the brackish groundwater assessment of the United States: U.S. Geological Survey data release, https://doi.org/10.5066/F72F7KK1.

Miller, J.A., 2000, Ground water atlas of the United States—Segment 6, Alabama, Florida, Georgia, South Carolina: U.S. Geological Survey Hydrologic Atlas 730–G, 28 p., accessed July 17, 2018, at https://pubs.usgs.gov/ha/730g/report.pdf.

Qi, S.L., and Harris, A.C., 2017, Geochemical database for the brackish groundwater assessment of the United States: U.S. Geological Survey data release, accessed December 20, 2019, at https://doi.org/10.5066/F72F7KK1.

Ratcliffe, N.M., Stanley, R.S., Gale, M.H., Thompson, P.J., and Walsh, G.J., 2011, Bedrock geologic map of Vermont: U.S. Geological Survey Scientific Investigations Map 3184, 3 sheets, scale 1:100,000.

Renken, R.A., 1998, Ground water atlas of the United States—Segment 5, Arkansas, Louisiana, Mississippi: U.S. Geological Survey Hydrologic Atlas 730–F, 28 p.

Ryder, P.D., 1996, Ground water atlas of the United States—Segment 3, Oklahoma, Texas: U.S. Geological Survey Hydrologic Atlas 730–E, 30 p., accessed October 23, 2018, at https://pubs.usgs.gov/ha/730e/report.pdf.

U.S. Energy Information Administration, 2018, Arkansas—State profile and energy estimates: U.S. Energy Information Administration, online map interface, accessed August 8, 2018, at https://www.eia.gov/state/?sid=AR.

U.S. Geological Survey [USGS], 2017a, Aquifers—Map of the principal aquifers of the United States, accessed July 3, 2019, at https://water.usgs.gov/ogw/aquifer/map.html.

U.S. Geological Survey [USGS], 2017b, USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed July 9, 2019, at https://doi.org/10.5066/F7P55KJN.

U.S. Geological Survey [USGS], 2018, USGS Water Resources NSDI Node—Spatial data sets available on the WRD NSDI Node, accessed April 18, 2019, at https://water.usgs.gov/lookup/getgislist.

For more information about this publication, contact

Director, Lower Mississippi-Gulf Water Science Center
U.S. Geological Survey
640 Grassmere Park, Suite 100
Nashville, TN 37211

For additional information, visit
https://www.usgs.gov/centers/lmg-water/

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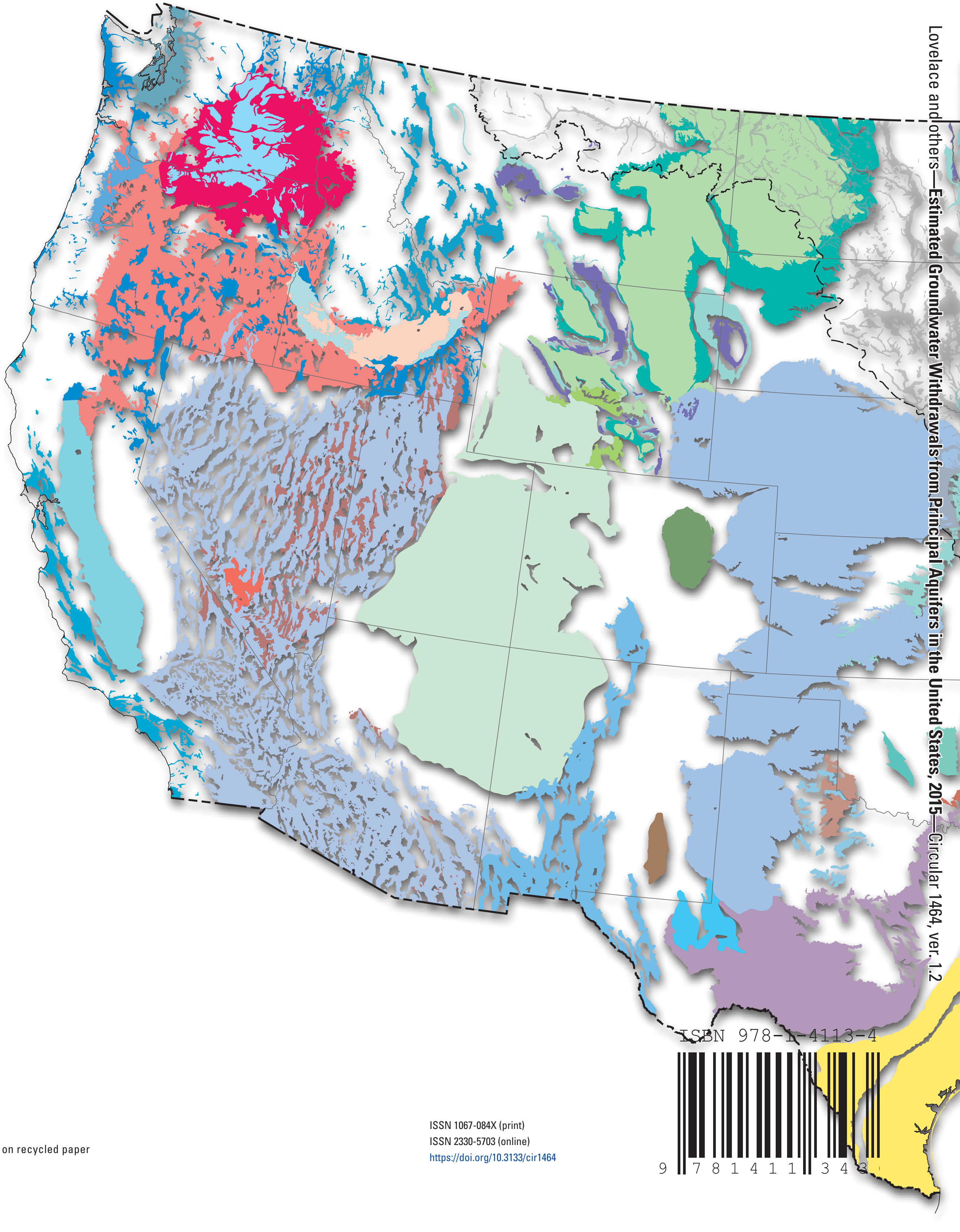

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