In cooperation with the Montana Department of Natural Resources and Conservation

Estimated Water Use in Montana in 2000

Scientific Investigations Report 2004-5223

U.S. Department of the Interior
U.S. Geological Survey

COVER PHOTOGRAPHS: View to the southwest showing Chessman Reservoir, Montana (lower left) and sprinkler irrigation of pasture in western Montana (upper right). Photographs by M.R. Cannon, U.S. Geological Survey, taken in July 2003.

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by M.R. Cannon and Dave R. Johnson

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U.S. Geological Survey

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CONTENTS

Glossary....vi
Abstract....1
Introduction....1
Purpose and Scope....2
Sources of Data....3
Methods of Analysis....3
Factors Affecting Water Availability and Use in Montana....3
Previous Investigations....8
Units of Water Measurement....8
Estimated Use of Water in 2000....8
Water Withdrawals and Consumptive Use by Category....8
Irrigation....11
Public Supply....22
Self-Supplied Domestic....26
Self-Supplied Industrial....26
Thermoelectric Power Generation....26
Livestock....26
Instream Water Use by Category....34
Hydroelectric Power Generation....34
Water Reserved for Instream Flow Purposes....34
Evaporation from Major Reservoirs and Regulated Lakes....36
Summary....36
References Cited....39
Appendix 1: Water Withdrawals by Hydrologic Unit for Six Categories of Use....41

FIGURES

1-6. Maps showing:
1. Major river basins, counties, and selected towns in Montana....2
2. Stream basins and Hydrologic Unit Codes....4
3. Average annual precipitation in Montana, 1961-1990....6
4. Average annual runoff in Montana, 1951-1980....7
5. General extent of major aquifers in near-surface bedrock and semiconsolidated sediments in Montana....9
6. General extent of unconsolidated deposits that yield water to shallow wells in Montana....10
7. Graphs showing total water withdrawals in Montana by category and total water consumed in Montana by category in 2000....16
8-14. Maps showing:
8. Total water withdrawals in Montana counties in 2000....17
9. Total water withdrawals in Montana hydrologic units in 2000....18
10. Irrigation water withdrawals in Montana counties in 2000....19
11. Public-supply water withdrawals in Montana counties in 2000....25

12. Self-supplied domestic water withdrawals in Montana counties in 2000 28
13. Self-supplied industrial water withdrawals in Montana counties in 2000 30
14. Livestock water withdrawals in Montana counties in 2000 33

TABLES

1. Runoff from Montana's rivers, 2000 calendar year and 1971-2000 average 3
2. Common water-measurement units 11
3. Total population and water withdrawals in Montana by county, 2000 12
4. Total population and water withdrawals in Montana by hydrologic unit, 2000 14
5. Irrigation water withdrawals and consumptive use in Montana by county, 2000 20
6. Public-supply water withdrawals in Montana by county, 2000 23
7. Self-supplied domestic water withdrawals in Montana by county, 2000 27
8. Self-supplied industrial water withdrawals in Montana by county, 2000 29
9. Water withdrawals for thermoelectric power generation in Montana by county, 2000 31
10. Livestock water requirements 31
11. Livestock water withdrawals in Montana by county, 2000 32
12. Instream water use for hydroelectric power generation in Montana by county, 2000 34
13. Montana streams with Murphy Rights instream-flow protection 35
14. Estimated net reservoir evaporation for major reservoirs 37

Appendix 1

1-1. Irrigation water withdrawals and consumptive use in Montana by hydrologic unit, 2000 42
1-2. Public-supply water withdrawals in Montana by hydrologic unit, 2000 44
1-3. Self-supplied domestic water withdrawals in Montana by hydrologic unit, 2000 46
1-4. Self-supplied industrial water withdrawals in Montana by hydrologic unit, 2000 48
1-5. Water withdrawals for thermoelectric power generation by hydrologic unit, 2000 48
1-6. Livestock water withdrawals in Montana by hydrologic unit, 2000 49

Conversion Factors and Datum

Multiply	By	To obtain
acre	0.4047	hectare
acre foot	1,233	cubic meter
acre-foot per day (acre-ft/d)	1,233	cubic meter per day
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year
cubic foot	0.02832	cubic meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot	0.3048	meter
foot per year (ft/yr)	0.3048	meter per year
gallon	3.785	liter
gallon per day (gal/d)	0.003785	cubic meter per day
gallon per minute (gal/min)	0.06309	liter per second
gallon per second	3.785	liter per second
inch	25.4	millimeter
million gallons	3,785	cubic meter
million gallons per day (Mgal/d)	0.04381	cubic meter per second

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

GLOSSARY

Aquifer A geological formation, group of formations, or part of a formation that contains sufficient saturated material to yield significant quantities of water to wells and springs.

Agricultural water use Includes water used for irrigation and nonirrigation purposes. Irrigation water use includes the artificial application of water on lands to assist in the growing of crops and pasture, or to maintain vegetative growth in recreational lands, parks, and golf courses. Nonirrigation agricultural water use includes water used for livestock, which includes water for stock watering, feedlots, dairy operations, fish farming, and other farm needs.

Commercial water use Water use for motels, hotels, restaurants, office buildings, commercial facilities, and civilian and military institutions. The water can be obtained from a public supply or can be self supplied.

Consumptive use That 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. Consumptive use is sometimes called water consumed. Additionally, any water withdrawn in the basin and transferred out of the basin for use is considered 100 percent consumptively used.

Cooling water Water used for cooling purposes, such as in condensers.

Domestic water use Water for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. The water can be obtained from a public supply or can be self supplied.

Flood Irrigation Irrigation systems that spread water on the land surface with a system of lateral supply ditches or conduits. These include open field ditch systems, semiclosed conveyance systems, subsurface conduit systems, and continuous flood systems.

Hydroelectric power water use The use of water in the generation of electricity at plants where the turbine generators are driven by falling water. Hydroelectric power water use is considered an instream use of water, and is generally a non-consumptive use of water.

Industrial water use Water used for industrial purposes such as fabricating, processing, washing, and cooling, and includes water used for such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining. The water can be obtained from a public supply or can be self supplied.

Instream use Water used within the stream channel for such purposes as hydroelectric power generation, navigation, water-quality improvement, fish and wildlife propagation, and recreation. Sometimes called nonwithdrawal use or in-channel use.

Miner's inch In general, the quantity of water that will escape from an aperture 1-inch square through a 2-inch plank, with a steady flow with water standing 6 inches above the top of the escape aperture. In Montana, the value of a miner's inch has been fixed by statute to be 1/40 of a cubic foot per second.

Normal capacity The total volume in a reservoir below the normal retention level, including dead storage, but excluding flood control or surcharge storage.

Public supply Water withdrawn by public and private water suppliers and delivered to users. Public suppliers provide water for a variety of uses, such as domestic, commercial, industrial, thermoelectric power (domestic and cooling purposes), and public-water use. Also see domestic water use, commercial water use, industrial water use, public-water use, and other water use.

Public-water use Water supplied from a public-water supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools. Public-water use also includes system water losses (water lost to leakage). Also referred to as water-utility use.

Return flow Water that reaches a ground- or surface-water source after release from the point of use and thus becomes available for further use.

Self-supplied water Water withdrawn from a ground- or surface-water source by a user and not obtained from a public supply.

Sprinkler irrigation A pressurized irrigation system where water is distributed through pipes to the field and applied through a variety of sprinkler heads or drop tubes and emitters. Pressure is used to spread water droplets above the crop canopy to simulate rainfall. These systems include portable and traveling guns systems, solid or permanent fixture systems, center pivot systems, and periodic moving systems.

Thermoelectric power Electrical power generated by using fossil-fuel (coal, oil, or natural gas) or geothermal energy.

Thermoelectric-power water use Water used in the process of the generation of thermoelectric power. The water can be obtained from a public supply or be self-supplied. Water used for thermoelectric power generation purposes is considered an offstream use of water, and is generally a non-consumptive use.

Water transfer Artificial conveyance of water from one area to another. This transfer may be referred to as an import or export of water from one basin or county to another.

Withdrawal Water removed from the ground or diverted from a surface-water source for use.

Estimated Water Use in Montana in 2000

by M.R. Cannon and Dave R. Johnson

Abstract

The future health and economic welfare of Montana's population is dependent on a continuing supply of fresh water. Montana's finite water resources are being stressed by increasing water withdrawals and instream-flow requirements. Various water managers in Montana need comprehensive, current, and detailed water-use data to quantify current stresses and estimate and plan for future water needs. This report summarizes selected water-use data for all of Montana's counties and stream basins to help meet those needs.

In 2000, the citizens of Montana withdrew and used about 10,749 million gallons per day (Mgal/d) of water from Montana's streams and aquifers. Withdrawals from surface water were about 10,477 Mgal/d and withdrawals from ground water were about 272 Mgal/d. Agricultural irrigation accounted for about 10,378 Mgal/d or about 96.5 percent of total withdrawals for all uses. Withdrawals for public supply were about 136 Mgal/d, self-supplied domestic withdrawals were about 23 Mgal/d, self-supplied industrial withdrawals were about 61 Mgal/d, withdrawals for thermoelectric power generation were about 110 Mgal/d, and withdrawals for livestock were about 41 Mgal/d. Total consumptive use of water in 2000 was about 2,370 Mgal/d, of which about 2,220 Mgal/d (93.6 percent) was for agricultural irrigation.

Instream uses of water included hydroelectric power generation and maintenance of instream flows for conservation of wildlife and aquatic life, and for public recreational purposes. In 2000, about 74,486 Mgal/d was used at hydroelectric plants for generation of about 11,591 gigawatt-hours of electricity. Evaporation from large water bodies, although not a classified water use, accounts for a large loss of water in some parts of the State. Net evaporation from Montana's 60 largest reservoirs and regulated lakes averaged about 891 Mgal/d.

INTRODUCTION

Water is one of Montana's most valued renewable resources. A continuing supply of fresh water is vital to the future health and economic welfare of the people in Montana. Montana's water resources include surface water and ground water from diverse sources such as alpine lakes and swift streams in the high mountain ranges, potholes and sluggish streams in the rolling prairies, and aquifers in consolidated rocks and unconsolidated sediments. These water resources are withdrawn for agriculture, industry, and drinking water and are used instream for recreation, wildlife, and hydroelectric power generation. Montana, which straddles the Continental Divide of the Northern Rocky Mountains, is in the headwaters of three major drainage basins—the Hudson Bay basin, the Missouri River basin, and the upper Columbia River basin (fig. 1). Because of its unique geography and diverse landscapes, Montana's river basins and water resources are equally diverse in water supply and use.

Detailed information on the use of water from Montana's diverse surface-water and ground-water resources is needed as drought, increasing population, and requirements for instream flow put increasing stresses on Montana's finite water supplies. Comprehensive, current, and detailed water-use data will provide water managers in Montana with information they need to quantify current stresses and estimate and plan for future water needs. The U.S. Geological Survey, in cooperation with the Montana Department of Natural Resources and Conservation, estimated water-use data for 2000 for all of Montana's counties and river basins to help meet those needs.

Purpose and Scope

The purpose of this report is to summarize the quantities of water withdrawn and consumed from Montana's surface-water and ground-water resources for various uses in 2000 and to describe other instream water uses such as hydroelectric power generation and maintenance of instream flows. Water withdrawals in Montana are summarized for each of the following categories: irrigation, public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock. Summaries also are included for instream water use for the categories of hydroelectric power generation and reserved-instream flow.

Within each category, withdrawal data are presented by source of withdrawal, with sources being either surface water or ground water. Water withdrawal data for each category also are presented by county and by hydrologic unit (stream basin). Counties and selected cities, towns, and geographic features of Montana are shown in figure 1 and stream drainage basins with hydrologic unit code numbers are shown in figure 2.

Net evaporation rates from major reservoirs and regulated lakes in Montana are estimated because evaporation accounts for a large loss of water in some parts of the State. Evaporation data are presented for comparison with the other water-use categories.

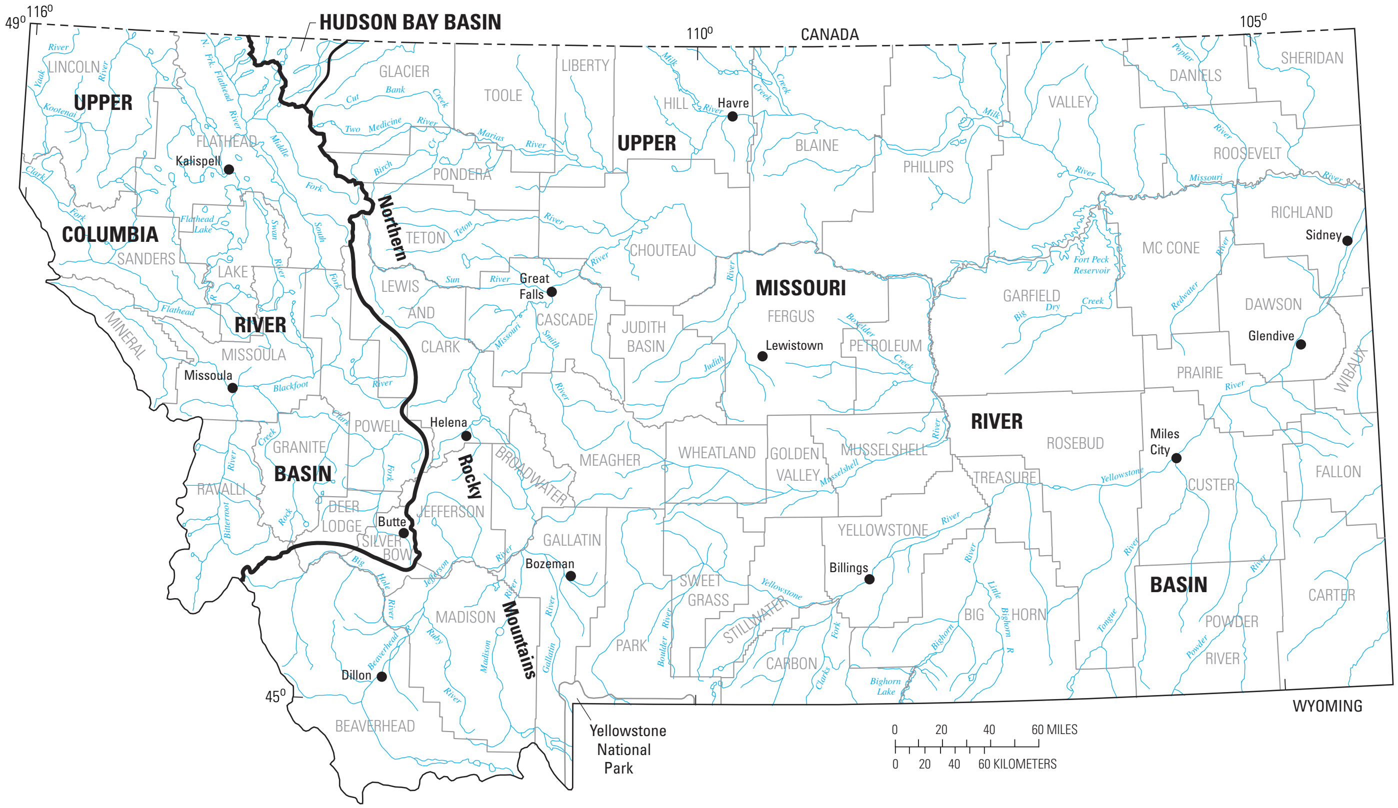


Figure 1. Major river basins, counties, and selected towns in Montana.

Sources of Data

Water-use data for 2000 were compiled by the U.S. Geological Survey from a variety of sources. Many of the water-use estimates in this report have been revised from previous Montana water-use estimates (Hutson and others, 2004). The largest changes are in estimated water withdrawals for irrigation. This report includes estimates of withdrawals for irrigated pasture lands that were not included in the earlier report. Small revisions also have been made in estimates of water withdrawn for public water supplies and self-supplied domestic use.

Population data for Montana counties were obtained from the U.S. Census Bureau from population data collected during the 2000 Census. Populations within hydrologic units were calculated from U.S. Census Bureau digital data for the 874 census blocks in Montana and combined with a digital map of all hydrologic units in Montana. Digital maps of hydrologic units were obtained from the Montana Natural Resource Information System, which is a part of the Montana State Library. Population served by each public water-supply system in Montana was obtained from the Safe Drinking Water Information System database maintained by the U.S. Environmental Protection Agency; the database also contained information on whether the public source was ground water or surface water.

Irrigated-acreage data were compiled from a number of sources including the U.S. Department of Agriculture, National Agricultural Statistics Service and the Montana Department of Agriculture, Montana Agricultural Statistics Service. Crop irrigation requirements in Montana were obtained from reports by the U.S. Soil Conservation Service (1974, 1978) and Montana Department of Natural Resources and Conservation (1986). The Montana Agricultural Statistics Service also was the source of data for numbers and types of livestock and acreage and types of crops grown in Montana.

Power-generation data were obtained from the Energy Information Administration, the independent statistical and analytical agency within the U.S. Department of Energy. Hydroelectric-power data were obtained from the Bureau of Reclamation and the Montana Department of Natural Resources and Conservation.

Methods of Analysis

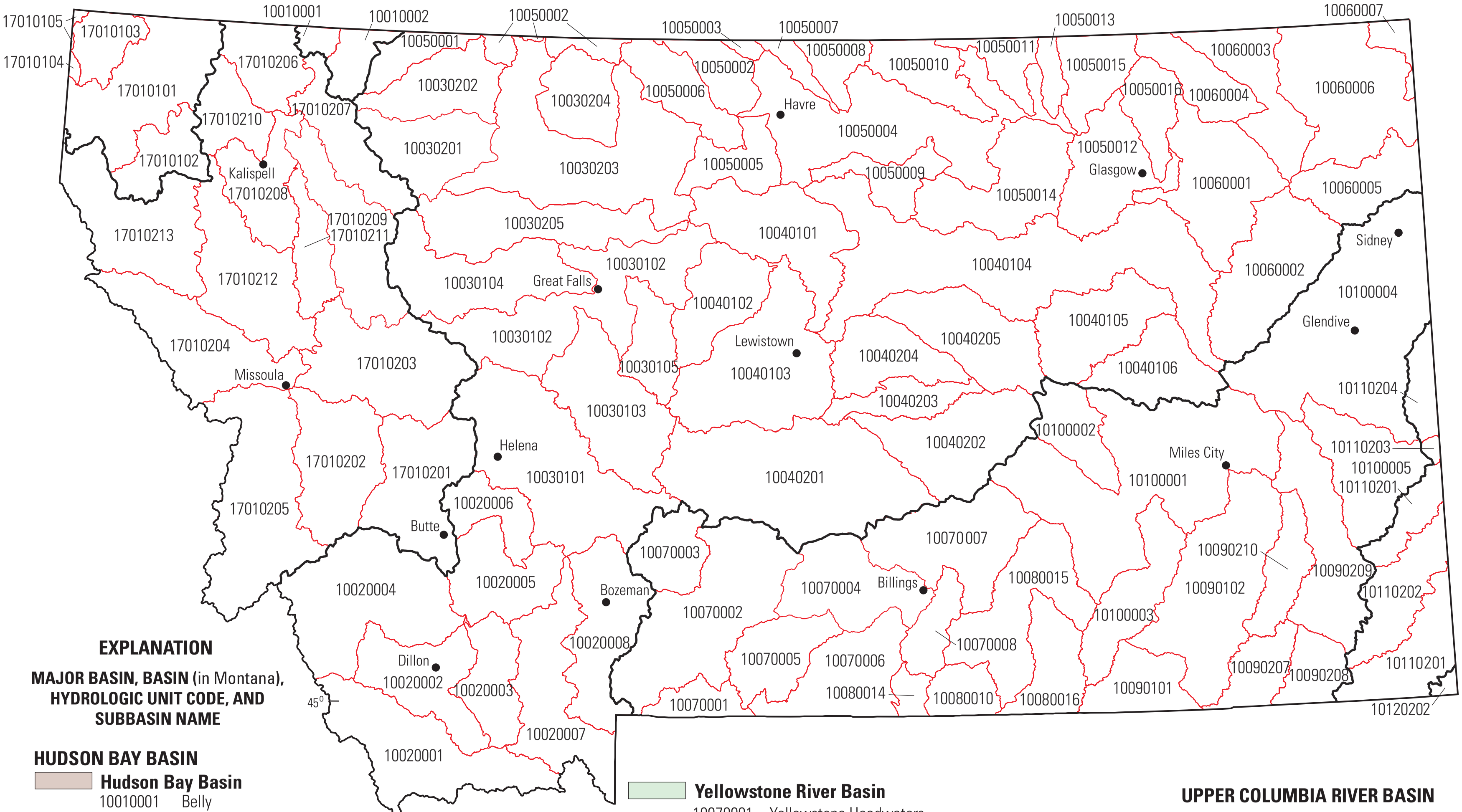
Volumes of water withdrawn for each category of use were calculated by a variety of methods, which are explained in more detail in subsequent sections of this report. In general, water withdrawals for irrigation, self-supplied domestic, and livestock uses were estimated because these withdrawals typically are not metered or are not accurately measured. Water withdrawals for public-water supply were obtained from metered data for some water systems, but were estimated for many water systems that were not metered or for systems that had insufficient records. Water withdrawals for thermoelectric power generation and self-supplied industrial uses generally were estimated based on water use permits and measured withdrawals.

Factors Affecting Water Availability and Use in Montana

Water use in Montana is affected by natural factors that are directly related to water availability and also by human factors that relate to water demand. The supply of water is extremely variable from place to place within Montana and also can be highly variable from year to year. Average annual precipitation in Montana (fig. 3) ranges from less than 10 inches in several valleys to more than 100 inches in some areas of high altitude in the northwestern part of the State (Oregon Climate Service, 1998). Evaporation from land and water surfaces and transpiration by plants consumes the largest part of the annual precipitation that falls in Montana. Average annual free-water-surface evaporation ranges from less than 25 inches in the high mountains north of Yellowstone National Park to 45 inches in parts of the lower Yellowstone River valley (National Oceanic and Atmospheric Administration, 1982). These large spatial variations in precipitation and evaporation are reflected in the large range in average annual runoff for different areas of the State (fig. 4). Total runoff from Montana's rivers in 2000 was more than 34.8 million acre-feet (table 1), although about 35 percent of this water originated in Wyoming and Canada (U.S. Geological Survey, 2002).

Table 1. Runoff from Montana’s rivers, 2000 calendar year and 1971-2000 average (calendar years)

River basin (fig. 1, 2)	U.S. Geological Survey streamflow-gaging station number (fig. 4)	2000 Annual runoff (acre-feet)	2000 Annual discharge (cubic feet per second)	1971-2000 average annual runoff (acre-feet)	1971-2000 average annual discharge (cubic feet per second)
St. Mary	05020500	318,400	439	462,800	639
Missouri	06185500	6,046,000	8,330	7,779,000	10,740
Yellowstone	06329500	5,854,000	8,060	9,039,000	12,480
Little Missouri	06334500	8,170	11.2	93,400	129
Kootenai	12305000	9,134,000	12,580	10,154,000	14,020
Clark Fork	12392000	13,490,000	18,580	16,260,000	22,450
TOTAL		34,850,570	48,000	43,788,200	60,458



EXPLANATION

MAJOR BASIN, BASIN (in Montana), **HYDROLOGIC UNIT CODE, AND SUBBASIN NAME**

HUDSON BAY BASIN

Hudson Bay Basin

10010001	Belly
10010002	St. Mary

MISSOURI RIVER BASIN

Upper Missouri River Basin

10020001	Red Rock
10020002	Beaverhead
10020003	Ruby
10020004	Big Hole
10020005	Jefferson
10020006	Boulder
10020007	Madison
10020008	Gallatin
10030101	Upper Missouri

Yellowstone River Basin

10070001	Yellowstone Headwaters
10070002	Upper Yellowstone
10070003	Shields
10070004	Upper Yellowstone-Lake Basin
10070005	Stillwater
10070006	Clarks Fork Yellowstone
10070007	Upper Yellowstone-Pompeys Pillar
10070008	Pryor
10080010	Bighorn Lake
10080014	Shoshone
10080015	Lower Bighorn
10080016	Little Bighorn
10090101	Upper Tongue

UPPER COLUMBIA RIVER BASIN

Kootenai River Basin

17010101	Upper Kootenai
17010102	Fisher
17010103	Yaak
17010104	Lower Kootenai
17010105	Moyie

Clark Fork Basin

17010201	Upper Clark Fork
17010202	Flint-Rock
17010203	Blackfoot
17010204	Middle Clark Fork
17010205	Bitterroot

10030102 Upper Missouri-Dearborn
10030103 Smith
10030104 Sun
10030105 Belt
10030201 Two Medicine
10030202 Cut Bank
10030203 Marias
10030204 Willow
10030205 Teton
10040101 Bullwhacker-Dog
10040102 Arrow
10040103 Judith
10040104 Fort Peck Reservoir
10040105 Big Dry
10040106 Little Dry
10040201 Upper Musselshell
10040202 Middle Musselshell
10040203 Flatwillow
10040204 Box Elder
10040205 Lower Musselshell
10050001 Milk Headwaters
10050002 Upper Milk
10050003 Wild Horse Lake
10050004 Middle Milk
10050005 Big Sandy
10050006 Sage
10050007 Lodge
10050008 Battle
10050009 Peoples
10050010 Cottonwood
10050011 Whitewater
10050012 Lower Milk
10050013 Frenchman
10050014 Beaver
10050015 Rock
10050016 Porcupine
10060001 Prairie Elk-Wolf
10060002 Redwater
10060003 Poplar
10060004 West Fork Poplar
10060005 Charlie-Little Muddy
10060006 Big Muddy
10060007 Brush Lake
10120202 Lower Belle Fourche

10090102 Lower Tongue
10090207 Middle Powder
10090208 Little Powder
10090209 Lower Powder
10090210 Mizpah
10100001 Lower Yellowstone-Sunday
10100002 Big Porcupine
10100003 Rosebud
10100004 Lower Yellowstone
10100005 O'Fallon

Little Missouri River Basin

10110201 Upper Little Missouri
10110202 Boxelder
10110203 Middle Little Missouri
10110204 Beaver

17010206 North Fork Flathead
17010207 Middle Fork Flathead
17010208 Flathead Lake
17010209 South Fork Flathead
17010210 Stillwater
17010211 Swan
17010212 Lower Flathead
17010213 Lower Clark Fork

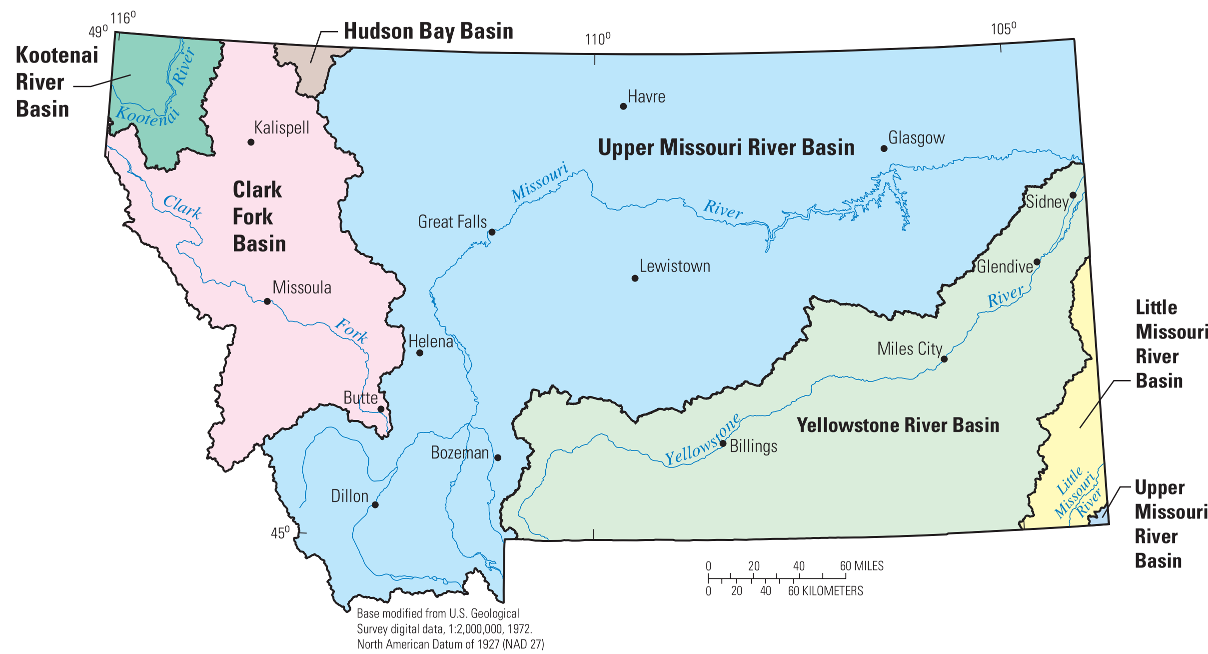


Figure 2. Stream basins and Hydrologic Unit Codes.

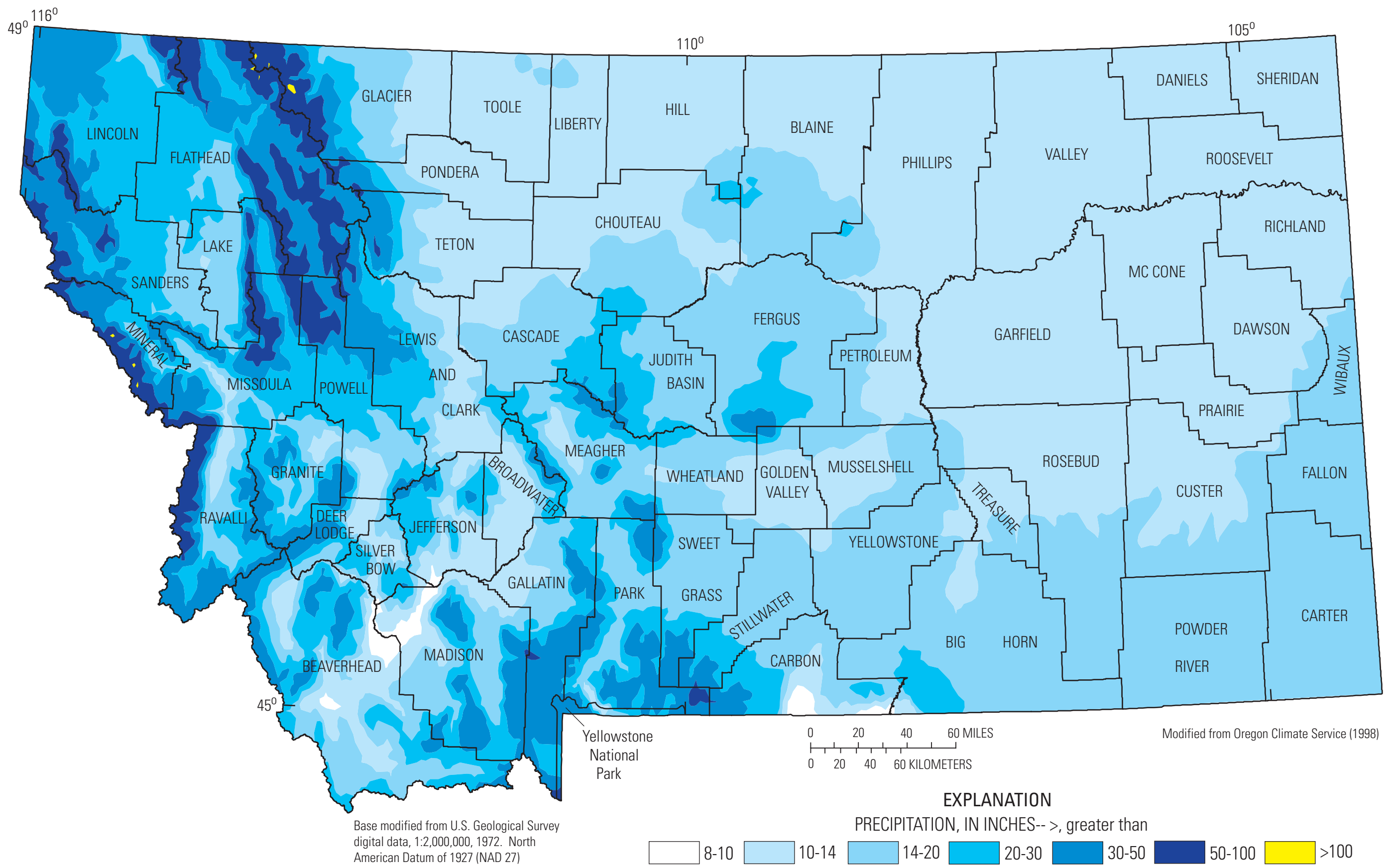


Figure 3. Average annual precipitation in Montana, 1961-90.

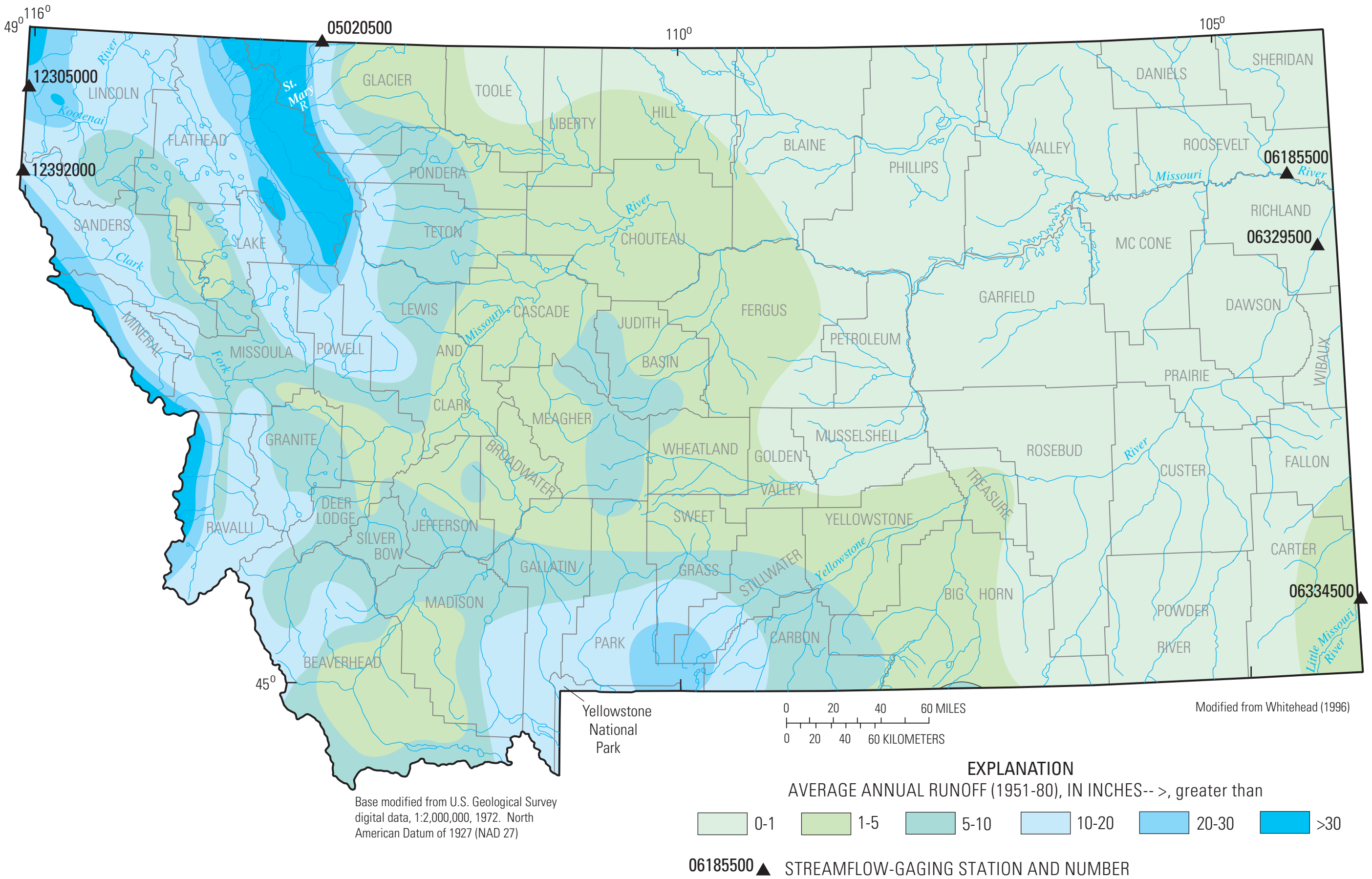


Figure 4. Average annual runoff in Montana, 1951-80.

The diverse geology of Montana, with many different types of rocks and unconsolidated deposits, determines in a large part the availability of ground water. Large areas of central and eastern Montana (fig. 5) are underlain by shale and fine-grained sandstone of Cretaceous and Tertiary age that yield small amounts of water, or yield water that is too mineralized for many uses. Many of the rocks that form the large mountain ranges of western Montana typically yield small amounts of water but do not form a principal aquifer (fig. 5). Small but adequate yields of ground water for domestic and livestock uses generally are available from sandstone and coal beds of early Tertiary age (lower Tertiary aquifers, fig. 5) in eastern Montana. Semiconsolidated sediments of late Tertiary age underlie the intermontane valleys of western Montana (upper Tertiary aquifers, fig. 5) and yield large volumes of ground water in some locations, with well yields large enough for irrigation and public-water supply. Unconsolidated deposits of Quaternary (or Tertiary and Quaternary) age, including coarse-grained glacial deposits, alluvium, and basin fill, generally are the most productive and utilized aquifers in Montana. Many stock, domestic, irrigation, and public-supply wells are completed in these productive aquifers that underlie most of the broad valleys of western Montana and the narrow river valleys of central and eastern Montana (fig. 6). Other unconsolidated deposits of Quaternary age, such as till and fine-grained glacial-lake deposits of Quaternary age in northern Montana (fig. 6), generally yield small quantities of water to wells.

The population of Montana is concentrated in the intermontane valleys of western Montana, along the valley of the Yellowstone River in south-central and eastern Montana, and along the Missouri River in north-central and eastern Montana. The population of Montana in 2000 was 902,195, an increase of 13 percent from the population of 799,065 in 1990 (Montana Department of Commerce, Census and Economic Information Center, 2003). Water demand for most non-agricultural uses is closely tied to this population distribution.

Agriculture is one of Montana's largest industries (Montana Agricultural Statistics Service, 2001), with farms and ranches making up 63 percent of the total land area of the State. Because of the large agricultural industry and the relatively dry climate in much of the State, irrigation of crops is the largest offstream water use in Montana.

Instream uses of water for recreation and habitat for fish and wildlife are becoming more important to Montana's rapidly growing tourism industry. Montana's rivers are a popular vacation destination for float trips, fishing, and wildlife viewing. Guided river trips are popular on many Montana rivers including the Yellowstone, Smith, Flathead, Bighorn, and Missouri Rivers.

Previous Investigations

Reports documenting state-wide estimates of water use in Montana were published for 1970 and 1980 (Montana Department of Natural Resources and Conservation 1975, 1986). These two reports summarized water use by county and by hydrologic unit for categories of irrigation, municipal, rural domestic, self-supplied industry, livestock, and thermoelectric power generation.

National summaries of water use that include data for Montana have been compiled by the U.S. Geological Survey every 5 years since 1950 (MacKichan, 1951, 1957; MacKichan and Kammerer, 1961; Murray, 1968; Murray and Reeves, 1972, 1977; Solley and others, 1983, 1988, 1993, 1998; Hutson and others, 2004). A summary of water supply and use in Montana for 1985 also was published by the U.S. Geological Survey in the National Water Summary (U.S. Geological Survey, 1990). Another U.S. Geological Survey publication contains graphs showing estimated water use in 1980 for all 50 states and national trends in water withdrawals from 1950-80 (Solley and others, 1986).

Units of Water Measurement

Numerical data in the tables of this report are mostly reported in units of million gallons per day (Mgal/d) and are rounded to two decimal places. Irrigation data are reported in both Mgal/d and acre-feet per year (acre-ft/yr). All values in units of acre-ft/yr are rounded to the nearest ten. All numbers are rounded independently and, as a result of this rounding, sums of the rounded numbers may not equal the totals. The independent rounding used in numerical data affects only the value of the last significant figure. Other commonly used units for water measurement are shown in table 2. The table can be used to convert from one unit of water measurement to another.

ESTIMATED USE OF WATER IN 2000

Water Withdrawals and Consumptive Use by Category

Water-use information for 2000 was compiled for six categories: irrigation, public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock. For each category, withdrawal volumes were compiled for surface-water and ground-water sources and consumptive use was estimated. Also for each category, water withdrawal volumes were compiled by counties (table 3) and by hydrologic units (table 4 and tables 1-1 through 1-6 in appendix 1) to show the place of withdrawals within Montana.

In 2000, the total amount of water withdrawn from Montana surface-water and ground-water sources for the six categories of use was about 10,749 Mgal/d (table 3, fig. 7). Withdrawals from surface water were about 10,477 Mgal/d or 97.5 percent of the total. Withdrawals from ground water were about 272 Mgal/d, or 2.5 percent of the total withdrawals. Irrigation required about 10,378 Mgal/d, or 96.5 percent of total withdrawals for all uses. Total withdrawals for other categories

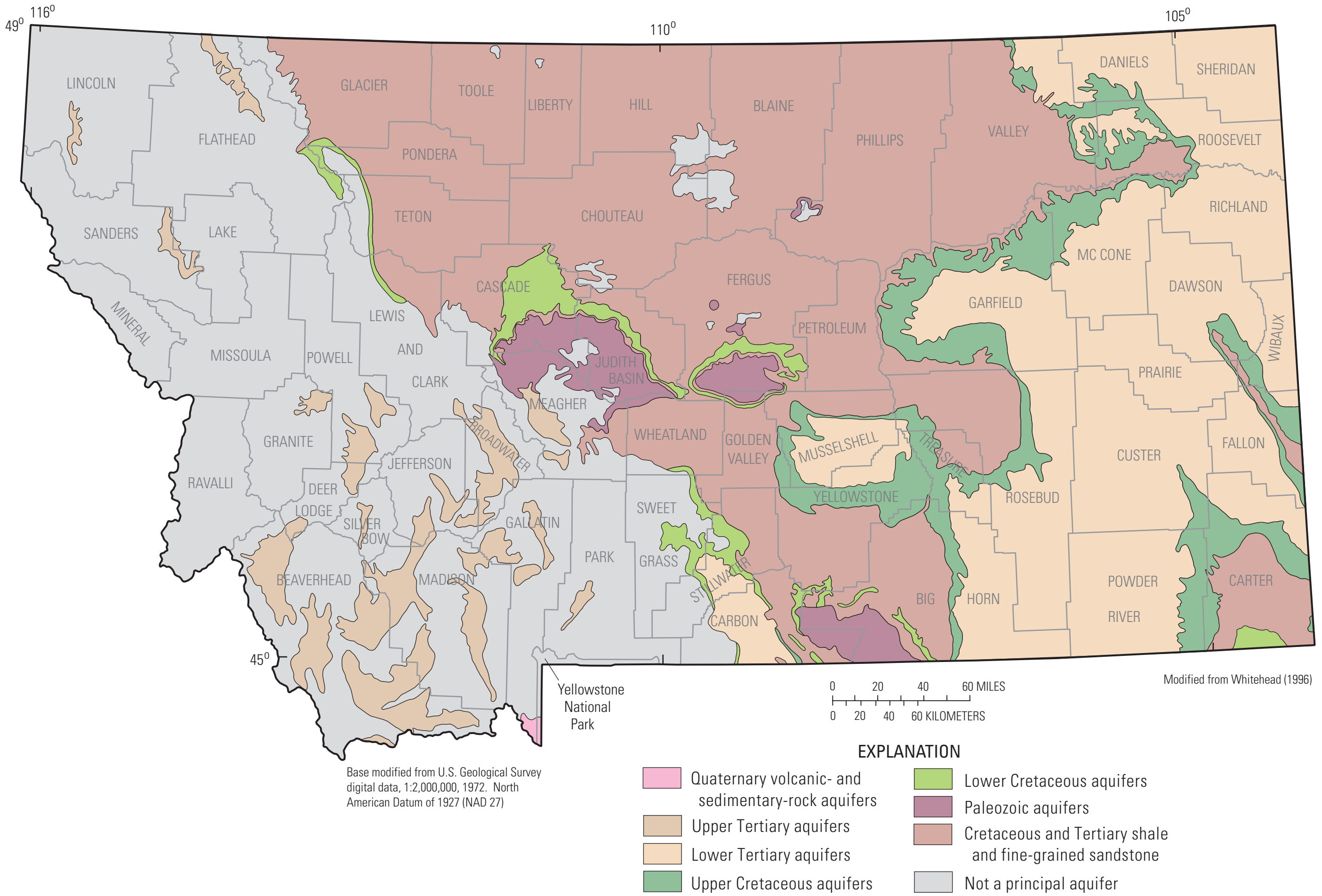


Figure 5. General extent of major aquifers in near-surface bedrock and semiconsolidated sediments in Montana.

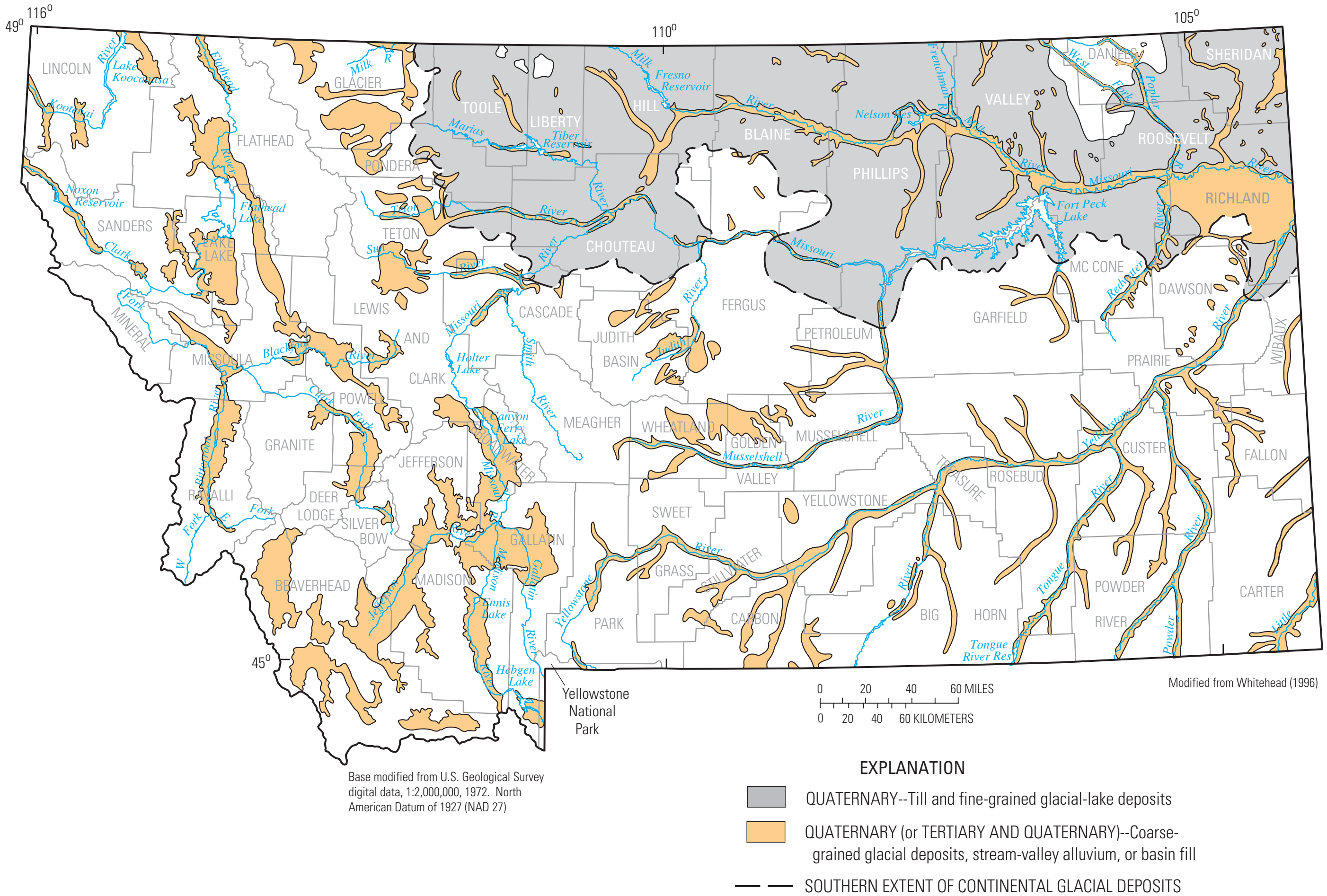


Figure 6. General extent of unconsolidated deposits that yield water to shallow wells in Montana.

Table 2. Common water-measurement units

VOLUME			
1 cubic foot =	7.4805 gallons =		28.317 liters
1 acre foot =	325,850 gallons =	43,560 cubic feet =	1,233.5 cubic meters
1 million gallons =	3.0689 acre feet =	133,680 cubic feet =	3,785.4 cubic meters
FLOW RATE			
1 cubic foot per second (ft^3/s) =	7.4805 gallons per second =	448.8 gallons per minute =	40 Montana statutory miner's inches
1 cubic foot per second for 24 hours =	1.983 acre feet		
1 cubic foot per second for 1 year =	724 acre feet		
1 million gallons per day (Mgal/d) =	3.0689 acre-feet per day =	1.5472 cubic feet per second =	3,785,400 liters per day
1 million gallons per day (Mgal/d) =	1,120.1 acre-feet per year	(1,123.2 acre-feet per year for leap year 2000)	
1 thousand gallons per minute =	4.419 acre-feet per day =	2.228 cubic feet per second =	3,785 liters per minute

were 136.14 Mgal/d for public supply; 22.85 Mgal/d for self-supplied domestic; 61.27 Mgal/d for self-supplied industrial; 109.96 Mgal/d for thermoelectric power generation; and 40.65 Mgal/d for livestock.

In 2000, the total consumptive use of water for the six categories of use was about 2,370 Mgal/d (fig. 7). Consumptive use for irrigation was about 2,220 Mgal/d or about 93.6 percent of the total for the six categories of use. Estimated consumptive uses for other categories were 50.37 Mgal/d for public supply; 22.85 Mgal/d for self-supplied domestic; 9.19 Mgal/d for self-supplied industrial; 27.70 Mgal/d for thermoelectric power generation; and 40.65 Mgal/d for livestock.

Total withdrawals are shown by county (fig. 8) and by hydrologic unit (fig. 9) to show the spatial distribution of water withdrawals in Montana. Counties with the largest total withdrawals (greater than 500 Mgal/d) in 2000 were Beaverhead, Teton, Madison, Carbon, Yellowstone, and Lake. Counties with the smallest total withdrawals (less than 6 Mgal/d) were Wibaux, Fallon, and Daniels (table 3).

Irrigation

Irrigation accounts for Montana's largest water withdrawals and consumptive use. Irrigation-water withdrawals include all water consumed by irrigated crops and pasture plus all water lost in irrigation conveyance and application systems. Montana's irrigated crops include alfalfa, barley, cherries, corn, grass, oats, potatoes, sugar beets, and wheat. Irrigation withdrawals during 2000 were an estimated 10,378 Mgal/d (31,850 acre-ft/d) on an annual basis (fig. 7, table 5). Actual daily withdrawals during the irrigation season were larger but were variable and depended on water needs of the crops and length of the irrigation season. Water consumed by irrigated crops and pasture was about 2,220 Mgal/d (6,810 acre-ft/d) or about 21 percent of the water withdrawn for irrigation. Ground water supplied about 140 Mgal/d (1.4 percent) of the irrigation water, and surface water supplied about 10,238 Mgal/d (98.6 percent). Counties with the largest irrigation withdrawals (more than 500 Mgal/d) were Beaverhead, Teton, Madison, Carbon, and Lake (fig. 10).

Water used for irrigation in 2000 was estimated using a series of computations based on irrigated acres and crop types in each county, consumptive-use rates and net irrigation requirements of crops in each of five Montana climatic areas, and overall irrigation efficiency in each county. For example, an acre of alfalfa grown in Custer County is in a high consumptive-use climatic area and has a net irrigation requirement of 22.14 inches or 1.84 acre-feet of water (U.S. Soil Conservation Service, 1974). If the overall efficiency of the flood-irrigation system that delivers and applies water to the alfalfa is 28 percent, then about 6.6 acre feet of water is withdrawn to satisfy the 1.84 acre-feet of water required by the crop.

Irrigated acres and crop types in 2000 were obtained for each county from the Montana Agricultural Statistics Service (2001). Acres of irrigated pasture for each county were estimated from the average of the 1997 and 2002 census of agriculture (U.S. Department of Agriculture, 2004). Irrigated-acreage data from these sources indicate that about 2,172,000 acres of agricultural crop land and pasture were irrigated in Montana in 2000. Irrigated crop lands totaled about 1,722,000 acres and irrigated pasture totaled about 450,000 acres (table 5). Crops with the largest number of irrigated acres were hay (975,000 acres), barley (288,000 acres), wheat (162,700 acres), sugar beets (60,700 acres), corn (60,000 acres), oats (29,000 acres), and potatoes (11,500 acres) (Montana Agricultural Statistics Service, 2001). A statewide irrigation survey conducted in 1995 by the Natural Resources Conservation Service (U. S. Department of Agriculture, Natural Resources Conservation Service, Bozeman, Montana, unpub. data) determined that irrigated acreage in Montana was about 2,536,000 acres, or about 1.17 times the acreage indicated by the agricultural census data. A reason for the difference in irrigated acreages may have been that there was some under reporting of irrigated land in the census data, which relies on landowner surveys. The 1995 irrigation survey by the Natural Resources Conservation Service used aerial photographs and the knowledge of its staff to determine irrigated acreage and could have included some lands that were unreported by landowners. For this report, data from the Montana Agricultural Statistics Service and the National Agricultural Statistics Service were used to estimate water used for irrigation in 2000 because those data were available by county

Table 3. Total population and water withdrawals in Montana by county, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviations: acre-ft/yr, acre feet per year; Mgal/d, million gallons per day]

County (fig. 8)	Population of county	Withdrawals by category (Mgal/d)						Total with-drawals (Mgal/d)	Total withdrawals (acre-ft/yr)
		Irrigation	Public supply	Self-supplied domestic	Self-supplied industrial	Thermo-electric power gen-eration	Livestock		
Beaverhead	9,202	1,012.42	1.62	0.34	0.27	0	2.40	1,017.05	1,142,370
Big Horn	12,671	252.65	1.05	.51	.01	0	1.45	255.67	287,170
Blaine	7,009	326.90	.78	.15	0	0	1.10	328.94	369,470
Broadwater	4,385	235.87	.84	.20	.01	0	.36	237.28	266,520
Carbon	9,552	580.54	1.38	.39	.12	0	.92	583.36	655,240
Carter	1,360	10.49	.08	.07	0	0	1.03	11.67	13,110
Cascade	80,357	188.09	12.92	.79	.51	0	1.33	203.64	228,730
Chouteau	5,970	44.46	1.21	.18	0	0	.69	46.54	52,280
Custer	11,696	88.23	1.51	.15	.01	0	1.15	91.06	102,280
Daniels	2,017	4.52	.23	.06	0	0	.23	5.04	5,660
Dawson	9,059	77.26	2.17	.19	.05	0	.66	80.32	90,220
Deer Lodge	9,417	62.50	3.50	.24	0	0	.14	66.39	74,560
Fallon	2,837	2.82	.43	.07	.01	0	.62	3.95	4,440
Fergus	11,893	66.13	1.86	.32	.09	0	1.63	70.03	78,660
Flathead	74,471	63.66	5.13	2.42	6.31	0	.26	77.77	87,360
Gallatin	67,831	483.01	8.08	1.81	.09	0	.91	493.90	554,750
Garfield	1,279	9.70	.04	.07	0	0	.93	10.73	12,060
Glacier	13,247	111.18	1.92	.21	.30	0	.66	114.26	128,340
Golden Valley	1,042	62.52	.08	.05	0	0	.34	62.99	70,750
Granite	2,830	130.81	.04	.15	.01	0	.36	131.37	147,550
Hill	16,673	10.85	1.61	.22	.01	0	.47	13.15	14,770
Jefferson	10,049	126.09	1.49	.45	.29	0	.33	128.65	144,500
Judith Basin	2,329	72.57	.09	.11	0	0	.99	73.76	82,840
Lake	26,507	507.50	1.63	.93	.03	0	.85	510.94	573,900
Lewis and Clark	55,716	196.74	7.26	1.49	.94	0	.73	207.15	232,680
Liberty	2,158	30.48	.38	.04	0	0	.32	31.22	35,070
Lincoln	18,837	16.79	.91	.97	13.89	0	.06	32.62	36,640
McCone	1,977	16.28	.10	.10	0	0	.55	17.03	19,130
Madison	6,851	660.94	.31	.34	0	0	1.19	662.78	744,440
Meagher	1,932	350.37	.30	.04	.12	0	.95	351.79	395,130
Mineral	3,884	4.86	.28	.18	3.19	0	.01	8.52	9,570
Missoula	95,802	77.99	25.49	2.01	21.91	0	.18	127.58	143,300
Musselshell	4,497	100.58	.63	.19	0	0	.55	101.95	114,510
Park	15,694	352.33	2.21	.49	.03	0	.67	355.73	399,560
Petroleum	493	42.66	.01	.02	0	0	.37	43.06	48,370
Phillips	4,601	276.22	.39	.12	0	0	1.20	277.93	312,170
Pondera	6,424	253.86	1.04	.08	0	0	.54	255.52	287,010
Powder River	1,858	15.08	.16	.11	0	0	1.13	16.48	18,510
Powell	7,180	236.62	1.35	.16	0	0	.77	238.90	268,330
Prairie	1,199	56.85	.01	.09	0	0	.49	57.43	64,510
Ravalli	36,070	321.64	2.74	2.14	.12	0	.54	327.18	367,490
Richland	9,667	375.86	1.23	.26	.82	31.70	.94	410.81	461,430

Table 3. Total population and water withdrawals in Montana by county, 2000—Continued

County (fig. 8)	Population of county	Withdrawals by category (Mgal/d)						Total with-drawals (Mgal/d)	Total withdrawals (acre-ft/yr)
		Irrigation	Public supply	Self-supplied domestic	Self-supplied industrial	Thermo-electric power gen-eration	Livestock		
Roosevelt	10,620	72.06	.55	.43	.04	0	.45	73.53	82,580
Rosebud	9,383	159.35	1.54	.03	.09	25.59	1.29	187.89	211,050
Sanders	10,227	132.50	.66	.42	.21	0	.33	134.12	150,640
Sheridan	4,105	16.06	.41	.10	0	0	.37	16.95	19,040
Silver Bow	34,606	34.66	10.91	.48	1.65	0	.14	47.84	53,730
Stillwater	8,195	192.29	.60	.39	0	0	.88	194.16	218,090
Sweet Grass	3,609	322.84	.34	.14	0	0	.76	324.08	364,020
Teton	6,445	661.69	1.04	.23	0	0	.91	663.87	745,670
Toole	5,267	10.74	.88	.03	.22	0	.39	12.26	13,780
Treasure	861	107.57	.18	.04	0	0	.47	108.25	121,590
Valley	7,675	201.53	1.40	.13	.06	0	.98	204.11	229,260
Wheatland	2,259	101.25	.14	.06	0	0	.61	102.05	114,620
Wibaux	1,068	2.00	.07	.03	0	0	.30	2.40	2,700
Yellowstone	129,352	446.54	22.96	1.40	9.86	52.67	1.75	535.18	601,110
TOTAL	902,195	10,378	136.14	22.85	61.27	109.96	40.65	10,749	12,073,300

Table 4. Total population and water withdrawals in Montana by hydrologic unit, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviations: acre-ft/yr, acre-feet per year; Mgal/d, million gallons per day. Symbol: <. less than]

Hydrologic unit (fig. 9)	Population of hydrologic unit	Withdrawals by category (Mgal/d)						Total with-drawals (Mgal/d)	Total withdrawals (acre-ft/yr)
		Irrigation	Public supply	Self-supplied domestic	Self-supplied industrial	Thermo-electric power generation	Livestock		
10010001	13	0.67	0	<0.01	0	0	0.04	0.71	800
10010002	369	3.99	.01	.02	0	0	.10	4.13	4,640
10020001	847	340.59	.09	.05	0	0	.97	341.70	383,800
10020002	7,107	341.57	1.56	.17	.27	0	.58	344.15	386,560
10020003	2,008	170.12	.14	.07	0	0	.31	170.64	191,670
10020004	3,243	497.85	10.77	.25	0	0	1.03	509.90	572,730
10020005	6,664	233.80	.69	.30	0	0	.36	235.15	264,120
10020006	3,258	49.29	.54	.13	.29	0	.13	50.38	56,590
10020007	4,658	250.25	.14	.28	0	0	.61	251.28	282,240
10020008	61,712	408.77	7.74	1.48	.09	0	.58	418.66	470,240
10030101	62,674	372.50	8.67	1.76	.94	0	.92	384.79	432,200
10030102	71,170	78.58	13.29	.05	.51	0	.89	93.33	104,830
10030103	2,419	223.26	.24	.10	.12	0	.81	224.54	252,200
10030104	12,525	512.54	.59	.79	0	0	.69	514.62	578,030
10030105	2,111	8.82	.17	.09	0	0	.36	9.43	10,600
10030201	2,853	116.82	.20	.14	0	0	.36	117.52	132,000
10030202	10,513	88.93	1.83	.03	.30	0	.27	91.36	102,620
10030203	11,675	205.36	2.26	.02	.22	0	.81	208.67	234,380
10030204	812	9.78	.04	.05	0	0	.20	10.06	11,300
10030205	4,148	286.64	.66	.15	0	0	.60	288.05	323,540
10040101	1,496	13.27	.04	.10	0	0	.44	13.85	15,560
10040102	1,262	37.44	.16	.04	0	0	.39	38.03	42,720
10040103	11,250	74.20	1.81	.27	.09	0	1.17	77.54	87,090
10040104	2,414	65.86	.02	.17	0	0	1.41	67.47	75,780
10040105	407	4.15	.04	<.01	0	0	.29	4.48	5,030
10040106	374	3.29	0	.03	0	0	.24	3.56	4,000
10040201	4,806	314.37	.27	.21	0	0	1.74	316.60	355,610
10040202	3,460	85.97	.63	.11	0	0	.50	87.20	97,940
10040203	377	14.40	0	.03	0	0	.20	14.63	16,430
10040204	747	46.71	.08	.02	0	0	.36	47.17	52,990
10040205	549	9.73	0	.04	0	0	.39	10.16	11,410
10050001	644	7.10	0	.05	0	0	.12	7.27	8,160
10050002	1,192	4.84	.02	.09	0	0	.19	5.13	5,760
10050003	62	1.53	0	<.01	0	0	.01	1.55	1,740
10050004	19,520	330.80	2.33	.09	.01	0	.74	333.97	375,120
10050005	3,679	3.29	.46	.08	0	0	.14	3.97	4,460
10050006	920	8.19	.01	.07	0	0	.18	8.44	9,480
10050007	780	10.45	0	.06	0	0	.05	10.56	11,860
10050008	266	32.37	0	.02	0	0	.12	32.51	36,520
10050009	1,304	43.51	.15	.02	0	0	.19	43.88	49,290
10050010	495	20.51	.01	.03	0	0	.21	20.77	23,330
10050011	333	9.96	.01	.02	0	0	.12	10.10	11,350
10050012	5,281	109.55	1.05	.06	.06	0	.32	111.04	124,720
10050013	165	9.98	0	.01	0	0	.06	10.06	11,300
10050014	706	90.80	.03	.03	0	0	.37	91.24	102,490
10050015	443	20.66	.05	.02	0	0	.17	20.90	23,470
10050016	514	7.60	0	.04	0	0	.14	7.78	8,740
10060001	5,551	97.65	.57	.13	0	0	.59	98.93	111,120
10060002	1,971	20.95	.14	.09	0	0	.80	21.97	24,680
10060003	3,406	10.05	.31	.11	0	0	.22	10.70	12,010

Table 4. Total population and water withdrawals in Montana by hydrologic unit, 2000—Continued

Hydrologic unit (fig. 9)	Population of hydrologic unit	Withdrawals by category (Mgal/d)						Total with-drawals (Mgal/d)	Total withdrawals (acre-ft/yr)
		Irrigation	Public supply	Self-supplied domestic	Self-supplied industrial	Thermo-electric power generation	Livestock		
10060004	550	5.92	.03	.03	0	0	.16	6.14	6,900
10060005	3,387	68.41	.14	.16	.04	0	.39	69.14	77,660
10060006	5,278	22.65	.41	.19	0	0	.50	23.75	26,680
10060007	485	4.17	.04	.02	0	0	.06	4.29	4,810
10070001	1,167	92.92	.20	.02	0	0	.09	93.23	104,720
10070002	16,108	428.96	2.21	.49	.03	0	.98	432.66	485,980
10070003	2,342	172.42	.14	.14	0	0	.23	172.92	194,230
10070004	99,691	348.94	23.05	.37	9.86	52.67	.79	435.68	489,360
10070005	3,486	127.02	.18	.20	0	0	.45	127.85	143,600
10070006	8,772	527.39	1.38	.33	.12	0	.69	529.91	595,210
10070007	33,317	158.95	.31	1.15	0	0	1.18	161.59	181,500
10070008	2,069	26.38	.07	.13	0	0	.30	26.87	30,180
10080010	690	19.54	0	.05	0	0	.18	19.77	22,210
10080014	318	24.11	0	.02	0	0	.11	24.25	27,240
10080015	6,216	190.07	.64	.20	.01	0	.64	191.55	215,160
10080016	3,879	52.52	.37	.14	0	0	.27	53.30	59,860
10090101	520	25.59	0	.04	0	0	.24	25.87	29,060
10090102	5,215	48.95	.24	.14	0	0	.87	50.20	56,380
10090207	927	3.62	.16	.03	0	0	.20	4.02	4,510
10090208	223	2.66	0	.02	0	0	.23	2.91	3,270
10090209	715	14.89	0	.06	0	0	.60	15.55	17,470
10090210	251	8.08	0	.02	0	0	.25	8.35	9,370
10100001	14,337	254.90	2.47	.13	.10	25.59	1.54	284.73	319,810
10100002	218	12.36	0	.02	0	0	.21	12.59	14,140
10100003	3,494	15.28	.52	.04	0	0	.33	16.17	18,160
10100004	18,868	440.30	3.36	.47	.87	31.70	1.48	478.18	537,090
10100005	2,784	5.42	.43	.07	.01	0	.52	6.45	7,240
10110201	693	5.61	.08	.02	0	0	.54	6.24	7,010
10110202	488	3.76	0	.04	0	0	.33	4.13	4,640
10110203	39	0	0	<.01	0	0	.02	.02	20
10110204	828	.52	.07	.02	.01	0	.14	.75	840
10120202	18	.12	0	<.01	0	0	.02	.15	170
17010101	16,576	14.97	.91	.80	13.89	0	.03	30.60	34,370
17010102	1,200	7.38	0	.09	0	0	.02	7.49	8,410
17010103	838	.62	0	.07	0	0	.01	.69	780
17010104	55	.06	0	<.01	0	0	<.01	.06	70
17010105	39	.03	0	<.01	0	0	<.01	.04	40
17010201	49,331	227.68	5.00	.74	1.65	0	.56	235.64	264,670
17010202	5,143	110.02	.04	.33	.01	0	.27	110.68	124,310
17010203	6,280	103.01	.47	.39	0	0	.50	104.38	117,240
17010204	56,684	36.01	24.29	.74	25.10	0	.07	86.21	96,840
17010205	70,813	339.36	3.74	3.06	.12	0	.56	346.83	389,560
17010206	445	1.32	0	.03	0	0	.05	1.40	1,570
17010207	275	2.25	.01	.01	0	0	.06	2.33	2,620
17010208	42,858	81.60	2.51	1.68	6.34	0	.24	92.37	103,760
17010209	1,796	14.47	0	.14	0	0	.22	14.83	16,660
17010210	32,790	18.30	2.55	.87	0	0	.04	21.77	24,450
17010211	4,129	42.45	.16	.22	0	0	.21	43.04	48,340
17010212	22,127	508.16	1.64	.60	0	0	.52	510.91	573,870
17010213	8,290	48.52	.55	.33	.21	0	.24	49.86	56,000
TOTAL	902,195	10,378	136.14	22.85	61.27	109.96	40.65	10,749	12,073,300

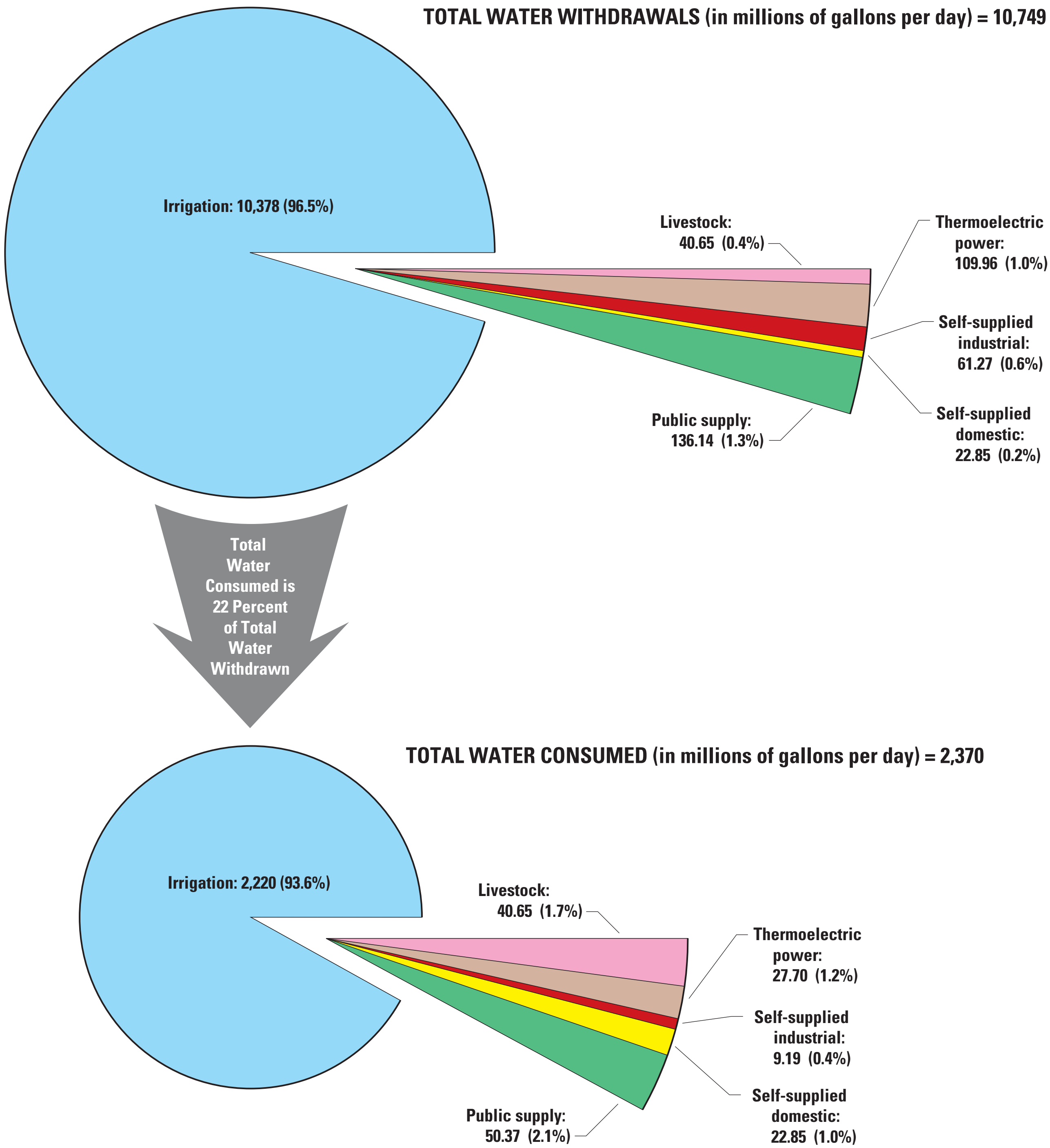


Figure 7. Total water withdrawals in Montana by category (top) and total water consumed in Montana by category (bottom) in 2000.

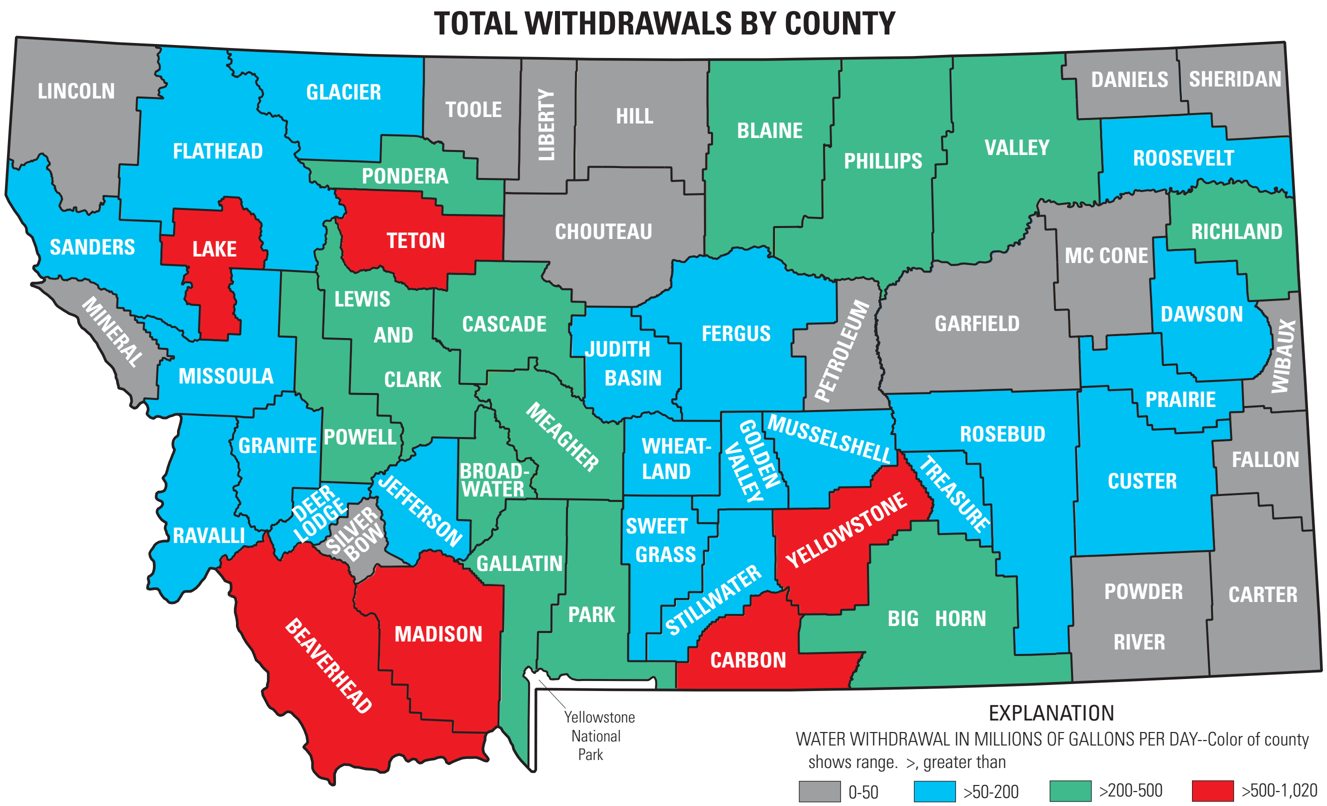


Figure 8. Total water withdrawals in Montana counties in 2000.

TOTAL WITHDRAWALS BY HYDROLOGIC UNIT

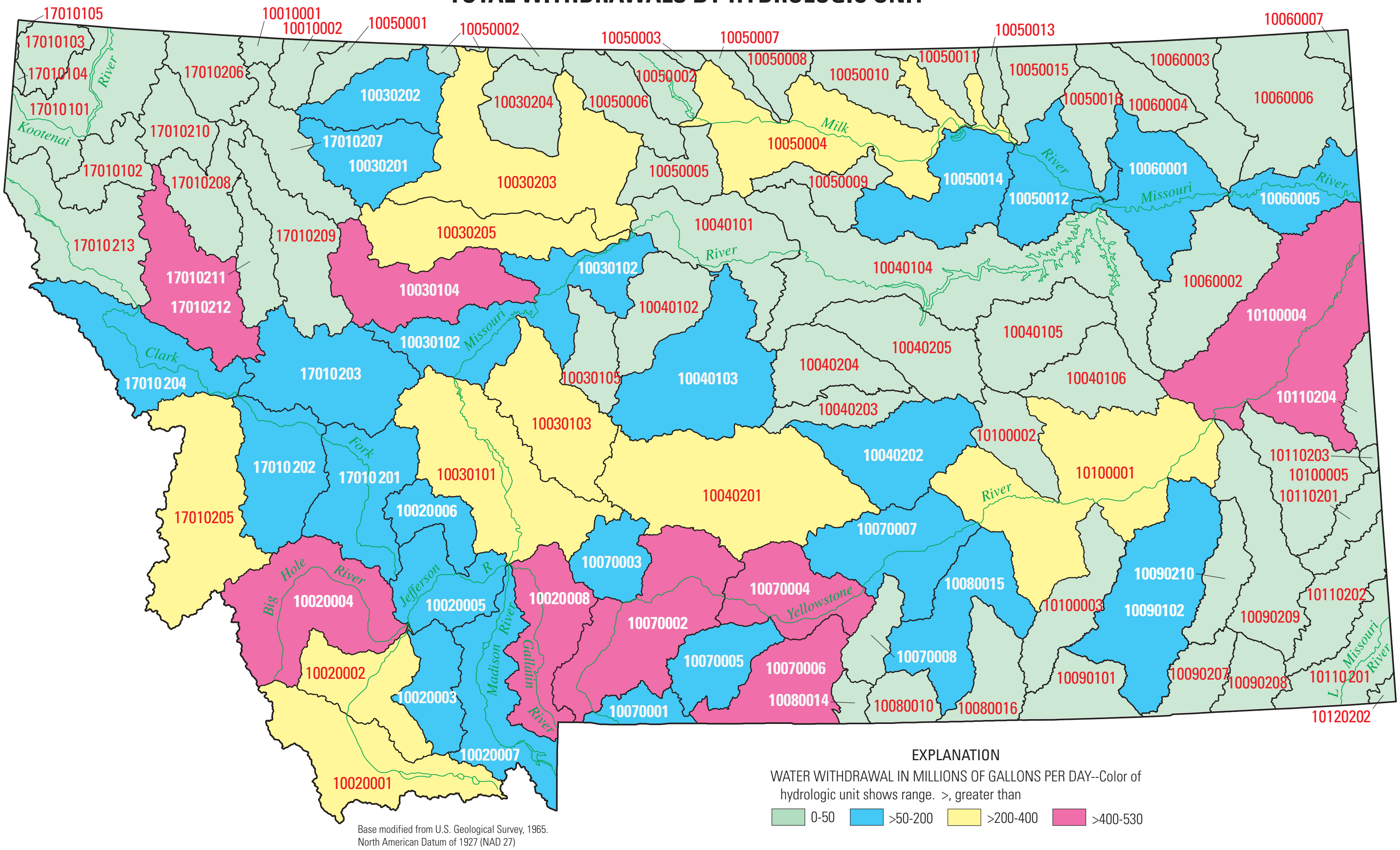


Figure 9. Total water withdrawals in Montana hydrologic units (stream basins) in 2000.

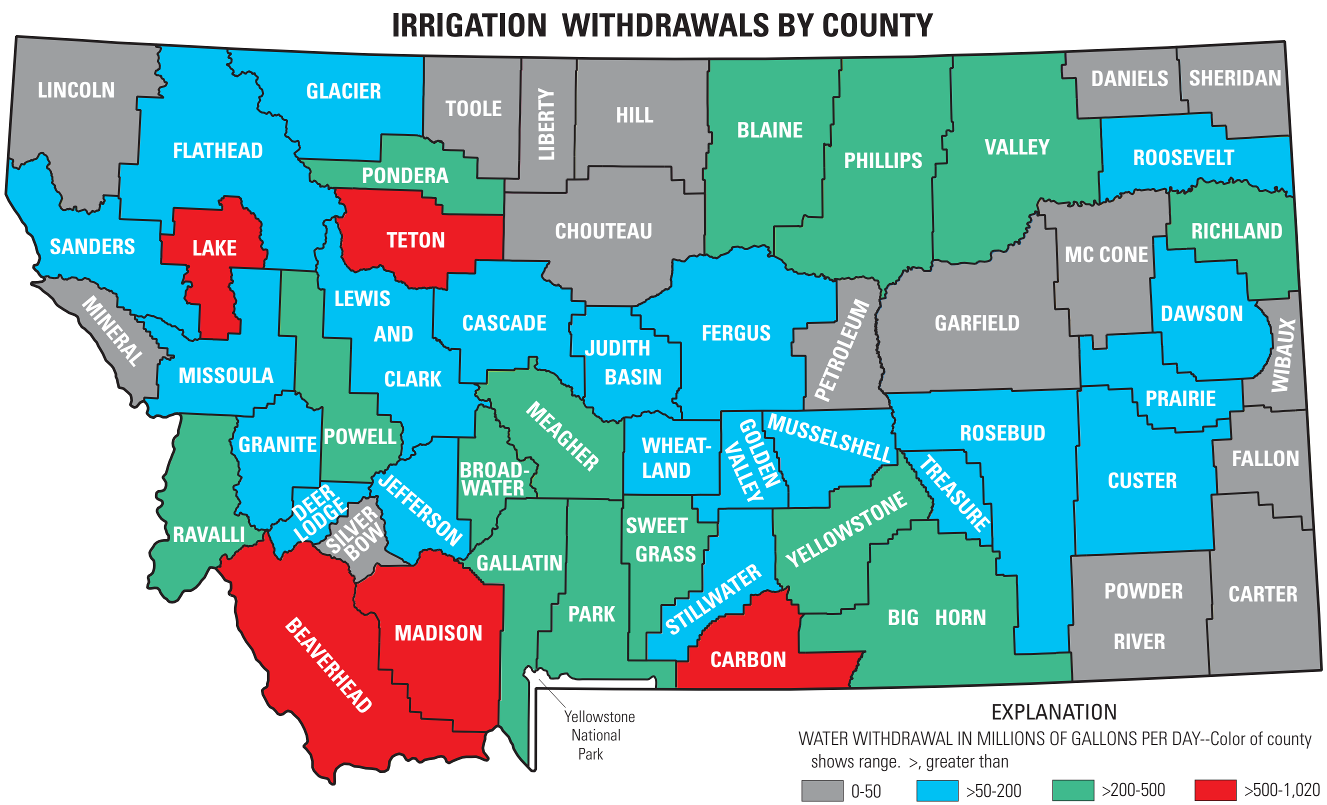


Figure 10. Irrigation water withdrawals in Montana counties in 2000.

Table 5. Irrigation water withdrawals and consumptive use in Montana by county, 2000

[Values may not add for column or total withdrawals because of rounding. Abbreviations: acre-ft/yr, acre-feet per year; Mgal/d, million gallons per day]

County (fig. 10)	Withdrawals				Consumptive use		Irrigated land		
	Ground water (Mgal/d)	Surface water (Mgal/d)	Total (Mgal/d)	Total (acre-ft/yr)	(Mgal/d)	(acre-ft/yr)	Crop land (thousand acres)	Pasture land (thousand acres)	Total (thousand acres)
Beaverhead	4.44	1,007.99	1,012.42	1,137,170	192.16	215,830	121.93	98.66	220.59
Big Horn	2.58	250.07	252.65	283,780	56.73	63,720	38.03	9.63	47.66
Blaine	5.72	321.18	326.90	367,180	81.27	91,290	57.67	7.90	65.57
Broadwater	2.19	233.68	235.87	264,940	47.29	53,110	38.95	6.74	45.69
Carbon	.82	579.72	580.54	652,070	93.16	104,640	61.65	20.47	82.12
Carter	.32	10.17	10.49	11,790	5.21	5,850	3.85	1.93	5.78
Cascade	1.63	186.45	188.09	211,260	48.70	54,700	38.57	7.53	46.10
Chouteau	.82	43.64	44.46	49,940	11.39	12,800	11.55	.54	12.09
Custer	.65	87.58	88.23	99,100	28.76	32,300	26.86	2.51	29.37
Daniels	1.40	3.12	4.52	5,070	1.99	2,240	1.48	.31	1.79
Dawson	.21	77.04	77.26	86,780	21.97	24,670	17.46	.96	18.42
Deer Lodge	.54	61.95	62.50	70,200	13.15	14,770	10.54	4.97	15.51
Fallon	.49	2.33	2.82	3,170	1.68	1,890	2.07	0	2.07
Fergus	1.79	64.33	66.13	74,270	14.74	16,550	12.08	1.08	13.16
Flathead	12.41	51.25	63.66	71,500	35.16	39,500	31.00	3.77	34.77
Gallatin	16.18	466.83	483.01	542,520	103.24	115,960	89.06	18.84	107.90
Garfield	.45	9.25	9.70	10,890	4.37	4,910	3.96	.84	4.80
Glacier	.50	110.68	111.18	124,870	20.65	23,200	33.81	1.84	35.65
Golden Valley	.01	62.51	62.52	70,220	10.93	12,270	8.74	1.53	10.27
Granite	.54	130.27	130.81	146,930	31.28	35,140	28.28	9.57	37.85
Hill	1.03	9.81	10.85	12,180	3.35	3,760	3.44	.07	3.51
Jefferson	1.95	124.15	126.10	141,630	26.67	29,950	17.33	7.23	24.56
Judith Basin	1.30	71.26	72.57	81,510	10.77	12,090	9.66	.42	10.08
Lake	4.93	502.57	507.50	570,040	131.17	147,330	77.35	38.01	115.36
Lewis and Clark	9.64	187.10	196.74	220,980	47.26	53,090	37.97	5.83	43.80
Liberty	.09	30.39	30.48	34,240	6.66	7,480	5.39	1.82	7.21
Lincoln	.68	16.11	16.79	18,860	5.12	5,750	3.48	.89	4.37
McCone	.01	16.27	16.28	18,280	7.86	8,820	8.47	.58	9.05
Madison	1.99	658.96	660.95	742,380	107.76	121,040	84.84	29.04	113.88
Meagher	2.67	347.70	350.37	393,550	51.91	58,310	47.21	4.08	51.29
Mineral	.69	4.17	4.86	5,460	2.07	2,330	1.35	.32	1.67
Missoula	4.84	73.15	77.99	87,600	23.90	26,850	15.09	6.99	22.08
Musselshell	.38	100.20	100.58	112,980	17.91	20,110	9.70	2.72	12.42
Park	2.64	349.69	352.33	395,740	58.43	65,630	39.82	12.89	52.71

Table 5. Irrigation water withdrawals and consumptive use in Montana by county, 2000—Continued

County (fig. 10)	Withdrawals				Consumptive use		Irrigated land		
	Ground water (Mgal/d)	Surface water (Mgal/d)	Total (Mgal/d)	Total (acre-ft/yr)	(Mgal/d)	(acre-ft/yr)	Crop land (thousand acres)	Pasture land (thousand acres)	Total (thousand acres)
Petroleum	.34	42.32	42.66	47,920	10.77	12,100	9.03	0	9.03
Phillips	3.46	272.76	276.22	310,250	62.74	70,470	48.43	4.49	52.92
Pondera	2.93	250.93	253.86	285,140	68.41	76,840	82.51	4.93	87.44
Powder River	.21	14.87	15.08	16,940	7.71	8,660	10.62	.18	10.80
Powell	1.89	234.72	236.62	265,770	49.89	56,030	46.50	12.89	59.39
Prairie	1.48	55.37	56.85	63,850	14.79	16,610	13.18	1.04	14.22
Ravalli	4.81	316.83	321.64	361,270	89.65	100,700	43.23	37.13	80.36
Richland	1.69	374.17	375.86	422,170	64.74	72,710	47.51	1.95	49.46
Roosevelt	2.28	69.78	72.06	80,940	19.08	21,420	19.57	.33	19.90
Rosebud	1.58	157.77	159.35	178,990	37.28	41,880	34.41	2.98	37.39
Sanders	4.01	128.49	132.50	148,830	32.12	36,080	20.67	4.63	25.30
Sheridan	9.12	6.94	16.06	18,040	10.15	11,400	8.78	.37	9.15
Silver Bow	.69	33.97	34.66	38,930	7.87	8,840	7.76	1.39	9.15
Stillwater	4.42	187.87	192.29	215,990	37.06	41,630	23.59	8.62	32.21
Sweet Grass	.57	322.27	322.84	362,620	48.22	54,160	23.63	15.57	39.20
Teton	1.19	660.49	661.69	743,220	130.37	146,440	125.20	17.66	142.86
Toole	.30	10.44	10.74	12,070	3.18	3,570	4.30	.23	4.53
Treasure	1.07	106.50	107.57	120,820	25.33	28,450	18.80	1.15	19.95
Valley	4.90	196.64	201.54	226,370	55.00	61,780	42.90	8.74	51.64
Wheatland	1.82	99.42	101.25	113,720	16.10	18,080	14.81	1.53	16.34
Wibaux	.03	1.97	2.00	2,250	.98	1,100	1.72	0	1.72
Yellowstone	4.86	441.68	446.54	501,560	103.50	116,250	76.06	14.16	90.22
TOTAL	140.22	10,238	10,378	11,656,700	2,220	2,493,100	1,722	450	2,172

and crop type and provided a consistent and reasonable estimate of irrigated acreage.

Net irrigation requirements for crops in each of five climatic areas of Montana were estimated from total consumptive use of crops minus the effective rainfall in the area (U.S. Soil Conservation Service, 1974). Net irrigation requirements range from about 22.1 inches for alfalfa in the highest consumptive-use climate area, to about 7 inches for grain in the lowest consumptive-use climate area. The average consumptive-use rate for all crops and pasture in Montana was about 1.15 acre-feet per irrigated acre.

Overall irrigation efficiencies in Montana, for most irrigation systems, range from about 15 to 60 percent (U.S. Soil Conservation Service, 1978) and are dependent on many factors in the irrigation delivery and application systems. Characteristics of the lowest efficiency systems include long unlined irrigation ditches over permeable soils and flood application of irrigation water over an irregular field surface. Large conveyance losses, which are typical of the mostly unlined irrigation ditches used in Montana, are documented in a statewide study by the U.S. Soil Conservation Service (1978) and by a study of irrigation withdrawals in Gallatin County (Parrett and Johnson, 1988). Conveyance losses from seepage can recharge underlying aquifers or become available for additional use when it flows back to the stream as irrigation return flow, typically during late summer or fall. Characteristics of higher-efficiency irrigation systems include lined irrigation ditches, pipelines, and sprinkler application of water. Application efficiency of center-pivot sprinkler irrigation systems can be as high as 85 percent (Neibling, 1997). For this report, the average irrigation efficiency for all systems in Montana was assumed to be about 21 percent, which might be too low because the 1995 irrigation survey by the Natural Resources Conservation Service indicated that sprinkler systems were used on about 31 percent of irrigated lands in Montana. Each year, many irrigators in Montana are converting lands from flood irrigation to more efficient center pivot or other sprinkler irrigation systems. The conversion of irrigation systems from flood to sprinkler improves irrigation efficiency and results in smaller water withdrawals per acre irrigated; however, consumptive use is not reduced and could even increase with the better water distribution and crop production that often is realized on more efficiently irrigated fields.

Public Supply

Public supply is water supplied by a publicly or privately owned water system for public distribution. Any water system that serves drinking water to at least 25 people for at least 60 days of the calendar year or has at least 15 service connections is considered a public supply, as defined by the Safe Drinking Water Act of 1974 (Public Law 93-523). Water from public-supply systems is distributed to multiple users for domestic, commercial, industrial, and public uses.

Three types of drinking-water systems are regulated by the Montana Department of Environmental Quality, as required by the Safe Drinking Water Act of 1974. The three types are community-water systems, nontransient-noncommunity water systems, and transient-noncommunity water systems. Community-water systems serve the same resident population in cities, towns, subdivisions, and trailer courts every day. Nontransient-noncommunity water systems serve a nonresident population in locations such as schools and places of business for at least 6 months of the calendar year. Transient-noncommunity water systems serve a transient population in locations such as restaurants, rest areas, and campgrounds. In 2000, Montana had about 645 community-water systems, 225 nontransient-noncommunity water systems, and 1,153 transient-noncommunity water systems (U.S. Environmental Protection Agency, 2001). These three types of water systems served drinking water to as many as 900,098 people daily (Montana Department of Environmental Quality, 2001). In addition, Montana had 44 tribal-water systems in 2000 that were not regulated by the Montana Department of Environmental Quality. These tribal-water systems served a population of about 15,900 (U.S. Environmental Protection Agency, 2003, Safe Drinking Water Information System database).

For the purpose of estimating water use in each county, only community- and tribal-water systems that supply water daily to the same population were included in estimations of water withdrawals and the population served. In this report, these water systems are referred to as public supplies. Noncommunity systems were not included because most users of noncommunity-water systems also have supplies from community or self-supplied domestic water sources. Numbers of persons served in each county were based on figures reported to the U.S. Environmental Protection Agency by suppliers of public-drinking water and, in those instances where the population served was larger than what was reported from the 2000 Census, the population served was adjusted to the actual population as reported by the U.S. Census Bureau.

The quantity of water withdrawn for public supplies during 2000 was estimated to be 136.14 Mgal/d (table 6), and the number of people served by these public-supply systems was estimated to be 609,200. On the basis of previous studies, 37 percent (50.37 Mgal/d) of the water withdrawn for public supplies was consumed (Montana Department of Natural Resources and Conservation, 1986). Total public-supply withdrawals in Montana averaged about 223 gal/d for each person served, compared with about 263 gal/d in Idaho, 264 gal/d in Wyoming, and 179 gal/d nationally (Hutson and others, 2004). These per capita use rates include water used for public use (firefighting, street washing, municipal parks) and water lost to leakage in the supply system. Withdrawals by county for public supply in Montana are shown in figure 11.

Surface water was the source for about 52 percent of the public-supply withdrawals, or about 70.72 Mgal/d. Counties that withdrew the largest volumes of surface water for public supply (more than 5 Mgal/d) were Yellowstone, Cascade, Silver Bow, Lewis and Clark, and Gallatin. Ground water was the source for 48 percent of withdrawals or about 65.42 Mgal/d. Many counties with small populations depend largely on

Table 6. Public-supply water withdrawals in Montana by county, 2000

[Values may not add for totals because of rounding. Abbreviations: gal/d, gallons per day; Mgal/d, million gallons per day. Symbol: <, less than]

County (fig. 11)	Population served (thousands)			Water withdrawals (Mgal/d)			Water deliveries by type of use (Mgal/d)				Per capita use (gal/d)	
	Ground water	Surface water	Total	Ground water	Surface water	Total	Domestic	Commercial	Industrial	Public use and losses	Total public with-drawals	Domestic use
Beaverhead	4.78	0	4.78	1.62	0	1.62	0.92	0.30	0.01	0.39	339	193
Big Horn	1.31	4.78	6.08	.22	.82	1.05	.60	.19	.01	.25	172	98
Blaine	1.16	3.90	5.05	.18	.60	.78	.45	.14	.01	.19	155	88
Broadwater	1.82	0	1.82	.84	0	.84	.48	.15	.01	.20	462	263
Carbon	2.55	1.96	4.51	.78	.60	1.38	.79	.25	.01	.33	307	175
Carter	.44	0	.44	.08	0	.08	.04	.01	<.01	.02	171	98
Cascade	7.08	63.11	70.19	1.30	11.61	12.92	7.36	2.36	.10	3.10	184	105
Chouteau	3.12	.60	3.72	1.02	.20	1.21	.69	.22	.01	.29	326	186
Custer	.08	9.63	9.71	.01	1.50	1.51	.86	.28	.01	.36	156	89
Daniels	1.22	0	1.22	.23	0	.23	.13	.04	<.01	.06	189	108
Dawson	1.86	4.81	6.66	.60	1.56	2.17	1.23	.39	.02	.52	325	185
Deer Lodge	6.29	0	6.29	3.50	0	3.50	2.00	.64	.03	.84	557	317
Fallon	1.91	0	1.91	.43	0	.43	.24	.08	<.01	.10	224	127
Fergus	7.73	0	7.73	1.86	0	1.86	1.06	.34	.01	.45	241	137
Flathead	26.50	16.95	43.45	3.13	2.00	5.13	2.92	.94	.04	1.23	118	67
Gallatin	16.64	28.02	44.66	3.01	5.07	8.08	4.61	1.47	.06	1.94	181	103
Garfield	.37	0	.37	.04	0	.04	.02	.01	0	.01	100	57
Glacier	5.90	4.65	10.55	1.07	.85	1.92	1.09	.35	.01	.46	182	104
Golden Valley	.13	.27	.40	.03	.06	.08	.05	.01	0	.02	205	117
Granite	0	.91	.91	0	.04	.04	.02	.01	0	.01	41	23
Hill	2.25	11.61	13.86	.26	1.35	1.61	.92	.29	.01	.39	116	66
Jefferson	4.30	0	4.30	1.49	0	1.49	.85	.27	.01	.36	347	198
Judith Basin	.95	0	.95	.09	0	.09	.05	.02	0	.02	97	55
Lake	12.77	1.75	14.52	1.43	.20	1.63	.93	.30	.01	.39	112	64
Lewis and Clark	9.20	27.45	36.65	1.82	5.44	7.26	4.14	1.32	.06	1.74	198	113
Liberty	.68	.96	1.64	.16	.23	.38	.22	.07	0	.09	234	134
Lincoln	2.48	3.88	6.36	.36	.55	.91	.52	.17	.01	.22	143	82
McCone	.70	0	.70	.10	0	.10	.06	.02	0	.02	148	84
Madison	2.55	0	2.55	.31	0	.31	.18	.06	0	.07	121	69
Meagher	.42	1.00	1.42	.09	.21	.30	.17	.05	<.01	.07	209	119
Mineral	1.19	.40	1.59	.21	.07	.28	.16	.05	0	.07	178	101
Missoula	69.13	.90	70.03	25.16	.33	25.49	14.53	4.65	.19	6.12	364	208
Musselshell	1.89	.18	2.07	.58	.06	.63	.36	.12	0	.15	305	174
Park	9.13	.30	9.43	2.14	.07	2.21	1.26	.40	.02	.53	234	133
Petroleum	.19	0	.19	.01	0	.01	.01	0	0	0	63	36
Phillips	3.02	0	3.02	.39	0	.39	.22	.07	<.01	.09	129	74
Pondera	1.55	3.91	5.46	.30	.75	1.04	.59	.19	.01	.25	191	109

Table 6. Public-supply water withdrawals in Montana by county, 2000—Continued

County (fig. 11)	Population served (thousands)			Water withdrawals (Mgal/d)			Water deliveries by type of use (Mgal/d)				Per capita use (gal/d)	
	Ground water	Surface water	Total	Ground water	Surface water	Total	Domestic	Commercial	Industrial	Public use and losses	Total public with-drawals	Domestic use
Powder River	.51	0	.51	.16	0	.16	.09	.03	0	.04	318	181
Powell	5.12	0	5.12	1.35	0	1.35	.77	.25	.01	.32	263	150
Prairie	.05	0	.05	.01	0	.01	<.01	<.01	<.01	<.01	138	79
Ravalli	6.28	2.30	8.58	2.00	.73	2.74	1.56	.50	.02	.66	319	182
Richland	6.28	0	6.28	1.23	0	1.23	.70	.22	.01	.29	195	111
Roosevelt	4.30	.80	5.10	.46	.09	.55	.31	.10	<.01	.13	108	62
Rosebud	4.41	4.54	8.96	.76	.78	1.54	.88	.28	.01	.37	172	98
Sanders	2.95	1.84	4.79	.40	.25	.66	.37	.12	<.01	.16	137	78
Sheridan	2.79	0	2.79	.41	0	.41	.24	.08	<.01	.10	148	84
Silver Bow	.10	28.30	28.40	.04	10.87	10.91	6.22	1.99	.08	2.62	384	219
Stillwater	1.09	2.16	3.24	.20	.40	.60	.34	.11	<.01	.14	185	105
Sweet Grass	1.85	0	1.85	.34	0	.34	.19	.06	<.01	.08	183	104
Teton	3.33	.17	3.50	.99	.05	1.04	.59	.19	.01	.25	298	170
Toole	4.58	.25	4.83	.83	.05	.88	.50	.16	.01	.21	182	104
Treasure	0	.40	.40	0	.18	.18	.10	.03	<.01	.04	438	249
Valley	1.36	4.68	6.04	.32	1.09	1.40	.80	.26	.01	.34	232	132
Wheatland	1.50	0	1.50	.14	0	.14	.08	.02	<.01	.03	90	51
Wibaux	.63	0	.63	.07	0	.07	.04	.01	0	.02	104	59
Yellowstone	4.21	107.24	111.45	.87	22.09	22.96	13.09	4.19	.17	5.51	206	118
TOTAL	264.61	344.59	609.20	65.42	70.72	136.14	77.60	24.83	1.04	32.67	223	127

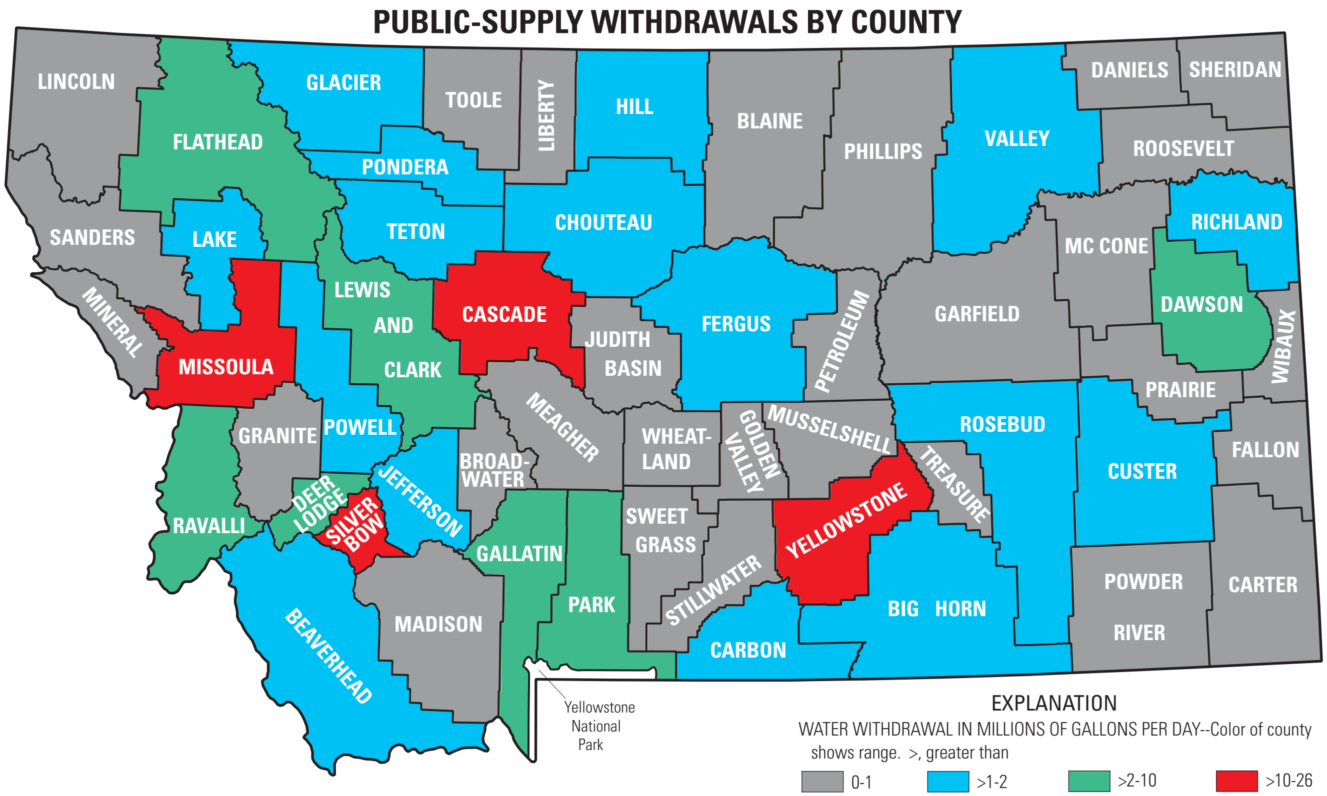


Figure 11. Public-supply water withdrawals in Montana counties in 2000.

ground water for public supply (table 6). Counties that withdrew the largest volumes of ground water for public supply (more than 2 Mgal/d) were Missoula, Deer Lodge, Flathead, Gallatin, and Park (table 6). Coarse-grained glacial deposits, stream-valley alluvium, or basin fill (fig. 6) are the primary source of the large quantities of ground water withdrawn in those counties.

Public-supply water used solely for domestic (residential) purposes was 77.60 Mgal/d, which is equivalent to a per capita use of 127 gal/d. The per capita use in 2000 is slightly less than the reported Montana 1990 per capita use of 129 gal/d and is above the national average in 1990 of 105 gal/d (Solley and others, 1993).

Self-Supplied Domestic

Domestic water use includes water for household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. The number of people served by their own water systems (table 7) was determined by subtracting the number of people served by public systems in each county from the 2000 total population of each county, as reported by the U.S. Census Bureau (2000).

Self-supplied domestic water withdrawals during 2000 were estimated at 22.85 Mgal/d (table 7) and the water served a population of about 292,990. Withdrawals were estimated based on a per capita use of 78 gal/d (Montana Department of Natural Resources and Conservation, 1986). Most (95 percent) of the domestic-water supply was withdrawn from ground water. Counties with the largest domestic-water withdrawals (more than 1 Mgal/d) were Flathead, Ravalli, Missoula, Gallatin, Lewis and Clark, and Yellowstone (fig. 12). All water withdrawn for self-supplied domestic use was assumed to be consumed (Montana Department of Natural Resources and Conservation, 1986).

Self-Supplied Industrial

Industrial water use includes water for such purposes as processing, washing, and cooling in facilities that manufacture products. In western Montana, the largest industrial use of water was for manufacturing of wood products, which includes pulp and paper production. Montana petroleum refining and sugar processing industries also were substantial industrial users of water.

Self-supplied industrial water withdrawals during 2000 were estimated at 61.27 Mgal/d (table 8). Withdrawals from ground water were about 31.94 Mgal/d, or 52 percent of total industrial withdrawals. A large part of the ground-water withdrawals were from unconsolidated deposit aquifers in western Montana (fig. 6). Surface water supplied about 29.33 Mgal/d, or 48 percent of the total withdrawals. Counties with the largest withdrawals (about 6 to 22 Mgal/d) were Missoula, Lincoln, Yellowstone, and Flathead (fig. 13; table 8). Fifteen percent (9.19 Mgal/d) of the water withdrawn for self-supplied industrial use was assumed to be consumed (Montana Department of Natural Resources and Conservation, 1986).

Thermoelectric Power Generation

Total water withdrawn for thermoelectric power generation in 2000 was estimated at 109.96 Mgal/day (table 9). All of the water used for this purpose was from surface water and was used for cooling purposes at fossil-fuel plants in Richland, Rosebud, and Yellowstone Counties (table 9). Power plants in Richland and Yellowstone Counties used surface water for once-through cooling and returned almost all withdrawn water back to the source. Power plants in Rosebud County recirculated their cooling water; however, that water was obtained from surface-water sources and was not returned to the source of withdrawal. Water consumed for thermoelectric power generation was about 27.70 Mgal/d, most of which was consumed in Rosebud County because cooling water used at power plants in Rosebud County was not returned to the source of withdrawal.

Livestock

Livestock water uses are those related to the production of meat, milk, poultry, eggs, and wool. The quantity of water used for livestock production was estimated by county, based on the reported 2000 inventory of livestock in each county (Montana Agricultural Statistics Service, 2001) and the daily per head water consumption of various types of livestock (table 10). Daily livestock water requirements are influenced by a number of factors, including temperature, feed intake, lactation, activity, and feed type (North Dakota State University Extension Service, 1999). Livestock categories used for estimates of water use and the reported 2000 livestock population in Montana are: cattle, 2,600,000 head (includes beef and dairy cattle); chickens, 460,000 head; sheep, 370,000 head; hogs and pigs, 55,000 head (Montana Agricultural Statistics Service, 2001).

Total water withdrawn and consumed for livestock use in 2000 was about 40.65 Mgal/day (table 11). Surface water was the source for about 70 percent of the total livestock withdrawals, or about 28.45 Mgal/day, whereas ground water was the source for about 30 percent of the withdrawals, or about 12.20 Mgal/day. Counties with the largest withdrawals (more than 1.20 Mgal/d) for livestock were Beaverhead, Yellowstone, Fergus, Big Horn, Cascade, and Rosebud (fig. 14). Water withdrawals from surface water and ground water were estimated for each county based on the percentage of withdrawals from surface water and ground water reported from the Montana Department of Natural Resources and Conservation (1986). In that report, water-rights permits that listed livestock water use by source of supply were used to estimate the percentage supplied by either surface water or ground water.

Table 7. Self-supplied domestic water withdrawals in Montana by county, 2000

[Values may not add for totals because of rounding. Abbreviation: Mgal/d, million gallons per day]

County (fig. 12)	Self-supplied population (thousands)	Water withdrawals (Mgal/d)		
		Ground water	Surface water	Total
Beaverhead	4.42	0.34	0	0.34
Big Horn	6.59	.51	0	.51
Blaine	1.96	.15	0	.15
Broadwater	2.57	.20	0	.20
Carbon	5.04	.39	0	.39
Carter	.92	.06	.01	.07
Cascade	10.17	.79	0	.79
Chouteau	2.25	.16	.01	.18
Custer	1.99	.15	0	.15
Daniels	.80	.06	0	.06
Dawson	2.40	.19	0	.19
Deer Lodge	3.13	.24	0	.24
Fallon	.93	.07	0	.07
Fergus	4.16	.32	0	.32
Flathead	31.02	1.62	.80	2.42
Gallatin	23.17	1.81	0	1.81
Garfield	.91	.07	0	.07
Glacier	2.70	.21	0	.21
Golden Valley	.64	.05	0	.05
Granite	1.92	.15	0	.15
Hill	2.82	.22	0	.22
Jefferson	5.75	.45	0	.45
Judith Basin	1.38	.11	0	.11
Lake	11.99	.89	.05	.93
Lewis and Clark	19.06	1.41	.07	1.49
Liberty	.52	.04	0	.04
Lincoln	12.48	.94	.03	.97
McCone	1.28	.10	0	.10
Madison	4.30	.33	.01	.34
Meagher	.51	.04	0	.04
Mineral	2.29	.17	.01	.18
Missoula	25.77	2.01	0	2.01
Musselshell	2.43	.19	0	.19
Park	6.27	.49	0	.49
Petroleum	.31	.02	0	.02
Phillips	1.58	.12	0	.12
Pondera	.96	.08	0	.08
Powder River	1.35	.11	0	.11
Powell	2.06	.16	0	.16
Prairie	1.15	.09	0	.09
Ravalli	27.50	2.14	0	2.14
Richland	3.38	.26	0	.26
Roosevelt	5.52	.43	0	.43
Rosebud	.43	.03	0	.03
Sanders	5.44	.40	.02	.42
Sheridan	1.31	.10	0	.10
Silver Bow	6.21	.48	0	.48
Stillwater	4.95	.37	.02	.39
Sweet Grass	1.76	.14	0	.14
Teton	2.95	.23	0	.23
Toole	.44	.03	0	.03
Treasure	.46	.04	0	.04
Valley	1.63	.10	.03	.13
Wheatland	.76	.06	0	.06
Wibaux	.44	.03	0	.03
Yellowstone	17.90	1.40	0	1.40
TOTAL	292.99	21.80	1.05	22.85

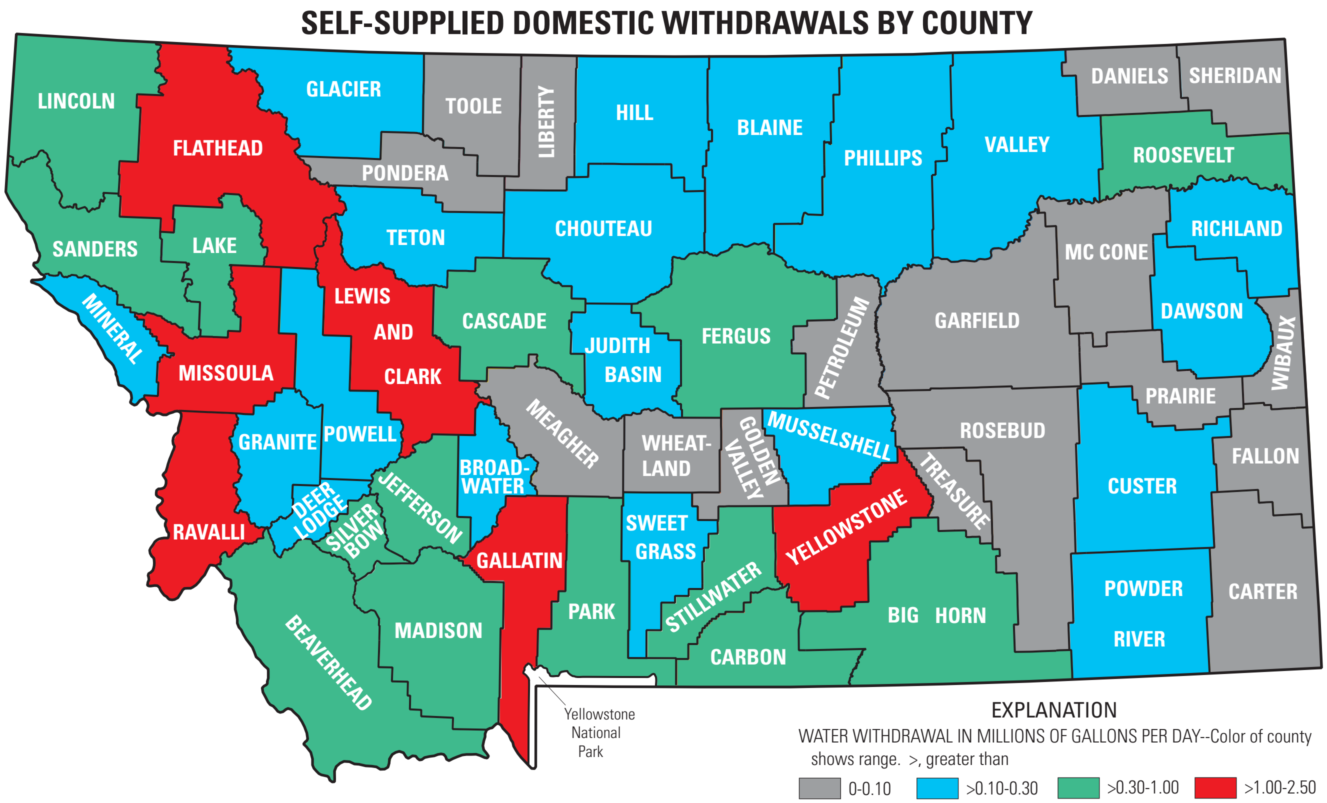


Figure 12. Self-supplied domestic water withdrawals in Montana counties in 2000.

Table 8. Self-supplied industrial water withdrawals in Montana by county, 2000

[Counties with no withdrawal are not listed. Abbreviation: Mgal/d, million gallons per day]

County (fig. 13)	Water withdrawals (Mgal/d)		Total
	Ground water	Surface water	
Beaverhead	0.11	0.16	0.27
Big Horn	.01	0	.01
Broadwater	.01	0	.01
Carbon	.12	0	.12
Cascade	.01	.50	.51
Custer	.01	0	.01
Dawson	.05	0	.05
Fallon	.01	0	.01
Fergus	.09	0	.09
Flathead	6.24	.07	6.31
Gallatin	.09	0	.09
Glacier	.30	0	.30
Granite	.01	0	.01
Hill	.01	0	.01
Jefferson	.29	0	.29
Lake	.03	0	.03
Lewis and Clark	.15	.79	.94
Lincoln	.12	13.77	13.89
Meagher	.12	0	.12
Mineral	2.66	.53	3.19
Missoula	18.80	3.11	21.91
Park	.03	0	.03
Ravalli	.12	0	.12
Richland	.01	.81	.82
Roosevelt	.04	0	.04
Rosebud	.09	0	.09
Sanders	.21	0	.21
Silver Bow	1.65	0	1.65
Toole	0	.22	.22
Valley	.06	0	.06
Yellowstone	.49	9.37	9.86
TOTAL	31.94	29.33	61.27

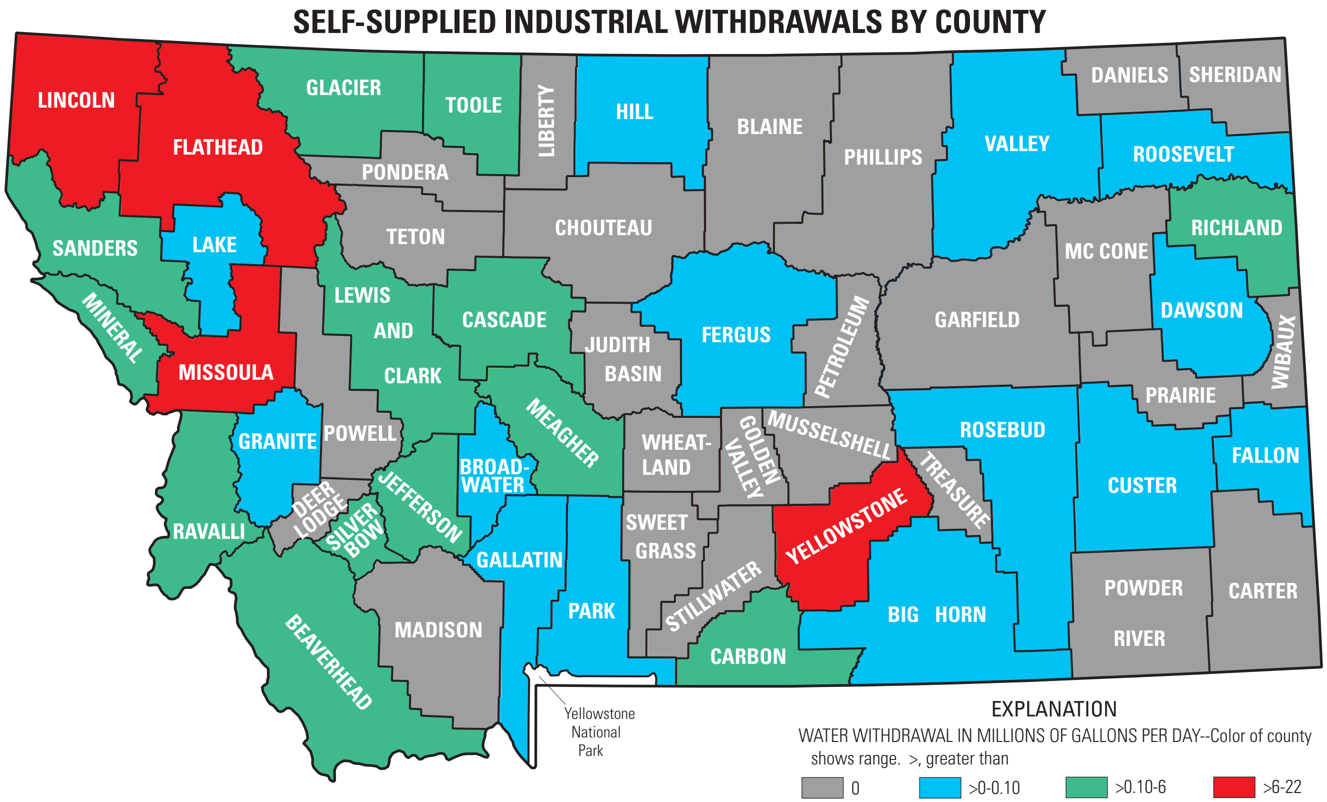


Figure 13. Self-supplied industrial water withdrawals in Montana counties in 2000.

Table 9. Water withdrawals for thermoelectric power generation in Montana by county, 2000

[Counties with no withdrawal are not listed. Abbreviations: Mgal/d, million gallons per day; Gwatt-hours, gigawatt hours]

County	Water withdrawals (Mgal/d)			Power generated (Gwatt-hours)
	Ground water	Surface water	Total withdrawals	
Richland	0	31.70	31.70	456.40
Rosebud	0	25.59	25.59	14,310.45
Yellowstone	0	52.67	52.67	1,173.11
TOTAL	0	109.96	109.96	15,940

Table 10. Livestock water requirements

Animal	Gallons per head per day[1]
Beef cattle	15
Dairy cows	23
Hogs and pigs	5
Sheep	2
Chickens	.05

[1]North Dakota State University Extension Service (1999).

Table 11. Livestock water withdrawals in Montana by county, 2000

[Abbreviation: Mgal/d, million gallons per day. Symbol: <, less than]

County (fig. 14)	Water withdrawals (Mgal/d)		Total
	Ground water	Surface water	
Beaverhead	1.05	1.34	2.40
Big Horn	1.16	.29	1.45
Blaine	.20	.90	1.10
Broadwater	.10	.26	.36
Carbon	.03	.89	.92
Carter	.04	.99	1.03
Cascade	.28	1.05	1.33
Chouteau	.17	.52	.69
Custer	.22	.94	1.15
Daniels	.23	<.01	.23
Dawson	.19	.48	.66
Deer Lodge	.04	.10	.14
Fallon	.01	.62	.62
Fergus	.21	1.41	1.63
Flathead	.17	.08	.26
Gallatin	.39	.52	.91
Garfield	.23	.70	.93
Glacier	0	.66	.66
Golden Valley	.33	.01	.34
Granite	.20	.16	.36
Hill	.08	.39	.47
Jefferson	.06	.26	.33
Judith Basin	.38	.61	.99
Lake	.15	.69	.85
Lewis and Clark	.18	.54	.73
Liberty	.03	.29	.32
Lincoln	.02	.03	.06
McCone	.09	.46	.55
Madison	.77	.42	1.19
Meagher	.36	.59	.95
Mineral	0	.01	.01
Missoula	.01	.16	.18
Musselshell	.01	.54	.55
Park	.11	.56	.67
Petroleum	.03	.34	.37
Phillips	.01	1.18	1.20
Pondera	.10	.44	.54
Powder River	1.04	.09	1.13
Powell	.03	.74	.77
Prairie	.15	.34	.49
Ravalli	.13	.41	.54
Richland	.17	.77	.94
Roosevelt	.09	.36	.45
Rosebud	.40	.89	1.29
Sanders	.22	.11	.33
Sheridan	.09	.28	.37
Silver Bow	.06	.08	.14
Stillwater	.57	.31	.88
Sweet Grass	.50	.27	.76
Teton	.07	.84	.91
Toole	.24	.14	.39
Treasure	.01	.47	.48
Valley	.35	.63	.98
Wheatland	.21	.40	.61
Wibaux	.11	.20	.30
Yellowstone	.09	1.66	1.75
TOTAL	12.20	28.45	40.65

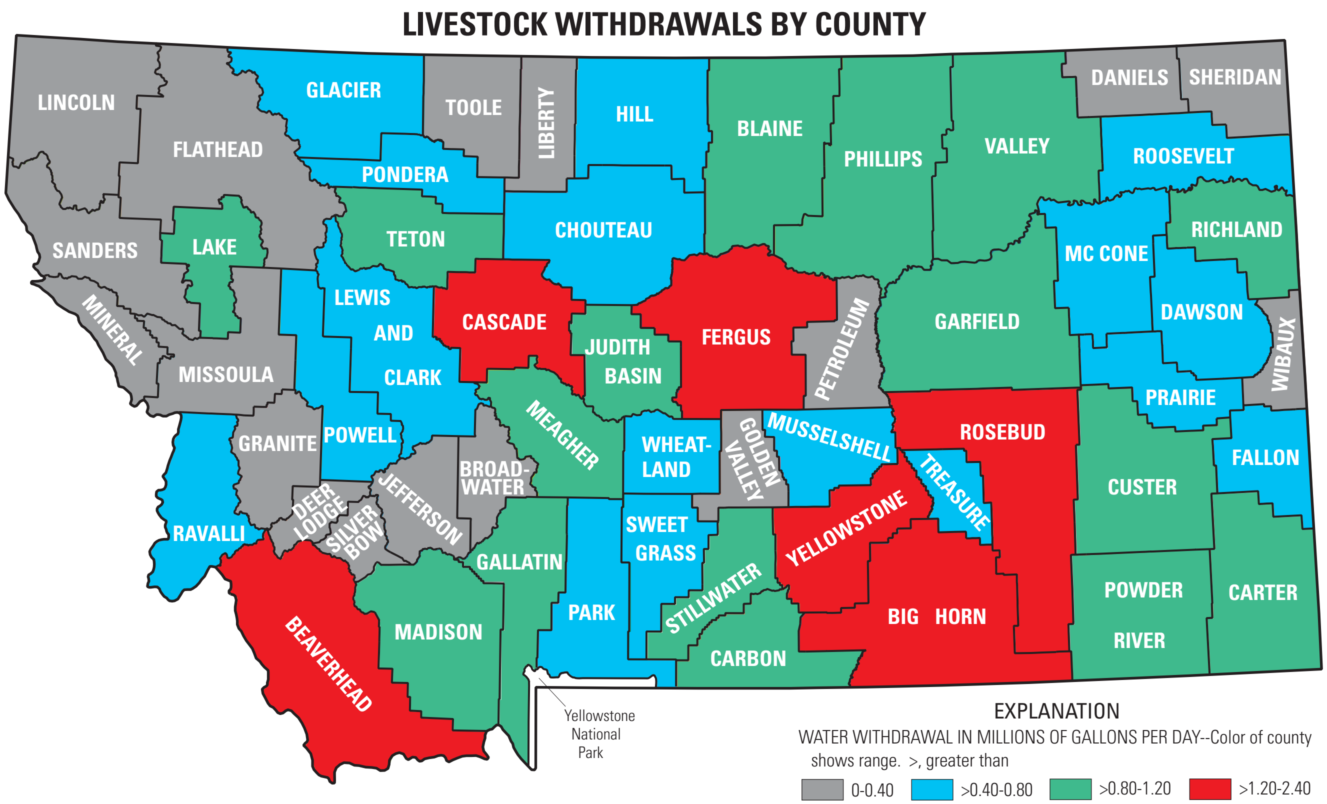


Figure 14. Livestock water withdrawals in Montana counties in 2000.

Instream Water Use by Category

Instream water uses are those that take place within the stream channel. Examples of instream use include hydroelectric power generation, fish and wildlife propagation, recreation, navigation, and water-quality improvement. In Montana, instream water uses for hydroelectric power and maintenance of instream flows are legally protected by water rights and the Montana Water Use Act of 1973 (Montana Code Annotated 2003, 85-2-316).

Hydroelectric Power Generation

Water used for hydroelectric power generation is classified as an instream use and refers to the water used in the generation of electricity at facilities where the turbine generators are driven by moving water. Estimates of water used for hydroelectric power generation may vary because of the way individual estimates are made of the quantities of water passed through the plants. Estimates of water use and power generation are based on published inventories of power production (Energy Information Administration, 2002, 2003), on ratios of the volume of water passed through turbines to amount of power generated (Montana Department of Natural Resources and Conservation, 1986), and on energy production data from the U.S. Army Corps of Engineers (*http://www.nws.usace.army.mil*), the Bureau of Reclamation (*http://www.usbr.gov*), the Bonneville Power Administration (*http://www.bpa.gov*), and the Montana Department of Natural Resources and Conservation (unpub. data, 2003).

Instream water use for hydroelectric power generation in 2000 was about 74,486 Mgal/day (table 12). The large volume of instream water use is largely a result of multiple use of the same water resource, especially in the Missouri River basin where many dams generate hydroelectric power. Twenty-three hydroelectric plants operating in Montana in 2000 produced about 11,591 gigawatt-hours of electricity (table 12).

Water Reserved for Instream Flow Purposes

The State of Montana has recognized the importance of instream flows for conservation of wildlife and aquatic life, and for public recreation and has developed several legal strategies to protect those flows. The water policy of Montana states that "the water resources of the state must be protected and conserved to assure adequate supplies for public recreational purposes and for the conservation of wildlife and aquatic life" [Montana Code Annotated, 2003, Section 85-1-101 (5)].

In 1969, the Montana Fish and Game Commission (now Montana Fish, Wildlife and Parks) was given the authority by the Legislature to file for water rights on the unappropriated waters of 11 streams to maintain streamflows necessary for the preservation of fish and wildlife habitat [Revised Codes of Montana, 1947, Section 89-801 (2)]. Those water rights became known as the "Murphy Rights," named after the principal sponsor of the bill. The Murphy Rights apply to 12 reaches of the 11 streams (table 13), and are senior only to those water rights or permits obtained after December 14, 1970.

The Montana Water Use Act was passed in 1973 and established a formal method of reserving water for instream flow. The Water Use Act states "The State, any political subdivision or agency of the State, or the United States or any agency of the United States may apply to the department to acquire a State water reservation for existing or future beneficial uses or

Table 12. Instream water use for hydroelectric power generation in Montana by county, 2000

[Counties with no use are not listed. Abbreviations: Mgal/d; million gallons per day; Gwatt-hours; Gigawatt hours]

County	Water use (Mgal/d)	Power generated (Gwatt-hours)	Number of facilities operating
Big Horn	1,777.50	743.55	1
Broadwater	2,144.50	48.36	1
Cascade	16,911.30	1,389.08	5
Flathead	2,920.00	1,168.82	2
Lake	7,468.00	1,382.51	3
Lewis and Clark	7,367.40	667.19	3
Lincoln	9,296.60	2,661.33	2
McCone	5,660.60	904.28	1
Madison	195.00	12.38	1
Missoula	991.30	20.56	1
Sanders	19,717.50	2,558.94	2
Stillwater	36.60	34.14	1
TOTAL	74,486	11,591	23

Table 13. Montana streams with Murphy Rights instream-flow protection[1]

Stream name	Location of stream with Murphy Right
Big Spring Creek	in Fergus County from its mouth in T.17 N., R.16 E., sec. 26 to the state fish hatchery in T.14 W., R.19 E., sec. 5.
Blackfoot River	in Missoula and Powell Counties from its mouth in T.13 N., R.18 W., sec. 21 to the mouth of its North Fork in T.14 N., R.12 W., sec. 9.
Flathead River	in Flathead County from its mouth in T.27 N., R.20 W., sec. 34 to the Canadian border in T.37 N., R.22 W., sec. 4 and 5, including the section commonly known as the North Fork of the Flathead River.
Gallatin River	in Gallatin County from its mouth in T.2 N., R.2 E., sec. 9 to the junction of its East Fork in T.2 N., R.3 E., sec. 27.
Gallatin River	in Gallatin County (commonly called the West Gallatin) from the Beck and Border ditch intake in T.2 S., R.4 E., sec. 14 to where it leaves the Yellowstone National Park boundary in T.9 S., R.5 E., sec. 18.
Madison River	in Madison and Gallatin Counties from its mouth in T.2 N., R.2 E., sec. 17 to Hebgen Dam in T.11 S., R.3 E., sec. 23.
Missouri River	in Lewis and Clark, Broadwater, and Cascade Counties from its junction with the Smith River in T.19 N., R.2 E., sec. 9 to Toston Dam in T.4 N., R.3 E., sec. 7.
Rock Creek	in Granite and Missoula Counties from its mouth in T.11 N., R.17 W., sec. 12 to the junction of its East and West Forks in T.6 N., R.15 W., sec. 31.
Smith River	in Cascade and Meagher Counties from the mouth of Hound Creek in T.17 N., R.3 E., sec. 20 to the Fort Logan bridge in T.11 N., R.5 E., sec. 31.
Yellowstone River	in Stillwater, Sweetgrass, and Park Counties from the north-south Carbon-Stillwater County lines in T.3 S., R.21 E., sec. 10 to where it leaves the Yellowstone National Park boundary in T.9 S., R.8 E., sec. 23.
Middle Fork Flathead River	in Flathead County from its mouth in T.31 N., R.19 W., sec. 7 to the mouth of Cox Creek in T.27 N., R.12 W., (a nonsectioned township).
South Fork Flathead River	in Flathead and Powell Counties from its mouth at Hungry Horse Reservoir in T.26 N., R.16 W., sec. (unknown), to its source at the junction of Danaher and Youngs Creeks in T.20 N., R.13 W., sec. 36.

[1]Revised Codes of Montana, 1947, 89-801(2).

to maintain a minimum flow, level, or quality of water throughout the year or at periods or for a length of time that the department designates" [Montana Code Annotated, 2003, Section 85-2-316 (1)] . Under authority of the Water Use Act, Montana Fish, Wildlife and Parks has been granted numerous reservations for instream flows on many of Montana's streams. These water reservations are defined for specific stream reaches and specify reserved flow rate, applicable dates for the reserved flow, and priority date of the water right. Details of the water rights are listed in the Montana Fisheries Information Database, maintained by Montana Fish, Wildlife and Parks. Access to the database is available on the World Wide Web through the Montana Natural Resource Information System (*http://www.nris.state.mt.us*).

EVAPORATION FROM MAJOR RESERVOIRS AND REGULATED LAKES

Most of Montana's major river and tributary basins contain reservoirs developed for various uses such as irrigation, hydroelectric power generation, flood control, or wildlife and recreation. Evaporation from reservoirs and regulated natural lakes (such as Flathead Lake) accounts for the loss of a large volume of water, especially in the semi-arid eastern and southwestern parts of Montana. Evaporation is not considered a water use, but is estimated for major reservoirs and regulated lakes for comparison with estimates of withdrawals by category.

Net annual evaporation was estimated for the 60 largest reservoirs and regulated lakes in Montana (table 14). These 60 impoundments each have 5,000 acre-feet of normal capacity or have a maximum capacity of at least 25,000 acre-feet (Ruddy and Hitt, 1990). Net annual evaporation is defined as average annual free-water-surface evaporation minus average annual precipitation falling on the reservoir. Evaporation estimates are based on the surface area of the reservoir (at normal capacity), the average annual free-water-surface evaporation for the reservoir location (National Oceanic and Atmospheric Administration, 1982), and the average annual 1961-1990 precipitation in the area of the reservoir (Oregon Climate Service, 1998). The resulting net evaporation values were estimated for average conditions and do not necessarily reflect actual net evaporation rates for the year 2000.

Data for the 60 reservoirs and regulated lakes for which net evaporation were estimated are listed in table 14. Fort Peck Reservoir has one of the highest net evaporation rates (2.33 feet/year) and also the largest annual volume of evaporation (571,670 acre-feet/year) because of a large annual free-water-surface evaporation rate (40 inches), a low annual precipitation (12 inches), and a large surface area (245,000 acres). Several reservoirs located in northwestern Montana and several at high altitudes had zero net evaporation rates because annual free-water-surface evaporation values were equal to average annual precipitation. Reservoirs and regulated lakes that had zero estimated net evaporation are Georgetown Lake, Hungry Horse Reservoir, Lower Two Medicine Lake, Mystic Lake, Painted Rocks Lake, and Swift Reservoir (table 14). Noxon Rapids Reservoir on the lower Clark Fork had an estimated net gain in annual water content (0.17 feet/year) because estimated annual evaporation was slightly less than average annual precipitation.

Estimated net evaporation for the 60 reservoirs totaled about 1 million acre-feet per year, or about 891 Mgal/day. The average daily net evaporation rate of 891 Mgal is larger than the combined average rates of withdrawals (table 3) for public supply (136.14 Mgal/day), self-supplied domestic (22.85 Mgal/day), self-supplied industrial (61.27 Mgal/day), thermoelectric power generation (109.96 Mgal/day), and livestock (40.65 Mgal/day).

SUMMARY

The purpose of this report is to summarize the quantities of water withdrawn and consumed from Montana's surface-water and ground-water resources for various uses in 2000 and to describe other instream water uses such as hydroelectric power generation and maintenance of instream flows. Water withdrawals in Montana are summarized for each of the following categories: irrigation, public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock. Water-use data summarized in this report were estimated by the U.S. Geological Survey, in cooperation with the Montana Department of Natural Resources and Conservation.

Water use in Montana is affected by natural factors that are directly related to water availability and also by human factors that relate to water demand. Average annual precipitation in Montana ranges from less than 10 inches in several valleys to more than 100 inches in some areas of high altitude in the northwestern part of the State. Evaporation from land and water surfaces and transpiration by plants consumes the largest part of the annual precipitation that falls in Montana. Average annual free-water-surface evaporation ranges from less than 25 inches in the high mountains north of Yellowstone National Park to 45 inches in parts of the lower Yellowstone River valley. These large spatial variations in precipitation and evaporation are reflected in the large range in average annual runoff for different areas of the State. Total runoff from Montana's rivers in 2000 was more than 34.8 million acre-feet, although about 35 percent of this water originated in Wyoming and Canada.

The diverse geology of Montana, with many different types of rocks and unconsolidated deposits largely determines the availability of ground water. Large areas of central and eastern Montana are underlain by shale or fine-grained sandstone that yield small amounts of water, or yield water that is too mineralized for many uses. Many of the rocks that form the large mountain ranges of western Montana typically yield small amounts of water and do not form a principal aquifer. Unconsolidated deposits, including coarse-grained glacial deposits, alluvium, and basin fill underlie most broad valleys of western Montana and the narrow river valleys of central and eastern

Table 14. Estimated net reservoir evaporation for major reservoirs

[Abbreviations: acre-ft, acre-feet; Mgal/d, million gallons per day]

Reservoir or lake name	County	Hydrologic unit	Surface area at normal capacity (acres)	Average annual evaporation (inches)	Average annual precipitation (inches)	Average annual net evaporation (feet)	(acre-ft)	(Mgal/d)
Ackley Lake	Judith Basin	10040103	247	35	18	1.42	350	0.31
Ashley Lake	Flathead	17010208	3,000	30	20	.83	2,500	2.23
Bair Reservoir	Meagher	10040201	275	30	16	1.17	321	.29
Beaver Creek	Hill	10050004	185	40	12	2.33	432	.38
Bighorn Lake	Big Horn, Carbon	10080010	17,300	40	14	2.17	37,483	33.37
Bynum Reservoir	Teton	10030205	3,300	30	14	1.33	4,400	3.92
Canyon Ferry Lake	Broadwater, Lewis and Clark	10030101	35,200	30	12	1.50	52,800	47.01
Clark Canyon Reservoir	Beaverhead	10020001	4,100	30	10	1.67	6,833	6.08
Clark Fork	Sanders	17010213	1,450	30	20	.83	1,208	1.08
Cooney Reservoir	Carbon	10070006	1,025	30	18	1.00	1,025	.91
Deadmans Basin Reservoir	Wheatland	10040201	2,042	35	14	1.75	3,574	3.18
Delmoe Lake	Jefferson	10020005	479	30	20	.83	399	.36
East Fork Rock Creek Reservoir	Granite	17010202	442	30	20	.83	368	.33
Flathead Lake	Flathead, Lake	17010208	126,000	30	16	1.17	147,000	130.87
Fort Peck Reservoir	Phillips, Valley, Petroleum, Garfield, McCone	10040104	245,000	40	12	2.33	571,670	508.95
Four Horns Lake	Glacier	10030201	897	30	16	1.17	1,047	.93
Frenchman Creek	Phillips	10050013	806	35	12	1.92	1,545	1.38
Fresno Reservoir	Hill	10050002	5,757	35	12	1.92	11,034	9.82
Georgetown Lake	Granite, Deer Lodge	17010202	3,000	30	30	0	0	0
Gibson Reservoir	Lewis and Clark, Teton	10030104	1,360	30	16	1.17	1,587	1.41
Hauser Lake	Lewis and Clark	10030101	3,800	30	14	1.33	5,067	4.51
Hebgen Reservoir	Gallatin	10020007	12,668	30	25	.42	5,278	4.70
Helena Valley Regulating Reservoir	Lewis and Clark	10030101	531	30	12	1.50	797	.71
Holter Lake	Lewis and Clark	10030101	4,800	30	12	1.50	7,200	6.41
Hungry Horse Reservoir	Flathead	17010209	23,750	30	30	0	0	0
Hyalite Reservoir	Gallatin	10020008	223	30	20	.83	186	.17
Lake Como	Ravalli	17010205	936	30	25	.42	390	.35
Lake Ennis	Madison	10020007	3,800	30	16	1.17	4,433	3.95
Lake Francis	Pondera	10030203	5,300	30	14	1.33	7,067	6.29
Lake Helena	Lewis and Clark	10030101	2,100	30	10	1.67	3,500	3.12
Lake Koocanusa	Lincoln	17010101	28,850	30	20	.83	24,042	21.40
Lake Sherburne	Glacier	10010002	1,730	30	25	.42	721	.64
Lake Sutherlin	Meagher	10030103	334	30	16	1.17	390	.35
Lima Reservoir	Beaverhead	10020001	6,400	30	16	1.17	7,467	6.65

Table 14. Estimated net reservoir evaporation for major reservoirs—Continued

Reservoir or lake name	County	Hydrologic unit	Surface area at normal capacity (acres)	Average annual evaporation (inches)	Average annual precipitation (inches)	Average annual net evaporation (feet)	Average annual net evaporation (acre-ft)	Average annual net evaporation (Mgal/d)
Little Bitterroot Lake	Flathead	17010212	2,994	30	14	1.33	3,992	3.55
Lodge Grass Reservoir	Big Horn	10080016	750	40	16	2.00	1,500	1.34
Lower Two Medicine Lake	Glacier	10030201	806	30	30	0	0	0
Martinsdale Reservoir	Meagher, Wheatland	10040201	985	30	16	1.17	1,149	1.02
McCarter Lake	Toole	10030204	960	35	14	1.75	1,680	1.50
Medicine Lake	Sheridan	10060006	5,700	35	14	1.75	9,975	8.88
Mission Lake	Glacier	10030202	1,024	30	14	1.33	1,365	1.22
Morony	Cascade	10030102	300	30	14	1.33	400	.36
Mystic Lake	Stillwater	10070005	440	30	30	0	0	0
Nelson Reservoir	Phillips	10050004	4,560	35	12	1.92	8,740	7.78
Nevada Lake	Powell	17010203	376	30	20	.83	313	.28
Newlan Creek Reservoir	Meagher	10030103	317	30	14	1.33	423	.38
Nilan Reservoir	Lewis and Clark	10030104	520	30	16	1.17	607	.54
Noxon Rapids Reservoir	Sanders	17010213	7,930	30	32	[1](.17)	[1](1,322)	[1](1.18)
Pablo Reservoir	Lake	17010212	1,746	30	16	1.17	2,037	1.81
Painted Rocks Lake	Ravalli	17010205	655	30	30	0	0	0
Petrolia Lake	Petroleum	10040203	515	35	14	1.75	901	.80
Pishkun Reservoir	Teton	10030104	1,550	30	16	1.17	1,808	1.61
Ruby River Reservoir	Madison	10020003	970	30	12	1.50	1,455	1.30
Swift Reservoir	Pondera	10030201	455	30	30	0	0	0
Tiber Reservoir	Liberty, Toole	10030203	22,180	35	12	1.92	42,512	37.85
Tongue River Reservoir	Big Horn	10090101	3,497	40	16	2.00	6,994	6.23
War Horse Lake	Petroleum	10040204	640	35	16	1.58	1,013	.90
Whitetail Reservoir	Jefferson	10020005	1,020	30	25	.42	425	.38
Willow Creek Reservoir	Lewis and Clark	10030104	1,450	30	16	1.17	1,692	1.51
Willow Creek Reservoir	Madison	10020005	850	30	14	1.33	1,133	1.01
TOTAL			610,277				1,000,902	891.10

[1]Average annual precipitation exceeds average annual evaporation for a net gain.

Montana, and generally are the most productive and utilized aquifers in the state.

Water-use information for 2000 was compiled for six categories: irrigation, public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock. In 2000, the total amount of water withdrawn from Montana surface-water and ground-water sources for the six categories of use was about 10,749 Mgal/d. Withdrawals from surface water were about 10,477 Mgal/d or 97.5 percent of the total. Withdrawals from ground water were about 272 Mgal/d, or 2.5 percent of the total withdrawals. In 2000, the total consumptive use of water for the six categories of use was about 2,370 Mgal/d.

Irrigation accounts for Montana's largest water withdrawals and consumptive use. Irrigations withdrawals during 2000 were an estimated 10,378 Mgal/d (31,850 acre-ft/d) on an annual basis. Surface water supplied about 10,238 Mgal/d (98.6 percent) of the irrigation water and ground water supplied about 140 Mgal/d (1.4 percent). Counties with the largest irrigation withdrawals (more than 500 Mgal/d) were Beaverhead, Teton, Madison, Carbon, and Lake. Irrigated crop lands totaled about 1,722,000 acres and irrigated pasture totaled about 450,000 acres. Water consumed by irrigated crops and pasture was about 2,220 Mgal/d (6,810 acre-ft/d) or about 21 percent of the water withdrawn for irrigation. The average consumptive-use rate for all crops and pasture in Montana was about 1.15 acre-feet per irrigated acre.

In 2000, Montana had about 645 community water systems and 44 tribal water systems that supplied water daily to the same population and were included in estimates of water withdrawals and population served. The quantity of water withdrawn for public supplies during 2000 was estimated to be 136.14 Mgal/d, and the number of people served by these public-supply systems was estimated to be 609,200. Surface water was the source for about 52 percent of the public-supply withdrawals, or about 70.72 Mgal/d and ground water was the source for 48 percent of withdrawals or about 65.42 Mgal/d. Counties that withdrew the largest volumes of ground water for public supply (more than 2 Mgal/d) were Missoula, Deer Lodge, Flathead, Gallatin, and Park. On the basis of previous studies, 37 percent of the water withdrawn for public supplies was consumed.

Self-supplied domestic water withdrawals during 2000 were estimated at 22.85 Mgal/d and the water served a population of about 292,990. Withdrawals were estimated based on a per capita use of 78 gal/d. Most (95 percent) of the domestic-water supply was withdrawn from ground water. Counties with the largest domestic water withdrawals (more than 1 Mgal/d) were Flathead, Ravalli, Missoula, Gallatin, Lewis and Clark, and Yellowstone. All water withdrawn for self-supplied domestic use was assumed to be consumed.

Self-supplied industrial water withdrawals during 2000 were estimated at 61.27 Mgal/d. Withdrawals from ground water were about 31.94 Mgal/d, or 52 percent of total industrial withdrawals. Surface water supplied about 29.33 Mgal/d, or 48 percent of the total withdrawals. Counties with the largest withdrawals (about 6 to 22 Mgal/d) were Missoula, Lincoln, Yellowstone and Flathead. Fifteen percent (9.19 Mgal/d) of the water withdrawn for self-supplied industrial use was assumed to be consumed.

Total water withdrawn for thermoelectric power generation in 2000 was estimated at 109.96 Mgal/day. All of the water used for this purpose was from surface water and was used for cooling purposes at fossil-fuel plants in Richland, Rosebud, and Yellowstone Counties. Water consumed for thermoelectric power generation was about 27.70 Mgal/d, most of which was consumed in Rosebud County because cooling water used at power plants in Rosebud County was not returned to the source of withdrawal.

Total water withdrawn and consumed for livestock use in 2000 was about 40.65 Mgal/day. Surface water was the source for about 70 percent of the total livestock withdrawals, or about 28.45 Mgal/day, whereas ground water was the source for about 30 percent of the withdrawals, or about 12.20 Mgal/day. Counties with the largest withdrawals (more than 1.20 Mgal/d) for livestock were Beaverhead, Yellowstone, Fergus, Big Horn, Cascade, and Rosebud.

Instream water use for hydroelectric power generation in 2000 was about 74,486 Mgal/day. The large volume of instream water use is largely a result of multiple use of the same water resource, especially in the Missouri River basin where many dams generate hydroelectric power. Twenty-three hydroelectric plants operating in Montana in 2000 produced about 11,591 gigawatt-hours of electricity.

The State of Montana has recognized the importance of instream flows for conservation of wildlife and aquatic life, and for public recreation and has developed several legal strategies to protect those flows. The Montana Water Use Act was passed in 1973 and established a formal method of reserving water for instream flow. Under authority of the Water Use Act, Montana Fish, Wildlife and Parks has been granted numerous reservations for instream flows on many of Montana's streams.

Evaporation from reservoirs and regulated natural lakes accounts for the loss of a large volume of water, especially in the semi-arid eastern and southwestern parts of Montana. Evaporation is not considered a water use, but is estimated for major reservoirs and regulated lakes for comparison with estimates of withdrawals by category. Net annual evaporation was estimated for the 60 largest reservoirs and regulated lakes in Montana. Estimated net evaporation totaled about 1 million acre-feet per year, or about 891 Mgal/day. The average daily net evaporation rate of 891 Mgal is larger than the combined average rates of withdrawals for public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock.

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APPENDIX 1. WATER WITHDRAWALS BY HYDROLOGIC UNIT FOR SIX CATEGORIES OF USE

Tables 1-1 through 1-6 list water withdrawals by Hydrologic Unit Code for categories of irrigation, public supply, self-supplied domestic, self-supplied industrial, thermoelectric power generation, and livestock. Water withdrawal data for hydrologic units (fig. 2) were compiled by converting county withdrawal data through various accounting methods, including manual and computerized (Geographic Information System) methods. Population in each hydrologic unit was compiled by overlaying digital maps of U.S. Census Block Data for 2000 with digital hydrologic unit polygons.

In table 1-2, the population served by public-water supply is not necessarily equivalent to the population living in the hydrologic unit. In some hydrologic units, the water is withdrawn in one unit, but serves a population in another. A good example is the public-water supply for Butte, which is withdrawn from the Big Hole River (10020004) and exported to the upper Clark Fork basin (17010201).

Table 1-6. Livestock water withdrawals in Montana by hydrologic unit, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviation: Mgal/d, million gallons per day. Symbol: <, less than]

Hydrologic unit	Withdrawals (Mgal/d)		
	Ground water	Surface water	Total
10010001	<0.01	0.04	0.04
10010002	<.01	.10	.10
10020001	.44	.53	.97
10020002	.25	.33	.58
10020003	.07	.24	.31
10020004	.45	.58	1.03
10020005	.10	.26	.36
10020006	.03	.10	.13
10020007	.19	.42	.61
10020008	.25	.33	.58
10030101	.26	.66	.92
10030102	.20	.69	.89
10030103	.28	.53	.81
10030104	.11	.58	.69
10030105	.10	.26	.36
10030201	.05	.31	.36
10030202	<.01	.27	.27
10030203	.21	.60	.81
10030204	.11	.09	.20
10030205	.07	.53	.60
10040101	.09	.35	.44
10040102	.12	.27	.39
10040103	.32	.85	1.17
10040104	.39	1.02	1.41
10040105	.08	.21	.29
10040106	.06	.18	.24
10040201	.40	1.34	1.74
10040202	.04	.46	.50
10040203	.02	.18	.20
10040204	.04	.32	.36
10040205	.06	.33	.39
10050001	0	.12	.12
10050002	.05	.14	.19
10050003	<.01	.01	.01
10050004	.10	.64	.74
10050005	.03	.11	.14
10050006	.03	.15	.18
10050007	.01	.04	.05
10050008	.02	.10	.12
10050009	.03	.16	.19
10050010	.03	.18	.21
10050011	<.01	.12	.12
10050012	.11	.21	.32
10050013	<.01	.06	.06
10050014	.02	.35	.37
10050015	.06	.11	.17
10050016	.05	.09	.14
10060001	.31	.28	.59
10060002	.40	.40	.80
10060003	.13	.09	.22
10060004	.09	.07	.16
10060005	.08	.31	.39

Table 1-6. Livestock water withdrawals in Montana by hydrologic unit, 2000—Continued

Hydrologic unit	Withdrawals (Mgal/d)		
	Ground water	Surface water	Total
10060006	.16	.34	.50
10060007	.02	.04	.06
10070001	.02	.07	.09
10070002	.46	.52	.98
10070003	.06	.17	.23
10070004	.35	.44	.79
10070005	.24	.21	.45
10070006	.03	.66	.69
10070007	.11	1.07	1.18
10070008	.07	.23	.30
10080010	.09	.09	.18
10080014	.02	.09	.11
10080015	.45	.19	.64
10080016	.22	.05	.27
10090101	.16	.08	.24
10090102	.49	.38	.87
10090207	.18	.02	.20
10090208	.20	.03	.23
10090209	.21	.39	.60
10090210	.16	.09	.25
10100001	.33	1.21	1.54
10100002	.07	.14	.21
10100003	.17	.17	.33
10100004	.40	1.08	1.48
10100005	.03	.49	.52
10110201	.02	.52	.54
10110202	.01	.32	.33
10110203	<.01	.02	.02
10110204	.04	.10	.14
10120202	<.01	.02	.02
17010101	.02	.01	.03
17010102	.01	.01	.02
17010103	<.01	.01	.01
17010104	<.01	<.01	<.01
17010105	<.01	<.01	<.01
17010201	.12	.44	.56
17010202	.16	.11	.27
17010203	.05	.45	.50
17010204	.01	.06	.07
17010205	.14	.42	.56
17010206	.03	.02	.05
17010207	.04	.02	.06
17010208	.06	.18	.24
17010209	.05	.17	.22
17010210	.03	.01	.04
17010211	.04	.17	.21
17010212	.14	.38	.52
17010213	.17	.07	.24
TOTAL	12.20	28.45	40.65

Table 1-1. Irrigation water withdrawals and consumptive use in Montana by hydrologic unit, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviations: acre-ft/yr, acre-feet per year; Mgal/d, million gallons per day]

Hydrologic unit	Withdrawals				Consumptive use		Irrigated land		
	Ground water (Mgal/d)	Surface water (Mgal/d)	Total (Mgal/d)	Total (acre-ft/yr)	(Mgal/d)	(acre-ft/yr)	Crop land (thousand acres)	Pasture land (thousand acres)	Total (thousand acres)
10010001	0.00	0.67	0.67	760	0.12	130	0.00	0.12	0.12
10010002	.01	3.98	3.99	4,480	.72	810	.76	.31	1.07
10020001	.32	340.28	340.60	382,560	64.66	72,620	31.54	40.78	72.32
10020002	3.19	338.38	341.57	383,660	62.80	70,540	49.15	23.03	72.18
10020003	1.06	169.06	170.12	191,080	27.78	31,200	21.36	7.97	29.33
10020004	1.24	496.61	497.85	559,200	94.98	106,680	69.85	40.05	109.90
10020005	1.67	232.13	233.80	262,610	42.33	47,550	34.80	8.44	43.24
10020006	1.33	47.96	49.29	55,360	10.42	11,700	6.57	3.01	9.58
10020007	.56	249.69	250.25	281,090	42.32	47,540	29.39	15.09	44.48
10020008	15.32	393.45	408.77	459,140	86.84	97,540	78.32	12.52	90.84
10030101	8.81	363.69	372.50	418,400	79.73	89,560	62.72	13.15	75.87
10030102	1.97	76.61	78.58	88,270	19.49	21,890	13.26	5.22	18.48
10030103	2.72	220.54	223.26	250,770	35.36	39,710	30.71	3.94	34.65
10030104	2.36	510.18	512.54	575,700	110.66	124,290	108.09	8.26	116.35
10030105	.01	8.81	8.82	9,900	2.17	2,430	.37	1.56	1.93
10030201	1.01	115.81	116.82	131,220	28.93	32,500	33.39	3.21	36.60
10030202	.40	88.53	88.93	99,890	16.60	18,640	28.38	.79	29.17
10030203	2.42	202.94	205.36	230,660	53.85	60,480	62.78	4.70	67.48
10030204	0	9.78	9.78	10,980	2.59	2,910	3.05	.35	3.40
10030205	.87	285.77	286.64	321,960	56.91	63,920	51.63	9.98	61.61
10040101	.57	12.70	13.27	14,900	3.29	3,700	2.19	1.02	3.21
10040102	.34	37.10	37.44	42,050	6.21	6,980	5.79	.23	6.02
10040103	1.89	72.31	74.20	83,340	13.54	15,200	11.66	.66	12.32
10040104	.92	64.94	65.86	73,980	15.67	17,600	9.17	3.70	12.87
10040105	.22	3.93	4.15	4,660	1.91	2,140	1.91	.27	2.18
10040106	.12	3.17	3.29	3,690	1.30	1,460	1.10	.30	1.40
10040201	2.11	312.26	314.37	353,110	50.04	56,200	40.81	6.94	47.75
10040202	.22	85.75	85.97	96,560	16.04	18,010	9.69	2.02	11.71
10040203	.12	14.28	14.40	16,170	3.57	4,020	2.93	.09	3.02
10040204	.68	46.03	46.71	52,470	10.98	12,340	9.33	.19	9.52
10040205	.14	9.59	9.73	10,920	2.78	3,120	2.34	.20	2.54
10050001	.21	6.89	7.10	7,980	1.30	1,460	1.75	.33	2.08
10050002	.06	4.78	4.84	5,430	1.26	1,420	1.41	.22	1.63
10050003	.14	1.39	1.53	1,720	.47	530	.50	0	.50
10050004	5.83	324.97	330.80	371,560	80.17	90,040	62.27	3.84	66.11
10050005	.12	3.17	3.29	3,690	.89	1,000	.85	.08	.93
10050006	.13	8.06	8.19	9,200	1.92	2,150	1.6	.44	2.04
10050007	.22	10.23	10.45	11,740	2.63	2,960	1.98	.18	2.16
10050008	.57	31.80	32.37	36,360	8.05	9,050	5.65	.86	6.51
10050009	.69	42.82	43.51	48,870	10.67	11,980	7.36	1.29	8.65
10050010	.22	20.29	20.51	23,040	4.85	5,440	2.67	1.30	3.97
10050011	.10	9.85	9.96	11,180	2.23	2,510	1.41	.45	1.86
10050012	3.35	106.20	109.55	123,050	29.69	33,350	25.23	2.75	27.98
10050013	.12	9.86	9.98	11,210	2.30	2,580	1.66	.29	1.95
10050014	1.18	89.62	90.80	101,990	21.30	23,920	16.60	1.73	18.33
10050015	.30	20.36	20.66	23,210	5.51	6,180	3.55	1.48	5.03
10050016	.02	7.58	7.60	8,530	1.86	2,090	.23	1.30	1.53
10060001	1.99	95.65	97.65	109,680	27.56	30,960	26.31	1.47	27.78
10060002	.02	20.93	20.95	23,530	7.35	8,250	6.95	.84	7.79
10060003	1.59	8.46	10.05	11,290	3.23	3,630	2.91	.25	3.16
10060004	.32	5.60	5.92	6,650	1.68	1,890	.75	.72	1.47
10060005	.31	68.10	68.41	76,830	12.78	14,350	9.83	.73	10.56

Table 1-1. Irrigation water withdrawals and consumptive use in Montana by hydrologic unit, 2000—Continued

Hydrologic unit	Withdrawals				Consumptive use		Irrigated land		
	Ground water (Mgal/d)	Surface water (Mgal/d)	Total (Mgal/d)	Total (acre-ft/yr)	(Mgal/d)	(acre-ft/yr)	Crop land (thousand acres)	Pasture land (thousand acres)	Total (thousand acres)
10060006	6.92	15.73	22.65	25,440	10.74	12,060	9.34	.48	9.82
10060007	2.94	1.23	4.17	4,680	2.27	2,550	2.20	.06	2.26
10070001	.54	92.38	92.92	104,370	15.50	17,410	12.26	1.80	14.06
10070002	1.93	427.03	428.96	481,810	66.29	74,460	35.94	19.99	55.93
10070003	.99	171.43	172.42	193,660	29.08	32,660	23.09	4.24	27.33
10070004	4.50	344.44	348.94	391,930	75.58	84,890	57.95	8.36	66.31
10070005	2.65	124.37	127.02	142,670	23.78	26,710	14.72	5.92	20.64
10070006	.88	526.51	527.39	592,370	85.43	95,950	60.92	14.91	75.83
10070007	1.81	157.14	158.95	178,540	36.72	41,250	21.73	9.56	31.29
10070008	.16	26.21	26.38	29,630	6.06	6,810	2.76	2.35	5.11
10080010	0	19.54	19.54	21,950	3.35	3,760	.27	2.42	2.69
10080014	.01	24.10	24.11	27,080	3.92	4,400	1.03	2.22	3.25
10080015	1.89	188.18	190.07	213,500	43.72	49,110	32.78	4.20	36.98
10080016	.71	51.81	52.52	58,990	11.43	12,840	7.70	1.86	9.56
10090101	.23	25.37	25.60	28,750	5.72	6,420	3.89	1.33	5.22
10090102	.42	48.53	48.95	54,980	15.22	17,090	15.25	1.16	16.41
10090207	.04	3.58	3.62	4,060	1.85	2,080	2.56	.03	2.59
10090208	.03	2.63	2.66	2,990	1.35	1,520	1.78	.08	1.86
10090209	.14	14.76	14.90	16,730	5.34	6,000	4.71	1.00	5.71
10090210	.06	8.02	8.08	9,070	2.90	3,260	2.98	.25	3.23
10100001	2.52	252.38	254.90	286,310	63.96	71,840	55.34	4.31	59.65
10100002	.09	12.27	12.36	13,880	2.87	3,220	2.29	.47	2.76
10100003	.08	15.20	15.28	17,170	3.38	3,800	1.61	1.35	2.96
10100004	3.19	437.11	440.30	494,550	89.66	100,710	71.59	2.28	73.87
10100005	.32	5.10	5.42	6,090	2.06	2,310	1.81	.37	2.18
10110201	.25	5.36	5.61	6,300	2.90	3,260	2.62	.78	3.40
10110202	.19	3.57	3.76	4,220	1.91	2,150	1.53	.61	2.14
10110203	0	0	0	0	0	0	0	0	0
10110204	.02	.50	.52	580	.26	290	.45	0	.45
10120202	0	.12	.12	140	.05	60	0	.04	.04
17010101	.65	14.32	14.97	16,810	4.57	5,130	3.35	.55	3.90
17010102	.80	6.58	7.38	8,280	3.79	4,260	3.42	.27	3.69
17010103	0	.62	.62	700	.19	210	.01	.15	.16
17010104	0	.06	.06	60	.02	20	0	.01	.01
17010105	0	.03	.03	40	.01	10	0	.01	.01
17010201	2.53	225.15	227.68	255,730	48.86	54,880	46.40	11.64	58.04
17010202	.46	109.56	110.02	123,580	26.38	29,630	24.13	7.61	31.74
17010203	1.95	101.07	103.02	115,710	23.67	26,590	16.97	8.44	25.41
17010204	3.18	32.83	36.01	40,450	11.60	13,030	8.03	2.48	10.51
17010205	6.17	333.18	339.36	381,170	95.12	106,840	47.33	38.14	85.47
17010206	0	1.32	1.32	1,480	.70	780	0	.71	.71
17010207	.01	2.23	2.25	2,520	.94	1,060	0	.94	.94
17010208	8.25	73.35	81.60	91,660	30.77	34,560	18.64	10.24	28.88
17010209	0	14.47	14.47	16,260	3.60	4,040	0	3.59	3.59
17010210	3.54	14.77	18.31	20,560	10.12	11,370	9.41	.58	9.99
17010211	.23	42.22	42.45	47,680	11.24	12,620	.31	9.49	9.80
17010212	7.52	500.64	508.16	570,770	130.67	146,770	92.28	21.08	113.36
17010213	1.32	47.21	48.53	54,500	11.82	13,270	5.95	3.45	9.40
TOTAL	140.22	10,238	10,378	11,656,700	2,220	2,493,100	1,722	450	2,172

Table 1-2. Public-supply water withdrawals in Montana by hydrologic unit, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviation: Mgal/d, million gallons per day]

Hydrologic unit	Population served (thousands)			Withdrawals (Mgal/d)		
	Ground water	Surface water	Total	Ground water	Surface water	Total
10010001	0	0	0	0	0	0
10010002	.07	0	.07	.01	0	.01
10020001	.27	0	.27	.09	0	.09
10020002	4.88	0	4.88	1.56	0	1.56
10020003	1.13	0	1.13	.14	0	.14
10020004	.05	28.00	28.05	.02	10.75	10.77
10020005	2.84	0	2.84	.69	0	.69
10020006	1.54	0	1.54	.54	0	.54
10020007	1.11	0	1.11	.14	0	.14
10020008	14.74	28.02	42.75	2.67	5.07	7.74
10030101	12.61	27.45	40.06	3.23	5.44	8.67
10030102	7.39	63.12	70.51	1.65	11.64	13.29
10030103	.15	1.00	1.15	.03	.21	.24
10030104	2.25	.17	2.42	.54	.05	.59
10030105	.73	.19	.92	.13	.03	.17
10030201	.78	.28	1.06	.15	.05	.20
10030202	5.69	4.37	10.07	1.04	.80	1.83
10030203	6.02	5.35	11.37	1.14	1.12	2.26
10030204	.15	.07	.22	.03	.01	.04
10030205	2.20	0	2.20	.66	0	.66
10040101	.15	0	.15	.04	0	.04
10040102	.80	0	.80	.16	0	.16
10040103	7.82	0	7.82	1.81	0	1.81
10040104	.17	0	.17	.02	0	.02
10040105	.37	0	.37	.04	0	.04
10040106	0	0	0	0	0	0
10040201	1.90	.27	2.17	.22	.06	.27
10040202	1.89	.18	2.07	.58	.06	.63
10040203	0	0	0	0	0	0
10040204	.46	0	.46	.08	0	.08
10040205	0	0	0	0	0	0
10050001	0	0	0	0	0	0
10050002	0	.10	.10	0	.02	.02
10050003	0	0	0	0	0	0
10050004	2.91	15.51	18.42	.37	1.95	2.33
10050005	2.67	0	2.67	.46	0	.46
10050006	.05	0	.05	.01	0	.01
10050007	0	0	0	0	0	0
10050008	0	0	0	0	0	0
10050009	.99	0	.99	.15	0	.15
10050010	.06	0	.06	.01	0	.01
10050011	.04	0	.04	.01	0	.01
10050012	.84	3.67	4.52	.20	.85	1.05
10050013	0	0	0	0	0	0
10050014	.26	0	.26	.03	0	.03
10050015	0	.23	.23	0	.05	.05
10050016	0	0	0	0	0	0
10060001	3.13	.78	3.90	.39	.18	.57
10060002	.77	0	.77	.14	0	.14
10060003	2.05	0	2.05	.31	0	.31
10060004	.11	0	.11	.03	0	.03
10060005	.53	.80	1.33	.06	.09	.14

Table 1-2. Public-supply water withdrawals in Montana by hydrologic unit, 2000—Continued

Hydrologic unit	Population served (thousands)			Withdrawals (Mgal/d)		
	Ground water	Surface water	Total	Ground water	Surface water	Total
10060006	2.82	0	2.82	.41	0	.41
10060007	.25	0	.25	.04	0	.04
10070001	.55	.30	.85	.13	.07	.20
10070002	9.84	0	9.84	2.21	0	2.21
10070003	.59	0	.59	.14	0	.14
10070004	2.83	109.31	112.14	.58	22.47	23.05
10070005	.96	0	.96	.18	0	.18
10070006	2.55	1.96	4.51	.78	.60	1.38
10070007	1.40	.09	1.49	.29	.02	.31
10070008	.36	0	.36	.07	0	.07
10080010	0	0	0	0	0	0
10080014	0	0	0	0	0	0
10080015	.47	3.23	3.70	.08	.55	.64
10080016	.58	1.55	2.13	.10	.27	.37
10090101	0	0	0	0	0	0
10090102	1.37	0	1.37	.24	0	.24
10090207	.51	0	.51	.16	0	.16
10090208	0	0	0	0	0	0
10090209	0	0	0	0	0	0
10090210	0	0	0	0	0	0
10100001	.08	14.58	14.65	.01	2.46	2.47
10100002	0	0	0	0	0	0
10100003	3.04	0	3.04	.52	0	.52
10100004	8.06	4.81	12.87	1.79	1.56	3.36
10100005	1.91	0	1.91	.43	0	.43
10110201	.44	0	.44	.08	0	.08
10110202	0	0	0	0	0	0
10110203	0	0	0	0	0	0
10110204	.63	0	.63	.07	0	.07
10120202	0	0	0	0	0	0
17010101	2.48	3.88	6.36	.36	.55	.91
17010102	0	0	0	0	0	0
17010103	0	0	0	0	0	0
17010104	0	0	0	0	0	0
17010105	0	0	0	0	0	0
17010201	11.50	.30	11.80	4.89	.12	5.00
17010202	0	.91	.91	0	.04	.04
17010203	.40	.90	1.30	.15	.33	.47
17010204	67.11	.40	67.51	24.22	.07	24.29
17010205	9.04	2.30	11.33	3.01	.73	3.74
17010206	0	0	0	0	0	0
17010207	.09	0	.09	.01	0	.01
17010208	21.29	0	21.29	2.51	0	2.51
17010209	0	0	0	0	0	0
17010210	4.68	16.95	21.63	.55	2.00	2.55
17010211	1.37	0	1.37	.16	0	.16
17010212	12.70	1.75	14.45	1.44	.20	1.64
17010213	2.16	1.84	4.00	.30	.25	.55
TOTAL	264.61	344.59	609.20	65.42	70.72	136.14

Table 1-3. Self-supplied domestic water withdrawals in Montana by hydrologic unit, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviation: Mgal/d, million gallons per day. Symbol: <, less than]

Hydrologic unit	Self-supplied population (thousands)	Withdrawals (Mgal/d)		
		Ground water	Surface water	Total
10010001	0.01	<0.01	<0.01	<0.01
10010002	.30	.02	.01	.02
10020001	.58	.05	0	.05
10020002	2.22	.17	0	.17
10020003	.88	.07	0	.07
10020004	3.20	.25	0	.25
10020005	3.82	.30	0	.30
10020006	1.71	.13	<.01	.13
10020007	3.55	.27	.01	.28
10020008	18.96	1.46	.01	1.48
10030101	22.61	1.75	.02	1.76
10030102	.66	.05	<.01	.05
10030103	1.27	.10	0	.10
10030104	10.11	.77	.02	.79
10030105	1.19	.09	0	.09
10030201	1.80	.14	0	.14
10030202	.45	.03	0	.03
10030203	.30	.02	<.01	.02
10030204	.59	.05	0	.05
10030205	1.95	.09	.06	.15
10040101	1.35	.10	0	.10
10040102	.46	.03	<.01	.04
10040103	3.43	.15	.12	.27
10040104	2.24	.02	.15	.17
10040105	.04	<.01	0	<.01
10040106	.37	.03	0	.03
10040201	2.64	.21	0	.21
10040202	1.39	.11	0	.11
10040203	.38	.03	0	.03
10040204	.29	.02	0	.02
10040205	.55	.04	0	.04
10050001	.64	.04	.01	.05
10050002	1.09	.07	.02	.09
10050003	.06	<.01	<.01	<.01
10050004	1.10	.07	.01	.09
10050005	1.01	.07	.01	.08
10050006	.87	.07	0	.07
10050007	.78	.05	.01	.06
10050008	.27	.02	<.01	.02
10050009	.31	.02	0	.02
10050010	.44	.03	<.01	.03
10050011	.29	.02	0	.02
10050012	.77	.05	.01	.06
10050013	.17	.01	0	.01
10050014	.45	.03	0	.03
10050015	.21	.02	0	.02
10050016	.51	.03	.01	.04
10060001	1.65	.08	.05	.13
10060002	1.20	.09	0	.09
10060003	1.36	.11	0	.11
10060004	.44	.03	0	.03
10060005	2.06	.10	.06	.16
10060006	2.46	.19	0	.19

Table 1-3. Self-supplied domestic water withdrawals in Montana by hydrologic unit, 2000—Continued

Hydrologic unit	Self-supplied population (thousands)	Withdrawals (Mgal/d)		
		Ground water	Surface water	Total
10060007	.23	.02	<.01	.02
10070001	.32	.02	<.01	.02
10070002	6.27	.48	<.01	.49
10070003	1.76	.14	<.01	.14
10070004	4.68	.37	0	.37
10070005	2.53	.20	<.01	.20
10070006	4.26	.33	<.01	.33
10070007	14.69	1.15	0	1.15
10070008	1.71	.13	0	.13
10080010	.69	.05	0	.05
10080014	.32	.02	0	.02
10080015	2.52	.20	0	.20
10080016	1.75	.14	0	.14
10090101	.52	.04	0	.04
10090102	1.81	.14	0	.14
10090207	.42	.03	0	.03
10090208	.22	.02	0	.02
10090209	.72	.06	0	.06
10090210	.25	.02	0	.02
10100001	1.71	.13	0	.13
10100002	.22	.02	0	.02
10100003	.45	.04	0	.04
10100004	6.00	.46	<.01	.47
10100005	.87	.07	0	.07
10110201	.25	.02	0	.02
10110202	.49	.04	0	.04
10110203	.04	<.01	0	<.01
10110204	.20	.02	0	.02
10120202	.02	<.01	0	<.01
17010101	10.22	.77	.02	.80
17010102	1.20	.08	.01	.09
17010103	.84	.05	.02	.07
17010104	.06	<.01	<.01	<.01
17010105	.04	<.01	<.01	<.01
17010201	9.52	.74	.01	.74
17010202	4.23	.32	.01	.33
17010203	4.98	.37	.02	.39
17010204	9.47	.70	.04	.74
17010205	39.18	3.03	.03	3.06
17010206	.45	.03	<.01	.03
17010207	.19	.01	<.01	.01
17010208	21.57	1.55	.13	1.68
17010209	1.80	.14	0	.14
17010210	11.16	.81	.06	.87
17010211	2.76	.20	.02	.22
17010212	7.68	.56	.04	.60
17010213	4.29	.30	.03	.33
TOTAL	292.99	21.80	1.05	22.85

Table 1-4. Self-supplied industrial water withdrawals in Montana by hydrologic unit, 2000

[Hydrologic units with no withdrawal are not listed. Values may not add for column totals or total withdrawals because of rounding. Abbreviation: Mgal/d, million gallons per day]

Hydrologic unit	Withdrawals (Mgal/d)		
	Ground water	Surface water	Total
10020002	0.11	0.16	0.27
10020006	.29	0	.29
10020008	.09	0	.09
10030101	.15	.79	.94
10030102	.01	.50	.51
10030103	.12	0	.12
10030202	.30	0	.30
10030203	0	.22	.22
10040103	.09	0	.09
10050004	.01	0	.01
10050012	.06	0	.06
10060005	.04	0	.04
10070002	.03	0	.03
10070004	.49	9.37	9.86
10070006	.12	0	.12
10080015	.01	0	.01
10100001	.10	0	.10
10100004	.06	.81	.87
10100005	.01	0	.01
10110204	.01	0	.01
17010101	.12	13.77	13.89
17010201	1.65	0	1.65
17010202	.01	0	.01
17010204	21.46	3.64	25.10
17010205	.12	0	.12
17010208	6.27	.07	6.34
17010213	.21	0	.21
TOTAL	31.94	29.33	61.27

Table 1-5. Water withdrawals for thermoelectric power generation by hydrologic unit, 2000

[Hydrologic units with no withdrawal are not listed. Values may not add for column totals or total withdrawals because of rounding. Abbreviations: Mgal/d, million gallons per day. Gwatt-hours, gigawatt hours]

Hydrologic unit	Withdrawals (Mgal/d)			Power generated (Gwatt-hours)
	Ground water	Surface water	Total	
10070004	0	52.67	52.67	1,173.11
10100001	0	25.59	25.59	14,310.45
10100004	0	31.70	31.70	456.40
TOTAL	0	109.96	109.96	15,940

Table 1-6. Livestock water withdrawals in Montana by hydrologic unit, 2000

[Values may not add for column totals or total withdrawals because of rounding. Abbreviation: Mgal/d, million gallons per day. Symbol: <, less than]

Hydrologic unit	Withdrawals (Mgal/d)		
	Ground water	Surface water	Total
10010001	<0.01	0.04	0.04
10010002	<.01	.10	.10
10020001	.44	.53	.97
10020002	.25	.33	.58
10020003	.07	.24	.31
10020004	.45	.58	1.03
10020005	.10	.26	.36
10020006	.03	.10	.13
10020007	.19	.42	.61
10020008	.25	.33	.58
10030101	.26	.66	.92
10030102	.20	.69	.89
10030103	.28	.53	.81
10030104	.11	.58	.69
10030105	.10	.26	.36
10030201	.05	.31	.36
10030202	<.01	.27	.27
10030203	.21	.60	.81
10030204	.11	.09	.20
10030205	.07	.53	.60
10040101	.09	.35	.44
10040102	.12	.27	.39
10040103	.32	.85	1.17
10040104	.39	1.02	1.41
10040105	.08	.21	.29
10040106	.06	.18	.24
10040201	.40	1.34	1.74
10040202	.04	.46	.50
10040203	.02	.18	.20
10040204	.04	.32	.36
10040205	.06	.33	.39
10050001	0	.12	.12
10050002	.05	.14	.19
10050003	<.01	.01	.01
10050004	.10	.64	.74
10050005	.03	.11	.14
10050006	.03	.15	.18
10050007	.01	.04	.05
10050008	.02	.10	.12
10050009	.03	.16	.19
10050010	.03	.18	.21
10050011	<.01	.12	.12
10050012	.11	.21	.32
10050013	<.01	.06	.06
10050014	.02	.35	.37
10050015	.06	.11	.17
10050016	.05	.09	.14
10060001	.31	.28	.59
10060002	.40	.40	.80
10060003	.13	.09	.22
10060004	.09	.07	.16
10060005	.08	.31	.39

Table 1-6. Livestock water withdrawals in Montana by hydrologic unit, 2000—Continued

Hydrologic unit	Withdrawals (Mgal/d)		
	Ground water	Surface water	Total
10060006	.16	.34	.50
10060007	.02	.04	.06
10070001	.02	.07	.09
10070002	.46	.52	.98
10070003	.06	.17	.23
10070004	.35	.44	.79
10070005	.24	.21	.45
10070006	.03	.66	.69
10070007	.11	1.07	1.18
10070008	.07	.23	.30
10080010	.09	.09	.18
10080014	.02	.09	.11
10080015	.45	.19	.64
10080016	.22	.05	.27
10090101	.16	.08	.24
10090102	.49	.38	.87
10090207	.18	.02	.20
10090208	.20	.03	.23
10090209	.21	.39	.60
10090210	.16	.09	.25
10100001	.33	1.21	1.54
10100002	.07	.14	.21
10100003	.17	.17	.33
10100004	.40	1.08	1.48
10100005	.03	.49	.52
10110201	.02	.52	.54
10110202	.01	.32	.33
10110203	<.01	.02	.02
10110204	.04	.10	.14
10120202	<.01	.02	.02
17010101	.02	.01	.03
17010102	.01	.01	.02
17010103	<.01	.01	.01
17010104	<.01	<.01	<.01
17010105	<.01	<.01	<.01
17010201	.12	.44	.56
17010202	.16	.11	.27
17010203	.05	.45	.50
17010204	.01	.06	.07
17010205	.14	.42	.56
17010206	.03	.02	.05
17010207	.04	.02	.06
17010208	.06	.18	.24
17010209	.05	.17	.22
17010210	.03	.01	.04
17010211	.04	.17	.21
17010212	.14	.38	.52
17010213	.17	.07	.24
TOTAL	12.20	28.45	40.65