

# **HYDROLOGIC AND WATER-QUALITY DATA RELATED TO THE OCCURRENCE OF ARSENIC FOR AREAS ALONG THE MADISON AND UPPER MISSOURI RIVERS, SOUTHWESTERN AND WEST-CENTRAL MONTANA**

**By L.K. Tuck, DeAnn M. Dutton, and David A. Nimick**

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## CONVERSION FACTORS, VERTICAL DATUM, ABBREVIATED WATER-QUALITY UNITS, AND ACRONYMS

Multiply	By	To obtain
acre	4,047	square meter
cubic foot per second (ft <sup>3</sup> /s)	0.028317	cubic meter per second
foot (ft)	0.3048	meter (m)
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer
square mile (mi <sup>2</sup> )	2.59	square kilometer

Degree Celsius (°C) may be converted to degree Fahrenheit (°F) by using the following equation:

$$^{\circ}\text{F} = 9/5 (^{\circ}\text{C}) + 32$$

**Sea level:** In this report “sea level” refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentration in water is reported in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute mass (milligram) per unit volume (liter) of water and is about the same as parts per million unless concentrations are more than 7,000 milligrams per liter (Hem, 1985, p. 55). One thousand micrograms per liter is equivalent to 1 milligram per liter. Tritium concentration is expressed in tritium units (TU). A tritium unit is equal to 3.2 picocuries per liter (pCi/L), which is equal to 2.2 radioactive disintegrations per minute in a unit volume (liter) of water.

**Abbreviated water-quality units used in this report:**

$\mu\text{g/L}$	micrograms per liter
$\mu\text{S/cm}$	microsiemens per centimeter at 25 degrees Celsius
$\text{mg/L}$	milligrams per liter
permil	parts per thousand
TU	tritium unit

**Acronyms used in this report:**

BOR	Bureau of Reclamation, U.S. Department of the Interior
MBMG	Montana Bureau of Mines and Geology
MDNRC	Montana Department of Natural Resources and Conservation
MCL	Maximum Contaminant Level
RSD	Relative standard deviation
SRS	Standard reference sample
USGS	U.S. Geological Survey
WATSTORE	Water-Data Storage and Retrieval System



# HYDROLOGIC AND WATER-QUALITY DATA RELATED TO THE OCCURRENCE OF ARSENIC FOR AREAS ALONG THE MADISON AND UPPER MISSOURI RIVERS, SOUTHWESTERN AND WEST-CENTRAL MONTANA

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## Abstract

Geothermal waters in Yellowstone National Park contribute large quantities of arsenic to the headwaters of the Madison River, which, in part, forms the upper Missouri River. Water in some Quaternary and Tertiary valley-fill deposits along the Madison and upper Missouri Rivers also is locally enriched in arsenic. Arsenic in surface and ground water in these valleys is an important public-health concern because arsenic concentrations frequently exceed the State of Montana water-quality human health standard of 18 micrograms per liter as well as the U.S. Environmental Protection Agency Maximum Contaminant Level of 50 micrograms per liter.

This report presents hydrologic and water-quality data for the Madison and upper Missouri Rivers and selected tributaries, irrigation supply canals or ditches, drains, springs and seeps, for Lake Helena, and for ground water in adjacent areas. Hydrologic and water-quality data were collected and compiled to provide information to more fully understand the extent, magnitude, and source of arsenic in surface and ground water along the Madison and upper Missouri Rivers; to assess, to the extent possible, the mechanisms that control arsenic concentrations; and to assess the effect of irrigation on arsenic concentrations. Hydrologic and arsenic-concentration data were collected by the U.S. Geological Survey and other agencies for 104 surface-water sites and 273 ground-water sites during this and previous studies. The quality of analytical results for arsenic concentrations was evaluated by quality-control samples that were submitted from the field and analyzed in the laboratory with routine samples. Quality-control samples consisted of replicates, standard refer-

ence samples, interlaboratory comparison samples, and field blanks.

## INTRODUCTION

Geothermal waters in Yellowstone National Park contribute large quantities of arsenic to the headwaters of the Madison River (fig. 1). The median total-recoverable arsenic concentration in water from the Madison River near West Yellowstone is 280  $\mu\text{g/L}$ . The Madison River joins the Jefferson and Gallatin Rivers near Three Forks to form the upper Missouri River, where the median total-recoverable arsenic concentration in streamflow is about 74  $\mu\text{g/L}$ . Farther downstream, below Canyon Ferry Lake near Helena, the median total-recoverable arsenic concentration in streamflow is 27  $\mu\text{g/L}$  (Knapton and Horpestad, 1987; Knapton and Brosten, 1987, 1989; U.S. Geological Survey, published annually). Water in some Quaternary and Tertiary valley-fill deposits along the Madison and upper Missouri Rivers also is locally enriched in arsenic. Arsenic concentrations in ground water are highest in the lower Madison River Valley near Three Forks, where an arsenic concentration as high as 176  $\mu\text{g/L}$  has been reported (Sonderegger and Sholes, 1989).

Water from the Missouri River is not used for municipal supply upstream from Canyon Ferry Lake; however, domestic and public-supply wells exist in areas where arsenic concentrations in ground water are high. Recent increases in residential development, particularly near the flood plains and on adjacent terraces, have resulted in additional wells in areas of high arsenic concentrations.

Arsenic in surface and ground water in the Madison and upper Missouri River Valleys is an important public-health concern. Arsenic concentrations in the

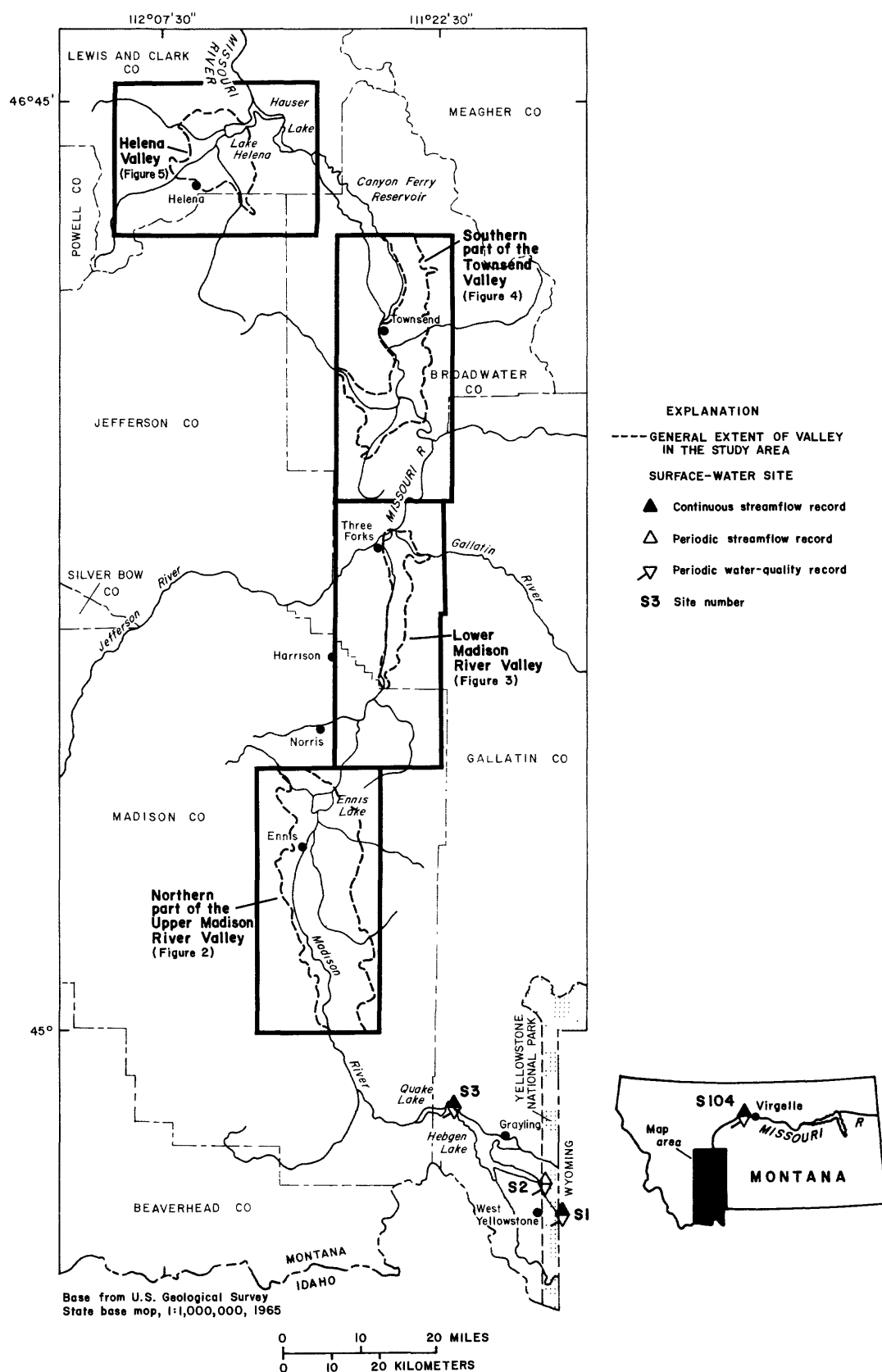


Figure 1. Location of study area in Montana.

2 Hydrologic and Water-Quality Data Related to the Occurrence of Arsenic for Areas Along the Madison and Upper Missouri Rivers, Southwestern and West-Central Montana



Madison and upper Missouri Rivers and some ground water exceed the State of Montana water-quality human health standard of 18 µg/L (Montana Department of Environmental Quality, 1995) as well as the U.S. Environmental Protection Agency Maximum Contaminant Level (MCL) of 50 µg/L (U.S. Environmental Protection Agency, 1996). The extent of affected areas and the mechanisms that control arsenic concentrations in surface and ground water in the Madison and upper Missouri Rivers are relatively unknown.

The Montana Department of Natural Resources and Conservation (MDNRC) adopted standards in 1992 that prevent new irrigation projects if water diverted for irrigation increases arsenic concentrations in surface or ground water. A better understanding of the historic effects of irrigation on arsenic in surface and ground water was needed to be able to predict the effect that proposed new irrigation would have on arsenic concentrations. Consequently, the U.S. Geological Survey (USGS), in cooperation with the MDNRC and the Bureau of Reclamation (BOR), conducted a study to obtain additional information to meet these needs.

This report presents hydrologic and water-quality data for the Madison and upper Missouri Rivers and selected tributaries, irrigation supply canals or ditches, drains, springs and seeps, for Lake Helena, and for ground water in adjacent areas. Hydrologic and water-quality data were collected and compiled during 1992-1995 to provide information to more fully understand the extent, magnitude, and source of arsenic in surface and ground water along the Madison and upper Missouri Rivers; to assess, to the extent possible, the mechanisms that control arsenic concentrations; and to assess the effect of irrigation on arsenic concentrations. The data presented were obtained by the USGS and other agencies during this and previous studies.

## **Description of the Study Area**

The study area consists of about 2,320 mi<sup>2</sup> located within Madison, Gallatin, Jefferson, Broadwater, and Lewis and Clark Counties in southwestern and west-central Montana. The study area extends from West Yellowstone to the Helena Valley and is divided into four areas where stream water has been diverted for irrigation: the northern part of the upper Madison River Valley, the lower Madison River Valley, the southern part of the Townsend Valley, and the Helena

Valley. Additionally, three surface-water sites (S1, S2, and S3) are located southeast of the upper Madison River Valley near West Yellowstone to Quake Lake and one surface-water site (S104) is located downstream from the Helena Valley at Virgelle (fig. 1).

These valleys are filled with generally permeable, unconsolidated to consolidated Tertiary to Quaternary deposits, which form modern flood plains, terraces, alluvial fans, and benches. This valley fill forms a complexly stratified sequence of gravel, sand, silt, and clay that can be several thousand feet thick. Valleys are surrounded by mountains composed of generally impermeable Archean to Quaternary bedrock or Tertiary semiconsolidated, fine-grained sediments.

The northern part of the upper Madison River Valley (fig. 2) extends from south of Cameron to north of Ennis Lake. About 10,000 acres of land primarily located on the Cameron Bench and along the West Madison Canal are irrigated. Water is diverted for irrigation from the Madison River and some of its major tributaries, which include Indian, O'Dell, Bear, and Blaine Spring Creeks; therefore, many areas are irrigated from a mixture of water from the Madison River and its tributaries. The main supply canals include Granger and Shewmaker Ditches, an unnamed canal that diverts water from O'Dell Creek to the Jeffers area, and the West Madison Canal. Water has been diverted for irrigation to some areas in the upper Madison River Valley for more than 80 years (Keith, 1995). Irrigated crops consist of alfalfa and native grass; some irrigated land is used for pasture.

The lower Madison River Valley (fig. 3) extends from near Elk Creek to near Trident. About 5,900 acres of land located mostly between the river and prominent cliffs of the Madison Plateau to the east are irrigated. Water is diverted for irrigation from the Madison River near Elk Creek to near the Missouri River north of Three Forks, as well as from two creeks (Spring and Rey Creeks) that originate as springs on the valley floor. Some areas are sub-irrigated by shallow ground water. The main supply canals include Sloan, Hutchison, Crowley, and Darlington Ditches, and Dell, Spring and Rey Creeks on the east side of the valley, and the Francis Walbert Ditch on the northwest side of the valley. Water has been diverted for irrigation to some areas in the lower Madison River Valley for more than 90 years (Keith, 1995). Irrigated crops consist of cereal grains, alfalfa, and native grass; some irrigated land is used for pasture.

The southern part of the Townsend Valley (fig. 4) extends from Plunket Lake to north of Townsend along the east side of Canyon Ferry Lake. About 31,700 acres of land are irrigated. Water is diverted from the Missouri River from near Toston to as far north as Duck Creek and some diversions include a mixture of water from tributaries and ground water. The main supply canals include Toston Canal, Warm Springs Creek, Broadwater-Missouri Westside Canal, Broadwater Missouri Canal and Montana Ditch. Water has been diverted for irrigation to some areas in the Townsend Valley for more than 100 years (Lorenz and McMurtrey, 1956). Irrigated crops consist of cereal grains, seed potatoes, alfalfa, and native grass; some irrigated land is used for pasture.

The Helena Valley (fig. 5) extends from Helena and the Scratchgravel Hills northeast to Lake Helena. About 21,200 acres of land are within the irrigation district. Water is diverted from the Missouri River and is pumped to the Helena Valley Regulating Reservoir. Water is then released to the Helena Valley Canal and its extensive network of distributary canals and ditches. Water is also diverted from Prickly Pear, Tenmile, and Sevenmile Creeks; therefore, some irrigated areas include a mixture of water from these sources. Some areas are sub-irrigated by shallow ground water. Water has been diverted for irrigation to some areas in the Helena Valley for more than 100 years (Lorenz and Swenson, 1951). Irrigated crops consist of cereal grains, alfalfa, and native grass; some irrigated land is used for pasture.

## Site-Numbering Systems

For clarity, surface-water sites are assigned a site number from S1 through S104 in downvalley order (table 1). (All tables are at the back of the report.) Eight-digit station-identification numbers for routine surface-water sites represent the standard USGS numbering system for streamflow-gaging stations. Fifteen-digit station-identification numbers are used for miscellaneous or temporary surface-water stations; these numbers represent the approximate latitude and longitude of this site (first 13 digits), plus the sequence number (last 2 digits).

Ground-water sites are assigned location numbers according to their geographic position within the rectangular grid system used for the subdivision of public lands (fig. 6). The location number consists of

as many as 14 characters. The first three characters specify the township and its position north or south (N or S) of the Montana Base Line. The next three characters specify the range and its position east or west (E or W) of the Montana Principal Meridian. The next two characters are the section number. The next two to four alpha characters designate the quarter section (160-acre tract), the quarter-quarter section (40-acre tract), the quarter-quarter-quarter section (10-acre tract), and the quarter-quarter-quarter-quarter section (2.5-acre tract), respectively, in which the well is located. These four subdivisions of the section are designated A, B, C, and D in a counter-clockwise direction, beginning in the northeast quadrant. The last two numeric characters specify a sequence number, based on the order of inventory, to distinguish between multiple wells at a single location. For example, as shown in figure 6, well 11N03W33BBAA02 is the second well inventoried in the NE 1/4 NE 1/4 NW1/4 NW1/4 sec. 33, T. 11 N., R. 3 W.

## Acknowledgments

The authors acknowledge with appreciation the many individuals who assisted in the study. Particular thanks are given to the many landowners in the study area for allowing access to their property. Appreciation is also extended to Andrew R. Skerda, Steven W. Nichols, Kevin L. Sattler, Randal G. Cramer, and David W. Clark (USGS) for assisting in the collection of hydrologic and water-quality data; and to Charles E. Dalby (MDNRC), Jeff Lucero (BOR), Joanna N. Thamke, and Kent A. Dodge (USGS) for colleague review.

## SAMPLING LOCATIONS AND TYPES OF DATA

Surface water was sampled at 40 sites on the Madison and upper Missouri Rivers and selected tributaries from West Yellowstone to Virgelle (fig. 1-5, tables 1-9). Sites were selected on the basis of available historical hydrologic and water-quality data. Selected tributaries were sampled to describe hydrologic and water-quality characteristics of water entering the Madison and upper Missouri Rivers and to document other possible sources of arsenic. In addition, water-quality data were obtained for six diel (or daily) investigations at five mainstem sites located on the Madison and upper Missouri Rivers (tables 4-9).

## EXPLANATION FOR FIGURE 2

----- GENERAL EXTENT OF VALLEY IN THE STUDY AREA

### SURFACE-WATER SITE

▲ Continuous streamflow record

△ Periodic streamflow record

⌘ Periodic water-quality record

S4 Site number

### GROUND-WATER SITE

● Hydrologic data. For some sites, data include onsite measurements of water temperature, specific conductance, pH, and nitrate concentration

⊕ Hydrologic and water-quality data

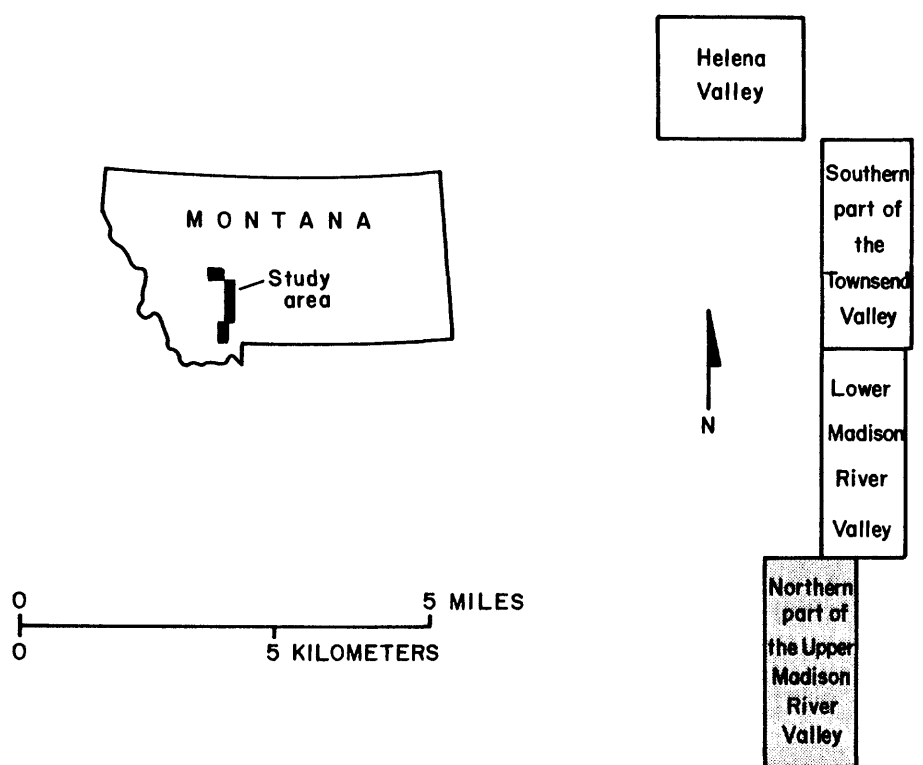
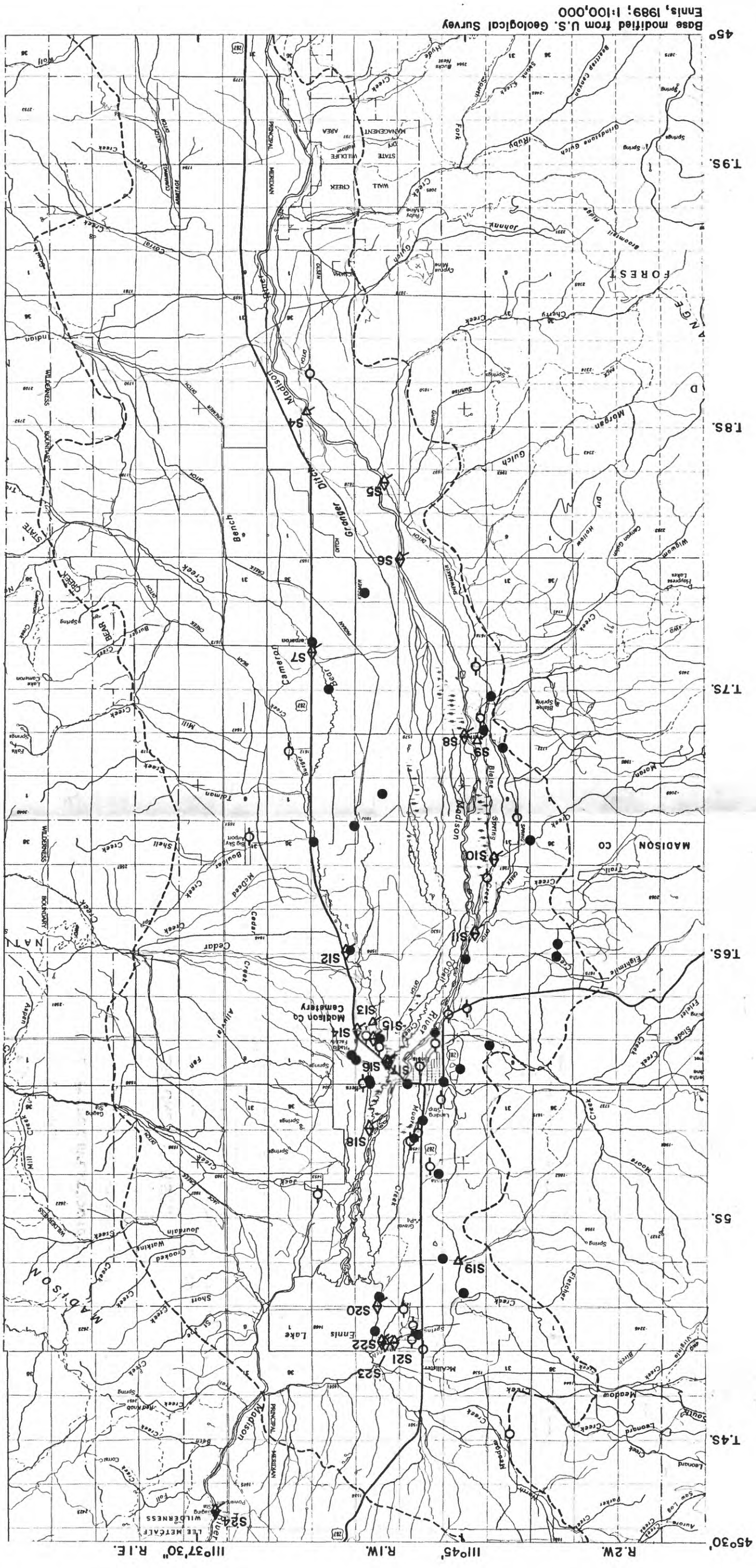


DIAGRAM SHOWING  
LOCATION OF VALLEYS



**Figure 2.** General extent of the northern part of the upper Madison River Valley and location of surface-water and ground-water sites. (Explanation shown on back of map.)

### EXPLANATION FOR FIGURE 3

----- GENERAL EXTENT OF VALLEY IN THE STUDY AREA

#### SURFACE-WATER SITE

△ Periodic streamflow record

⋈ Periodic water-quality record

s25 Site number

#### GROUND-WATER SITE

● Hydrologic data. For some sites, data include onsite measurements of water temperature, specific conductance, pH, and nitrate concentration

⊙ Hydrologic and water-quality data. Numeral indicates the number of wells at the same general location

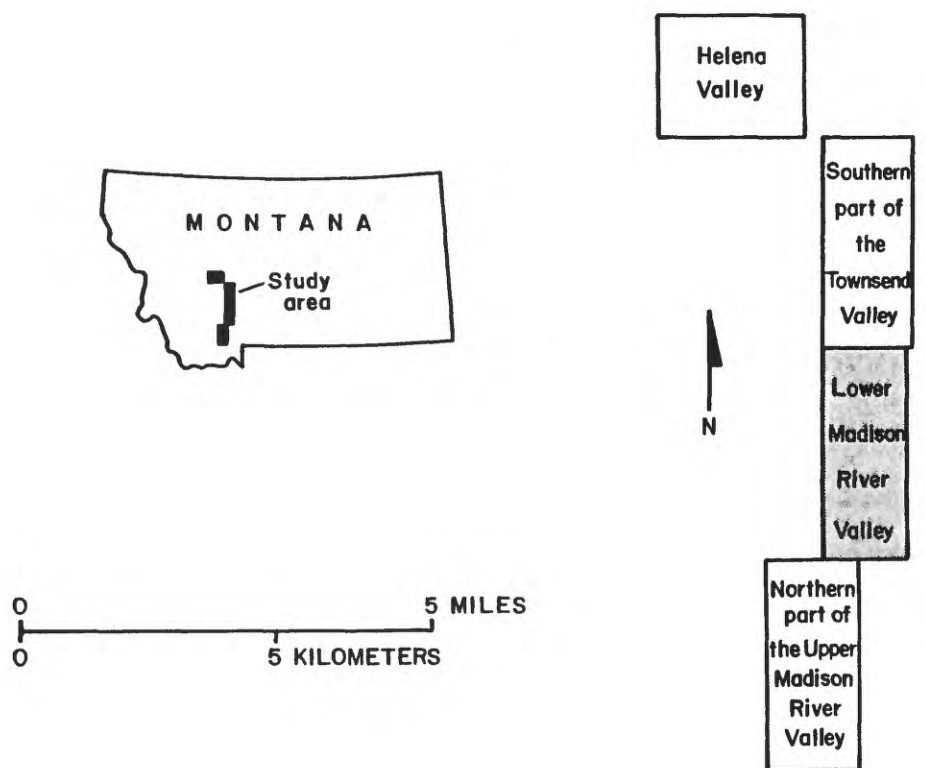


DIAGRAM SHOWING  
LOCATION OF VALLEYS



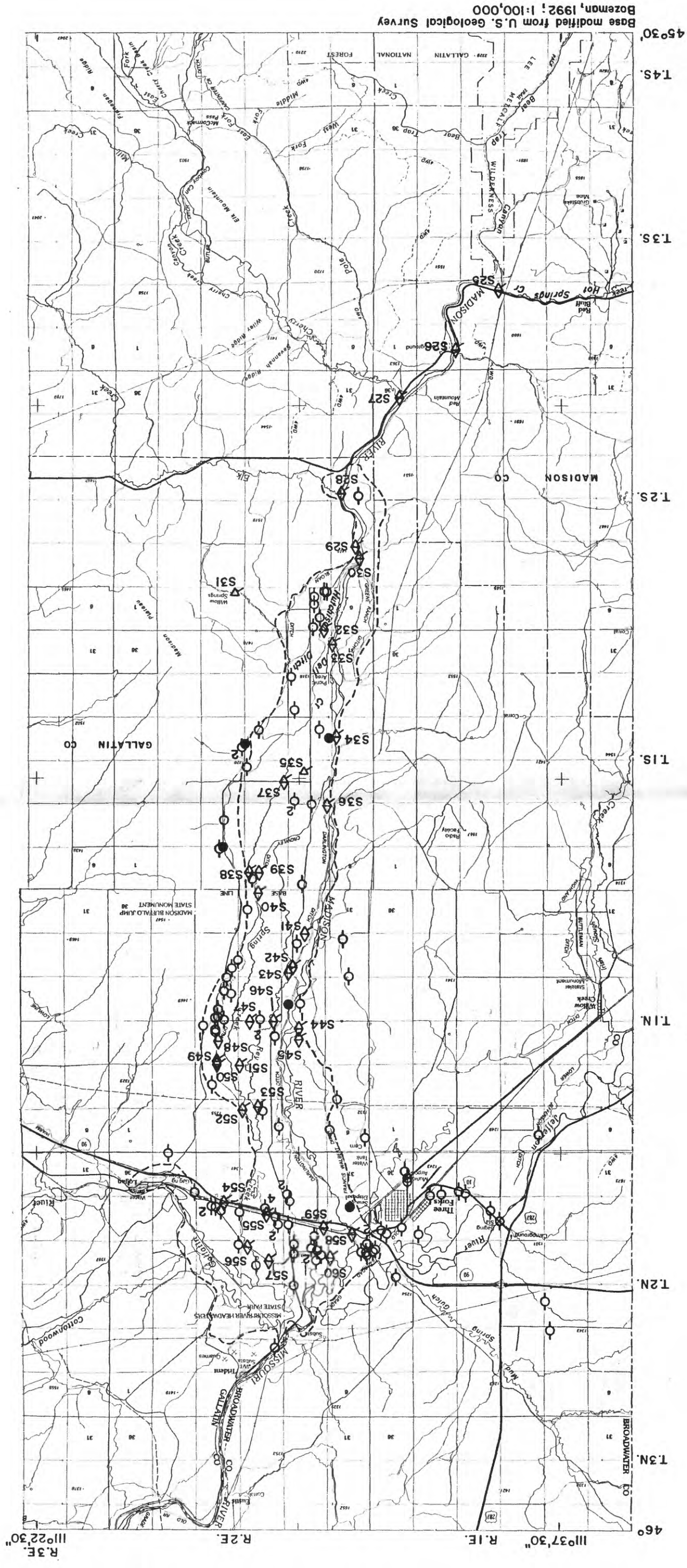


Figure 3. General extent of the lower Madison River Valley and location of surface-water and ground-water sites.  
(Explanation shown on back of map.)

# EXPLANATION FOR FIGURE 4

----- GENERAL EXTENT OF VALLEY IN THE STUDY AREA

## SURFACE-WATER SITE

▲ Continuous streamflow record

△ Periodic streamflow record

⋈ Periodic water-quality record

S6I Site number

## GROUND-WATER SITE

● Hydrologic data. For some sites, data include onsite measurements of water temperature, specific conductance, pH, and nitrate concentration

⊕ Hydrologic and water-quality data

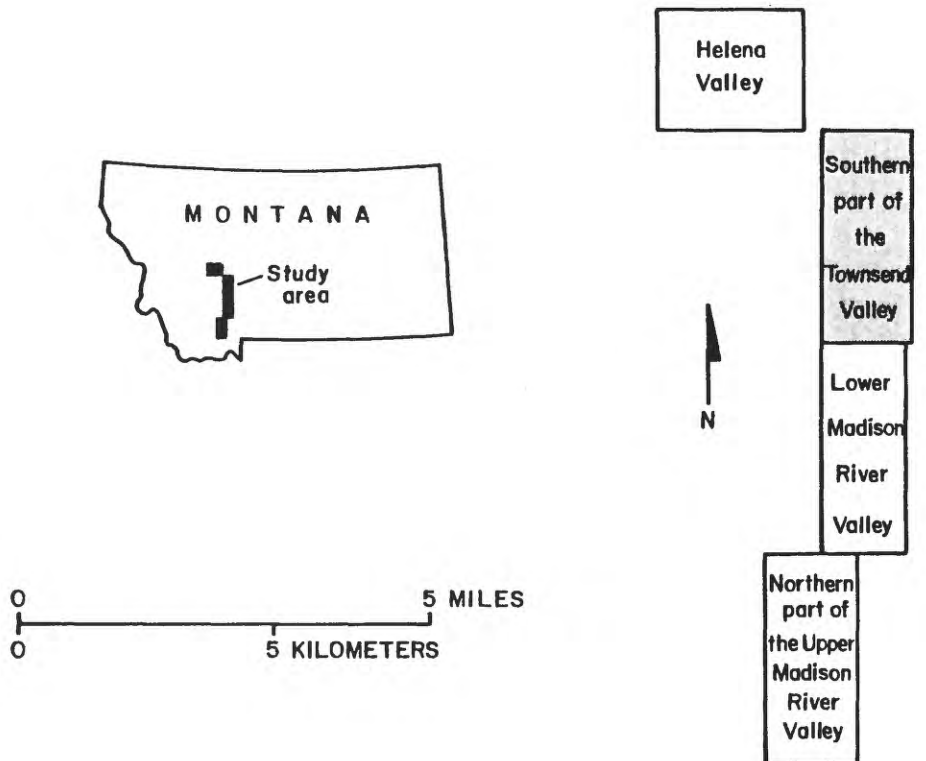


DIAGRAM SHOWING  
LOCATION OF VALLEYS

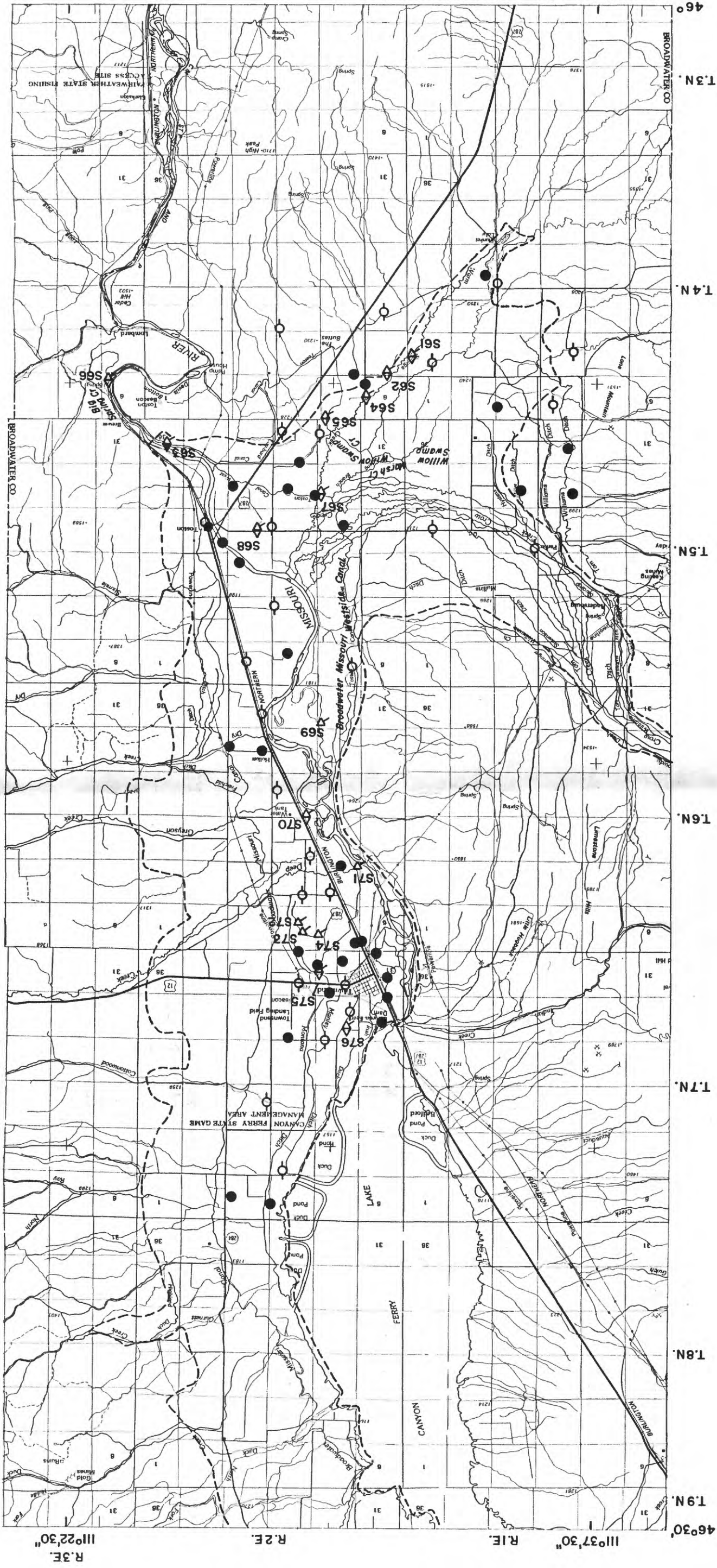


Figure 4. General extent of the southern part of the Townsend Valley and location of surface-water and ground-water sites. (Explanation shown on back of map.)



# EXPLANATION FOR FIGURE 5

----- GENERAL EXTENT OF VALLEY IN THE STUDY AREA

## SURFACE-WATER SITE

- △ Periodic streamflow record
- ⋈ Periodic water-quality record
- Lake Helena periodic water-quality record

S77 Site number

## GROUND-WATER SITE

- Hydrologic data. For some sites, data include onsite measurements of water temperature, specific conductance, pH, and nitrate concentration
- ⊕ Hydrologic and water-quality data. Numeral indicates the number of wells at the same general location

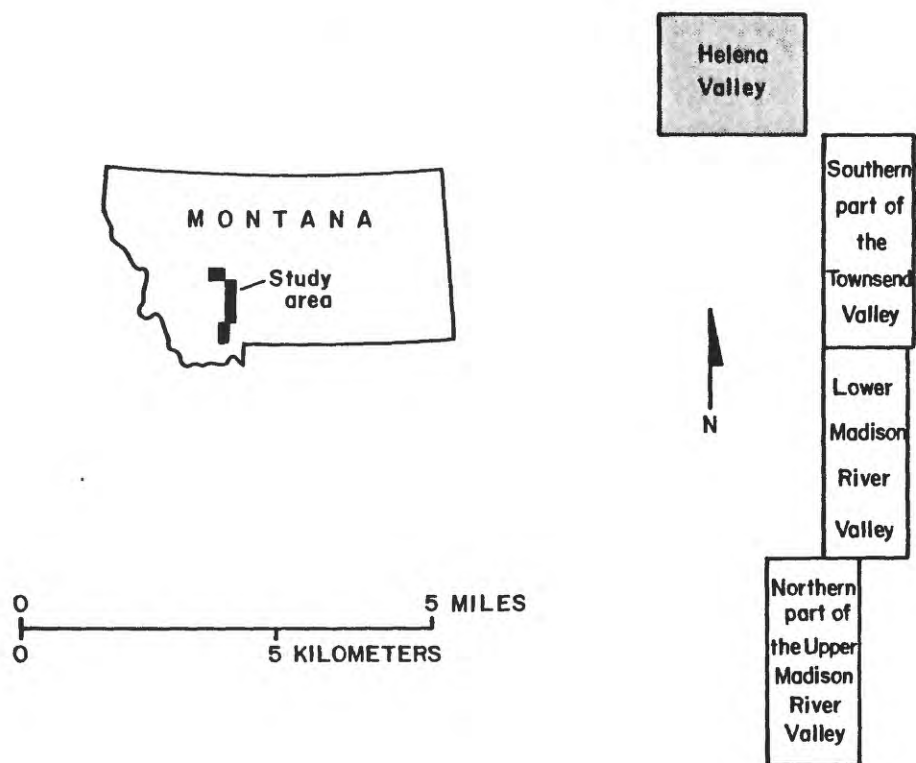
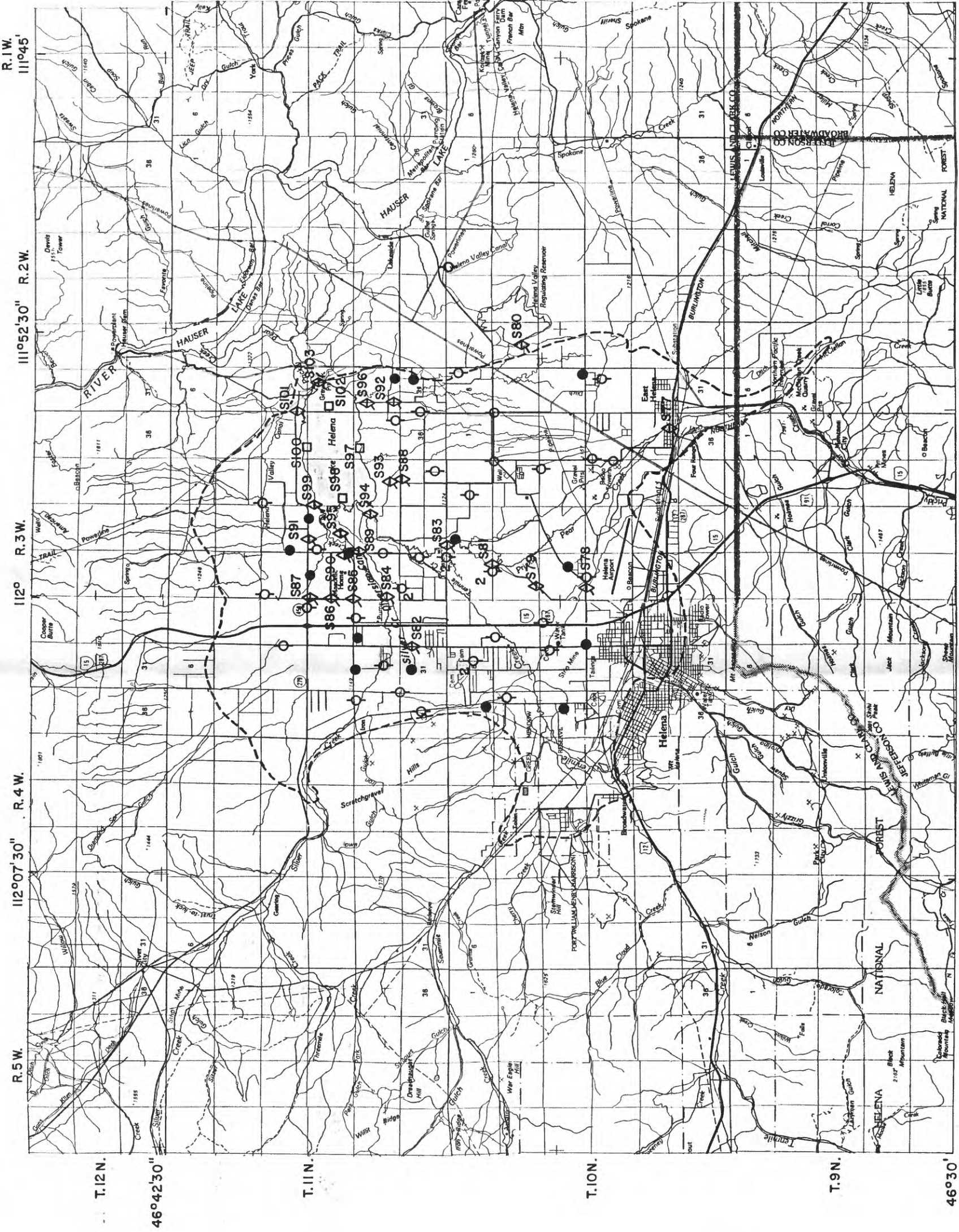
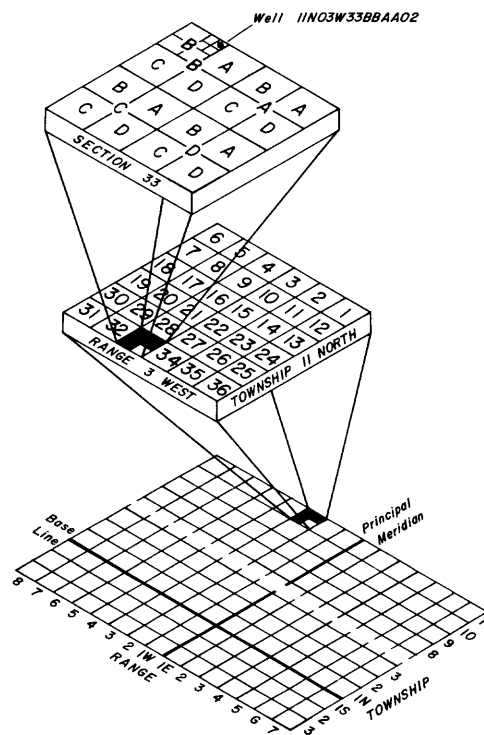


DIAGRAM SHOWING  
LOCATION OF VALLEYS



Base modified from U.S. Geological Survey  
Elliston, 1990 and Bureau of Land Manage-  
ment Canyon Ferry Dam, 1975, 1:100,000

Figure 5. General extent of the Helena Valley and location of surface-water and ground-water sites.  
(Explanation shown on back of map.)



**Figure 6.** Numbering system for ground-water sites along the Madison and upper Missouri Rivers in Montana.

Surface water was also sampled at 64 sites on irrigation canals, ditches, drains, springs and seeps, and Lake Helena. Most of these sites were selected either on the basis of data available from the BOR (Mangelson and Brummer, 1994) or to provide data for areas not covered by existing data sources.

Ground-water sites were selected along the Madison and upper Missouri Rivers from south of Cameron to the northern part of the Helena Valley (fig. 1-5, tables 10-12). Sites were chosen based on review of hydrologic and arsenic-concentration data available from previous studies, drillers' logs, and to provide data in areas not covered by existing data sources. Hydrologic or arsenic-concentration data were obtained for 273 ground-water sites.

Most ground-water sites in the upper and lower Madison River Valleys were selected because arsenic-concentration data were available from previous studies. Data for some sites in the upper Madison River Valley had been collected by the USGS and were retrieved from WATSTORE. Data for most sites in the lower Madison River Valley were retrieved from the Montana Bureau of Mines and Geology (MBMG). Most of these sites are reported in Sonderegger and Sholes (1989) or Sonderegger and others (1989).

Ground-water sites from the MBMG were not field checked by the USGS. Additionally, drillers' logs were obtained for these sites and hydrologic data from the drillers' logs were used as part of this study to help in understanding the hydrogeology of the lower Madison River Valley.

Privately owned water wells were inventoried during 1992-1995 to obtain ground-water data in areas not covered by existing data sources. Hydrologic and field water-quality data were collected as part of the inventory (table 10). Drillers' logs were obtained for most of these sites and compiled as part of this study. Water samples were collected from many of these wells in 1992-95 (tables 11 and 12).

## METHODS OF SAMPLE COLLECTION, PROCESSING, AND ANALYSIS

Surface-water samples were collected using either cross-sectional, depth-integrated methods described by Edwards and Glysson (1988), U.S. Geological Survey (1977), and Knapton (1985) for larger streamflows or grab methods described by Knapton (1985) for smaller streamflows (tables 2-9). Sampling equipment consisted of standard USGS depth-integrat-

ing suspended-sediment samplers, which were either constructed of plastic or coated with non-metallic epoxy paint and equipped with nylon nozzles. Instantaneous discharge was determined by direct measurement, from stage-discharge ratings, or estimation (Rantz and others, 1982). Water temperature, specific conductance, pH, and dissolved oxygen were determined during collection of water-quality samples. Field processing of surface-water samples was performed according to procedures described by Ward and Harr (1990), U.S. Geological Survey (1977), and Knapton (1985).

Suspended-sediment samples also were collected when some water-quality samples were collected at selected surface-water sites. These samples were analyzed by the USGS Montana District office for suspended-sediment concentration and sand-silt distribution (percent finer than 0.062-mm diameter) according to methods described by Guy (1969) and Lambing and Dodge (1993).

Samples for six diel investigations were collected at about 1-hour intervals for 1- to 2-day periods at five mainstem sites (tables 4-9). Depth-integrated samples were collected at a single vertical at sites within the active flow of the channel, where the water was well-mixed, and as far from the river's edge as could be safely waded at night.

Ground-water samples (tables 11 and 12) were collected using a variety of samplers and were processed as described by Knapton (1985). Samples from domestic and stock wells were obtained using the existing pump and at a discharge point as close to the well as possible. Most wells had submersible pumps; however, a few wells had jet pumps, which can cause aeration and, possibly, chemical changes in the water. Test wells installed by Sonderegger and others (1989) and Briar and Madison (1992) were sampled with a stainless steel submersible pump. All wells were purged until at least three well volumes of water were removed and field parameters measured onsite (water temperature, specific conductance, pH, and dissolved oxygen) had stabilized. Field parameters were measured in a flow-through chamber for all wells. Field values for alkalinity were determined by incremental titration of the sample with sulfuric acid. Samples for arsenic speciation were filtered and preserved with hydrochloric acid. Water samples analyzed for oxygen-18/oxygen-16 (O-18/O-16) and deuterium/hydrogen (D/H) isotopic ratios were not filtered or preserved.

Water chemistry samples were analyzed by one of three laboratories: USGS National Water Quality Laboratory, Arvada, Colo.; MBMG Analytical Division, Butte, Mont.; or BOR, Bismarck, N.D. Samples submitted to the USGS were analyzed using methods described by Fishman and Friedman (1989) and Fishman (1993).

Dissolved arsenic was determined on samples filtered through 0.45- $\mu$ m pore-size filter. Total-recoverable arsenic was determined on unfiltered samples. Samples sent to the USGS were analyzed by hydride generation atomic absorption spectrometry after a sulfuric acid-potassium persulfate digestion designed to liberate organic arsenic-containing compounds as described by Fishman and Friedman (1989). Samples sent to the MBMG laboratory were analyzed by inductively-coupled plasma-mass spectrometry with no digestion before analysis as described by American Public Health Association and others (1992). Samples sent to the BOR laboratory were analyzed by graphite furnace atomic absorption after a nitric acid digestion as described by American Public Health Association and others (1992). Minimum reporting levels and policies regarding significant figures varied among the three laboratories. Arsenic data are reported as received from each laboratory.

Analyses for arsenic species were performed for selected ground-water samples by the MBMG using hydride generation atomic absorption spectrometry. For this analysis, the concentration of arsenite plus arsenate ( $\text{As}^{+3}$  and  $\text{As}^{+5}$ , shown in tables 12, 15, and 17) was determined on subsamples that were reduced in the laboratory with concentrated hydrochloric acid. The concentration of arsenite ( $\text{As}^{+3}$ , shown in tables 12, 15, and 17) was determined from subsamples that were not reduced with concentrated hydrochloric acid in the laboratory. The concentration of arsenate then can be calculated as the difference between the concentration of arsenite plus arsenate and the concentration of arsenite.

## QUALITY ASSURANCE AND QUALITY CONTROL

Quality-assurance procedures used for collecting and field processing of water-quality samples are described by Ward and Harr (1990), Edwards and Glysson (1988), Knapton and Nimick (1991), and Knapton (1985). For water samples submitted to the

USGS, standard procedures for internal sample handling and quality assurance are described by Friedman and Erdman (1982), Jones (1987), and Pritt and Raese (1992). For suspended-sediment samples submitted to the USGS Montana District, standard procedures for sample handling and quality assurance are described by Lambing and Dodge (1993).

The quality of arsenic concentrations determined for this study was evaluated by quality-control samples that were submitted from the field and analyzed in the laboratory with routine surface- and ground-water samples. Quality-control samples consisted of replicates, standard reference samples (SRS), interlaboratory comparison samples, and field blanks (tables 13-17). These quality-control samples provided information on the precision or bias of laboratory analyses, presence and magnitude of possible equipment or sample contamination, or comparability of arsenic data from different laboratories.

Replicate samples are two or more samples considered to be identical. Analyses of replicate samples indicate the precision, or reproducibility, of environmental data, which is affected by the combined variability of field and laboratory processes to which the sample is exposed. The precision, or reproducibility, of arsenic data was evaluated by computing the relative standard deviation (RSD) of arsenic concentrations measured in one set of replicate, standard reference, or interlaboratory samples. The RSD provides estimates of the variation that can be expected for arsenic concentrations reported for this study. No RSD's were calculated when one or both of the replicate concentrations was less than the minimum reporting level. RSD's were computed from the equation:

$$\text{RSD} = \frac{\text{standard deviation of values}}{\text{mean of values}} \times 100 \quad (1)$$

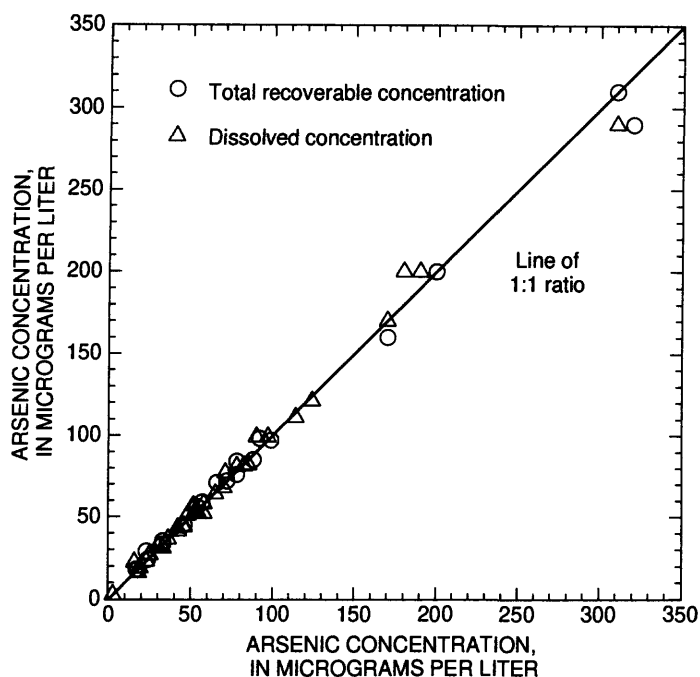
Replicate samples were submitted individually to the USGS and the MBMG. The USGS alone analyzed 22 replicate samples for total-recoverable arsenic and 24 replicate samples for dissolved arsenic. The RSD's for these samples were less than 9 percent except for one value of about 16 percent. MBMG alone analyzed

15 replicate samples for dissolved arsenic. The RSD's for these samples were less than 7 percent except for one value of about 25 percent (fig. 7, tables 13-15).

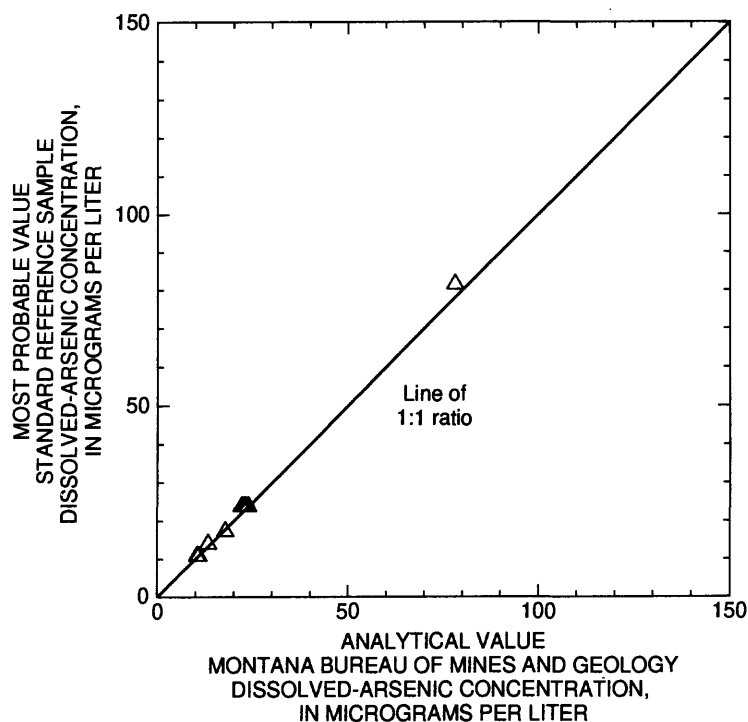
Data from SRS's indicate the accuracy or ability to measure a known concentration. These samples are not processed in the field, but are sent directly to the laboratory for analysis, and thus provide quality-assurance data primarily on laboratory procedures. Concentrations for SRS's are assumed to be the median, or most probable value, for any given constituent from many analyses performed as part of the USGS's interlaboratory evaluation program (H.K. Long and J.W. Farrar, U.S. Geological Survey, written commun., 1989, 1991; Long and Farrar, 1992). MBMG analyzed 10 SRS's for common-ion and trace-element data including arsenic (table 16). Only RSD's for arsenic were calculated and all values were less than 6 percent (fig. 8).

Replicates were also divided between different laboratories to evaluate interlaboratory precision. Nine replicates were sent to the USGS and MBMG, 27 replicates were sent to the MBMG and BOR, and 4 replicates were sent to the USGS and BOR. The RSD's for dissolved-arsenic concentration for the 9 sets of replicates sent to the USGS and MBMG ranged from about 0.6 percent to about 27 percent (fig. 9, tables 14 and 15). The RSD's for dissolved-arsenic concentration for the 27 sets of replicates sent to the BOR and MBMG ranged from about 0.1 percent to about 31 percent (fig. 10, table 14). Twenty-one of 27 RSD's were less than about 10 percent; for the four replicate sets with RSD's of more than about 10 percent, arsenic concentrations were near the minimum reporting level and ranged from 0.7 to 5.1. The RSD's for dissolved-arsenic concentration for the four sets of replicates sent to the BOR and USGS ranged from about 2.5 percent to about 15 percent, with three of the four values being more than 10 percent (fig. 11, table 14).

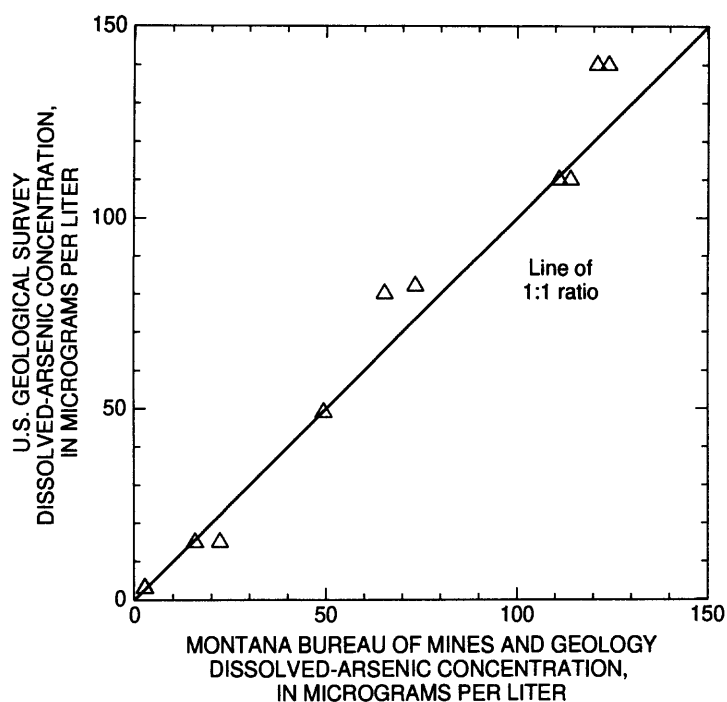
Analytical results for field blanks are presented in table 17. Blanks are aliquots of deionized water that are processed through sampling equipment used to collect environmental samples and subjected to the same subsequent processing as environmental samples. A field blank with constituent concentrations equal to or less than the minimum reporting level for the analytical



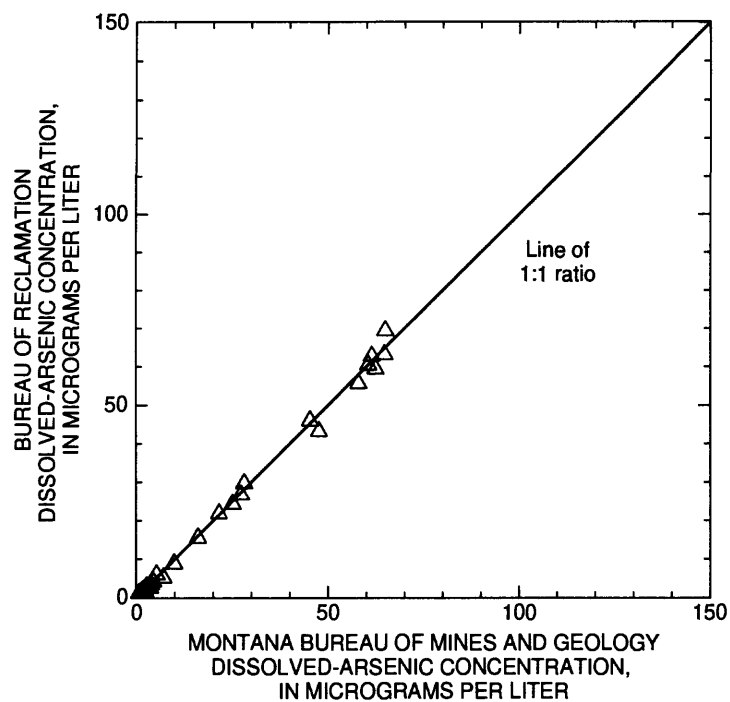
**Figure 7.** Relation between arsenic-concentration data for replicate samples analyzed either by the U.S. Geological Survey or the Montana Bureau of Mines and Geology laboratories.



**Figure 8.** Relation between dissolved-arsenic concentration data from the Montana Bureau of Mines and Geology laboratory and the most probable value for standard reference samples.

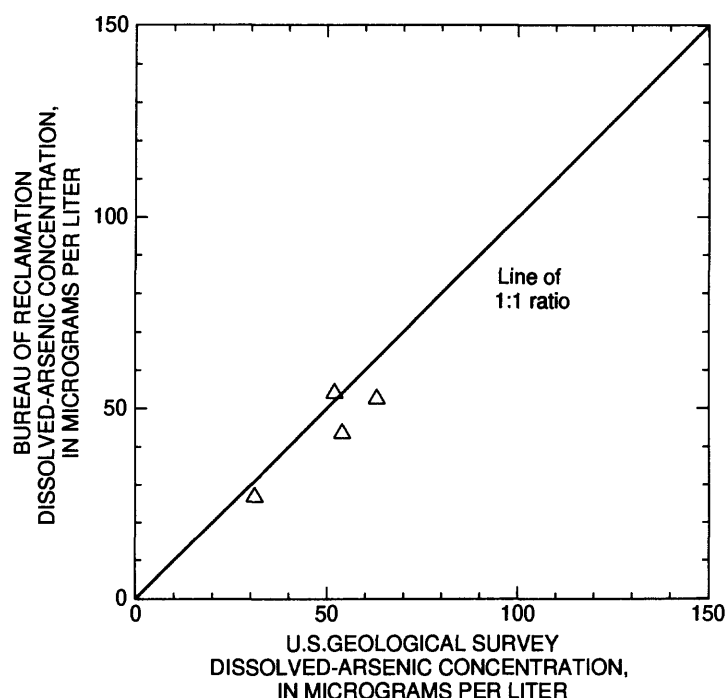


**Figure 9.** Relation between dissolved-arsenic concentration data from the Montana Bureau of Mines and Geology and the U.S. Geological Survey laboratories.



**Figure 10.** Relation between dissolved-arsenic concentration data from the Montana Bureau of Mines and Geology and the Bureau of Reclamation laboratories.





**Figure 11.** Relation between dissolved-arsenic concentration data from the U.S. Geological Survey and the Bureau of Reclamation laboratories.

method indicates that the entire sample-collection, processing, and analytical process is presumably free of significant contamination for those constituents. Exceedances of twice the minimum reporting level probably represent contamination or instrument calibration error. Six field blanks were submitted to either the USGS or MBMG. All values for arsenic in field blanks were below the minimum reporting level. Exceedances of twice the minimum reporting level include calcium (on 08-13-92), chloride (on 08-13-92), fluoride (09-21-92 and 09-23-92), silica (all 1992 samples), barium (on 09-21-92 and 09-23-92), and iron (on 09-21-92 and 09-23-92). No adjustments were made to analytical results.

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# DATA

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**Table 1.** Location of surface-water sites along the Madison and upper Missouri Rivers in Montana

[Site number described in text. Station-identification number described in text. Abbreviations: Site type: C, irrigation supply canal or ditch; D, drain; L, lake; M, mainstem; S, spring or seep, T, tributary. Symbol: --, not applicable]

Site number	Station-identification number	Station name <sup>1</sup>	Site type	Bureau of Reclamation designation <sup>2</sup>
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY</b>				
S1	06037500	Madison River near West Yellowstone	M	--
S2	06037600	Madison River above Hebgen Lake, near West Yellowstone	M	--
S3	06038500	Madison River below Hebgen Lake, near Grayling	M	--
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>				
S4	450734111402901	Granger Ditch at diversion with the Madison River	C	MGD
S5	450857111424301	Shewmaker Ditch at diversion with the Madison River	C	MSMD
S6	451029111430901	O'Dell Creek at diversion with the Madison River	T	MOCA
S7	451218111404201	Bear Creek at bridge north of Cameron	T	BCS
S8	06040000	Madison River near Cameron	M	--
S9	451403111452301	Blaine Spring Creek near Varney	T	BSPG
S10	451628111455001	Seeps east of Thexton house	S	THEX
S11	451756111451801	West Madison Canal near Ennis	C	MWMC
S12	451818111414201	Bear Creek about 2.5 miles south of O'Dell Creek	T	BCM
S13	451942111422701	Bear Creek above O'Dell Creek Ditch Crossing	T	BCO
S14	451953111415801	O'Dell Creek Ditch at Highway 287 south of Ennis	C	OCD
S15	452005111422901	Bear Creek at road near Madison County Cemetery	T	BCR
S16	452031111425101	Bear Creek at mouth, at Ennis	T	BC
S17	452032111425201	Odell Creek at Ennis	T	OCB
S18	452149111421901	Odell Creek near mouth, near Ennis	T	OCA
S19	452426111445401	West Madison Canal 2 miles west of Ennis Lake	C	WMC
S20	452520111423501	Ennis Lake seep 1 near McAllister	S	ENSA
S21	452603111430301	Seeps at bridge over Spring Branch	S	ESBS
S22	452604111424501	Ennis Lake seep 3 near McAllister	S	ENDA
S23	452606111424701	Ennis Lake seep 2 near McAllister	S	ESB
S24	06041000	Madison River below Ennis Lake, near McAllister	M	--
<b>LOWER MADISON RIVER VALLEY</b>				
S25	06041300	Hot Springs Creek near Norris	T	--
S26	06041500	Madison River near Norris	M	--
S27	06041700	Cherry Creek near Norris	T	--
S28	453916111311001	Elk Creek at mouth, near Norris	T	--
S29	454019111313501	Sloan Ditch near Norris	C	MSD
S30	454033111314301	Hutchison Ditch near Norris	C	MHD
S31	454115111280901	Willow Springs east of Kilgore Ranch	S	KWS
S32	454159111303801	Dell Ditch near Harrison	C	MDELL
S33	454218111305501	Abandoned ditch near Harrison	C	MDELLA
S34	454406111305901	Crowley Ditch near Willow Creek	C	MCROW

**Table 1.** Location of surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Station-identification number	Station name <sup>1</sup>	Site type	Bureau of Reclamation designation <sup>2</sup>
<b>LOWER MADISON RIVER VALLEY--Continued</b>				
S35	454450111300501	01S02E17DCAB01	S	SHW
S36	454531111304401	Darlington Ditch near Willow Creek	C	MDD
S37	454504111293201	Spring Creek near Willow Creek	T,D	--
S38	454653111283401	Spring Creek above Crowley Ditch, near Logan	T,D	SCD
S39	454653111284801	Crowley Ditch above Spring Creek, near Logan	C	--
S40	454718111284701	Spring Creek below Crowley Ditch, near Logan	T,D	--
S41	454806111300701	Darlington Ditch tributary near Logan	T	DDS
S42	454847111294601	Darlington Ditch near Logan	C	--
S43	454852111294001	Rey Creek at Madison County road, near Logan	T	--
S44	455000111295901	Frances Walbert Ditch 1 near Three Forks	C	MFWD
S45	455011111295601	Frances Walbert Ditch 2 near Three Forks	C	MFWDB
S46	454952111291601	Rey Creek at Crowley Lane, near Logan	T	REYE
S47	454952111283301	Spring Creek diversion near Logan	C	--
S48	455017111273801	Sloan Ditch near Crowley Lane, near Logan	C,D	--
S49	455054111273801	Sloan Ditch drain 3 near Logan	D	--
S50	455044111273801	Sloan Ditch drain 2 near Logan	D	--
S51	455043111281601	Rey Creek drain near Logan	D	--
S52	455137111282201	Spring Creek at mouth, near Logan	T,D	--
S53	455134111284801	Rey Creek above Spring Creek, near Logan	T	REYC
S54	455330111274901	Unnamed ditch from Rey Creek near Logan	C	
S55	455342111290101	Rey Creek at frontage road, near Logan	T,D	
S56	455421111283001	Rey Creek above diversion, near Logan	T,D	REYB
S57	455438111290801	Rey Creek tributary near Logan	T	
S58	06042600	Madison River at Three Forks	M	--
S59	455359111304201	Unnamed ditch from Darlington Ditch near Three Forks	C	
S60	455435111305201	Darlington Ditch near Three Forks	C	MDDA
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>				
S61	460700111320701	Warm Springs Creek above Willow Swamp Creek, near Toston	T,D	WSCA
S62	460720111312601	Warm Springs Creek tributary near Toston	C	CWA
S63	06054500	Missouri River at Toston	M	--
S64	460748111305401	Warm Springs Creek tributary above Willow Swamp Creek, near Toston	T,D	CDB
S65	460814111294201	Warm Springs Creek tributary above Marsh Creek, near Toston	T,D	CDA
S66	460729111233101	Big Spring Creek near Toston	T	--
S67	460944111293301	Warm Springs Creek above Marsh Creek, near Toston	T,D	WSCB
S68	461026111274601	Broadwater-Missouri drain near Toston	D	BMDA
S69	461415111293701	Seep on westside of road on Stanfill property	S	MBSB
S70	461609111291201	Missouri River drain near Townsend	D	MBSA
S71	461704111303901	Montana Ditch at siphon at Deep Creek	C	MND
S72	461812111285701	Field drain pipe outlet on same drain	D	UM108-FD

**Table 1.** Location of surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Station-identification number	Station name <sup>1</sup>	Site type	Bureau of Reclamation designation <sup>2</sup>
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>				
S73	461823111290601	Drain on Bruce property near center section 4	D	UM108-D
S74	461827111293301	Drain below UM108-D on same drain	D	UM104-D
S75	461908111293101	Townsend drain east near Townsend	D	TDA
S76	462016111302101	Townsend drain north at Townsend	D	TDB
<b>HELENA VALLEY</b>				
S77	06062000	Prickly Pear Creek at East Helena	T	--
S78	463701111593401	Helena Valley Canal at Highway 280, near Helena	C	CHV
S79	463758111593301	Helena Valley diversion canal site 1 near Helena	D	HVPU
S80	463816111525601	Helena Valley Regulating Reservoir Outlet, near East Helena	C	--
S81	463846111585901	Helena Valley diversion canal site 2 near Helena	D	HVP
S82	464018112011301	Drain at Montana Avenue, by radio towers	D	HVSW
S83	463939111582801	Prickly Pear Creek above Tenmile Creek, near East Helena	T	--
S84	464047111595501	Helena Valley diversion canal 3 near Helena	C, D	HVS
S85	464124111595801	Silver Creek drain at Masonic Home Road, near East Helena	D	--
S86	464150111595601	Drain south of Lincoln Road near Masonic Home	D	HVFE
S87	464214111595601	Drain south of Lincoln Road near Masonic Home north	D	HVFF
S88	464031111564101	Helena Valley Field Drain site 2 near East Helena	D	HVFC
S89	464119111583901	Drain 3 near Masonic Home, near Helena	C, D	HVCS
S90	464137111584201	Helena Valley diversion canal 5 near Helena	D	HVFA
S91	464217111581901	Helena Valley drain above Lincoln Road, near Helena	D	HVFB
S92	464042111543401	Helena Valley Field Drain 1 near East Helena	D	HVFD
S93	464045111564401	Helena Valley Field Drain 2 near East Helena	D	--
S94	464107111573701	Prickly Pear Creek at Lake Helena, near East Helena	T	--
S95	464140111580901	Silver Creek diversion canal near East Helena	C	--
S96	464122111543501	Helena Valley Field Drain 1 at mouth, near East Helena	C, D	--
S97	464120111555001	Lake Helena (south) near East Helena	L	--
S98	464139111571201	Lake Helena (west) near East Helena	L	--
S99	464210111572401	Helena Valley drain above Lake Helena, near Helena	D	HVW
S100	464220111555001	Lake Helena (north) near East Helena	L	--
S101	464230111545001	End of Helena Valley Canal	C	HCE
S102	464155111544101	Lake Helena (east) near East Helena	L	
S103	464207111540201	Outlet of Lake Helena (Prickly Pear Creek)	L	LHO
<b>MISSOURI RIVER BELOW HELENA VALLEY</b>				
S104	06109500	Missouri River at Virgelle	M	--

<sup>1</sup>Where the U.S. Geological Survey collected water-quality samples, station names for Bureau of Reclamation sites have been changed to comply with standard U.S. Geological Survey station names.

<sup>2</sup>Mangelson and Brummer (1994).

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana

[Constituents are reported as dissolved except as indicated. Significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Site number described in text. Analyzing agency: MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont.; USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo. Abbreviations: ft<sup>3</sup>/s, cubic feet per second; °C, degrees Celsius; e, estimated; lab, laboratory; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25° C; mg/L, milligrams per liter; mm, millimeter; permil, parts per thousand. Symbols: <, less than minimum reporting level; --, no data]

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY</b>											
S1	USGS	04-14-89	437	505	8.0	16.0	8.2	6.7	0.82	95	9.4
	USGS	04-20-89	726	358	7.6	16.0	7.8	6.3	.98	64	7.7
	USGS	05-17-89	975	262	7.6	14.5	8.4	5.2	.83	43	5.6
	USGS	06-08-89	755	295	7.7	16.0	8.0	5.3	.73	55	5.8
	USGS	07-06-89	391	439	7.9	18.0	7.8	6.5	.80	80	8.3
	USGS	08-04-89	369	472	7.9	16.0	8.2	6.7	.72	87	9.8
	USGS	10-11-89	383	490	--	13.0	--	--	--	--	--
	USGS	12-04-89	377	520	--	6.5	--	--	--	--	--
	USGS	03-06-90	369	545	--	9.5	--	--	--	--	--
	USGS	05-01-90	526	405	--	14.0	--	--	--	--	--
	USGS	06-12-90	672	326	--	14.0	--	--	--	--	--
	USGS	07-25-90	426	475	--	21.5	--	--	--	--	--
	USGS	08-24-90	399	480	8.5	19.5	8.0	6.8	.78	91	9.3
	USGS	08-25-90	391	485	8.1	14.5	7.6	7.1	.83	92	9.3
	USGS	09-12-90	352	506	--	19.5	--	--	--	--	--
	USGS	10-23-90	406	514	--	10.5	--	--	--	--	--
	USGS	02-12-91	377	559	--	7.5	--	--	--	--	--
	USGS	04-11-91	422	550	--	6.0	--	--	--	--	--
	USGS	05-29-91	1,060	268	--	12.5	--	--	--	--	--
	USGS	06-19-91	604	364	--	19.5	--	--	--	--	--
	USGS	07-16-91	429	448	--	27.0	--	--	--	--	--
	USGS	08-21-91	391	460	--	17.5	--	--	--	--	--
	USGS	10-08-91	399	493	--	14.5	8.9	--	--	--	--
	USGS	11-19-91	421	502	--	6.0	10.0	--	--	--	--
	USGS	02-19-92	391	540	7.8	7.0	9.3	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbo- nate, field (mg/L as CO <sub>3</sub> )	Alka- linity, field (mg/L as CaCO <sub>3</sub> )	Alka- linity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Anti- mony (µg/L as Sb)
MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY										
S1	--	--	--	113	21	64	8.2	--	274	--
	--	--	--	79	19	40	5.0	--	192	--
	--	--	--	59	13	28	3.5	--	135	--
	--	--	--	72	11	33	4.5	--	159	--
	--	--	--	108	14	53	6.7	--	235	--
	--	--	--	115	13	59	6.7	--	253	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
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	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	128	6	116	117	18	63	7.5	99	366	18
	142	0	117	116	18	62	7.4	98	366	15
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
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--	--	--	--	--	--	--	--	--	--	
--	--	--	--	--	--	--	--	--	--	
--	--	--	--	--	--	64	--	--	--	
--	--	--	--	--	--	64	--	--	--	
--	--	--	--	--	--	70	--	--	--	

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Iron (µg/L as Fe)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Strontium (µg/L as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY</b>											
S1	280	--	850	--	--	--	--	25	79	--	--
	180	--	520	--	--	--	--	45	63	--	--
	150	--	400	--	--	--	--	33	48	--	--
	160	--	440	--	--	--	--	11	58	--	--
	300	--	670	--	--	--	--	5	57	--	--
	300	--	740	--	--	--	--	6	83	--	--
	290	--	--	--	--	--	--	--	--	--	--
	370	--	--	--	--	--	--	--	--	--	--
	360	--	--	--	--	--	--	--	--	--	--
	200	--	--	--	--	--	--	--	--	--	--
	200	--	--	--	--	--	--	--	--	--	--
	280	--	--	--	--	--	--	--	--	--	--
	--	330	780	61	630	2	--	2	91	--	--
	--	310	770	67	620	2	--	2	92	--	--
	290	--	--	--	--	--	--	--	--	--	--
	240	--	--	--	--	--	--	--	--	--	--
	280	--	--	--	--	--	--	--	--	--	--
	340	--	--	--	--	--	--	--	--	--	--
	120	--	--	--	--	--	--	--	--	--	--
	170	--	--	--	--	--	--	--	--	--	--
	260	--	--	--	--	--	--	--	--	--	--
	270	--	--	--	--	--	--	--	--	--	--
	320	--	800	--	640	--	--	5	48	--	--
	280	250	810	--	600	--	--	7	92	--	--
	320	310	870	--	670	--	--	11	92	--	--



**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued</b>											
S-1	USGS	04-07-92	406	463	8.0	10.5	10.2	--	--	--	--
(Continued)	USGS	05-20-92	623	361	8.3	20.5	8.1	--	--	--	--
	USGS	07-01-92	493	434	8.3	17.5	8.0	--	--	--	--
	USGS	08-19-92	355	500	8.5	23.0	7.7	--	--	--	--
	USGS	10-07-92	384	493	8.3	7.0	9.9	--	--	--	--
	USGS	11-16-92	377	521	8.3	7.5	9.8	--	--	--	--
	USGS	01-05-93	369	529	8.2	5.0	10.3	--	--	--	--
	USGS	04-07-93	414	521	8.3	13.0	8.8	--	--	--	--
	USGS	05-18-93	1,630	174	7.5	13.0	8.7	--	--	--	--
	USGS	05-26-93	1,420	200	7.7	16.0	8.1	4.4	.69	33	4.1
	USGS	06-08-93	1,160	251	7.6	13.5	8.4	--	--	--	--
	USGS	07-28-93	485	399	8.2	17.5	8.1	--	--	--	--
	USGS	08-17-93	468	430	8.2	15.0	8.2	5.2	.72	66	7.3
	USGS	10-05-93	423	459	8.2	14.5	8.4	--	--	--	--
	USGS	11-30-93	417	470	8.4	6.0	9.8	--	--	--	--
	USGS	02-15-94	395	501	8.1	5.0	10.4	--	--	--	--
	USGS	04-05-94	437	506	7.8	5.5	10.0	--	--	--	--
	USGS	05-09-94	1,020	220	7.8	15.5	8.5	--	--	--	--
	USGS	05-16-94	953	259	7.4	13.0	8.1	--	--	--	--
	USGS	06-02-94	765	326	7.7	15.5	8.6	--	--	--	--
	USGS	07-05-94	429	453	8.1	18.0	7.2	--	--	--	--
	USGS	08-22-94	377	497	8.2	19.0	7.4	--	--	--	--
	USGS	10-13-94	408	498	8.2	10.5	9.0	--	--	--	--
	USGS	01-10-95	447	522	7.7	9.0	--	--	--	--	--
	USGS	04-05-95	531	497	8.0	13.0	9.7	--	--	--	--
	USGS	06-06-95	1,710	176	7.8	11.0	8.4	--	--	--	--
	USGS	08-08-95	463	407	7.9	19.5	7.3	--	--	--	--
S2	USGS	04-06-93	478	479	8.3	12.0	8.3	--	--	--	--
	USGS	05-18-93	1,630	176	7.5	14.5	8.5	--	--	--	--
	USGS	05-26-93	1,380	209	7.8	18.0	7.8	4.1	.66	36	4.7
	USGS	08-17-93	544	401	8.1	15.5	8.4	6.5	.83	74	2.4
	USGS	11-30-93	457	430	8.3	6.0	9.8	--	--	--	--
	USGS	02-15-94	440	463	8.1	5.0	10.4	--	--	--	--
	USGS	08-22-94	418	458	8.4	18.0	7.5	--	--	--	--
S3	USGS	10-12-89	1,000	270	--	11.0	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued</b>										
S1	--	--	--	--	--	61	--	--	--	--
(Continued)	--	--	--	--	--	46	--	--	--	--
	--	--	--	--	--	55	--	--	--	--
	--	--	--	--	--	64	--	--	--	--
	--	--	--	--	--	66	--	--	--	--
	--	--	--	--	--	66	--	--	--	--
	--	--	--	--	--	70	--	--	--	--
	--	--	--	--	--	69	--	--	--	--
	--	--	--	--	--	27	--	--	--	--
	--	--	--	50	8.0	21	2.9	45	150	--
	--	--	--	--	--	45	--	--	--	--
	--	--	--	--	--	44	--	--	--	--
	--	--	--	105	13	63	6.4	90	316	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	59	--	--	--	--
	--	--	--	--	--	64	--	--	--	--
	--	--	--	--	--	63	--	--	--	--
	--	--	--	--	--	25	--	--	--	--
	--	--	--	--	--	28	--	--	--	--
	--	--	--	--	--	37	--	--	--	--
	--	--	--	--	--	53	--	--	--	--
	--	--	--	--	--	60	--	--	--	13
	--	--	--	--	--	64	--	--	--	--
	--	--	--	--	--	69	--	--	--	--
	--	--	--	--	--	64	--	--	--	--
	--	--	--	--	--	19	--	--	--	--
	--	--	--	--	--	47	--	--	--	--
S2	--	--	--	--	--	62	--	--	--	--
	--	--	--	--	--	17	--	--	--	--
	--	--	--	53	8.1	22	3.2	47	158	--
	--	--	--	101	12	48	6.0	89	301	--
	--	--	--	--	--	68	--	--	--	--
	--	--	--	--	--	58	--	--	--	--
	--	--	--	--	--	53	--	--	--	--
S3	--	--	--	--	--	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Iron (µg/L as Fe)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Strontium (µg/L as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued</b>											
S1	280	260	750	--	610	--	--	9	88	--	--
(Continued)	230	200	540	--	440	--	--	8	60	--	--
	250	240	600	--	510	--	--	9	74	--	--
	340	330	840	--	590	--	--	2	71	--	--
	310	310	860	--	660	--	--	4	76	--	--
	330	310	930	--	700	--	--	4	85	--	--
	320	290	890	--	710	--	--	28	92	--	--
	310	280	870	--	660	--	--	10	92	--	--
	110	96	260	--	180	--	--	52	70	--	--
	120	110	290	--	210	--	--	28	72	--	--
	150	120	370	--	290	--	--	14	77	--	--
	230	220	600	--	480	--	--	4	79	--	--
	260	200	640	--	430	--	--	4	83	--	--
	280	260	710	--	590	--	--	3	90	--	--
	310	300	770	--	640	--	--	8	91	--	--
	310	300	830	--	690	--	--	11	88	--	--
	310	290	810	--	670	--	--	12	83	--	--
	130	120	330	--	280	--	--	35	81	--	--
	150	140	380	--	320	--	--	28	48	--	--
	200	190	560	--	420	--	--	11	89	--	--
	270	270	680	--	600	--	--	3	92	--	--
	360	340	760	--	620	--	--	2	85	--	--
	340	340	880	--	670	--	--	2	97	--	--
	370	330	860	--	700	--	--	22	89	--	--
	340	320	810	--	690	--	--	14	91	--	--
	120	120	280	--	200	--	--	46	63	--	--
	270	270	570	--	540	--	--	--	--	--	--
S2	290	290	790	--	620	--	--	23	50	--	--
	110	100	260	--	190	--	--	50	64	--	--
	130	140	320	--	230	--	--	27	74	--	--
	220	220	610	--	490	--	--	6	60	--	--
	290	290	710	--	560	--	--	12	73	--	--
	300	260	660	--	550	--	--	12	85	--	--
	300	290	630	--	560	--	--	2	84	--	--
S3	100	--	--	--	--	--	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued</b>											
S3	USGS	12-06-89	744	294	--	2.5	--	--	--	--	--
(Continued)	USGS	03-06-90	744	389	--	2.5	--	--	--	--	--
	USGS	05-01-90	485	390	--	4.5	--	--	--	--	--
	USGS	06-12-90	1,420	280	--	10.5	--	--	--	--	--
	USGS	07-24-90	838	273	--	14.0	--	--	--	--	--
	USGS	09-11-90	813	281	--	16.0	--	--	--	--	--
	USGS	10-24-90	1,450	297	--	9.0	--	--	--	--	--
	USGS	02-12-91	708	375	--	2.5	--	--	--	--	--
	USGS	04-11-91	536	398	--	3.0	--	--	--	--	--
	USGS	05-29-91	2,470	298	--	7.0	--	--	--	--	--
	USGS	06-19-91	1,410	272	--	11.0	--	--	--	--	--
	USGS	07-15-91	819	266	--	14.0	--	--	--	--	--
	USGS	08-20-91	939	258	--	17.0	--	--	--	--	--
	USGS	10-08-91	1,370	275	--	13.0	9.1	--	--	--	--
	USGS	11-20-91	1,560	271	--	5.0	11.0	--	--	--	--
	USGS	02-20-92	708	372	7.8	3.0	10.8	--	--	--	--
	USGS	04-07-92	708	350	8.2	3.0	11.2	--	--	--	--
	USGS	05-19-92	664	281	8.2	11.5	8.8	--	--	--	--
	USGS	07-01-92	1,150	274	8.0	13.0	8.8	--	--	--	--
	USGS	08-18-92	1,090	275	8.2	16.0	8.0	--	--	--	--
	USGS	10-07-92	1,080	287	8.5	12.0	10.2	--	--	--	--
	USGS	11-17-92	1,580	292	8.0	4.0	10.6	--	--	--	--
	USGS	01-06-93	732	339	8.2	2.0	11.2	--	--	--	--
	USGS	04-06-93	840	392	8.1	3.0	11.1	--	--	--	--
	USGS	05-19-93	1,340	303	8.2	6.0	10.3	--	--	--	--
	USGS	05-26-93	3,180	283	8.0	8.5	9.7	11	2.3	42	4.7
	USGS	06-09-93	2,450	241	7.9	8.5	9.6	--	--	--	--
	USGS	07-28-93	1,200	205	8.0	16.0	8.7	--	--	--	--
	USGS	08-17-93	1,010	210	7.9	15.5	8.4	11	2.2	28	1.2
	USGS	10-05-93	978	228	8.0	12.5	9.9	--	--	--	--
	USGS	12-01-93	766	258	7.9	1.0	12.3	--	--	--	--
	USGS	02-16-94	776	333	8.1	2.0	10.8	--	--	--	--
	USGS	04-05-94	656	345	8.2	2.5	10.8	--	--	--	--
	USGS	05-09-94	715	299	8.2	5.5	10.8	--	--	--	--
	USGS	05-16-94	732	285	8.0	6.5	10.0	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued										
S3	--	--	--	--	--	--	--	--	--	--
(Continued)	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	27	--	--	--	--
	--	--	--	--	--	28	--	--	--	--
	--	--	--	--	--	40	--	--	--	--
	--	--	--	--	--	42	--	--	--	--
	--	--	--	--	--	28	--	--	--	--
	--	--	--	--	--	26	--	--	--	--
	--	--	--	--	--	29	--	--	--	--
	--	--	--	--	--	28	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	30	--	--	--	--
	--	--	--	--	--	45	--	--	--	--
	--	--	--	--	--	29	--	--	--	--
	--	--	--	81	9.3	23	3.7	49	194	--
	--	--	--	--	--	24	--	--	--	--
	--	--	--	--	--	15	--	--	--	--
	--	--	--	66	7.6	17	2.6	38	148	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	32	--	--	--	--
	--	--	--	--	--	36	--	--	--	--
	--	--	--	--	--	26	--	--	--	--
	--	--	--	--	--	25	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Iron (µg/L as Fe)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Strontium (µg/L as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY--Continued</b>											
S3	140	--	--	--	--	--	--	--	--	--	--
(Continued)	180	--	--	--	--	--	--	--	--	--	--
	170	--	--	--	--	--	--	--	--	--	--
	110	--	--	--	--	--	--	--	--	--	--
	230	--	--	--	--	--	--	--	--	--	--
	140	--	--	--	--	--	--	--	--	--	--
	96	--	--	--	--	--	--	--	--	--	--
	160	--	--	--	--	--	--	--	--	--	--
	190	--	--	--	--	--	--	--	--	--	--
	110	--	--	--	--	--	--	--	--	--	--
	94	--	--	--	--	--	--	--	--	--	--
	100	--	--	--	--	--	--	--	--	--	--
	120	--	--	--	--	--	--	--	--	--	--
	130	130	340	--	270	--	--	2	64	--	--
	120	120	370	--	290	--	--	2	75	--	--
	200	190	510	--	400	--	--	2	77	--	--
	170	180	510	--	390	--	--	3	61	--	--
	120	110	310	--	270	--	--	12	12	--	--
	120	120	330	--	260	--	--	4	49	--	--
	130	130	340	--	240	--	--	1	50	--	--
	130	130	360	--	290	--	--	3	56	--	--
	140	130	290	--	300	--	--	2	67	--	--
	160	150	420	--	370	--	--	1	63	--	--
	180	180	560	--	450	--	--	1	71	--	--
	130	120	380	--	280	--	--	2	84	--	--
	120	120	360	--	270	--	--	10	60	--	--
	99	97	300	--	240	--	--	2	90	--	--
	78	71	220	--	170	--	--	2	90	--	--
	86	90	210	--	180	--	--	1	68	--	--
	99	96	220	--	200	--	--	2	93	--	--
	110	110	270	--	250	--	--	1	92	--	--
	140	150	450	--	370	--	--	1	89	--	--
	170	170	500	--	390	--	--	1	86	--	--
	120	120	350	--	290	--	--	2	64	--	--
	110	110	330	--	280	--	--	2	70	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued</b>											
S3	USGS	06-02-94	1,200	255	8.1	10.5	9.3	--	--	--	--
(Continued)	USGS	07-06-94	732	242	8.0	13.5	8.4	--	--	--	--
	USGS	08-23-94	918	252	8.3	17.0	7.8	--	--	--	--
	USGS	10-13-94	1,200	279	8.4	12.5	9.5	--	--	--	--
	USGS	01-11-95	723	360	8.0	3.0	10.8	--	--	--	--
	USGS	04-04-95	1,170	358	8.0	3.0	--	--	--	--	--
	USGS	06-06-95	2,530	194	7.8	12.0	8.7	--	--	--	--
	USGS	08-09-95	1,080	192	7.7	16.0	8.5	--	--	--	--
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>											
S8	USGS	04-08-93	1,150	354	8.5	3.5	11.7	--	--	--	--
	USGS	05-19-93	3,070	254	8.2	12.0	9.5	--	--	--	--
	USGS	05-27-93	5,320	234	8.2	10.0	9.4	16	3.8	25	3.3
	USGS	08-18-93	1,550	213	8.2	13.0	8.7	16	3.9	20	3.1
	USGS	12-01-93	1,260	254	8.3	.0	13.0	--	--	--	--
	USGS	02-16-94	1,030	307	8.3	1.0	12.1	--	--	--	--
	USGS	05-17-94	1,850	233	8.1	6.5	10.2	--	--	--	--
	USGS	06-08-94	1,780	227	8.2	13.0	10.1	--	--	--	--
	USGS	08-23-94	970	258	8.5	17.0	8.6	--	--	--	--
	USGS	10-17-94	1,500	266	8.1	7.5	10.2	--	--	--	--
	USGS	01-11-95	1,030	314	8.3	3.5	11.4	--	--	--	--
	USGS	04-05-95	1,480	344	8.3	7.0	10.6	--	--	--	--
	USGS	06-07-95	4,880	195	8.0	8.5	10.0	--	--	--	--
	USGS	08-09-95	1,630	202	8.5	17.5	8.5	--	--	--	--
S24	USGS	10-12-89	1,560	301	--	10.5	--	--	--	--	--
	USGS	12-06-89	1,480	309	--	1.5	--	--	--	--	--
	USGS	03-06-90	1,470	344	--	2.5	--	--	--	--	--
	USGS	04-30-90	1,260	328	--	7.5	--	--	--	--	--
	USGS	06-13-90	2,960	255	--	14.0	--	--	--	--	--
	USGS	07-24-90	1,140	258	--	19.0	--	--	--	--	--
	USGS	09-11-90	1,280	300	--	18.5	--	--	--	--	--
	USGS	10-24-90	1,920	305	--	4.5	--	--	--	--	--
	USGS	02-11-91	1,320	348	--	2.5	--	--	--	--	--
	USGS	04-12-91	1,060	321	--	2.0	--	--	--	--	--
	USGS	05-28-91	3,640	306	--	11.5	--	--	--	--	--
	USGS	06-19-91	2,870	236	--	14.5	--	--	--	--	--
	USGS	07-15-91	1,490	259	--	20.5	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

[illegible]



**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Iron (µg/L as Fe)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Strontium (µg/L as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>MADISON RIVER ABOVE UPPER MADISON RIVER VALLEY—Continued</b>											
S3	110	110	320	--	260	--	--	1	88	--	--
(Continued)	110	100	270	--	240	--	--	1	78	--	--
	130	110	290	--	270	--	--	1	76	--	--
	150	140	360	--	280	--	--	2	72	--	--
	190	180	480	--	410	--	--	1	85	--	--
	200	180	500	--	440	--	--	1	90	--	--
	84	85	230	--	180	--	--	3	78	--	--
	89	79	190	--	180	--	--	--	--	--	--
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>											
S8	150	140	440	--	350	--	--	4	75	--	--
	78	78	240	--	170	--	--	94	73	--	--
	66	69	210	--	160	--	--	322	51	--	--
	56	51	130	--	120	--	--	3	83	--	--
	84	86	200	--	190	--	--	4	77	--	--
	110	110	320	--	270	--	--	4	67	--	--
	57	58	190	--	140	--	--	16	84	--	--
	59	64	190	--	150	--	--	8	72	--	--
	98	99	210	--	180	--	--	2	94	--	--
	120	110	310	--	220	--	--	3	79	--	--
	140	110	330	--	290	--	--	3	81	--	--
	160	150	390	--	350	--	--	4	77	--	--
	51	46	140	--	110	--	--	141	56	--	--
	48	46	130	--	120	--	--	6	75	--	--
S24	67	--	--	--	--	--	--	--	--	--	--
	68	--	--	--	--	--	--	--	--	--	--
	120	--	--	--	--	--	--	--	--	--	--
	70	--	--	--	--	--	--	--	--	--	--
	64	--	--	--	--	--	--	--	--	--	--
	76	--	--	--	--	--	--	--	--	--	--
	62	--	--	--	--	--	--	--	--	--	--
	54	--	--	--	--	--	--	--	--	--	--
	57	--	--	--	--	--	--	--	--	--	--
	63	--	--	--	--	--	--	--	--	--	--
	81	--	--	--	--	--	--	--	--	--	--
	35	--	--	--	--	--	--	--	--	--	--
	70	--	--	--	--	--	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY—Continued</b>											
S24	USGS	08-19-91	1,140	278	--	21.5	--	--	--	--	--
(Continued)	USGS	10-08-91	1,970	281	--	11.5	9.2	--	--	--	--
	USGS	11-18-91	2,150	288	--	2.0	12.2	--	--	--	--
	USGS	02-18-92	1,190	337	8.4	2.5	11.6	--	--	--	--
	USGS	04-06-92	1,180	342	8.5	10.0	9.7	--	--	--	--
	USGS	05-19-92	1,370	285	8.4	15.0	8.5	--	--	--	--
	USGS	06-30-92	1,480	245	8.9	19.5	7.5	--	--	--	--
	USGS	08-20-92	1,190	285	9.0	21.0	7.8	--	--	--	--
	USGS	10-08-92	1,600	297	8.5	8.0	9.3	--	--	--	--
	USGS	11-17-92	2,770	299	8.5	2.0	12.2	--	--	--	--
	USGS	01-07-93	1,120	349	7.8	.0	10.8	--	--	--	--
	USGS	04-06-93	1,210	303	8.3	4.0	11.8	--	--	--	--
	USGS	05-20-93	3,780	290	8.3	15.0	8.5	--	--	--	--
	USGS	05-28-93	6,290	239	8.2	13.0	8.2	20	4.8	23	3.1
	USGS	06-09-93	4,860	230	8.3	12.0	9.6	--	--	--	--
	USGS	07-27-93	2,330	225	8.4	15.0	8.3	--	--	--	--
	USGS	08-18-93	1,830	237	8.3	17.5	8.5	22	5.5	19	--
	USGS	10-06-93	1,560	286	8.1	13.0	9.5	--	--	--	--
	USGS	12-02-93	1,740	290	8.0	.5	12.7	--	--	--	--
	USGS	02-17-94	1,430	354	8.2	2.0	11.3	--	--	--	--
	USGS	04-06-94	1,250	319	8.7	6.0	10.4	--	--	--	--
	USGS	05-10-94	1,790	319	8.4	14.0	9.5	--	--	--	--
	USGS	05-17-94	2,090	275	8.3	13.0	9.5	--	--	--	--
	USGS	06-09-94	2,120	245	8.2	15.0	8.1	--	--	--	--
	USGS	07-07-94	1,110	258	8.5	16.5	8.4	--	--	--	--
	USGS	08-24-94	1,120	285	8.8	19.0	6.6	--	--	--	--
	USGS	10-17-94	1,870	286	8.2	6.0	10.5	--	--	--	--
	USGS	01-12-95	1,170	365	8.1	1.0	11.2	--	--	--	--
	USGS	04-06-95	1,460	347	8.4	7.0	10.3	--	--	--	--
	USGS	06-08-95	6,150	207	7.8	9.0	9.9	--	--	--	--
	USGS	08-10-95	1,740	214	8.2	18.5	7.8	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
NORTHERN PART OF THE UPPER MADISON RIVER VALLEY—Continued										
S24	--	--	--	--	--	--	--	--	--	--
(Continued)	--	--	--	--	--	18	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	23	--	--	--	--
	--	--	--	--	--	28	--	--	--	--
	--	--	--	--	--	19	--	--	--	--
	--	--	--	--	--	14	--	--	--	--
	--	--	--	--	--	20	--	--	--	--
	--	--	--	--	--	18	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	22	--	--	--	--
	--	--	--	--	--	29	--	--	--	--
	--	--	--	--	--	19	--	--	--	--
	--	--	--	88	9.8	12	1.7	27	155	--
	--	--	--	--	--	14	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	94	11	9.5	1.4	23	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	22	--	--	--	--
	--	--	--	--	--	20	--	--	--	--
	--	--	--	--	--	16	--	--	--	--
	--	--	--	--	--	14	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	--	--	17	--	--	--	5
	--	--	--	--	--	19	--	--	--	--
	--	--	--	--	--	25	--	--	--	--
	--	--	--	--	--	26	--	--	--	--
	--	--	--	--	--	9.4	--	--	--	--
	--	--	--	--	--	7.5	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Arsenic, total recoverable ( $\mu\text{g/L}$ as As)	Arsenic ( $\mu\text{g/L}$ as As)	Boron ( $\mu\text{g/L}$ as B)	Iron ( $\mu\text{g/L}$ as Fe)	Lithium ( $\mu\text{g/L}$ as Li)	Manganese ( $\mu\text{g/L}$ as Mn)	Strontium ( $\mu\text{g/L}$ as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY—Continued</b>											
S24	88	--	--	--	--	--	--	--	--	--	--
(Continued)	76	80	240	--	180	--	--	5	88	--	--
	85	90	260	--	200	--	--	7	56	--	--
	87	88	280	--	220	--	--	2	73	--	--
	110	120	340	--	260	--	--	5	88	--	--
	73	69	200	--	160	--	--	8	92	--	--
	50	51	130	--	90	--	--	9	78	--	--
	95	92	230	--	160	--	--	9	81	--	--
	84	82	250	--	190	--	--	6	91	--	--
	100	89	280	--	220	--	--	9	36	--	--
	90	75	280	--	220	--	--	3	91	--	--
	74	68	240	--	190	--	--	7	99	--	--
	87	79	240	--	190	--	--	15	91	--	--
	59	8	160	--	140	--	--	27	86	--	--
	58	57	190	--	140	--	--	22	98	--	--
	48	47	140	--	110	--	--	9	94	--	--
	56	50	110	--	98	--	--	7	91	--	--
	54	56	140	--	130	--	--	5	98	--	--
	90	91	270	--	220	--	--	3	97	--	--
	86	82	280	--	240	--	--	2	97	--	--
	83	78	270	--	210	--	--	11	96	--	--
	79	71	250	--	200	--	--	13	90	--	--
	75	72	210	--	160	--	--	15	94	--	--
	65	69	180	--	140	--	--	10	88	--	--
	100	99	160	--	150	--	--	9	98	--	--
	94	94	220	--	170	--	--	20	99	--	--
	88	85	260	--	200	--	--	11	98	--	--
	110	99	310	--	270	--	--	4	75	--	--
	120	110	320	--	270	--	--	14	98	--	--
	52	51	140	--	120	--	--	53	97	--	--
	45	42	90	--	90	--	--	7	94	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
LOWER MADISON RIVER VALLEY											
S26	USGS	04-08-93	1,210	303	8.7	10.0	10.8	--	--	--	--
	USGS	05-20-93	3,800	288	8.5	16.0	9.1	--	--	--	--
	USGS	05-28-93	6,300	240	8.2	14.0	8.9	19	4.6	23	3.1
	USGS	06-09-93	4,700	229	8.3	13.0	9.3	--	--	--	--
	USGS	07-27-93	2,350	226	8.7	17.5	9.6	--	--	--	--
	USGS	08-19-93	1,800	234	8.7	18.5	9.2	21	5.3	17	2.7
	USGS	10-06-93	1,550	263	9.0	15.0	11.8	--	--	--	--
	USGS	12-02-93	1,750	291	8.2	.5	13.8	--	--	--	--
	USGS	02-17-94	1,450	355	8.5	3.5	11.8	--	--	--	--
	USGS	04-06-94	1,250	320	8.9	7.0	11.0	--	--	--	--
	USGS	05-10-94	1,800	310	8.6	17.0	9.4	--	--	--	--
	USGS	05-17-94	2,100	272	8.5	15.0	7.3	--	--	--	--
	USGS	06-09-94	2,100	245	8.5	17.0	9.6	--	--	--	--
	USGS	07-07-94	1,100	257	8.9	22.5	12.2	--	--	--	--
	USGS	08-24-94	1,150	286	8.9	21.0	9.6	18	4.7	27	3.5
	USGS	10-17-94	1,850	280	8.7	7.0	11.4	--	--	--	--
	USGS	01-12-95	1,190	369	8.4	2.0	12.4	--	--	--	--
	USGS	04-06-95	1,450	340	8.6	9.0	11.0	20	5.5	41	4.7
	USGS	06-08-95	6,200	206	8.0	7.0	9.7	--	--	--	--
	USGS	08-10-95	1,750	212	8.9	21.5	10.0	--	--	--	--
S35	MBMG	08-31-93	--	2,130	8.5	32.0	--	25	1.0	420	16
S36	MBMG	09-09-93	19	260	8.8	16.0	--	25	6.4	21	3.3
S37	MBMG	09-10-93	10	493	8.2	10.0	--	58	15	29	5.7
	MBMG	03-30-94	1.3	420	8.5	17.5	--	47	12	25	5.7
S38	MBMG	03-30-94	2.8	625	8.1	15.5	--	54	16	60	7.9
S41	MBMG	03-30-94	3.7	429	8.8	18.0	--	44	12	31	5.4
S43	MBMG	09-10-93	3.9	452	8.4	16.0	--	51	14	28	5.5
	MBMG	03-30-94	3.4	443	8.0	7.0	--	50	13	27	5.4
S48	MBMG	03-13-95	.90	685	8.5	5.5	--	55	20	62	12
S49	MBMG	03-13-95	.07	1,500	8.0	7.5	--	140	41	130	26
S50	MBMG	03-13-95	.09	970	8.0	9.0	--	73	27	89	21
S51	MBMG	03-13-95	.05	1,470	8.3	3.5	--	70	43	200	28
S52	MBMG	09-10-93	9.9	574	8.6	18.0	--	61	17	46	8.5
	MBMG	03-30-94	1.4	1,030	8.4	9.0	--	89	26	86	19
	MBMG	03-13-95	1.8	945	8.3	5.5	--	81	26	85	18

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
LOWER MADISON RIVER VALLEY										
S26	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	20	--	--	--	--
	--	--	--	87	8.6	12	1.6	25	149	--
	--	--	--	--	--	14	--	--	--	--
	--	--	--	--	--	9.5	--	--	--	--
	--	--	--	93	12	9.5	1.4	23	148	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	22	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	19	--	--	--	--
	--	--	--	--	--	15	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	98	13	16	2.6	36	180	6
	--	--	--	--	--	19	--	--	--	--
	--	--	--	--	--	26	--	--	--	--
	--	--	--	113	15	24	3.2	42	224	--
	--	--	--	--	--	10	--	--	--	--
	--	--	--	--	--	7.3	--	--	--	--
S35	111	9	106	--	510	260	7.9	80	1,390	<2
S36	--	--	--	103	14	12	1.9	25	171	<2
S37	--	--	--	228	17	18	2.0	42	326	<2
	--	--	--	178	18	15	1.6	35	296	3
S38	--	--	--	253	34	35	2.0	42	407	<2
S41	--	--	--	180	23	20	1.7	35	281	<2
S43	--	--	--	201	20	17	1.7	39	366	<2
	--	--	--	197	19	17	1.6	37	291	2
S48	--	--	--	274	45	30	2.8	47	439	--
S49	--	--	--	325	300	130	3.2	59	1,020	--
S50	--	--	--	317	100	60	3.1	58	625	--
S51	--	--	--	440	250	70	5.8	61	990	--
S52	--	--	--	245	35	27	2.1	43	473	<2
	--	--	--	306	160	54	2.2	56	680	<2
	--	--	--	285	150	50	2.5	57	642	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Arsenic, total recoverable ( $\mu\text{g/L}$ as As)	Arsenic ( $\mu\text{g/L}$ as As)	Boron ( $\mu\text{g/L}$ as B)	Iron ( $\mu\text{g/L}$ as Fe)	Lithium ( $\mu\text{g/L}$ as Li)	Manganese ( $\mu\text{g/L}$ as Mn)	Strontium ( $\mu\text{g/L}$ as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>LOWER MADISON RIVER VALLEY</b>											
S26	74	76	250	--	200	--	--	7	98	--	--
	84	84	260	--	190	--	--	17	96	--	--
	59	62	170	--	140	--	--	28	91	--	--
	59	51	180	--	140	--	--	24	95	--	--
	49	51	130	--	100	--	--	9	96	-136.0	-17.92
	48	48	130	--	89	--	--	8	94	-134.0	-17.65
	57	57	120	--	120	--	--	5	86	--	--
	89	89	270	--	220	--	--	3	97	--	--
	86	82	270	--	230	--	--	4	88	--	--
	82	83	270	--	210	--	--	11	96	--	--
	75	76	260	--	190	--	--	14	94	--	--
	72	70	190	--	170	--	--	18	95	--	--
	69	68	170	--	140	--	--	10	91	--	--
	99	100	150	--	140	--	--	7	95	--	--
	98	93	220	--	150	--	--	14	96	--	--
	88	85	260	--	200	--	--	11	93	--	--
	100	98	310	--	250	--	--	3	90	--	--
	120	96	320	--	250	--	--	13	95	-138.0	-17.66
	46	42	140	--	120	--	--	45	97	--	--
	46	42	90	--	80	--	--	6	97	--	--
S35	--	4.0	2,200	<3	350	4	940	--	--	--	--
S36	--	47.6	140	20	110	4	99	--	--	-135.0	-17.39
S37	--	44.5	160	13	160	10	200	--	--	--	--
	--	46.1	150	24	130	21	160	--	--	-134.0	-17.26
S38	--	63.4	340	16	170	19	230	--	--	-133.0	-17.30
S41	--	52.4	160	5	170	2	160	--	--	-135.0	-17.18
S43	--	46.0	160	<3	150	<2	170	--	--	--	--
	--	43.3	150	<3	160	<2	170	--	--	-135.0	-17.36
S48	--	113	460	23	240	27	310	--	--	--	--
S49	--	96.5	950	8	350	86	820	--	--	--	--
S50	--	114	750	<3	270	16	500	--	--	--	--
S51	--	321	1,400	77	560	62	480	--	--	--	--
S52	--	61.0	290	6	180	17	250	--	--	--	--
	--	94.8	610	27	240	110	570	--	--	-138.0	-17.52
	--	106	680	22	240	91	530	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>LOWER MADISON RIVER VALLEY—Continued</b>											
S56	MBMG	09-09-93	28	502	8.7	18.0	--	48	15	40	7.2
S58	USGS	08-15-90	1,120	287	9.0	--	--	17	5.7	27	3.7
	USGS	08-16-90	1,030	297	8.4	--	--	17	6.2	27	3.7
	USGS	04-08-93	1,200	309	8.6	9.0	10.6	--	--	--	--
	USGS	05-20-93	3,590	274	8.4	18.0	8.6	--	--	--	--
	USGS	05-28-93	5,650	235	8.2	14.0	8.9	20	4.8	21	3.1
	USGS	06-10-93	4,210	231	8.1	13.0	8.3	--	--	--	--
	USGS	07-27-93	2,540	233	8.6	20.0	8.3	--	--	--	--
	USGS	08-19-93	1,700	239	8.8	21.5	10.0	21	5.3	18	2.7
	USGS	10-07-93	1,450	291	7.2	11.0	8.0	--	--	--	--
	USGS	12-02-93	1,800	290	8.3	.5	14.2	--	--	--	--
	USGS	02-18-94	1,500	339	8.3	1.0	12.2	--	--	--	--
	USGS	04-07-94	1,250	316	8.4	5.5	10.1	--	--	--	--
	USGS	05-11-94	2,000	304	8.2	13.5	8.8	--	--	--	--
	USGS	05-18-94	2,050	270	8.0	10.5	9.2	--	--	--	--
	USGS	06-10-94	2,100	247	8.1	12.0	8.4	--	--	--	--
	USGS	07-08-94	1,050	257	8.2	16.5	7.3	--	--	--	--
	USGS	08-25-94	960	296	7.9	16.0	7.6	20	5.3	28	3.6
	USGS	10-18-94	1,950	283	7.9	6.0	10.2	--	--	--	--
	USGS	01-13-95	1,220	363	8.2	1.0	12.5	--	--	--	--
	USGS	04-07-95	1,640	340	7.9	7.0	9.3	--	--	--	--
	USGS	06-09-95	5,450	207	8.0	8.5	9.8	--	--	--	--
	USGS	08-11-95	1,630	224	8.0	17.0	7.2	--	--	--	--
S60	MBMG	09-09-93	35	315	9.2	21.0	--	29	8.8	27	4.3
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>											
S63	USGS	12-14-88	4,100	413	8.2	1.0	13.8	39	12	27	4.0
	USGS	03-07-89	3,070	435	8.1	.5	12.9	45	13	26	4.0
	USGS	06-14-89	5,680	246	8.1	18.0	8.4	28	7.3	13	2.6
	USGS	09-13-89	2,550	382	8.5	12.0	9.8	38	12	25	4.2
	USGS	10-12-89	3,260	--	--	11.5	--	--	--	--	--
	USGS	11-02-89	4,440	380	8.4	3.0	12.2	40	12	24	3.9
	USGS	12-07-89	3,850	393	--	2.0	--	--	--	--	--
	USGS	03-06-90	3,480	395	--	2.5	--	--	--	--	--
	USGS	03-07-90	3,450	382	8.3	4.0	12.0	38	11	24	3.5
	USGS	04-30-90	5,210	281	--	6.5	--	--	--	--	--



**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
<b>LOWER MADISON RIVER VALLEY—Continued</b>										
S56	--	--	--	189	28	21	2.0	39	383	<2
S58	98	11	99	102	14	15	2.3	30	174	6
	123	3	107	108	14	15	2.4	30	179	5
	--	--	--	--	--	19	--	--	--	--
	--	--	--	--	--	18	--	--	--	--
	--	--	--	89	11	12	1.6	27	154	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	--	--	9.2	--	--	--	--
	--	--	--	92	12	9.7	1.5	22	148	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	25	--	--	--	--
	--	--	--	--	--	21	--	--	--	--
	--	--	--	--	--	20	--	--	--	--
	--	--	--	--	--	18	--	--	--	--
	--	--	--	--	--	15	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	103	12	17	2.5	33	184	4
	--	--	--	--	--	18	--	--	--	--
	--	--	--	--	--	25	--	--	--	--
	--	--	--	--	--	24	--	--	--	--
	--	--	--	--	--	10	--	--	--	--
	--	--	--	--	--	7.7	--	--	--	--
S60	--	--	--	99	17	12	1.8	31	189	<2
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>										
S63	176	0	145	145	41	16	1.5	29	258	--
	181	0	148	153	44	14	1.4	29	268	--
	115	0	95	97	18	6.2	.7	19	152	--
	156	6	138	144	36	13	1.4	25	238	--
	--	--	--	--	--	--	--	--	--	--
	163	5	141	142	38	12	1.3	26	243	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	152	7	136	136	39	12	1.4	26	238	--
	--	--	--	--	--	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Arsenic, total recoverable ( $\mu\text{g/L}$ as As)	Arsenic ( $\mu\text{g/L}$ as As)	Boron ( $\mu\text{g/L}$ as B)	Iron ( $\mu\text{g/L}$ as Fe)	Lithium ( $\mu\text{g/L}$ as Li)	Manganese ( $\mu\text{g/L}$ as Mn)	Strontium ( $\mu\text{g/L}$ as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
<b>LOWER MADISON RIVER VALLEY—Continued</b>											
S56	--	62.4	240	8	170	5	210	--	--	--	--
S58	--	81	200	13	150	5	--	6	80	--	--
	--	79	210	11	150	7	--	6	81	--	--
	70	64	240	--	200	--	--	12	67	--	--
	84	84	240	--	180	--	--	42	74	--	--
	57	53	160	--	120	--	--	78	61	--	--
	57	48	170	--	140	--	--	46	60	--	--
	45	42	130	--	90	--	--	22	76	--	--
	54	49	130	--	97	--	--	9	86	-133.0	-17.42
	51	52	140	--	120	--	--	11	66	--	--
	82	81	250	--	210	--	--	129	14	--	--
	84	75	270	--	230	--	--	64	38	--	--
	80	72	250	--	210	--	--	15	89	--	--
	77	69	240	--	190	--	--	51	72	--	--
	68	67	210	--	170	--	--	25	79	--	--
	66	65	180	--	140	--	--	14	87	--	--
	92	90	160	--	140	--	--	10	85	--	--
	95	95	230	--	160	--	--	22	50	-133.0	-16.82
	80	81	260	--	190	--	--	19	75	--	--
	100	90	310	--	240	--	--	5	96	--	--
	110	100	320	--	270	--	--	25	90	--	--
	45	42	130	--	110	--	--	65	73	--	--
	44	41	110	--	90	--	--	13	85	--	--
S60	--	57.9	170	15	140	7	120	--	--	--	--
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>											
S63	--	40	--	21	110	7	220	34	79	--	--
	--	31	--	27	99	9	250	43	63	--	--
	--	19	--	37	45	9	150	15	84	--	--
	--	45	--	15	96	12	230	6	93	--	--
	31	--	--	--	--	--	--	--	--	--	--
	30	30	--	10	93	7	230	6	94	--	--
	40	--	--	--	--	--	--	--	--	--	--
	36	--	--	--	--	--	--	--	--	--	--
	38	36	--	18	96	14	220	7	95	--	--
	19	--	--	--	--	--	--	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>											
S63	USGS	06-06-90	5,910	261	8.1	15.0	8.4	29	7.8	14	2.4
(Continued)	USGS	06-14-90	8,580	254	--	11.5	--	--	--	--	--
	USGS	07-23-90	1,420	337	--	22.0	--	--	--	--	--
	USGS	08-01-90	2,050	350	8.6	21.0	8.1	36	11	20	4.0
	USGS	09-10-90	2,640	404	--	18.5	--	--	--	--	--
	USGS	10-22-90	3,700	392	--	5.5	--	--	--	--	--
	USGS	11-28-90	3,590	378	8.4	.0	12.8	37	11	25	4.0
	USGS	02-11-91	3,240	411	--	.0	--	--	--	--	--
	USGS	03-07-91	2,780	400	8.2	1.0	13.5	42	13	24	3.8
	USGS	04-12-91	3,270	358	--	4.0	--	--	--	--	--
	USGS	05-31-91	1,100	247	--	13.0	--	--	--	--	--
	USGS	06-12-91	1,880	213	8.2	14.5	9.4	24	6.0	11	2.6
	USGS	06-19-91	9,850	233	--	15.5	--	--	--	--	--
	USGS	07-15-91	2,700	334	--	20.0	--	--	--	--	--
	USGS	08-19-91	1,170	340	--	17.5	--	--	--	--	--
	USGS	08-20-91	1,120	342	8.7	22.0	9.2	31	9.7	24	4.0
	USGS	09-02-91	1,490	345	8.8	19.5	8.1	32	10	25	3.9
	USGS	10-07-91	3,410	385	--	11.0	10.1	--	--	--	--
	USGS	11-06-91	4,880	423	8.2	.0	11.5	42	13	26	4.3
	USGS	11-21-91	5,010	374	--	3.0	13.4	--	--	--	--
	USGS	02-20-92	2,890	401	8.4	3.0	11.6	--	--	--	--
	USGS	03-18-92	3,320	372	8.2	8.0	10.6	39	12	22	4.3
	USGS	04-06-92	3,660	341	8.5	10.0	10.0	--	--	--	--
	USGS	05-18-92	2,400	316	8.5	18.0	9.5	--	--	--	--
	USGS	06-29-92	3,240	314	8.5	19.5	7.7	36	10	15	2.8
	USGS	08-12-92	1,080	335	8.8	20.5	10.0	31	10	23	3.8
	USGS	10-05-92	3,200	386	8.4	11.5	9.3	--	--	--	--
	USGS	11-09-92	4,200	383	8.5	4.5	11.8	36	11	25	4.2
	USGS	01-04-93	2,650	424	8.2	.0	12.3	--	--	--	--
	USGS	03-04-93	2,920	407	8.1	1.0	12.8	41	12	25	3.9
	USGS	04-08-93	4,240	352	8.4	8.0	9.1	--	--	--	--
	USGS	05-21-93	14,200	228	8.1	14.0	8.7	--	--	--	--
	USGS	05-25-93	13,300	231	8.0	12.5	9.2	25	6.6	11	2.6
	USGS	06-10-93	12,700	250	8.1	16.0	9.1	--	--	--	--
	USGS	07-28-93	10,800	312	8.2	17.5	8.9	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
SOUTHERN PART OF THE TOWNSEND VALLEY—Continued										
S63	125	0	102	104	20	8.0	.60	20	164	--
(Continued)	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	154	6	136	135	34	11	1.0	20	219	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	171	0	140	140	34	13	1.1	27	237	--
	--	--	--	--	--	--	--	--	--	--
	179	0	146	149	47	13	1.1	24	257	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	98	0	81	85	17	6.4	.60	19	136	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	134	8	123	127	27	14	1.5	25	211	--
	137	8	127	127	31	13	1.6	25	217	7
	--	--	--	--	--	14	--	--	--	--
	184	0	151	151	52	17	1.1	27	274	--
	--	--	--	--	--	15	--	--	--	--
	--	--	--	--	--	14	--	--	--	--
	169	0	139	139	40	13	1.1	22	238	--
	--	--	--	--	--	17	--	--	--	--
	--	--	--	--	--	16	--	--	--	--
	137	5	121	128	29	7.0	.70	17	190	--
	132	10	124	128	27	14	1.4	23	209	--
	--	--	--	--	--	13	--	--	--	--
	159	5	139	144	34	14	1.3	25	235	--
	--	--	--	--	--	16	--	--	--	--
	179	0	147	148	41	15	1.3	29	258	--
	--	--	--	--	--	11	--	--	--	--
	--	--	--	--	--	6.9	--	--	--	--
	104	0	86	92	18	5.9	.70	18	140	--
	--	--	--	--	--	7.3	--	--	--	--
	--	--	--	--	--	6.6	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Iron (µg/L as Fe)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Strontium (µg/L as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
SOUTHERN PART OF THE TOWNSEND VALLEY—Continued											
S63	22	21	--	41	49	13	160	25	92	--	--
(Continued)	21	--	--	--	--	--	--	--	--	--	--
	36	--	--	--	--	--	--	--	--	--	--
	35	32	--	8	71	11	220	13	95	--	--
	32	--	--	--	--	--	--	--	--	--	--
	34	--	--	--	--	--	--	--	--	--	--
	42	43	--	17	100	5	210	15	88	--	--
	36	--	--	--	--	--	--	--	--	--	--
	32	27	--	19	83	14	260	4	92	--	--
	21	--	--	--	--	--	--	--	--	--	--
	27	--	--	--	--	--	--	--	--	--	--
	17	19	--	97	39	9	130	169	74	--	--
	19	--	--	--	--	--	--	--	--	--	--
	45	--	--	--	--	--	--	--	--	--	--
	54	--	--	--	--	--	--	--	--	--	--
	54	50	--	9	110	3	170	9	92	--	--
	69	67	160	8	110	3	--	9	96	--	--
	41	39	140	--	90	--	--	--	--	--	--
	--	--	--	18	100	6	250	7	92	--	--
	43	39	150	--	110	--	--	8	94	--	--
	37	36	130	--	100	--	--	5	92	--	--
	--	--	--	31	76	22	230	9	86	--	--
	34	28	120	--	90	--	--	13	92	--	--
	33	30	110	--	80	--	--	15	78	--	--
	22	22	70	10	44	19	200	20	82	--	--
	54	53	160	8	100	9	180	11	93	--	--
	36	28	130	--	70	--	--	8	98	--	--
	37	39	150	8	110	7	220	6	89	--	--
	33	33	150	--	100	--	--	7	68	--	--
	--	--	--	16	110	8	240	7	89	--	--
	27	26	90	--	70	--	--	18	93	--	--
	25	19	70	--	40	--	--	161	82	--	--
	18	18	70	68	42	7	130	110	80	--	--
	23	18	80	--	50	--	--	92	85	--	--
	14	14	60	--	30	--	--	63	92	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Analyzing agency	Sample date	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>											
S63	USGS	08-23-93	5,930	331	8.3	17.0	9.5	39	11	13	3.2
(Continued)	USGS	10-04-93	3,570	483	8.7	13.5	10.2	--	--	--	--
	USGS	11-10-93	5,690	343	8.4	2.0	11.8	20	5.8	13	1.9
	USGS	03-08-94	4,000	378	8.4	4.0	11.4	36	11	21	4.4
	USGS	04-04-94	3,520	368	8.3	7.0	11.0	--	--	--	--
	USGS	05-11-94	6,360	267	8.2	16.0	8.2	--	--	--	--
	USGS	05-18-94	5,780	254	8.2	13.0	9.0	--	--	--	--
	USGS	06-14-94	4,160	311	8.3	14.5	8.6	33	9.5	16	3.2
	USGS	07-08-94	2,030	346	8.4	20.0	9.1	--	--	--	--
	USGS	08-16-94	1,200	340	8.6	18.0	8.2	31	9.8	25	4.3
	USGS	10-18-94	3,720	410	8.4	7.0	10.8	--	--	--	--
	USGS	01-09-95	2,940	424	8.1	.5	12.5	--	--	--	--
	USGS	04-07-95	4,770	362	8.2	10.0	9.1	--	--	--	--
	USGS	06-09-95	25,400	267	7.8	8.5	10.1	--	--	--	--
	USGS	08-07-95	3,700	350	8.4	21.5	8.4	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Bicarbonate, field (mg/L as HCO <sub>3</sub> )	Carbonate, field (mg/L as CO <sub>3</sub> )	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Alkalinity, lab (mg/L as CaCO <sub>3</sub> )	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dissolved solids, calculated (mg/L)	Antimony (µg/L as Sb)
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>										
S63	153	0	125	132	31	9.1	.60	19	202	--
(Continued)	--	--	--	--	--	38	--	--	--	--
	142	3	122	131	34	12	1.4	14	176	--
	151	5	132	142	38	13	1.3	23	229	--
	--	--	--	--	--	12	--	--	--	--
	--	--	--	--	--	7.4	--	--	--	--
	--	--	--	--	--	7.3	--	--	--	--
	145	0	119	125	27	8.5	.90	18	188	--
	--	--	--	--	--	9.1	--	--	--	--
	137	7	124	125	26	14	1.6	26	213	--
	--	--	--	--	--	15	--	--	--	--
	--	--	--	--	--	15	--	--	--	--
	--	--	--	--	--	13	--	--	--	--
	--	--	--	--	--	6.4	--	--	--	--
	--	--	--	--	--	7.2	--	--	--	--

**Table 2.** Water-quality data for selected surface-water sites along the Madison and upper Missouri Rivers in Montana  
(Continued)

Site number	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Iron (µg/L as Fe)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Strontium (µg/L as Sr)	Sediment, suspended (mg/L)	Sediment, suspended (percent finer than 0.062 mm)	Deuterium/hydrogen stable-isotope ratio (permil)	Oxygen-18/oxygen-16 stable-isotope ratio (permil)
SOUTHERN PART OF THE TOWNSEND VALLEY--Continued											
S63	20	19	60	29	39	14	210	20	94	--	--
(Continued)	24	23	70	--	60	--	--	9	91	--	--
	40	41	130	23	54	3	110	7	94	--	--
	33	33	130	26	84	13	220	9	95	--	--
	26	26	110	--	70	--	--	12	98	--	--
	24	22	80	--	50	--	--	45	97	--	--
	28	24	80	--	50	--	--	27	97	--	--
	23	25	80	37	54	19	200	10	97	--	--
	33	32	80	--	70	--	--	11	93	--	--
	65	65	160	26	110	9	180	12	95	--	--
	34	33	150	--	90	--	--	13	93	--	--
	41	36	160	--	110	--	--	8	95	--	--
	--	42	120	--	100	--	--	25	95	--	--
	16	12	50	--	30	--	--	378	39	--	--
	17	19	50	--	40	--	--	--	--	--	--



**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana

[Constituents are reported as dissolved. Significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Site number described in text. Collecting or analyzing agency: BOR, Bureau of Reclamation Laboratory, Bismarck, N.D.; MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont.; USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo. Abbreviations: ft<sup>3</sup>/s, cubic feet per second; °C, degrees Celsius; e, estimated; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbols: <, less than minimum reporting level; --, no data]

Site number	Sample date	Dis-charge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conduct-ance <sup>2</sup> (µS/cm)	pH <sup>2</sup> (stan-dard units)	Tempera-ture, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (µg/L as As)	Boron, (µg/L as B)	Lithium (µg/L as Li)	Collect-ing agency	Ana-lyzing agency
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>											
S4	07-16-92	--	268	6.6	--	--	58.4	--	--	BOR	BOR
S5	07-16-92	69	277	7.0	--	--	65.6	--	--	BOR	BOR
	08-04-92	--	273	8.0	--	--	75.2	--	--	BOR	BOR
S6	07-17-92	e7.5	290	7.6	--	--	58.0	--	--	BOR	BOR
	08-04-92	e50	267	7.7	--	--	85.2	--	--	BOR	BOR
S7	08-27-92	e2.0	277	8.1	--	--	<1	--	--	BOR	BOR
S9	09-22-92	--	444	8.1	--	--	3.0	--	--	BOR	BOR
S10	08-27-92	e1.0	485	7.6	--	--	4.0	--	--	BOR	BOR
	09-22-92	e.2	440	7.4	--	--	5.4	--	--	BOR	BOR
S11	07-15-92	--	333	7.2	--	--	42.0	--	--	BOR	BOR
	08-04-92	--	339	7.9	--	--	64.6	--	--	BOR	BOR
	08-27-92	52	329	--	10.5	--	74.6	--	--	USGS	BOR
	09-28-92	e45	338	8.3	8.0	--	53.6	--	--	USGS	BOR
	04-27-93	25	370	8.9	8.0	--	88.5	--	--	USGS	BOR
	06-22-93	59	218	8.3	11.5	--	31.9	--	--	USGS	BOR
	08-31-93	60	288	8.2	--	--	34.8	--	--	BOR	BOR
S12	08-27-92	e3.0	409	8.0	--	--	<1	--	--	BOR	BOR
S13	08-26-92	--	334	7.5	--	--	2.3	--	--	BOR	BOR
S14	03-30-93	e1.5	--	--	--	--	1.5	--	--	BOR	BOR
	07-09-93	--	286	8.2	--	--	<1	--	--	BOR	BOR
	08-31-93	14	338	8.3	--	--	6.9	--	--	BOR	BOR
S15	07-09-93	--	318	8.3	--	--	7.9	--	--	BOR	BOR
	08-31-93	16	319	8.2	--	--	14.4	--	--	BOR	BOR
S16	07-16-92	--	357	6.9	--	--	12.8	--	--	BOR	BOR
	08-04-92	--	337	8.0	--	--	20.6	--	--	BOR	BOR
	08-27-92	24	336	--	10.5	--	17.8	--	--	USGS	BOR
	09-28-92	27	337	8.5	8.5	--	16.0	--	--	USGS	BOR
	11-11-92	12	342	8.3	1.0	--	1.5	--	--	USGS	BOR
	03-16-93	13	332	8.2	2.0	6.4	<.7	20	<6	USGS	MBMG
	03-30-93	--	344	8.7	--	--	1.3	--	--	BOR	BOR
	04-27-93	14	349	8.8	9.0	--	<1	--	--	USGS	BOR
	06-22-93	23	300	8.3	13.0	--	8.1	--	--	USGS	BOR
	08-31-93	19	326	8.2	8.5	--	12.5	--	--	USGS	BOR

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Dis-charge, Instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY—Continued</b>											
S17	07-16-92	--	356	7.2	--	--	21.2	--	--	BOR	BOR
	08-04-92	--	315	8.6	--	--	27.1	--	--	BOR	BOR
	08-27-92	63	330	--	11.5	--	23.6	--	--	USGS	BOR
	09-28-92	88	335	8.7	8.0	--	22.6	--	--	USGS	BOR
	11-11-92	103	327	8.4	.5	--	21.9	--	--	USGS	BOR
	03-16-93	96	324	8.2	1.0	11	28.1	110	110	USGS	MBMG
	03-30-93	--	341	8.5	--	--	28.8	--	--	BOR	BOR
	04-27-93	100	343	9.0	9.0	--	23.5	--	--	USGS	BOR
	06-22-93	111	298	8.5	13.0	--	24.4	--	--	USGS	BOR
	08-31-93	86	329	8.1	8.0	--	29.6	--	--	USGS	BOR
S18	08-27-92	108	108	8.2	11.0	--	17.7	--	--	USGS	BOR
	09-28-92	108	346	8.5	9.0	--	17.5	--	--	USGS	BOR
	11-11-92	e120	342	8.2	1.0	--	18.6	--	--	USGS	BOR
	03-16-93	135	332	8.3	1.0	11	25.1	100	110	USGS	MBMG
	04-27-93	113	353	8.6	10.0	--	19.2	--	--	USGS	BOR
	06-22-93	188	290	8.4	14.0	--	16.0	--	--	USGS	BOR
	08-31-93	133	339	8.2	9.0	--	15.3	--	--	USGS	BOR
S19	07-15-92	--	343	7.4	--	--	43.4	--	--	BOR	BOR
	08-03-92	--	332	7.7	--	--	56.4	--	--	BOR	BOR
S20	07-15-92	--	589	7.0	--	--	5.8	--	--	BOR	BOR
	08-27-92	e.33	482	8.3	--	--	4.4	--	--	USGS	BOR
	09-28-92	e.5	501	8.3	10.5	--	6.5	--	--	USGS	BOR
	11-10-92	--	454	8.0	--	--	7.1	--	--	BOR	BOR
	04-27-93	.17	499	8.3	10.0	--	11.9	--	--	USGS	BOR
	06-22-93	.40	507	8.0	11.0	--	6.3	--	--	USGS	BOR
	08-31-93	.58	398	7.9	12.0	--	4.8	--	--	USGS	BOR
S21	08-03-92	e.1	440	6.6	--	--	5.8	--	--	BOR	BOR
	03-30-93	--	466	7.7	--	--	4.7	--	--	BOR	BOR
	07-08-93	--	412	7.7	--	--	6.2	--	--	BOR	BOR
S22	07-15-92	e2	532	7.0	--	--	6.1	--	--	BOR	BOR
	08-03-92	e2	484	7.6	--	--	6.4	--	--	BOR	BOR
	08-27-92	4.3	492	--	11.5	--	4.6	--	--	USGS	BOR
	09-28-92	4.1	480	8.1	12.0	--	7.6	--	--	USGS	BOR
	11-10-92	2.4	467	8.3	6.0	--	5.4	--	--	USGS	BOR
	03-16-93	.68	432	8.4	3.0	14	5.2	110	43	USGS	MBMG
	03-30-93	--	414	8.7	--	--	6.2	--	--	BOR	BOR
	04-27-93	3.2	465	8.3	10.0	--	3.9	--	--	USGS	BOR
	06-22-93	3.2	477	8.3	14.0	--	6.1	--	--	USGS	BOR
	08-31-93	3.0	458	8.0	--	--	6.5	--	--	BOR	BOR

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Dis-charge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY—Continued</b>											
S23	07-15-92	e10	448	6.7	--	--	10.3	--	--	BOR	BOR
	08-03-92	e10	455	7.6	--	--	15.3	--	--	BOR	BOR
	08-27-92	14	412	--	14.5	--	25.8	--	--	USGS	BOR
	09-28-92	11	411	8.2	13.0	--	19.8	--	--	USGS	BOR
	11-10-92	5.8	428	8.2	10.0	--	6.1	--	--	USGS	BOR
	03-16-93	1.8	440	8.3	7.0	13	4.3	110	66	USGS	MBMG
	03-30-93	--	449	7.9	--	--	4.2	--	--	BOR	BOR
	04-27-93	.65	490	8.5	10.0	--	5.4	--	--	USGS	BOR
	06-22-93	16	351	8.3	16.0	--	21.5	--	--	USGS	BOR
	08-31-93	11	369	8.1	12.0	--	13.5	--	--	USGS	BOR
<b>LOWER MADISON RIVER VALLEY</b>											
S25	06-09-93	5.1	471	8.8	21.0	13	4	50	20	USGS	USGS
	07-27-93	15	350	--	16.0	--	--	--	--	USGS	--
	08-18-93	6.1	354	8.5	19.5	7.8	3	30	20	USGS	USGS
	10-06-93	e5	409	--	14.0	--	--	--	--	USGS	--
	12-02-93	e4.5	392	--	.0	--	--	--	--	USGS	--
	02-17-94	6.9	362	8.4	.5	9.7	2	40	20	USGS	USGS
	04-06-94	11	390	--	4.0	--	--	--	--	USGS	--
	05-10-94	12	282	--	16.0	--	--	--	--	USGS	--
	05-17-94	14	270	8.4	16.0	6.6	2	30	10	USGS	USGS
	06-09-94	e5	423	--	15.3	--	--	--	--	USGS	--
	08-24-94	e3	572	--	21.0	--	--	--	--	USGS	--
	10-17-94	e10	451	--	7.5	--	--	--	--	USGS	--
	01-12-95	e7	384	--	.0	--	--	--	--	USGS	--
	04-06-95	e10	325	--	9.0	--	--	--	--	USGS	--
	06-08-95	e20	229	--	7.0	--	--	--	--	USGS	--
	08-10-95	e25	401	--	17.0	--	--	--	--	USGS	--
S27	05-28-93	170	78	7.8	10.0	.70	1	<10	<10	USGS	USGS
	06-09-93	120	104	--	14.0	--	--	--	--	USGS	--
	07-27-93	80	126	--	14.5	--	--	--	--	USGS	--
	08-19-93	45	169	8.2	14.0	1.0	2	<10	<10	USGS	USGS
	10-06-93	e30	214	--	15.0	--	--	--	--	USGS	--
	12-02-93	--	219	--	.0	--	--	--	--	USGS	--
	02-17-94	26	210	8.4	.5	1.7	2	<10	<10	USGS	USGS
	04-06-94	31	218	--	6.0	--	--	--	--	USGS	--
	05-10-94	110	89	--	12.0	--	--	--	--	USGS	--
	05-17-94	e130	90	--	12.0	--	--	--	--	USGS	--
	06-09-94	84	115	--	11.0	--	--	--	--	USGS	--
	07-07-94	89	114	--	17.0	--	--	--	--	USGS	--
	08-24-94	e20	225	--	20.5	--	--	--	--	USGS	--
	10-17-94	25	205	--	--	--	--	--	--	USGS	--
	01-12-95	e25	211	--	.0	--	--	--	--	USGS	--
	04-06-95	61	165	--	9.0	--	--	--	--	USGS	--
	06-08-95	260	98	--	5.5	--	--	--	--	USGS	--
	08-10-95	50	168	--	16.5	--	--	--	--	USGS	--

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Discharge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>LOWER MADISON RIVER VALLEY—Continued</b>											
S28	05-28-93	7.6	292	8.8	18.0	9.6	4	20	10	USGS	USGS
	06-09-93	5.0	264	--	19.0	--	--	--	--	USGS	--
	07-28-93	7.0	324	--	20.0	--	--	--	--	USGS	--
	08-19-93	5.0	386	8.5	15.0	15	5	20	20	USGS	USGS
	10-06-93	e4	427	--	15.0	--	--	--	--	USGS	--
	12-02-93	e3.5	411	--	.0	--	--	--	--	USGS	--
	02-17-94	1.2	372	8.4	.5	19	3	30	20	USGS	USGS
	04-06-94	9.5	403	--	5.0	--	--	--	--	USGS	--
	05-10-94	6.9	372	--	18.0	--	--	--	--	USGS	--
	05-17-94	--	364	--	17.0	--	--	--	--	USGS	--
	06-09-94	e4	381	--	18.0	--	--	--	--	USGS	--
	07-07-94	12	354	--	19.0	--	--	--	--	USGS	--
	08-24-94	e1	708	--	25.0	--	--	--	--	USGS	--
	10-17-94	e7	455	--	8.0	--	--	--	--	USGS	--
	01-12-95	e5	354	--	--	--	--	--	--	USGS	--
	04-06-95	12	266	--	10.0	--	--	--	--	USGS	--
	06-08-95	e15	318	--	8.5	--	--	--	--	USGS	--
	08-10-95	e7	412	--	19.0	--	--	--	--	USGS	--
S29	07-17-92	e50	251	8.5	--	--	45.2	--	--	BOR	BOR
	08-28-92	19	285	--	13.0	--	57.8	--	--	USGS	BOR
	09-28-92	7.1	298	8.8	14.0	--	76.0	--	--	USGS	BOR
	11-11-92	e9.5	288	8.5	1.0	--	82.9	--	--	USGS	BOR
	04-02-93	--	283	8.1	--	--	48.5	--	--	BOR	BOR
	04-28-93	e1.5	321	8.3	5.0	--	73.6	--	--	USGS	BOR
	06-22-93	9.6	173	9.0	19.0	8.3	31	100	70	USGS	USGS
	08-31-93	14	234	8.8	16.0	--	39.7	--	--	USGS	BOR
S30	07-17-92	e50	251	8.6	--	--	44.2	--	--	BOR	BOR
	08-28-92	11	287	--	12.5	--	56.8	--	--	USGS	BOR
	09-28-92	5.3	301	8.8	13.5	--	74.8	--	--	USGS	BOR
	11-11-92	e.5	294	8.3	.5	--	71.9	--	--	USGS	BOR
	04-28-93	e9	328	8.4	6.0	--	81.5	--	--	USGS	BOR
	06-22-93	19	176	8.7	18.0	--	27.0	--	--	USGS	BOR
	08-31-93	27	234	8.8	16.0	--	42.5	--	--	USGS	BOR
S31	08-28-92	--	853	7.4	--	--	31.8	--	--	BOR	BOR
	10-27-92	--	762	7.0	--	--	20.2	--	--	BOR	BOR
S32	08-28-92	21	287	--	14.0	--	60.8	--	--	USGS	BOR
	09-29-92	5.8	300	8.2	8.5	--	70.6	--	--	USGS	BOR
	11-11-92	.5	288	8.4	.0	--	86.2	--	--	USGS	BOR
	04-28-93	e1.5	333	8.4	6.0	--	74.8	--	--	USGS	BOR
	06-22-93	7.6	179	8.7	18.0	--	27.0	--	--	USGS	BOR
	08-31-93	18	233	8.8	17.0	--	42.0	--	--	USGS	BOR

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Dis-charge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>LOWER MADISON RIVER VALLEY—Continued</b>											
S33	08-28-92	12	287	--	15.5	--	72.4	--	--	USGS	BOR
	09-29-92	e.25	300	8.2	7.0	--	69.0	--	--	USGS	BOR
	11-11-92	e.3	291	8.5	.0	--	91.9	--	--	USGS	BOR
	04-28-93	e.5	337	8.4	7.0	--	86.7	--	--	USGS	BOR
	06-22-93	e1	185	8.6	17.5	--	29.6	--	--	USGS	BOR
S34	08-28-92	2.7	473	--	15.0	--	65.8	--	--	USGS	BOR
	09-29-92	2.3	430	7.8	--	--	47.4	--	--	USGS	BOR
	11-11-92	e2.1	383	8.2	6.0	--	69.7	--	--	USGS	BOR
	03-16-93	e1.5	376	8.5	5.0	22	61.4	200	190	USGS	MBMG
	04-28-93	e.5	409	8.2	7.0	--	49.4	--	--	USGS	BOR
	06-22-93	e4	390	8.1	15.0	--	53.1	--	--	USGS	BOR
	08-31-93	2.2	449	8.3	17.0	--	45.1	--	--	USGS	BOR
S35	08-28-92	--	1,900	8.3	--	--	6.2	--	--	BOR	BOR
	10-27-92	--	1,780	8.4	--	--	4.8	--	--	BOR	BOR
	04-02-93	--	2,280	8.0	--	--	<1	--	--	BOR	BOR
S36	08-26-92	--	313	9.1	--	--	67.8	--	--	BOR	BOR
	08-28-92	33	296	9.0	--	--	79.4	--	--	USGS	BOR
	09-29-92	e30	308	7.9	9.0	--	76.0	--	--	USGS	BOR
	06-23-93	32	208	8.2	14.0	--	36.8	--	--	USGS	BOR
	09-09-93	19	260	8.8	16.0	12	47.6	140	110	USGS	MBMG
S37	09-10-93	10	493	8.2	10.0	18	44.5	160	160	USGS	MBMG
	03-30-94	1.3	420	8.5	17.5	15	46.1	150	130	USGS	MBMG
S38	09-10-93	12	536	8.4	12.0	22	51.6	220	170	USGS	MBMG
	03-30-94	2.8	625	8.1	15.5	35	63.4	340	170	USGS	MBMG
S39	09-10-93	4.8	534	8.1	12.0	21	65.9	250	170	USGS	MBMG
	03-30-94	3.0	607	8.1	15.0	24	64.2	270	170	USGS	MBMG
S40	09-10-93	6.7	542	8.4	13.0	--	--	--	--	USGS	--
	03-30-94	4.7	627	--	17.0	--	--	--	--	USGS	--
S41	08-26-92	--	459	8.6		--	42.8	--	--	BOR	BOR
	09-10-93	4.3	425	8.9	19.5	20	48.2	180	160	USGS	MBMG
	03-30-94	3.7	429	8.8	18.0	20	52.4	160	170	USGS	MBMG
S42	09-10-93	27	308	9.2	21.5	15	54.3	160	130	USGS	MBMG
	03-30-94	11	422	8.8	17.0	18	54.5	180	150	USGS	MBMG
S43	09-10-93	3.9	452	8.4	16.0	17	46.0	160	150	USGS	MBMG
	03-30-94	3.4	443	8.0	7.0	17	43.3	150	160	USGS	MBMG
S44	08-28-92	15	298	--	18.0	--	74.6	--	--	USGS	BOR
	06-23-93	17	208	8.6	16.0	--	36.3	--	--	USGS	BOR
	09-01-93	.77	244	8.1	13.5	--	42.4	--	--	USGS	BOR

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Dis-charge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>LOWER MADISON RIVER VALLEY--Continued</b>											
S45	08-28-92	14	295	--	18.5	--	77.2	--	--	USGS	BOR
	09-29-92	14	306	9.1	14.0	--	67.0	--	--	USGS	BOR
	11-11-92	28	293	8.5	2.0	--	85.4	--	--	USGS	BOR
	04-28-93	8.9	357	8.6	13.5	--	98.7	--	--	USGS	BOR
	06-23-93	41	208	8.6	16.0	--	35.4	--	--	USGS	BOR
	09-01-93	7.0	243	8.0	13.5	--	43.0	--	--	USGS	BOR
S46	08-28-92	--	475	8.5		--	51.2	--	--	BOR	BOR
	04-02-93	--	475	8.0		--	43.7	--	--	BOR	BOR
	03-30-94	6.0	463	--	5.0	17	42.2	150	140	USGS	MBMG
S47	09-10-93	6.0	539	8.8	15.5	23	57.3	250	180	USGS	MBMG
	03-30-94	6.6	622	8.4	3.5	28	60.5	300	160	USGS	MBMG
S48	03-13-95	.90	685	8.5	5.5	30	113	460	240	USGS	MBMG
S49	03-13-95	.07	1,500	8.0	7.5	60	96.5	750	270	USGS	MBMG
S50	03-13-95	.09	970	8.0	9.0	60	114	750	270	USGS	MBMG
S51	03-13-95	.05	1,470	8.3	3.5	70	321	1,400	560	USGS	MBMG
S52	09-10-93	9.9	574	8.6	18.0	27	61.0	290	180	USGS	MBMG
	03-30-94	1.4	1,030	8.4	9.0	54	94.8	610	240	USGS	MBMG
	03-13-95	1.8	945	8.3	5.5	50	106	680	240	USGS	MBMG
S53	08-28-92	16	515	8.8	--	--	73.6	--	--	USGS	BOR
	09-29-92	18	552	8.2	8.5	--	57.3	--	--	USGS	BOR
	11-11-92	e20	559	8.4	4.5	--	61.0	--	--	USGS	BOR
	03-16-93	19	530	8.5	5.0	21	60.5	210	190	USGS	MBMG
	04-28-93	22	581	8.5	10.0	--	64.7	--	--	USGS	BOR
	06-23-93	20	523	8.4	11.0	19	63	250	180	USGS	USGS
	09-10-93	18	525	8.8	19.5	22	64.8	250	180	USGS	MBMG
	03-30-94	18	582	8.5	7.0	23	65.4	260	170	USGS	MBMG
S54	09-10-93	3.0	512	8.8	19.0	22	62.6	250	180	USGS	MBMG
	03-30-94	4.6	428	8.7	13.0	19	52.9	180	149	USGS	MBMG
S55	03-31-94	18	618	--	3.5	26	68.1	290	170	USGS	MBMG
S56	07-17-92	e30	492	8.5	--	--	55.6	--	--	BOR	BOR
	08-29-92	30	466	--	11.0	--	72.0	--	--	USGS	BOR
	09-29-92	23	568	8.7	9.5	--	64.4	--	--	USGS	BOR
	11-11-92	e21	576	8.5	3.5	--	57.8	--	--	USGS	BOR
	03-16-93	20	563	8.3	2.0	24	65.0	240	190	USGS	MBMG
	04-01-93	--	600	8.5	--	--	66.7	--	--	BOR	BOR
	04-28-93	20	616	8.4	11.5	--	62.4	--	--	USGS	BOR
	06-23-93	24	539	8.3	12.0	20	52	270	140	USGS	USGS
	09-09-93	28	502	8.7	18.0	21	62.4	240	170	USGS	MBMG
	03-31-94	15	616	8.5	4.0	27	68.2	300	160	USGS	MBMG

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Discharge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>LOWER MADISON RIVER VALLEY—Continued</b>											
S57	09-10-93	3.0	516	8.7	22.0	24	66.7	270	180	USGS	MBMG
	03-31-94	1.1	661	8.2	3.5	35	66.0	320	190	USGS	MBMG
S59	09-09-93	.29	344	8.5	19.0	15	48.2	170	140	USGS	MBMG
S60	07-17-92	e25	339	8.9	--	--	56.6	--	--	BOR	BOR
	08-29-92	25	355	--	18.0	--	56.4	--	--	USGS	BOR
	09-29-92	40	352	8.8	13.0	--	59.4	--	--	USGS	BOR
	11-11-92	19	422	8.5	3.5	--	52.7	--	--	USGS	BOR
	03-16-93	36	412	8.2	2.0	22	45.0	180	190	USGS	MBMG
	04-01-93	--	433	8.4	--	--	73.0	--	--	BOR	BOR
	04-28-93	20	428	8.7	16.0	--	56.8	--	--	USGS	BOR
	06-23-93	54	304	8.4	14.0	13	54	160	140	USGS	USGS
	09-09-93	35	315	9.2	21.0	12	57.9	170	140	USGS	MBMG
	03-31-94	14	424	8.8	14.0	19	58.6	180	150	USGS	MBMG
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>											
S61	10-01-92	1.1	368	8.3	12.0	--	35.4	--	--	USGS	BOR
S62	09-22-92	e2	380	8.2	--	--	38.4	--	--	BOR	BOR
	06-24-93	e6.0	247	8.0	--	--	12.5	--	--	BOR	BOR
S64	09-22-92	e.56	938	6.8	--	--	3.3	--	--	BOR	BOR
	10-01-92	.39	931	7.3	--	--	3.8	--	--	BOR	BOR
	11-12-92	.33	910	7.7	10.0	--	4.0	--	--	USGS	BOR
	03-15-93	--	882	7.9	6.0	35	1.7	200	46	USGS	MBMG
	04-01-93	e.1	902	7.6	--	--	1.5	--	--	BOR	BOR
	04-29-93	.27	907	7.5	7.0	--	1.6	--	--	USGS	BOR
	06-24-93	.39	918	7.6	9.0	--	2.2	--	--	USGS	BOR
	09-01-93	.58	929	7.4	11.0	--	1.7	--	--	USGS	BOR
S65	09-22-92	e1.8	1,129	7.9	--	--	5.8	--	--	BOR	BOR
	10-01-92	.84	1,180	7.9	10.5	--	6.3	--	--	USGS	BOR
	11-12-92	.86	1,170	8.2	10.0	--	3.4	--	--	USGS	BOR
	03-15-93	1.5	924	8.0	6.0	42	2.2	230	49	USGS	MBMG
	04-01-93	e1.5	1,383	8.0	--	--	5.0	--	--	BOR	BOR
	04-29-93	1.8	1,320	8.1	8.0	--	3.3	--	--	USGS	BOR
	06-23-93	2.0	1,260	7.8	10.0	--	2.8	--	--	USGS	BOR
	09-01-93	e1.5	1,130	7.9	13.0	--	2.1	--	--	USGS	BOR
S66	07-06-93	--	445	7.8	--	--	6.4	--	--	BOR	BOR
	06-10-94	7.0	430	7.4	15.0	6.8	4.0	100	50	USGS	USGS
S67	09-22-92	e6	849	7.7	--	--	11.7	--	--	BOR	BOR
	10-01-92	8.4	745	8.3	9.0	--	10.5	--	--	USGS	BOR
	11-12-92	8.0	824	8.5	5.0	--	6.7	--	--	USGS	BOR
	03-15-93	11	680	8.3	7.0	24	3.5	130	23	USGS	MBMG
	04-01-93	--	803	8.2	--	--	5.5	--	--	BOR	BOR
	04-29-93	12	969	8.3	8.0	--	3.6	--	--	USGS	BOR
	06-23-93	25	482	8.6	16.0	--	10.7	--	--	USGS	BOR
	09-01-93	18	533	8.2	15.5	--	7.4	--	--	USGS	BOR

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Dis-charge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>SOUTHERN PART OF THE TOWNSEND VALLEY--Continued</b>											
S68	09-22-92	e.5	636	6.4	--	--	10.0	--	--	BOR	BOR
	10-01-92	2.9	640	8.1	--	--	8.4	--	--	BOR	BOR
	11-12-92	1.4	655	8.0	--	--	6.7	--	--	BOR	BOR
	03-15-93	e.1	590	8.7	5.0	24	7.0	150	55	USGS	MBMG
	04-01-93	e.1	544	8.9	--	--	8.4	--	--	BOR	BOR
	04-29-93	.5	685	8.3	--	--	4.1	--	--	BOR	BOR
	06-24-93	4.0	642	8.0	--	--	4.9	--	--	BOR	BOR
	09-01-93	4.0	664	8.0	--	--	4.2	--	--	BOR	BOR
S69	09-24-92	--	708	7.1	--	--	12.8	--	--	BOR	BOR
S70	09-23-92	e2.5	534	7.2	--	--	4.2	--	--	BOR	BOR
	03-15-93	1.4	513	8.2	6.0	--	2.6	--	--	USGS	BOR
	04-01-93	--	487	8.3	--	--	1.2	--	--	BOR	BOR
	04-29-93	1.0	501	8.5	12.0	--	1.3	--	--	USGS	BOR
	06-23-93	e1.5	522	7.8	10.0	--	2.2	--	--	USGS	BOR
	09-01-93	e1.5	525	7.8	13.5	--	<1	--	--	USGS	BOR
S71	09-23-92	--	416	8.0	--	--	34.8	--	--	BOR	BOR
S72	09-24-92	--	520	7.7	--	--	3.5	--	--	BOR	BOR
S73	09-28-92	--	520	7.8	--	--	1.2	--	--	BOR	BOR
S74	09-28-92	--	520	7.9	--	--	2.4	--	--	BOR	BOR
S75	09-23-92	e1	494	7.7	--	--	4.8	--	--	BOR	BOR
	10-01-92	2.4	512	8.3	15.0	--	2.2	--	--	USGS	BOR
	11-12-92	e2.4	502	8.3	9.5	--	<1	--	--	USGS	BOR
	03-15-93	e2.0	486	8.4	11.0	13	.7	66	19	USGS	MBMG
	04-01-93	--	479	8.1	--	--	<1	--	--	BOR	BOR
	04-29-93	e.2	500	8.2	13.0	--	<1	--	--	USGS	BOR
	06-23-93	e1.5	502	8.0	10.5	--	1.0	--	--	USGS	BOR
	09-01-93	e1.7	518	8.2	14.0	--	1.0	--	--	USGS	BOR
S76	09-23-92	e5.5	540	8.0	--	--	5.2	--	--	BOR	BOR
	10-01-92	5.2	512	8.5	13.0	--	3.4	--	--	USGS	BOR
	11-12-92	e5.9	511	8.5	7.0	--	7.9	--	--	USGS	BOR
	04-01-93	--	497	8.1	--	--	1.0	--	--	BOR	BOR
	09-01-93	e4.0	479	8.5	14.0	--	2.7	--	--	USGS	BOR
<b>HELENA VALLEY</b>											
S77	03-23-95	39	255	8.7	6.0	--	7	--	--	USGS	USGS
	07-05-95	207	150	8.0	12.0	1.1	5	--	--	USGS	USGS
S78	05-10-93	49	391	8.4	9.0	22	27.3	113	91	USGS	MBMG
	06-30-93	121	381	8.6	12.0	--	26.3	--	--	USGS	BOR
	08-27-93	135	308	8.6	16.0	--	21.3	--	--	USGS	BOR



**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Dis-charge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
HELENA VALLEY—Continued											
S79	04-01-93	e2	699	7.7	--	--	5.4	--	--	BOR	BOR
	05-10-93	.78	703	7.5	7.5	32	2.5	69	20	USGS	MBMG
	06-30-93	e.08	681	7.6	9.0	--	2.3	--	--	USGS	BOR
	08-27-93	e.08	682	7.3	10.5	--	2.0	--	--	USGS	BOR
S80	07-05-95	105	363	8.6	13.5	13	31	--	--	USGS	USGS
S81	04-01-93	e5	648	7.7	--	--	5.4			BOR	BOR
	05-10-93	3.1	653	8.1	11.0	33	4.2	61	22	USGS	MBMG
	06-30-93	3.7	670	7.8	12.0	--	3.9	--	--	USGS	BOR
	08-27-93	3.4	690	7.8	10.5	--	3.5	--	--	USGS	BOR
S82	07-07-93	e.1	670	7.8	--	--	4.8	--	--	BOR	BOR
	08-26-93	e.25	664	7.7	--	--	3.1	--	--	BOR	BOR
S83	03-23-95	--	381	8.4	8.5	--	8.0	--	--	USGS	USGS
	07-05-95	142	238	8.2	16.0	--	8.0	--	--	USGS	USGS
S84	04-01-93	--	612	7.9	--	--	1.1	--	--	BOR	BOR
	05-10-93	24	447	8.4	16.0	14	21.5	100	68	USGS	MBMG
	06-29-93	e20	501	8.1	13.0	--	13.7	--	--	USGS	BOR
	08-26-93	e52	420	7.9	13.5	--	14.4	--	--	USGS	BOR
S85	03-23-95	.31	672	8.7	8.5	--	2.0	--	--	USGS	USGS
	07-05-95	12	399	8.7	11.0	13	25	--	--	USGS	USGS
S86	08-27-93	e1.3	790	6.9	--	--	2.7	--	--	BOR	BOR
S87	08-27-93	e1.3	681	7.1	--	--	1.7	--	--	BOR	BOR
S88	04-01-93	e1.0	470	7.0	--	--	<1	--	--	BOR	BOR
	05-05-93	1.3	485	7.1	6.5	11	<.8	42	18	USGS	MBMG
	06-29-93	e2.2	530	7.1	10.0	--	2.1	--	--	USGS	BOR
	08-27-93	e2.2	582	7.1	11.0	--	1.6	--	--	USGS	BOR
S89	04-01-93	--	609	7.7	--	--	1.8	--	--	BOR	BOR
	05-10-93	30	464	8.3	14.0	16	16.0	90	59	USGS	MBMG
	06-29-93	35	502	8.0	12.5	--	10.9	--	--	USGS	BOR
	08-26-93	e150	426	7.7	12.0	--	12.7	--	--	USGS	BOR
S90	04-01-93	e.45	742	7.4	--	--	4.2	--	--	BOR	BOR
	05-05-93	e.20	952	7.6	6.0	41	3.7	141	29	USGS	MBMG
	06-29-93	e1.2	1,000	7.3	8.5	--	3.4	--	--	USGS	BOR
	07-07-93	e.4	998	7.4	--	--	5.3	--	--	BOR	BOR
	08-26-93	e1.2	952	7.2	11.0	--	3.2	--	--	USGS	BOR

**Table 3.** Water-quality data used as geothermal tracers for selected surface-water sites along the Madison and upper Missouri Rivers in Montana (Continued)

Site number	Sample date	Discharge, instantaneous <sup>1</sup> (ft <sup>3</sup> /s)	Specific conductance <sup>2</sup> (μS/cm)	pH <sup>2</sup> (standard units)	Temperature, water (°C)	Chloride (mg/L as Cl)	Arsenic <sup>3</sup> (μg/L as As)	Boron (μg/L as B)	Lithium (μg/L as Li)	Collecting agency	Analyzing agency
<b>HELENA VALLEY—Continued</b>											
S91	04-01-93	e.06	861	7.7	--	--	2.4	--	--	BOR	BOR
	05-05-93	.37	840	7.6	7.0	23	2.6	134	34	USGS	MBMG
	06-29-93	e.25	820	7.6	10.0	--	2.4	--	--	USGS	BOR
	07-07-93	e.6	946	7.5	--	--	3.7	--	--	BOR	BOR
	08-26-93	e.25	862	7.7	10.5	--	2.0	--	--	USGS	BOR
S92	04-01-93	e.4	511	7.1	--	--	1.8	--	--	BOR	BOR
	05-05-93	.43	500	7.1	8.0	16	1.3	60	23	USGS	MBMG
	06-29-93	.8	501	7.9	--	--	<1	--	--	BOR	BOR
	07-06-93	--	526	7.3	--	--	1.0	--	--	BOR	BOR
	08-26-93	.8	508	7.1	--	--	<1	--	--	USGS	BOR
S93	03-27-95	9.7	440	8.4	6.0	--	2.0	--	--	USGS	USGS
	07-06-95	22	475	8.6	15.5	--	7.0	--	--	USGS	USGS
S94	03-27-95	52	380	8.3	5.0	--	8.0	--	--	USGS	USGS
	07-06-95	153	245	7.9	14.5	5.4	12	--	--	USGS	USGS
S95	03-27-95	13	519	8.5	8.0	--	3	--	--	USGS	USGS
	07-06-95	48	480	8.2	15.0	14	17	--	--	USGS	USGS
S96	03-27-95	6.3	428	8.1	5.0	--	2.0	--	--	USGS	USGS
	07-06-95	24	398	7.7	12.0	--	15	--	--	USGS	USGS
S97	07-06-95	--	331	9.0	20.0	--	15	--	--	USGS	USGS
S98	03-27-95	--	363	9.0	4.5	12	6	--	--	USGS	USGS
	07-06-95	--	247	7.9	14.5	5.5	12	--	--	USGS	USGS
S99	04-01-93	e.2	892	8.4	--	--	16.2	--	--	BOR	BOR
	05-05-93	e.08	830	8.3	13.0	30	9.8	150	35	USGS	MBMG
	06-29-93	e.03	802	--	10.0	--	5.8	--	--	USGS	BOR
	--	e.1	920	7.7	--	--	19.2	--	--	BOR	BOR
	08-26-93	e.20	820	7.7	10.5	--	5.2	--	--	USGS	BOR
	03-27-95	.07	922	8.8	6.0	--	17	--	--	USGS	USGS
	07-05-95	e.30	875	7.9	15.5	--	11	--	--	USGS	USGS
S100	07-06-95	--	309	8.7	20.0	--	15	--	--	USGS	USGS
S101	07-07-93	--	332	8.6	--	--	24.4	--	--	BOR	BOR
	08-26-93	24	312	8.3	--	--	20.7	--	--	BOR	BOR
S102	03-27-95	--	363	8.8	3.0	--	5	--	--	USGS	USGS
	07-06-95	--	295	8.3	17.0	7.2	17	--	--	USGS	USGS
S103	07-07-93	--	347	8.0	--	--	9.7	--	--	BOR	BOR
	08-26-93	--	352	8.3	--	--	12.8	--	--	BOR	BOR

<sup>1</sup>Discharge values reported as ranges by the Bureau of Reclamation were averaged.

<sup>2</sup>Values determined by the Bureau of Reclamation are laboratory values; values determined by the U.S. Geological Survey are field values.

<sup>3</sup>Samples collected for the Bureau of Reclamation by U.S. Geological Survey personnel were unfiltered samples.

**Table 4.** Water-quality data for diel investigations of the Madison River near West Yellowstone, Montana, August 24-26, 1990

[Site number is S1 in table 1. Constituents are reported as dissolved. Laboratory analyses and field measurements by U.S. Geological Survey. Abbreviations: °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbol: --, no data]

Sample date	Time	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Phosphorus, orthophosphate (mg/L as P)	Arsenic (µg/L as As)
08-24-90	1300	472	8.33	19.0	18.5	--	111	0.013	314
	1340	--	8.38	--	--	--	--	--	--
	1400	485	8.40	19.5	18.5	--	110	.012	313
	1430	--	8.52	--	--	115.2	--	--	--
	1445	--	8.49	--	--	--	--	--	--
	1500	490	8.59	19.5	18.9	--	--	.011	306
	1530	--	8.46	--	--	116.4	--	--	--
	1540	--	8.47	--	--	--	--	--	--
	1600	490	8.56	20.0	19.8	--	111	.011	313
	1625	--	8.68	--	--	118.9	--	--	--
	1645	--	8.52	--	--	--	--	--	--
	1700	480	8.51	18.0	19.7	--	113	.007	329
	1730	--	8.58	--	--	111.9	--	--	--
	1800	485	8.49	18.5	19.0	--	113	.012	311
	1830	--	8.51	--	--	111.1	--	--	--
	1900	485	8.50	20.0	19.0	--	113	.012	312
	1930	--	8.44	--	--	107.0	--	--	--
	1945	--	8.45	--	--	--	--	--	--
	2000	468	8.44	15.0	19.0	--	113	.011	308
	2030	--	8.38	--	--	99.3	--	--	--
	2045	--	8.35	--	--	--	--	--	--
	2100	479	8.29	12.0	18.0	--	114	.013	303
	2130	--	8.22	--	--	--	--	--	--
	2140	--	--	--	--	93.2	--	--	--
	2200	480	8.14	9.0	17.5	--	114	.009	314
	2230	--	8.07	--	--	92.2	--	--	--
	2328	--	--	--	--	90.1	--	--	--
	2300	490	8.02	6.5	17.0	--	112	.007	309
	2330	--	7.97	--	--	--	--	--	--
	2400	483	7.99	4.5	16.0	--	113	.010	307
08-25-90	0030	--	7.93	--	--	90.1	--	--	--
	0100	487	7.93	4.5	16.0	--	114	.006	312
	0130	--	7.93	--	--	88.8	--	--	--
	0200	485	7.95	6.0	16.0	--	114	.006	316
	0230	--	7.91	--	--	--	--	--	--
	0240	--	--	--	--	91.5	--	--	--
	0300	489	7.98	8.0	16.0	--	--	.009	314
	0330	--	7.88	--	--	--	--	--	--
	0340	--	7.90	--	--	90.2	--	--	--
	0400	484	7.91	7.0	16.0	--	114	.009	314

**Table 4.** Water-quality data for diel investigations of the Madison River near West Yellowstone, Montana, August 24-26, 1990 (Continued)

Sample date	Time	Specific conductance, field ( $\mu\text{S/cm}$ )	pH, field (standard units)	Temperature, air ( $^{\circ}\text{C}$ )	Temperature, water ( $^{\circ}\text{C}$ )	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as $\text{CaCO}_3$ )	Phosphorus, orthophosphate (mg/L as P)	Arsenic ( $\mu\text{g/L}$ as As)
08-25-90 (Continued)	0430	--	7.90	--	--	91.5	--	--	--
	0500	480	7.93	5.5	16.0	--	114	.006	317
	0530	--	7.89	--	--	90.6	--	--	--
	0600	485	8.05	3.0	15.0	--	112	.008	325
	0630	--	7.87	--	--	90.9	--	--	--
	0640	--	7.87	--	--	--	--	--	--
	0700	480	7.96	2.0	14.8	--	112	.006	317
	0730	--	7.92	--	--	90.9	--	--	--
	0745	--	7.94	--	--	--	--	--	--
	0800	472	8.02	4.5	14.5	--	113	.008	317
	0830	--	--	--	--	96.0	--	--	--
	0840	--	8.04	--	--	--	--	--	--
	0900	478	8.13	8.5	15.0	--	112	.006	315
	0925	--	8.12	--	--	101.0	--	--	--
	1000	480	8.21	13.0	16.0	--	112	.006	323
	1030	--	8.25	--	--	106.4	--	--	--
	1100	480	8.25	15.5	16.5	--	112	.008	313
	1130	--	8.29	--	--	111.4	--	--	--
	1200	480	8.34	19.0	17.5	--	112	.007	318
	1230	--	8.35	--	--	111.3	--	--	--
	1300	478	8.37	21.0	18.0	--	111	.006	300
	1330	--	8.37	--	--	112.6	--	--	--
	1400	472	8.39	21.0	18.5	--	110	.007	261
	1430	--	8.41	--	--	--	--	--	--
	1500	480	8.60	18.0	19.0	--	112	.007	316
	1520	--	8.49	--	--	112.2	--	--	--
	1540	--	8.50	--	--	--	--	--	--
	1600	485	8.49	18.0	19.0	--	112	.007	316
	1625	--	8.56	--	--	110.8	--	--	--
	1645	--	8.48	--	--	--	--	--	--
	1700	481	8.64	15.5	18.5	--	113	.006	298
	1730	--	8.52	--	--	104.3	--	--	--
	1800	480	8.43	16.0	18.0	--	113	.006	304
	1835	--	8.42	--	--	103.4	--	--	--
	1900	487	8.44	10.0	18.0	--	114	.006	302
	1935	--	8.40	--	--	98.4	--	--	--
	2000	490	8.34	7.5	17.0	--	112	.014	311
	2030	--	8.30	--	--	97.2	--	--	--
	2100	480	8.23	9.0	16.5	--	112	.014	297
	2130	--	8.14	--	--	96.2	--	--	--

**Table 4.** Water-quality data for diel investigations of the Madison River near West Yellowstone, Montana, August 24-26, 1990 (Continued)

Sample date	Time	Specific conductance, field ( $\mu\text{S}/\text{cm}$ )	pH, field (standard units)	Temperature, air ( $^{\circ}\text{C}$ )	Temperature, water ( $^{\circ}\text{C}$ )	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as $\text{CaCO}_3$ )	Phosphorus, orthophosphate (mg/L as P)	Arsenic ( $\mu\text{g}/\text{L}$ as As)
08-25-90 (Continued)	2200	480	8.09	8.5	16.5	--	114	.006	307
	2230	--	8.04	--	--	91.1	--	--	--
	2300	480	8.02	8.0	16.0	--	114	.007	306
	2325	--	7.99	--	--	92.3	--	--	--
	2400	490	7.92	6.0	16.0	--	114	.008	300
08-26-90	0030	--	7.90	--	--	92.8	--	--	--
	0100	490	7.93	6.0	15.0	--	114	.007	302
	0130	--	7.88	--	--	90.8	--	--	--
	0200	485	7.82	5.0	15.0	--	114	.007	308
	0230	--	7.88	--	--	90.1	--	--	--
	0300	487	7.94	4.0	15.0	--	114	.011	308
	0330	--	7.90	--	--	92.1	--	--	--
	0400	487	7.92	3.0	15.0	--	114	.010	304
	0430	--	7.90	--	--	92.1	--	--	--
	0500	480	7.93	3.0	14.9	--	115	.011	298
	0530	--	7.90	--	--	91.2	--	--	--
	0600	480	7.92	2.0	15.0	--	113	.011	300
	0630	--	7.85	--	--	92.0	--	--	--
	0645	--	7.96	--	--	--	--	--	--
	0700	483	7.96	1.0	14.5	--	114	.011	301
	0720	--	7.90	--	--	--	--	--	--
	0730	--	--	--	--	93.3	--	--	--
	0740	--	7.94	--	--	--	--	--	--
	0800	482	8.04	4.0	15.0	--	114	.010	300
	0830	--	8.03	--	--	96.7	--	--	--
	0900	475	8.08	10.0	15.0	--	114	.011	301
	0930	--	8.14	--	--	101.8	--	--	--
	1000	490	8.23	12.5	15.8	--	114	.006	318
	1030	--	8.26	--	--	107.3	--	--	--
	1100	491	8.30	13.5	16.5	--	114	.017	319
	1130	--	8.32	--	--	110.4	--	--	--
	1200	488	8.37	18.5	17.5	112.6	116	--	316
	1230	--	--	--	--	114.4	--	--	--

**Table 5. Water-quality data for diel investigations of the Madison River near Norris, Montana, July 27-28, 1993**

[Site number is S26 in table 1. Constituents are reported as dissolved. Laboratory analyses by Montana Bureau of Mines and Geology; field measurements by U.S. Geological Survey. Abbreviations: °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbol: --, no data]

Sample date	Time	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Arsenic (µg/L as As)
07-27-93	1020	240	8.49	--	--	--	--	41.3
	1055	239	8.60	--	--	--	--	--
	1100	238	8.58	20.5	16.0	115.4	86	41.8
	1130	--	8.65	21.5	17.0	118.0	--	--
	1200	237	8.68	22.5	17.0	118.0	88	42.0
	1230	--	8.74	--	17.5	--	--	--
	1300	235	8.74	27.5	18.0	122.0	86	41.9
	1320	--	8.79	--	18.0	122.0	--	--
	1340	--	8.79	--	18.3	122.4	--	--
	1400	233	8.79	26.5	18.4	122.9	86	42.6
	1420	--	8.86	--	18.5	122.3	--	--
	1440	--	8.87	--	--	--	--	--
	1500	232	8.89	25.5	19.0	123.9	85	44.1
	1530	--	8.88	24.5	19.0	121.5	--	--
	1545	--	8.88	25.0	19.0	--	--	--
	1600	232	8.87	24.0	19.0	122.4	86	44.3
	1630	--	8.90	24.2	19.2	122.8	--	--
	1645	--	8.89	24.2	19.0	121.1	--	--
	1700	231	8.85	22.6	18.8	118.5	84	43.0
	1730	--	8.84	--	18.6	115.7	--	--
	1745	--	8.84	--	18.5	114.0	--	--
	1800	232	8.81	22.0	18.5	114.9	84	45.4
	1830	--	8.79	--	18.3	112.3	--	--
	1845	--	8.78	--	17.8	110.7	--	--
	1900	230	8.76	20.0	17.8	110.1	--	44.7
	1930	--	--	19.0	17.5	106.0	--	--
	2000	232	8.67	18.5	17.5	102.8	84	45.4
	2030	--	8.61	--	17.2	100.4	--	--
	2045	--	8.57	17.5	17.0	99.1	--	--
	2100	233	8.51	16.5	16.8	97.4	85	44.8
	2130	--	8.44	15.0	16.5	93.7	--	--
	2200	233	8.36	13.5	16.0	92.1	85	44.3
	2230	--	8.28	12.5	16.0	92.1	--	--
	2300	234	8.30	12.0	16.0	92.1	86	43.9
	2330	--	8.27	13.0	16.0	92.1	--	--
07-28-93	2400	234	8.24	13.5	16.0	92.1	84	45.1
	0030	--	8.23	--	16.0	92.1	--	--
	0100	234	8.21	13.5	15.5	90.9	--	45.5
	0130	--	8.22	13.5	15.5	90.7	--	--
	0500	235	8.21	8.5	16.1	91.0	85	43.0

**Table 5.** Water-quality data for diel investigations of the Madison River near Norris, Montana, July 27-28, 1993 (Continued)

Sample date	Time	Specific conductance, field ( $\mu\text{S}/\text{cm}$ )	pH, field (standard units)	Temperature, air ( $^{\circ}\text{C}$ )	Temperature, water ( $^{\circ}\text{C}$ )	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as $\text{CaCO}_3$ )	Arsenic ( $\mu\text{g}/\text{L}$ as As)
07-28-93 (Continued)	0530	--	8.21	8.5	15.8	90.1	--	--
	0600	235	8.27	8.0	16.2	91.1	86	42.8
	0630	--	8.22	7.5	16.3	91.6	--	--
	0700	235	8.29	11.0	16.3	92.5	87	41.7
	0730	--	8.27	11.5	16.3	93.6	--	--
	0745	--	8.29	--	16.3	97.5	--	--
	0800	235	8.33	14.0	16.5	98.8	86	42.5
	0830	--	8.39	16.0	16.5	101.2	--	--
	0845	--	8.42	16.5	16.7	103.2	--	--
	0900	233	8.45	17.3	17.0	105.0	84	41.8
	0930	--	8.53	18.5	17.0	108.7	--	--
	0945	--	8.58	--	17.3	111.2	--	--
	1000	231	8.59	20.5	17.4	112.7	85	42.9
	1030	--	8.65	22.0	17.8	115.5	--	--
	1045	--	8.68	19.5	18.0	117.7	--	--
	1100	229	8.70	19.5	18.0	118.6	83	43.3
	1130	--	8.75	21.3	18.5	120.5	--	--
	1145	--	8.77	21.7	18.5	121.0	--	--
	1200	228	8.74	22.3	19.0	122.6	83	44.1
	1230	--	--	25.5	19.4	121.6	--	--
	1245	--	8.81	25.3	19.5	126.6	--	--
	1300	227	8.82	25.5	19.5	129.2	83	43.6
	1330	--	8.84	26.0	19.7	129.5	--	--
	1345	--	8.85	26.1	19.8	129.8	--	--
	1400	228	8.84	26.4	19.7	129.7	83	44.9
	1430	--	8.88	26.5	20.2	130.2	--	--
	1445	--	8.89	27.2	20.4	130.9	--	--
	1500	229	8.87	27.3	20.5	130.6	85	44.9
	1530	--	8.88	27.5	20.5	128.3	--	--
	1545	--	8.90	27.7	20.5	128.0	--	--
	1600	228	8.89	28.0	20.5	127.3	84	44.6
	1630	--	8.91	28.0	20.5	126.1	--	--
	1645	--	8.90	28.0	20.5	120.7	--	--
	1700	231	8.87	27.8	20.4	119.4	85	43.9
	1730	--	8.89	29.0	20.2	117.7	--	--
	1745	--	8.89	29.0	20.1	116.9	--	--
	1800	231	8.85	29.0	20.0	115.7	86	44.0
	1830	--	8.83	27.8	19.7	112.8	--	--
	1845	--	8.84	27.0	19.5	111.2	--	--
	1900	233	8.79	26.8	19.5	109.3	--	44.2
	1920	--	8.77	--	--	--	--	--

**Table 6.** Water-quality data for diel investigations of the Madison River at Three Forks, Montana, August 15-17, 1990

[Site number is S58 in table 1. Constituents are reported as dissolved. Laboratory analyses and field measurements by U.S. Geological Survey. Abbreviations: °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbol: <, less than minimum reporting level; --, no data]

Sample date	Time	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Phosphorus, ortho-phosphate (mg/L as P)	Arsenic (µg/L as As)
08-15-90	1100	300	8.26	24.0	20.0	--	106	0.001	82
	1120	--	8.42	--	--	97.3	--	--	--
	1155	296	8.31	28.0	20.5	--	109	<.001	84
	1215	--	--	--	--	111.1	--	--	--
	1240	--	8.30	--	--	112.6	--	--	--
	1300	302	8.37	33.0	21.0	116.3	106	.002	83
	1337	--	8.44	--	--	--	--	--	--
	1400	305	8.48	--	21.9	122.8	106	<.001	81
	1435	--	8.52	--	--	--	--	--	--
	1500	290	8.55	34.0	22.9	128.0	105	.001	83
	1535	--	8.59	--	--	--	--	--	--
	1600	293	8.62	33.0	24.0	125.3	104	.001	84
	1630	--	8.72	--	--	--	--	--	--
	1655	295	8.72	34.0	24.4	127.3	--	.005	83
	1730	--	8.81	--	--	--	--	--	--
	1810	285	8.80	--	24.9	115.2	100	.001	84
	1840	--	8.86	--	--	--	--	--	--
	1900	293	8.83	--	24.8	113.6	100	.002	88
	1940	--	8.91	--	--	--	--	--	--
	2005	290	9.00	28.0	25.0	110.8	98	.003	86
	2030	--	8.96	--	--	--	--	--	--
	2100	288	8.97	28.0	--	--	100	.003	85
	2140	--	9.00	--	--	--	--	--	--
	2200	288	8.96	23.0	24.3	--	99	.003	87
	2235	--	8.96	--	--	99.9	--	--	--
	2300	287	8.97	23.5	24.8	--	100	.002	87
	2335	--	8.98	--	24.5	88.5	--	--	--
	2400	285	8.96	25.5	23.6	--	100	.002	88
08-16-90	0040	--	8.93	--	23.3	84.9	--	--	--
	0100	287	8.91	23.0	23.5	--	--	.002	85
	0130	--	8.87	--	22.7	83.3	--	--	--
	0155	287	8.91	20.0	22.3	--	100	.002	86
	0235	--	8.86	--	22.5	82.2	--	--	--
	0300	289	8.76	15.5	22.0	--	101	.001	85
	0330	--	8.80	--	--	--	--	--	--
	0340	--	--	--	22.0	86.1	--	--	--
	0400	291	8.73	14.5	21.0	--	102	.001	87
	0430	--	8.66	--	--	--	--	--	--
	0445	--	--	--	--	82.5	--	--	--
	0500	295	8.61	13.5	21.0	--	103	<.001	86



**Table 6.** Water-quality data for diel investigation of the Madison River at Three Forks, Montana, August 15-17, 1990  
(Continued)

Sample date	Time	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Phosphorus, ortho-phosphate (mg/L as P)	Arsenic (μg/L as As)
08-16-90 (Continued)	0530	--	8.60	--	--	--	--	-	--
	0545	--	--	--	21.0	84.8	--	--	--
	0600	293	8.59	12.5	20.5	--	103	.002	85
	0630	--	8.60	--	--	--	--	--	--
	0640	--	--	--	20.5	81.9	--	--	--
	0700	298	8.49	13.0	20.0	--	104	.001	85
	0730	--	8.48	--	--	83.9	--	--	--
	0800	298	8.41	14.5	19.7	--	105	<.001	84
	0830	--	8.38	--	--	87.5	--	--	--
	0900	299	8.38	19.0	19.6	--	105	.001	83
	0933	--	8.34	--	--	95.3	--	--	--
	1000	304	8.28	21.5	19.6	--	107	<.001	81
	1030	--	8.32	--	--	99.3	--	--	--
	1045	--	8.34	--	--	--	--	--	--
	1105	302	8.29	27.5	20.2	--	107	.001	79
	1130	--	8.37	--	--	105.4	--	--	--
	1145	--	8.37	--	--	--	--	--	--
	1200	303	8.35	33.0	21.5	--	107	.001	79
	1235	--	8.42	--	--	--	--	--	--
	1300	302	8.45	38.0	21.5	--	107	<.001	78
	1335	--	--	--	21.9	116.9	--	--	--
	1350	--	8.48	--	--	--	--	--	--
	1400	303	8.46	31.5	22.0	--	107	.001	79
	1430	--	8.53	--	--	--	--	--	--
	1445	--	8.57	--	22.3	117.7	--	--	--
	1500	297	8.58	31.0	22.5	--	107	.002	79
	1530	--	8.62	--	23.4	119.8	--	--	--
	1600	297	8.77	29.5	24.0	--	105	.001	78
	1630	--	8.65	--	23.8	123.3	--	--	--
	1700	298	8.71	29.0	--	--	105	.001	79
	1735	--	8.74	--	23.5	120.3	--	--	--
	1800	294	8.93	27.0	--	--	104	.001	81
	1830	--	8.82	--	23.2	112.1	--	--	--
	1900	299	8.93	24.5	--	--	103	.001	80
	1930	--	8.86	--	22.5	105.5	--	--	--
	2000	301	8.88	23.0	--	--	104	.002	82
	2030	--	8.89	--	22.1	108.1	--	--	--
	2100	297	8.90	21.0	22.0	--	104	.002	82
	2130	--	8.91	--	21.6	92.8	--	--	--
	2200	295	8.89	20.0	21.4	--	103	.002	83

**Table 6.** Water-quality data for diel investigation of the Madison River at Three Forks, Montana, August 15-17, 1990  
(Continued)

Sample date	Time	Specific conductance, field ( $\mu\text{S}/\text{cm}$ )	pH, field (standard units)	Temperature, air ( $^{\circ}\text{C}$ )	Temperature, water ( $^{\circ}\text{C}$ )	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as $\text{CaCO}_3$ )	Phosphorus, orthophosphate (mg/L as P)	Arsenic ( $\mu\text{g}/\text{L}$ as As)
08-16-90 (Continued)	2230	--	8.91	--	21.3	--	--	--	--
	2300	290	8.87	18.0	21.0	--	104	.002	82
	2330	--	8.88	--	--	85.9	--	--	--
	2400	288	8.86	16.5	21.0	--	102	.002	83
08-17-90	0030	--	8.82	--	20.7	85.2	--	--	--
	0100	290	8.78	16.5	20.5	--	102	.001	83
	0130	--	8.82	--	--	83.9	--	--	--
	0150	--	8.82	--	--	--	--	--	--
	0200	288	8.78	16.5	--	--	102	.001	82
	0235	--	8.75	--	20.0	81.5	--	--	--
	0300	287	8.72	16.5	--	--	103	.002	83
	0335	--	8.75	--	20.0	83.4	--	--	--
	0400	291	8.72	15.5	--	--	103	.001	82
	0430	--	8.59	--	20.0	85.4	--	--	--
	0500	294	8.55	15.0	--	--	103	.001	80
	0530	--	8.50	--	20.0	83.4	--	--	--
	0600	293	8.44	13.5	--	--	103	<.001	81
	0630	--	8.37	--	19.2	83.0	--	--	--
	0700	291	8.31	12.5	--	--	105	.001	79
	0730	--	8.31	--	19.0	84.3	--	--	--
	0800	294	8.26	14.0	--	--	106	<.001	78
	0830	--	8.22	--	18.7	87.5	--	--	--
	0900	300	8.24	17.0	18.8	--	--	.001	78
	0930	--	8.22	--	19.0	93.0	--	--	--
	1000	294	8.24	18.0	--	--	105	.001	78
	1030	--	8.24	--	19.1	99.9	--	--	--

**Table 7.** Water-quality data for diel investigations of the Madison River at Three Forks, Montana, August 19-20, 1993

[Site number is S58 in table 1. Constituents are reported as dissolved. Laboratory analyses by Montana Bureau of Mines and Geology; field measurements by U.S. Geological Survey. Abbreviations: °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C. Symbol: --, no data]

Sample date	Time	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Arsenic (µg/L as As)
08-19-93	0930	254	8.24	--	16.5	--	47.5
	1000	--	8.25	--	--	--	--
	1020	253	8.27	22.5	16.8	103.0	48.5
	1040	--	8.34	--	17.0	104.7	--
	1100	251	8.37	23.5	17.0	106.7	49.8
	1120	--	8.41	--	17.0	108.5	--
	1140	--	8.46	24.0	17.3	110.4	--
	1200	250	8.49	23.5	17.6	112.7	49.5
	1220	--	8.55	23.0	17.7	114.9	--
	1240	--	8.60	23.0	18.0	118.3	--
	1300	249	8.62	23.5	18.3	120.6	49.2
	1320	--	8.68	24.0	18.5	122.1	--
	1340	--	8.72	24.5	19.0	125.2	--
	1400	246	8.75	24.5	19.4	127.4	50.4
	1420	--	8.79	24.5	19.6	128.6	--
	1440	--	8.82	25.0	19.8	129.1	--
	1500	244	8.85	25.5	20.2	130.3	52.5
	1520	--	8.89	26.0	20.5	131.1	--
	1540	--	8.92	25.5	21.0	132.5	--
	1600	242	8.93	26.0	21.2	132.8	50.5
	1620	--	8.97	26.0	21.3	133.3	--
	1700	242	9.01	26.5	21.7	133.6	51.9
	1720	--	9.05	26.5	21.9	133.6	--
	1740	--	9.07	26.5	22.0	132.3	--
	1800	240	9.09	26.3	22.2	130.3	50.5
	1820	--	9.11	26.0	22.5	129.7	--
	1840	--	9.12	26.0	22.3	127.2	--
	1900	241	9.12	25.5	22.5	124.0	52.5
	1920	--	9.15	24.0	22.5	122.5	--
	1940	--	9.16	--	22.5	118.9	--
	2000	240	9.16	25.5	22.4	115.6	51.6
	2025	--	9.15	23.5	22.4	112.7	--
	2040	--	9.17	22.3	22.3	109.3	--
	2100	242	9.16	21.3	22.2	104.0	53.7
	2120	--	9.18	20.5	22.1	100.9	--
	2140	--	9.17	21.0	21.9	97.9	--
	2200	243	9.14	20.7	22.0	96.4	54.2
	2220	--	9.14	20.3	21.9	93.9	--
	2240	--	9.14	19.5	21.7	92.0	--
	2300	244	9.12	19.5	21.9	90.7	53.4
	2320	--	9.11	18.5	21.7	88.6	--
	2340	--	9.08	17.8	21.7	87.4	--
	2400	245	9.07	17.5	21.6	86.5	52.6
08-20-93	0020	--	9.06	17.0	21.5	86.1	--
	0040	--	9.02	16.7	21.4	83.8	--

**Table 7.** Water-quality data for diel investigations of the Madison River at Three Forks, Montana, August 19-20, 1993  
(Continued)

Sample date	Time	Specific conductance, field ( $\mu\text{S}/\text{cm}$ )	pH, field (standard units)	Tem- perature, air ( $^{\circ}\text{C}$ )	Tem- perature, water ( $^{\circ}\text{C}$ )	Oxygen, field (percent saturation)	Arsenic ( $\mu\text{g}/\text{L}$ as As)
08-20-93 (Continued)	0100	247	8.99	16.4	21.2	82.8	51.6
	0120	--	8.98	15.8	21.1	82.6	--
	0140	--	8.95	16.2	20.9	81.7	--
	0200	248	8.93	17.3	20.8	81.3	51.9
	0220	--	8.90	16.8	20.7	81.3	--
	0240	--	8.89	16.4	20.6	81.1	--
	0300	248	8.86	16.6	20.5	80.9	51.9
	0500	252	8.68	12.5	19.0	79.7	51.7
	0520	--	8.65	12.5	19.0	80.7	--
	0540	--	8.57	12.5	19.0	80.7	--
	0600	253	8.52	12.0	19.0	80.9	50.7
	0620	--	8.47	11.5	18.8	80.6	--
	0640	--	8.42	11.0	18.5	80.4	--
	0700	254	8.36	11.5	18.5	81.4	48.8
	0720	--	8.31	11.7	18.5	82.0	--
	0740	--	8.26	12.5	18.3	82.3	--
	0800	256	8.26	13.0	18.3	84.2	49.6
	0820	--	8.23	13.7	18.3	85.4	--
	0840	--	8.25	14.7	18.3	87.3	--
	0900	258	8.26	16.5	18.3	90.3	48.0
	0920	--	8.25	16.9	18.3	92.8	--
	0940	--	8.27	18.6	18.3	95.7	--
	1000	255	8.32	19.7	18.3	100.5	47.1
	1020	--	8.34	19.8	18.3	103.7	--
	1040	--	8.38	21.2	18.3	106.2	--
	1100	253	8.42	22.0	18.5	108.0	47.6
	1120	--	8.45	22.0	18.5	110.5	--
	1140	--	8.49	23.5	18.8	113.2	--
	1200	251	8.54	25.0	19.0	117.1	48.0
	1220	--	8.58	26.0	19.3	118.8	--
	1240	--	8.63	27.5	19.3	120.3	--
	1300	248	8.66	26.0	19.5	122.2	47.4
	1320	--	8.70	27.0	19.5	123.4	--
	1340	--	8.74	28.0	19.8	125.3	--
	1400	247	8.76	27.5	20.3	129.2	48.5
	1420	--	8.81	27.3	20.5	131.1	--
	1440	--	8.84	28.5	20.8	131.8	--
	1500	245	8.86	30.5	21.0	132.5	49.9
	1520	--	8.91	30.0	21.0	132.5	--
	1540	--	8.94	30.0	21.3	132.7	--
	1600	244	8.95	31.5	21.5	133.6	49.8
	1620	--	8.98	31.5	21.8	134.0	--
	1640	--	9.00	30.0	21.8	133.4	--
	1700	244	9.02	31.5	22.0	132.6	49.9
	1720	--	9.04	30.5	22.0	131.6	--
	1740	--	9.06	28.0	22.0	126.0	--
	1800	245	9.06	26.5	22.2	124.0	49.1
	1820	--	9.08	25.0	22.2	122.0	--
	1840	--	--	25.5	22.2	118.7	--
	1900	245	9.10	24.5	22.2	116.7	50.2

**Table 8.** Water-quality data for diel investigations of the Missouri River at Toston, Montana, September 1-2, 1991

[Site number is S63 in table 1. Constituents are reported as dissolved. Laboratory analyses and field measurements by U.S. Geological Survey.

Abbreviations: ft<sup>3</sup>/s, cubic feet per second; °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbol: --, no data]

Sample date	Time	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Arsenic (µg/L as As)
09-01-91	1100	1,510	335	8.97	27.5	21.5	121.0	122	68
	1200	1,520	334	--	29.0	22.0	126.7	122	--
	1300	1,540	333	8.98	30.0	23.0	130.5	122	70
	1400	1,520	332	--	32.5	23.0	130.7	123	67
	1500	1,550	333	9.02	34.0	23.0	130.0	123	74
	1600	1,550	332	9.02	33.5	23.0	127.5	123	73
	1700	1,530	333	8.99	32.5	23.0	121.5	125	67
	1800	1,510	335	8.94	28.5	21.5	107.6	123	67
	1830	--	--	8.90	--	--	--	--	--
	1900	1,510	338	8.87	29.0	21.5	100.4	125	70
	1930	--	--	8.82	--	--	--	--	--
	2000	1,500	341	8.80	27.0	21.0	90.8	125	70
	2030	--	--	8.76	--	--	--	--	--
	2100	1,500	340	8.74	24.0	20.0	84.0	126	65
	2200	1,500	345	8.70	22.0	20.0	78.9	126	60
	2300	1,510	345	8.67	21.0	20.0	78.9	126	69
	2400	1,510	344	8.65	20.0	19.5	77.8	126	64
09-02-91	0100	1,510	345	8.63	19.5	19.5	79.2	126	71
	0200	1,510	343	8.63	18.0	19.0	78.4	125	65
	0445	1,490	346	8.62	17.0	19.0	77.0	126	61
	0530	--	--	8.63	--	--	--	--	--
	0600	1,500	347	8.63	16.0	19.0	77.7	125	67
	0700	1,500	346	8.65	15.0	19.0	80.6	126	71
	0800	1,500	346	8.69	14.0	19.0	85.6	125	68
	0830	--	--	8.74	--	--	--	--	--
	0900	1,500	344	8.80	17.0	19.5	97.1	123	64
	0930	1,490	345	8.85	18.0	20.0	--	125	67
	1000	1,480	342	8.89	18.0	20.5	110.2	--	70
	1030	--	--	8.93	--	--	--	--	--
	1100	1,480	343	8.96	18.5	20.5	114.5	124	66
	1200	1,480	341	8.98	21.0	22.0	127.6	124	69
	1230	--	--	9.00	--	--	--	--	--
	1300	1,480	341	8.99	21.5	22.0	127.6	124	66
	1400	1,490	341	9.00	23.0	22.5	129.5	124	66
	1500	1,490	341	9.00	22.5	24.0	130.1	125	63
	1600	1,500	343	8.98	24.0	22.5	124.4	125	61
	1700	1,500	343	8.95	23.5	22.0	117.3	126	65
	1800	1,510	344	8.91	24.5	21.5	112.0	126	67
	1900	1,500	347	8.84	23.5	20.5	100.2	127	65
	1930	--	--	8.80	--	--	--	--	--
	2000	1,520	350	8.76	22.5	19.5	88.9	128	--
	2030	--	--	8.72	--	--	--	--	--

**Table 9. Water-quality data for diel investigations of the Missouri River at Virgelle, Montana, September 4-6, 1991**

[Site number is S104 in table 1. Constituents are reported as dissolved. Laboratory analyses and field measurements by U.S. Geological Survey. Abbreviations: ft<sup>3</sup>/s, cubic feet per second; °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbol: --, no data]

Sample date	Time	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Arsenic (µg/L as As)
09-04-91	1530	--	--	8.85	--	20.5	--	--	--
	1600	7,010	--	8.87	28.0	20.5	123.8	143	13
	1630	7,010	--	8.90	28.0	20.5	--	144	16
	1700	7,010	439	--	28.0	20.5	123.8	--	14
	1730	--	439	8.91	--	--	--	--	--
	1800	6,980	440	--	25.0	20.5	122.8	144	14
	1830	--	440	--	20.4	20.4	--	--	--
	1900	6,950	439	--	25.0	20.4	116.5	143	14
	1930	--	440	--	20.5	20.3	--	--	--
	2000	6,890	441	--	18.0	20.0	111.3	144	14
	2030	--	442	--	16.0	20.0	--	--	--
	2100	6,840	444	--	16.5	20.0	109.5	144	14
	2130	--	445	--	16.0	19.5	--	--	--
	2200	6,780	445	--	16.0	19.5	105.4	143	15
	2230	--	445	--	16.0	19.5	--	--	--
	2300	6,750	448	--	11.0	19.0	102.4	144	14
	2330	--	448	--	11.0	19.0	--	--	--
	2400	6,730	449	--	11.0	19.0	100.1	145	14
09-05-91	0030	--	450	--	10.0	18.5	--	--	--
	0100	6,700	449	--	9.0	18.5	97.3	145	14
	0130	--	450	--	9.0	--	--	--	--
	0200	6,670	451	--	8.5	18.5	96.0	145	16
	0230	--	451	--	8.5	18.5	--	--	--
	0300	6,670	452	8.73	7.5	18.0	94.6	144	13
	0330	--	452	8.73	7.5	18.0	--	--	--
	0400	6,670	453	8.71	7.0	18.0	91.7	145	14
	0430	--	453	8.72	6.5	17.5	--	--	--
	0500	6,670	454	8.71	6.0	17.5	92.6	146	14
	0530	--	453	8.72	6.0	17.5	--	--	--
	0600	6,700	454	8.72	5.0	17.5	93.2	147	13
	0630	--	455	8.71	4.5	17.5	--	--	--
	0700	6,750	455	8.70	4.5	17.5	92.6	147	13
	0730	--	455	8.70	5.5	17.0	--	--	--
	0800	6,870	455	8.73	7.0	17.0	92.6	148	13
	0900	6,950	453	8.74	9.0	17.0	95.0	--	13
	0930	--	452	8.75	12.5	17.0	--	--	--
	1000	7,010	452	8.76	14.5	17.5	98.3	146	13
	1030	--	451	8.78	16.0	17.5	--	--	--
	1100	7,040	452	8.81	18.0	17.5	101.9	146	13
	1130	--	451	8.83	19.5	17.5	--	--	--
	1230	--	448	8.83	23.0	18.5	--	--	--
	1300	6,980	444	8.83	23.0	18.5	108.7	145	14
	1330	--	445	8.84	23.5	18.5	--	--	--
	1400	6,950	444	8.84	26.0	19.0	114.1	145	14
	1430	--	444	8.87	25.5	19.0	--	--	--

**Table 9.** Water-quality data for diel investigations of the Missouri River at Virgelle, Montana, September 4-6, 1991 (Continued)

Sample date	Time	Discharge, instantaneous (ft <sup>3</sup> /s)	Specific conductance, field (μS/cm)	pH, field (standard units)	Temperature, air (°C)	Temperature, water (°C)	Oxygen, field (percent saturation)	Alkalinity, field (mg/L as CaCO <sub>3</sub> )	Arsenic (μg/L as As)
09-05-91 (Continued)	1500	6,890	442	8.87	25.5	19.5	117.9	146	15
	1530	--	440	8.90	26.0	19.5	--	--	--
	1600	--	441	8.92	26.0	19.5	120.9	--	15
	1700	6,870	440	8.92	26.0	19.5	121.4	143	15
	1730	--	440	8.94	26.0	20.0	--	--	--
	1800	6,870	438	8.94	26.0	20.0	122.1	143	16
	1830	--	438	8.95	26.0	20.0	--	--	--
	1900	6,840	440	8.95	24.5	20.0	118.6	143	13
	1930	--	440	8.95	23.5	19.5	--	--	--
	2000	6,840	441	8.91	22.0	19.5	112.8	144	14
	2030	6,840	443	8.93	20.0	19.5	--	143	--
	2130	--	444	8.91	19.5	19.0	--	--	--
	2200	6,840	445	8.90	19.5	19.0	105.6	142	14
	2230	--	445	8.89	19.5	19.0	--	--	--
	2300	6,840	446	8.87	19.5	18.5	101.7	144	14
09-06-91	2330	--	446	8.86	19.5	18.5	--	--	--
	2400	6,840	447	8.83	19.0	18.5	99.9	145	15
	0030	--	448	8.82	19.0	18.0	--	--	--
	0100	6,840	449	8.80	18.5	18.5	97.6	145	15
	0130	--	449	8.77	18.0	18.5	--	--	--
	0200	6,840	450	8.75	17.0	18.5	96.4	146	--
	0230	--	451	8.73	16.5	18.5	--	--	--
	0300	6,840	451	8.72	15.0	18.5	95.4	--	13
	0330	--	452	8.72	14.0	18.0	--	--	--
	0400	6,840	453	8.72	12.5	18.0	93.8	147	14
	0430	--	453	8.73	11.5	17.5	--	--	--
	0500	6,840	454	8.71	10.0	17.5	92.1	146	14
	0530	--	454	8.69	9.0	17.5	--	--	--
	0600	6,870	455	8.69	8.0	17.5	91.7	147	13
	0630	--	455	8.69	8.0	17.5	--	--	--
	0700	6,870	455	8.68	7.5	17.5	97.9	146	13
	0800	6,890	455	8.69	10.0	17.5	94.0	146	13
	0830	--	455	8.69	11.0	17.0	--	--	--
	0900	6,890	454	8.67	13.0	17.0	94.6	147	13
	0930	--	454	8.69	15.5	17.3	--	--	--
	1000	6,890	453	8.72	18.0	17.5	97.9	--	13
	1030	--	--	8.74	--	--	--	--	--





**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana

Location number-- described in text.

Geologic unit--Qal, alluvial deposits (Quaternary); Ts, sedimentary deposits (Tertiary); QAb bedrock (Quaternary to Archean).

Altitude of land surface--in feet above sea level.

Primary use of water--C, commercial; H, domestic; I, irrigation; N, industrial; P, public supply; S, stock; U, unused.

Depth of well--in feet below land surface.

Type of finish--F, gravel perforated; G, screen with gravel; O, open end; P, perforated or slotted; S, screen; T, sand point; X, open hole.

Top of open interval--in feet below land surface.

Water level--in feet below or above (+) land surface.

Source of water-level data--A, other government agency; D, driller; O, owner; R, Montana Bureau of Mines and Geology or Montana Department of Environmental Quality; S, U.S. Geological Survey.

Source of discharge data--A, other government agency; D, driller; O, owner; R, Montana Bureau of Mines and Geology or Montana Department of Environmental Quality; S, U.S. Geological Survey.

Source of water-quality data--MBMG, Montana Bureau of Mines and Geology; USGS, U.S. Geological Survey.

Abbreviations--°C, degrees Celsius; gal/min, gallons per minute;  $\mu$ S/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter.

Symbols: -, or --, no data.

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>									
04S01W30BA 01	Ts	5,075	H	101	O	--	09-15-91	43.09	S
05S01W03ACCC01	Ts	4,850	H	126	-	--	07-22-93	61.65	S
05S01W04ABDD01	Ts	4,895	H	67	O	--	08-11-93	17.17	S
05S01W04ACBC01	Ts	4,905	H	60	-	--	07-23-93	14.52	S
05S01W04BAAB01	Qal	4,905	H	38	O	--	09-24-92	10.85	S
05S01W04DBAB01	Ts	4,895	H	68	P	60	--	--	-
05S01W04DDDB01	Qal	4,900	H	117	O	--	09-12-91	71.77	S
05S01W08ACBB01	Ts	4,980	H	60	-	--	--	--	-
05S01W10BADC01	Ts	4,885	H	160	-	--	--	--	-
05S01W17AAAA01	Ts	4,935	S	193	P	27	09-12-91	3.30	S
05S01W21CCCC01	Qal	4,970	S	33	O	--	09-22-92	16.54	S
05S01W23DABA01	Qal	4,890	H	44	P	35	09-12-91	21.80	S
05S01W28BACB01 <sup>1</sup>	Qal	4,910	S	--	-	--	09-22-92	7.39	S
05S01W28DBDD01	QAb	4,925	C	956	X	474	--	--	-
05S01W28DCBA01	Ts	4,930	U	46	-	--	07-22-93	20.08	S
05S01W28DCCB01	Ts	4,922	H	53	O	--	04-04-89	26	D
05S01W33BADB01	Ts	4,930	H	80	O	--	09-05-78	20	D
05S01W33CBCB01	Qal	4,950	P	84	O	--	09-11-91	9.24	S
06S02W13CDCD01	Ts	5,370	H	83	O	--	09-26-91	52.88	S
06S02W24BACD01	Ts	5,380	H	341	O	--	09-27-91	63.78	S
06S02W36DAAD01	Ts	5,190	H	100	O	--	09-27-91	5.68	S
06S01W02CBCB01	Qal	4,963	H	60	-	--	--	--	-
06S01W03AABA01	Qal	4,930	H	26	-	--	09-01-93	6.47	S
06S01W03ABAB01	Qal	4,925	H	20	-	--	--	--	-
06S01W03ABAC01	Qal	4,925	H	86	-	--	--	--	-
06S01W03CDAD01	Qal	4,955	H	34	O	--	08-23-74	5	D
06S01W03DAAA01	Qal	4,955	H	27	-	--	--	--	-
06S01W04AABB01	Qal	4,932	I	40	-	--	07-22-93	3.30	S
06S01W04ACCB01	Ts	4,960	P	164	P	100	08-24-60	13	D
06S01W04CCDB01	Ts	4,995	H	74	P	54	09-02-93	12.17	S
06S01W05AAAA01	Qal	4,975	H	65	-	--	07-21-93	21.63	S
06S01W05ACBD01	Ts	5,095	H	240	P	210	09-10-91	119.99	S
06S01W06DDA 01	Ts	5,245	H	228	P	222	09-11-91	122.67	S
06S01W08CADD01	Ts	5,145	H	162	O	--	09-05-85	35	D
06S01W08DABD01	Qal	5,010	H	50	P	40	09-24-91	15.85	S
06S01W09BBCA01	Ts	5,005	I	90	O	--	07-22-93	17.37	S
06S01W10ABAC01	Qal	4,170	I	30	-	--	--	--	-
06S01W10BAAA01	Qal	4,960	H	34	-	--	--	--	-
06S01W17CDDA01	Qal	5,035	H	58	P	38	07-23-93	11.05	S
06S01W23BBAC01	Qal	5,095	H	37	O	--	07-09-91	10	D

Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu$ S/cm)	pH, field (standard units)	Water temper- ature, field (°C)	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>								
12	D	300	7.4	11.0	1.1	09-15-91	USGS	04S01W30BA 01
--	-	458	8.1	11.0	.9	07-22-93	USGS	05S01W03ACCC01
18	D	468	7.4	14.0	--	08-11-93	USGS	05S01W04ABDD01
8	S	475	7.7	9.5	1.1	07-23-93	USGS	05S01W04ACBC01
25	D	424	7.3	10.0	--	09-24-92	USGS	05S01W04BAAB01
24	D	508	7.8	10.0	1.2	07-22-93	USGS	05S01W04DBAB01
30	D	283	8.0	11.5	.7	09-12-91	USGS	05S01W04DDDB01
--	-	780	7.0	9.5	--	08-10-93	USGS	05S01W08ACBB01
--	-	569	7.9	12.5	1.4	07-23-93	USGS	05S01W10BADC01
6	D	--	--	--	--	--	USGS	05S01W17AAAA01
--	-	--	--	--	--	--	USGS	05S01W21CCCC01
30	D	337	7.1	10.0	1.7	09-12-91	USGS	05S01W23DABA01
10	S	563	7.9	14.0	--	09-22-92	USGS	05S01W28BACB01 <sup>1</sup>
75	A	--	--	89.5	--	09-24-91	USGS	05S01W28DBDD01
--	-	--	--	--	--	--	USGS	05S01W28DCBA01
20	D	458	7.6	12.5	--	07-20-93	USGS	05S01W28DCCB01
5	D	400	8.0	13.0	--	07-20-93	USGS	05S01W33BADB01
30	D	248	7.9	13.0	1.1	09-11-91	USGS	05S01W33CBCB01
30	D	426	--	10.5	1.2	09-26-91	USGS	06S02W13CDCD01
10	D	417	7.1	14.0	2.5	10-27-91	USGS	06S02W24BACD01
10	D	461	--	10.0	1.0	09-27-91	USGS	06S02W36DAAD01
--	-	491	7.8	11.0	1.5	07-21-93	USGS	06S01W02CBCB01
--	-	572	7.6	9.5	--	09-01-93	USGS	06S01W03AABA01
--	-	559	7.7	9.0	1.4	06-23-93	USGS	06S01W03ABAB01
--	-	582	7.5	11.0	--	08-12-93	USGS	06S01W03ABAC01
60	D	414	7.8	10.0	1.3	07-22-93	USGS	06S01W03CDAD01
--	-	592	7.5	10.5	1.1	07-23-93	USGS	06S01W03DAAA01
11	S	475	7.4	11.0	1.3	07-22-93	USGS	06S01W04AABB01
200	D	--	--	--	--	--	USGS	06S01W04ACCB01
20	D	378	7.6	11.5	--	09-02-93	USGS	06S01W04CCDB01
1.6	S	457	7.5	14.0	.5	07-21-93	USGS	06S01W05AAAA01
--	-	736	--	16.0	1.6	09-10-91	USGS	06S01W05ACBD01
5	D	774	--	12.5	.9	09-11-91	USGS	06S01W06DDA 01
13	D	443	7.9	11.0	--	09-22-92	USGS	06S01W08CADD01
8.0	S	374	--	13.5	.4	09-24-91	USGS	06S01W08DABD01
15	D	404	7.8	12.0	.9	07-22-93	USGS	06S01W09BBCA01
--	-	594	7.6	9.0	--	07-20-93	USGS	06S01W10ABAC01
--	-	403	7.7	11.0	.5	07-21-93	USGS	06S01W10BAAA01
20	D	424	7.9	11.5	1.5	07-23-93	USGS	06S01W17CDDA01
40	D	489	7.8	10.0	--	09-22-92	USGS	06S01W23BBAC01

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY--Continued</b>									
06S01W23BBBA01	Ts	5,090	H	170	O	--	09-16-91	+19	S
06S01W30DADD01	Qal	5,080	H	72	-	--	07-21-93	26.12	S
06S01W34DDDA01	Ts	5,255	S	127	O	--	07-21-93	94.65	S
06S01W35DAAB01	Ts	5,200	U	72	O	--	09-16-91	42.62	S
06S01E31CAAC01	Ts	5,330	H	168	P	159	09-12-91	148.00	S
07S01W03CAB 01	Ts	5,260	U	138	O	--	09-16-91	112.71	S
07S01W06BBAC01	Ts	5,155	H	72	-	--	--	--	-
07S01W07DBCD01	Ts	5,300	H	204	O	--	09-25-91	126.50	S
07S01W12DBBC01	Ts	5,285	H	--	-	--	--	--	-
07S01W17BBBB01	Ts	5,190	H	100	-	--	--	--	-
07S01W17BCBD01	Ts	5,205	H	94	P	83	12-01-86	47	D
07S01W18DDAC01	Qal	5,260	H	71	P	51	09-24-91	51.87	S
07S01W20CBAA01	Qal	5,240	H	68	-	--	09-21-92	28.30	S
07S01W23ABBA01	Ts	5,335	U	175	O	--	09-16-91	144.05	S
07S01W26AAAA01	Ts	5,375	P	122	O	--	10-29-70	30	D
07S01W34AAC 01	Ts	5,415	U	225	O	--	09-25-91	196.65	S
08S01W25BBC 01	Qal	5,450	H	80	O	--	09-17-91	38.83	S
<b>LOWER MADISON RIVER VALLEY</b>									
02N01E08DDCA01	Ts	4,330	H	171	P	166	06-14-78	95	D
02N01E17DAAD01	Ts	4,275	H	79	P	38	11-06-75	20	D
02N01E24BADA01	Qal	4,075	H	21	-	--	--	--	-
02N01E24DDA 01	Qal	4,080	S	47	-	--	--	--	-
02N01E24DDAA01	Qal	4,055	H	20	-	--	--	--	-
02N01E25AACC01	Ts	4,060	H	89	P	62	09-11-73	7.0	D
02N01E25AB 01	Qal	4,060	S	22	S	1	07-02-84	4.80	R
02N01E25BDBB01	Qal	4,160	S	50	O	--	--	--	-
02N01E26AA 01	Qal	4,060	P	30	P	5	- -84	3.2	D
02N01E26DCDC01	Qal	4,190	H	--	-	--	--	--	-
02N01E27BCCB01	Qal	4,095	H	50	-	--	--	--	-
02N01E27CBD 01	Qal	4,090	H	20	-	--	--	--	-
02N01E34AAAD01	Qal	4,080	H	15	-	--	--	--	-
02N01E34AABA01	Qal	4,180	H	--	-	--	--	--	-
02N01E35BABA01	Qal	4,080	H	27	S	23	06-15-71	6	D
02N01E35BABA02	Qal	4,080	H	21	P	19	--	--	-
02N01E36BCBD01	Ts	4,070	N	266	S	205	11-09-83	88	D
02N01E36BCDD01	Qal	4,075	N	30	-	--	02-27-79	7	D
02N01E36CBA 01	Qal	4,070	N	33	-	--	--	--	-
02N02E09CBDA01	Qal	4,420	P	25	O	--	09-20-66	16	D

Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu$ S/cm)	pH, field (standard units)	Water temper- ature, field (°C)	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY—Continued</b>								
60	D	286	--	12.5	.7	09-16-91	USGS	06S01W23BBBA01
8.0	S	411	7.8	13.0	1.3	07-21-93	USGS	06S01W30DADD01
12	D	--	--	--	--	--	USGS	06S01W34DDDA01
30	D	--	--	--	--	--	USGS	06S01W35DAAB01
19	D	711	7.0	14.5	.7	09-12-91	USGS	06S01E31CAAC01
15	D	--	--	--	--	--	USGS	07S01W03CAB 01
--	-	476	7.6	13.0	--	09-21-92	USGS	07S01W06BBAC01
.8	D	579	--	11.5	1.5	09-24-91	USGS	07S01W07DBCD01
--	-	326	7.9	9.5	--	09-25-92	USGS	07S01W12DBBC01
--	-	452	7.5	11.5	--	08-11-93	USGS	07S01W17BBBB01
25	D	477	7.7	11.5	.7	08-19-92	USGS	07S01W17BCBD01
25	D	--	--	--	--	--	USGS	07S01W18DDAC01
--	-	549	7.4	8.5	--	09-21-92	USGS	07S01W20CBAA01
36	D	--	--	--	--	--	USGS	07S01W23ABBA01
10	D	--	--	--	--	--	USGS	07S01W26AAAA01
24	D	--	--	--	--	--	USGS	07S01W34AAC 01
60	D	299	7.8	12.0	.3	09-17-91	USGS	08S01W25BBC 01
<b>LOWER MADISON RIVER VALLEY</b>								
30	D	2,270	--	--	--	11-10-83	MBMG	02N01E08DDCA01
25	D	2,730	--	--	--	11-10-83	MBMG	02N01E17DAAD01
--	-	--	--	--	--	--	MBMG	02N01E24BADA01
--	-	613	--	12.0	--	11-11-87	MBMG	02N01E24DDA 01
--	-	599	--	--	--	11-14-83	MBMG	02N01E24DDAA01
20	D	479	--	10.5	--	11-09-83	MBMG	02N01E25AACC01
--	-	304	--	10.0	--	07-02-84	MBMG	02N01E25AB 01
--	-	494	--	--	--	11-16-83	MBMG	02N01E25BDBB01
24	D	425	--	9.0	--	07-02-84	MBMG	02N01E26AA 01
--	-	--	--	--	--	--	MBMG	02N01E26DCDC01
--	-	1,110	--	--	--	11-09-83	MBMG	02N01E27BCCB01
--	-	533	--	--	--	11-10-83	MBMG	02N01E27CBD 01
--	-	595	--	--	--	11-09-83	MBMG	02N01E34AAAD01
--	-	858	--	11.5	--	11-16-83	MBMG	02N01E34AABA01
20	D	1,630	--	--	--	11-11-83	MBMG	02N01E35BABA01
--	-	771	--	--	--	11-11-83	MBMG	02N01E35BABA02
130	D	1,280	--	10.5	--	11-09-83	MBMG	02N01E36BCBD01
30	D	811	--	--	--	11-08-83	MBMG	02N01E36BCDD01
--	-	1,300	--	--	--	11-09-83	MBMG	02N01E36CBA 01
30	D	426	--	--	--	11-14-83	MBMG	02N02E09CBDA01

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>LOWER MADISON RIVER VALLEY--Continued</b>									
02N02E17DDCC01	Ts	4,050	S	55	O	--	05-29-76	4	D
02N02E19CBCC01	Qal	4,080	H	26	-	--	--	--	-
02N02E19CCAB01	Qal	4,080	H	--	-	--	--	--	-
02N02E19CCB 01	Qal	4,080	H	20	O	--	12-30-63	6	O
02N02E19CCCB01	Qal	4,080	H	20	O	--	05-08-72	5	D
02N02E19CCCB02	Qal	4,080	I	12	O	--	05-20-73	3	D
02N02E20CABC01	Qal	4,050	S	30	-	--	--	--	-
02N02E20CBDC01	Qal	4,049	H	--	-	--	--	--	-
02N02E20CCAA01	Qal	4,050	H	--	-	--	--	--	-
02N02E20CDAC01	Qal	4,050	H	12	-	--	12-30-63	5	O
02N02E20DAC 01	Qal	4,059	H	30	-	--	12-27-63	10	O
02N02E20DDCB01	Qal	4,060	H	80	P	40	09-24-92	8.46	S
02N02E21ACDB01	Qal	4,058	H	25	O	--	07- -58	6	D
02N02E22CCC 01	Qal	4,067	H	60	-	--	12-30-63	10	O
02N02E27CADD01	Qal	4,080	H	60	O	--	01-22-53	8	D
02N02E27CBC 01	Qal	4,079	H	33	O	--	01-23-86	7.6	D
02N02E27DCA 01	Qal	4,089	S	29	-	--	12-27-63	16	O
02N02E27DCA 02	Qal	4,089	H	33	-	--	12-27-63	16	O
02N02E27DCB 01	Qal	4,084	H	56	O	--	07-18-52	20	D
02N02E28BC 01	Qal	4,065	H	48	P	43	12-02-83	5	D
02N02E28BCD 01	Ts	4,065	H	49	O	--	12-07-83	6	D
02N02E28CADC01	Qal	4,077	U	20	S	17	09-25-92	3.32	S
02N02E28CADC02	Qal	4,077	U	41	S	38	06-25-91	3.35	S
02N02E28CADC03	Qal	4,077	U	55	S	53	05-25-91	3.80	S
02N02E28CADC04	Ts	4,077	H	245	S	235	06-25-91	3.32	S
02N02E28CBDD01	Qal	4,050	H	50	O	--	11-29-83	6	D
02N02E29AD 01	Qal	4,065	H	37	O	--	05-20-86	5	D
02N02E29BABD01	Qal	4,050	H	27	O	--	02-15-80	4	D
02N02E29BABD02	Ts	4,050	H	100	P	60	02-14-86	8	D
02N02E29DD 01	Qal	4,078	H	30	O	--	--	--	-
02N02E30CDAA01	Ts	4,071	H	50	O	--	07-14-93	5.59	S
02N02E32AAAA01	Qal	4,079	H	25	-	--	--	--	-
02N02E32AAAA02	Qal	4,079	H	75	-	--	--	--	-
02N02E35BBB 01	QAb	4,120	H	--	-	--	--	--	-
02N02E35DCD 01	Qal	4,441	H	29	O	--	11-05-87	6	A
01N01E04BCDC01	Ts	4,170	H	141	-	--	--	--	-
01N02E04CB 01	Qal	4,105	S	21	-	--	--	--	-
01N02E04DCCC01	Qal	4,118	H	44	O	--	06-13-84	5	D
01N02E06BCBA01	Ts	4,250	S	176	P	160	05-29-91	83.29	S
01N02E06DAA 01	Qal	4,100	S	40	P	29	10-15-76	4.5	D

Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu$ S/cm)	pH, field (standard units)	Water temper- ature, field (°C)	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
<b>LOWER MADISON RIVER VALLEY—Continued</b>								
10	D	444	7.8	10.5	--	05-04-89	MBMG	02N02E17DDCC01
--	-	611	--	12.5	--	11-11-87	MBMG	02N02E19CBCC01
--	-	832	--	11.0	--	11-11-87	MBMG	02N02E19CCAB01
--	-	848	--	13.0	--	11-11-87	MBMG	02N02E19CCB 01
--	-	981	--	9.5	--	11-09-87	MBMG	02N02E19CCCB01
--	-	907	--	13.0	--	11-09-87	MBMG	02N02E19CCCB02
--	-	597	7.6	15.0	--	05-03-89	MBMG	02N02E20CABC01
--	-	566	--	14.0	--	11-06-87	MBMG	02N02E20CBDC01
--	-	548	7.4	10.5	--	05-02-89	MBMG	02N02E20CCAA01
--	-	570	7.3	10.0	--	05-03-89	MBMG	02N02E20CDAC01
6.5	O	421	7.6	16.0	--	05-02-89	MBMG	02N02E20DAC 01
20	D	469	7.8	8.5	--	09-24-92	USGS	02N02E20DDCB01
55	D	714	7.8	10.0	--	08-30-93	USGS	02N02E21ACDB01
--	-	416	--	11.0	--	11-09-87	MBMG	02N02E22CCC 01
--	-	425	--	11.5	--	11-09-87	MBMG	02N02E27CADD01
20	D	658	--	12.0	--	11-05-87	MBMG	02N02E27CBC 01
--	-	591	--	10.0	--	11-09-87	MBMG	02N02E27DCA 01
--	-	603	--	12.0	--	11-09-87	MBMG	02N02E27DCA 02
30	D	453	--	11.0	--	11-09-87	MBMG	02N02E27DCB 01
30	D	785	--	14.0	--	11-05-87	MBMG	02N02E28BC 01
30	D	801	--	12.0	--	11-05-87	MBMG	02N02E28BCD 01
--	-	737	7.2	10.0	--	09-17-93	USGS	02N02E28CADC01
--	-	727	7.1	9.5	--	08-31-94	USGS	02N02E28CADC02
--	-	710	7.2	13.0	--	08-31-94	USGS	02N02E28CADC03
99	D	603	7.9	10.0	--	08-31-94	USGS	02N02E28CADC04
30	D	925	7.6	11.0	--	05-04-89	MBMG	02N02E28CBDD01
20	D	468	--	11.0	--	11-05-87	MBMG	02N02E29AD 01
23	D	753	--	9.5	--	11-15-83	MBMG	02N02E29BABD01
15	D	573	7.7	10.0	--	05-03-89	MBMG	02N02E29BABD02
--	-	505	--	10.0	--	11-10-87	MBMG	02N02E29DD 01
35	D	637	7.7	7.5	1.1	07-14-93	USGS	02N02E30CDAA01
--	-	523	--	9.0	--	11-10-87	MBMG	02N02E32AAAA01
--	-	523	--	9.0	--	11-10-87	MBMG	02N02E32AAAA02
--	-	--	--	--	--	--	MBMG	02N02E35BBB 01
--	-	367	--	10.5	--	11-05-87	MBMG	02N02E35DCD 01
--	-	--	--	--	--	--	MBMG	01N01E04BCDC01
--	-	480	--	6.5	--	05-20-88	MBMG	01N02E04CB 01
50	D	677	--	11.0	--	06-13-84	MBMG	01N02E04DCCC01
25	D	782	7.8	10.0	.7	05-29-91	USGS	01N02E06BCBA01
45	D	757	--	12.0	--	11-15-83	MBMG	01N02E06DAA 01

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>LOWER MADISON RIVER VALLEY—Continued</b>									
01N02E07AACA01	Ts	4,170	S	79	O	--	05-30-91	56.42	S
01N02E10DBAB01	Ts	4,135	H	45	-	--	--	--	-
01N02E15DCBB01	Ts	4,160	H	40	O	--	11-24-70	6	D
01N02E15DCBD01	Ts	4,185	S	80	-	--	--	--	-
01N02E15DD 01	Ts	4,280	H	102	O	--	09-04-79	71	D
01N02E16CBD 01	Qal	4,150	H	--	-	--	--	--	-
01N02E19CDD01	Ts	4,384	U	303	P	240	08-31-73	220	D
01N02E20AC 01	Ts	4,220	H	92	P	76	04-04-73	42	D
01N02E20ADDB01	Qal	4,155	H	60	O	--	07-15-93	5.15	S
01N02E21ABBA01	Qal	4,145	H	32	O	--	--	--	-
01N02E21ABBB01	Qal	4,148	H	--	-	--	--	--	-
01N02E22ABB 01	Ts	4,225	H	78	O	--	04-10-84	55	D
01N02E22ABBB01	Ts	4,185	H	58	O	--	08-18-74	27	D
01N02E22BABA01	Qal	4,145	S	12	-	--	08-10-93	3.70	S
01N02E22BADD01	Ts	4,200	H	79	O	--	05-28-91	47.02	S
01N02E22CA 01	Ts	4,155	H	73	O	--	07-18-78	35	D
01N02E22CABD01	Ts	4,190	S	108	-	--	12-14-63	32	O
01N02E22CDC01	Ts	4,190	H	90	O	--	11-30-72	32	D
01N02E27BBDA01	Ts	4,225	H	145	P	125	04-02-80	75	D
01N02E27BCCB01	Ts	4,215	H	48	O	--	11-06-87	36	R
01N02E29DCA 01	Qal	4,180	H	--	-	--	--	--	-
01N02E30DCAC01	Ts	4,404	U	320	P	300	05-30-91	213.67	S
01N02E33DAB 01	Ts	4,239	H	--	-	--	--	--	-
01S02E03DCC 01	Ts	4,320	I	400	O	--	--	--	-
01S02E03DCCC02	Ts	4,332	I	404	F	180	05-28-91	181.02	S
01S02E04AACC01	Qal	4,225	H	55	-	--	--	--	-
01S02E05AB 01	Qal	4,210	H	20	O	--	--	--	-
01S02E08CDDC01	Qal	4,240	H	100	-	--	--	--	-
01S02E10CAAC01	Ts	4,281	H	65	-	--	--	--	-
01S02E16DDA 01	--	4,300	H	65	-	--	--	--	-
01S02E17AAAB01	Qal	4,245	H	80	-	--	--	--	-
01S02E17AAB 01	Qal	4,240	S	30	-	--	--	--	-
01S02E20CACC01	Qal	4,288	S	21	-	--	07-15-93	5.79	S
01S02E20CBBA01	Qal	4,281	H	63	O	--	07-15-93	7.29	S
01S02E21DBDB01	Ts	4,317	H	180	-	--	12-30-63	50	O
01S02E22BCBC01	Ts	4,339	H	140	P	83	05-28-91	68.02	S
01S02E22BCCB01	Ts	4,340	H	--	-	--	--	--	-
01S02E29AAC 01	Qal	4,295	H	61	O	--	08-02-81	8	D
01S02E29DDDB01	Qal	4,310	H	33	-	--	11-05-87	21	A
02S02E05BAA 01	Qal	4,340	H	59	O	--	10-29-81	21	D



Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu$ S/cm)	pH, field (standard units)	Water temper- ature, field (°C)	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
<b>LOWER MADISON RIVER VALLEY--Continued</b>								
26	D	--	--	--	--	--	USGS	01N02E07AACA01
--	-	1,180	7.3	11.0	--	09-23-92	USGS	01N02E10DBAB01
60	D	769	--	7.5	--	03-10-88	MBMG	01N02E15DCBB01
--	-	807	--	--	--	03-10-88	MBMG	01N02E15DCBD01
21	D	1,000	7.3	13.0	--	05-05-89	MBMG	01N02E15DD 01
--	-	532	--	10.5	--	11-09-87	MBMG	01N02E16CBD 01
30	D	--	--	--	--	--	USGS	01N02E19CDDD01
97	D	770	--	--	--	05-20-88	MBMG	01N02E20AC 01
20	D	515	7.5	10.0	.7	07-15-93	USGS	01N02E20ADDB01
--	-	561	7.4	10.5	--	08-31-93	USGS	01N02E21ABBA01
--	-	543	--	11.0	--	11-09-87	MBMG	01N02E21ABBB01
15	D	703	--	--	--	05-19-88	MBMG	01N02E22ABB 01
50	D	714	--	--	10.5	03-10-88	MBMG	01N02E22ABBB01
--	-	--	--	--	--	--	USGS	01N02E22BABA01
40	D	736	7.6	12.5	12.5	05-28-91	USGS	01N02E22BADD01
30	D	606	--	16.5	--	05-19-88	MBMG	01N02E22CA 01
20	O	688	7.5	22.0	--	05-05-89	MBMG	01N02E22CABD01
40	D	628	7.5	13.5	--	09-23-92	USGS	01N02E22CDCC01
30	D	868	--	14.0	--	05-19-88	MBMG	01N02E27BBDA01
--	-	543	--	13.0	--	11-06-87	MBMG	01N02E27BCCB01
--	-	470	--	8.5	--	11-09-87	MBMG	01N02E29DCA 01
20	D	--	--	--	--	--	USGS	01N02E30DCAC01
--	-	690	--	10.5	--	11-06-87	MBMG	01N02E33DAB 01
--	-	1,340	--	16.0	--	05-20-88	MBMG	01S02E03DCC 01
900	D	1,490	7.4	16.5	5.1	05-28-91	USGS	01S02E03DCCC02
--	-	782	7.5	14.5	--	05-05-89	MBMG	01S02E04AACC01
--	-	510	--	10.5	--	11-06-87	MBMG	01S02E05AB 01
2.5	R	424	--	11.0	--	11-06-87	MBMG	01S02E08CDDC01
20	O	1,200	7.4	13.5	--	08-31-93	USGS	01S02E10CAAC01
--	-	1,820	--	9.5	--	05-20-88	MBMG	01S02E16DDA 01
--	-	425	8.0	11.0	--	08-30-93	USGS	01S02E17AAAB01
--	-	473	--	10.0	--	11-09-87	MBMG	01S02E17AAB 01
11	S	793	7.5	11.0	5.5	07-15-93	USGS	01S02E20CACC01
35	D	432	7.8	11.0	1.1	07-15-93	USGS	01S02E20CBBA01
25	O	540	7.6	17.0	--	05-09-89	MBMG	01S02E21DBDB01
20	D	1,340	7.4	14.5	17.2	05-28-91	USGS	01S02E22BCBC01
--	-	1,140	7.5	17.0	--	05-05-89	MBMG	01S02E22BCCB01
30	D	516	--	11.5	--	11-05-87	MBMG	01S02E29AAC 01
--	-	553	--	11.5	--	11-05-87	MBMG	01S02E29DDDB01
20	D	375	--	11.0	--	06-13-84	MBMG	02S02E05BAA 01

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>LOWER MADISON RIVER VALLEY--Continued</b>									
02S02E05BDBB01	Qal	4,335	H	60	O	--	09-23-92	23.21	S
02S02E05CAAD01	Qal	4,353	H	62	O	--	--	--	-
02S02E05CC 01	Qal	4,260	H	62	O	--	05-03-84	40	D
02S02E05CCC 01	Qal	4,350	H	54	O	--	08-23-73	8	D
02S02E05CDA 01	Qal	4,350	H	63	O	--	05-10-84	43	D
02S02E19BA 01	Qal	4,360	H	--	-	--	--	--	-
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>									
07N02E03ADDA01	Ts	3,895	H	75	P	70	05-15-91	60.59	S
07N02E03BCBA01	Qal	3,815	H	60	-	--	05-04-89	40	A
07N02E09AABB01	Qal	3,815	H	42	O	--	03-17-79	18	D
07N02E15CBAB01	Qal	3,880	H	99	O	--	05-14-91	88.69	S
07N02E20DDCD01	Qal	3,820	H	40	-	--	--	--	-
07N02E21DCDD01	Ts	3,868	H	162	O	--	08-04-93	67.16	S
07N02E29CABC01	Qal	3,819	H	32	P	28	12-04-68	12	D
07N02E29DDCD01	Qal	3,835	H	43	P	23	09-02-88	7	D
07N02E30ACBC01	Qal	3,805	H	52	O	--	06-08-93	4.03	S
07N02E30CDDA01	Qal	3,820	S	57	O	--	06-08-93	3.66	S
07N02E31BDAD01	Qal	3,823	H	23	-	--	06-08-93	6.57	S
07N02E31DCDA01	Qal	3,821	S	--	-	--	06-09-93	7.82	S
07N02E32BADB01	Qal	3,825	H	39	O	--	06-08-93	9.41	S
07N02E32CADA01	Qal	3,825	H	100	O	--	06-07-93	4.60	S
07N02E33ABCD01	Ts	3,890	I	99	P	94	05-17-72	57	D
07N02E33CBBC01	Qal	3,838	H	33	P	28	06-07-93	3.36	S
07N02E33CDDA01	Qal	3,842	H	105	-	--	--	--	-
06N02E05BBAC01	Qal	3,830	H	98	P	78	06-07-93	3.94	S
06N02E05BBCB01	Ts	3,825	H	140	S	130	06-08-93	6.08	S
06N02E08AACC01	Qal	3,860	H	40	O	--	06-07-93	10.42	S
06N02E08DCBC01	Qal	3,840	H	40	O	--	06-09-93	4.62	S
06N02E09BACD01	Ts	3,875	H	110	-	--	10-21-92	17.30	S
06N02E16BBAA01	Qal	3,865	H	39	O	--	06-10-93	14.65	S
06N02E21DAAA01	Qal	3,880	H	40	O	--	07-08-76	20	D
06N02E26CBBB01	Qal	3,932	H	120	O	--	06-10-93	62.42	S
06N02E27BDCB01	Qal	3,885	H	41	O	--	06-11-93	24.31	S
06N02E34BDBB01	Qal	3,889	H	56	O	--	06-10-93	21.81	S
05N01E22BBAB01	Ts	4,145	S	82	O	--	06-16-79	4.60	R
05N01E24BDD 01	Qal	4,020	S	43	P	30	06-17-79	8.60	R
05N01E27BDA 01	Ts	4,115	I	354	P	50	05-01-91	58.15	S
05N01E28BCAA01	Ts	4,235	I	340	P	152	05-17-91	169.30	S
05N01E33BACD01	Ts	4,177	I	255	P	152	04-30-91	129.61	S
05N02E03ACDC01	Qal	3,905	S	58	O	--	10-19-92	30.28	S
05N02E04DBDA01	Qal	3,880	U	--	-	--	06-11-93	5.87	S
05N02E05BDCB01	Qal	3,894	H	30	-	--	--	--	-

Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu\text{S/cm}$ )	pH, field (standard units)	Water temper- ature, field ( $^{\circ}\text{C}$ )	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
<b>LOWER MADISON RIVER VALLEY--Continued</b>								
60	D	362	7.7	13.0	--	09-23-92	USGS	02S02E05BDBB01
20	D	414	7.8	13.5	--	08-31-93	USGS	02S02E05CAAD01
25	D	382	--	10.0	--	11-05-87	MBMG	02S02E05CC 01
40	D	399	--	9.0	--	11-05-87	MBMG	02S02E05CCC 01
15	D	386	--	11.5	--	11-05-87	MBMG	02S02E05CDA 01
--	-	512	--	11.5	--	11-05-87	MBMG	02S02E19BA 01
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>								
36	D	--	--	--	--	--	USGS	07N02E03ADDA01
--	-	478	7.5	14.0	--	08-04-93	USGS	07N02E03BCBA01
60	D	647	7.2	11.5	--	08-12-93	USGS	07N02E09AABB01
25	D	613	7.6	10.5	6.6	05-14-91	USGS	07N02E15CBAB01
--	-	635	7.5	11.5	--	08-04-93	USGS	07N02E20DDCD01
20	D	524	7.7	10.5	--	08-04-93	USGS	07N02E21DCDD01
30	D	687	7.5	11.5	--	10-21-92	USGS	07N02E29CABC01
35	D	414	7.9	13.0	.7	06-23-93	USGS	07N02E29DDCD01
50	D	694	7.5	7.5	--	06-08-93	USGS	07N02E30ACBC01
40	D	618	7.5	10.0	--	06-08-93	USGS	07N02E30CDDA01
7.5	S	597	7.6	9.5	.5	06-08-93	USGS	07N02E31BDAD01
4.3	S	636	7.4	9.5	.9	06-09-93	USGS	07N02E31DCDA01
60	D	595	7.7	--	--	06-08-93	USGS	07N02E32BADB01
--	-	451	7.8	9.5	--	06-07-93	USGS	07N02E32CADA01
25	D	588	7.6	12.0	--	08-04-93	USGS	07N02E33ABCD01
30	D	475	7.7	8.5	.0	06-07-93	USGS	07N02E33CBBC01
--	-	538	7.7	11.0	--	08-04-93	USGS	07N02E33CDDA01
30	D	--	--	12.5	--	06-07-93	USGS	06N02E05BBAC01
15	D	593	8.0	12.5	.7	06-08-93	USGS	06N02E05BBCB01
30	D	578	7.4	12.5	--	06-07-93	USGS	06N02E08AACC01
30	D	512	7.5	8.5	.8	06-09-93	USGS	06N02E08DCBC01
--	-	478	7.7	11.0	--	10-21-92	USGS	06N02E09BACD01
100	D	604	7.5	10.0	2.8	06-10-93	USGS	06N02E16BBAA01
30	D	573	7.5	12.0	2.7	06-10-93	USGS	06N02E21DAAA01
75	D	425	7.9	11.0	.8	06-10-93	USGS	06N02E26CBBB01
15	D	715	7.6	11.0	7.8	06-11-93	USGS	06N02E27BDCB01
35	D	848	7.3	12.5	3.0	06-10-93	USGS	06N02E34BDBB01
17	D	--	--	--	--	--	MBMG	05N01E22BBAB01
20	D	255	7.8	9.5	--	06-17-79	MBMG	05N01E24BDD 01
1,500	D	--	--	--	--	--	USGS	05N01E27BDA 01
1,600	D	--	--	--	--	--	USGS	05N01E28BCAA01
1,020	S	--	--	--	--	--	USGS	05N01E33BACD01
52	D	849	7.2	12.0	--	10-19-92	USGS	05N02E03ACDC01
--	-	--	--	--	--	--	USGS	05N02E04DBDA01
--	-	597	7.6	10.0	--	10-21-92	USGS	05N02E05BDCB01

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>									
05N02E10CBCC01	Qal	3,898	S	48	-	--	06-11-93	12.95	S
05N02E15DACB01	Qal	3,903	I	--	-	--	07-12-93	14.14	S
05N02E20CAAA01	Qal	3,935	H	56	O	--	06-23-93	2.53	S
05N02E22CBBA01	Qal	3,915	H	39	O	--	10-20-92	11.07	S
05N02E23BBDA01	Qal	3,898	H	34	O	--	06-11-93	4.66	S
05N02E23DBBB01	Qal	3,925	H	53	O	--	07-14-93	35.82	S
05N02E23DBCA01	Qal	3,930	H	55	O	--	10-19-92	41.85	S
05N02E27ADDA01	Qal	3,925	H	39	O	--	06-24-75	15	D
05N02E28ACDA01	Qal	3,941	H	35	O	--	05-04-89	20	A
05N02E28BBCC01	Qal	3,942	S	27	O	--	07-14-93	8.42	S
05N02E28CDDD01	Qal	3,962	H	65	O	--	05-04-89	20	A
05N02E32DAAD01	Qal	3,968	H	35	O	--	--	--	-
05N02E33DACA01	Ts	4,021	H	148	-	--	--	--	-
04N01E02BBCC01	Ts	4,075	I	191	P	100	04-30-91	56.54	S
04N01E04ADBB01	Ts	4,165	I	400	P	166	06-29-79	117.80	R
04N01E09CAB 01	Ts	4,195	S	253	-	--	06-20-79	172.70	R
04N01E12BADD01	Ts	4,040	S	40	O	--	09-16-79	7.90	R
04N01E23BAC 01	Ts	4,127	I	345	P	140	05-01-91	78.14	S
04N01E23BBB 01	Ts	4,045	I	322	F	140	06-28-80	65.20	R
04N02E05CBCC01	Ts	4,012	H	95	-	--	--	--	-
04N02E05CDDC01	Qal	4,042	H	35	-	--	--	--	-
04N02E16AAA 01	Ts	4,240	S	323	P	265	06-29-79	231.90	R
04N02E18ACAC01	Ts	4,105	S	109	-	--	06-12-79	70.20	R
<b>HELENA VALLEY</b>									
11N04W25AABA01	Qal	3,784	H	74	P	64	--	--	-
11N04W25DDDD01	Qal	3,733	U	20	T	17	08-07-95	11.53	S
11N04W36ACCA01	QAb	3,785	H	86	X	72	--	--	-
11N03W14BBBB01	QAb	3,768	H	110	O	--	04-27-95	69.97	S
11N03W15CBCC01 <sup>2</sup>	Qal	3,698	U	16	-	--	04-08-92	5.72	S
11N03W15DCDD01	Qal	3,666	U	24	T	20	04-08-92	6.83	S
11N03W16BBBB01	QAb	3,785	H	125	-	--	07-26-95	52.94	S
11N03W17DDCC01	Qal	3,722	H	36	P	27	08-08-89	15	A
11N03W18ADDD01	Qal	3,782	H	62	O	--	--	--	-
11N03W21BAAA01 <sup>3</sup>	Qal	3,690	U	46	T	42	04-08-92	3.18	S
11N03W21DDAD01	Qal	3,663	U	65	T	61	04-08-92	6.59	S
11N03W22BBCB02	Qal	3,670	U	48	G	33	04-08-92	9.72	S
11N03W25DDBD01	Qal	3,664	H	40	-	--	--	--	-
11N03W28DAAD01	Qal	3,661	U	6.5	S	5	08-07-95	4.85	S
11N03W29ABBA01	Qal	3,705	S	50	-	--	--	--	-

Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu$ S/cm)	pH, field (standard units)	Water temper- ature, field (°C)	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>								
15	S	618	7.9	9.5	3.5	06-11-93	USGS	05N02E10CBCC01
--	-	515	7.7	8.5	2.1	07-12-93	USGS	05N02E15DACB01
30	D	262	7.4	11.0	.4	06-23-93	USGS	05N02E20CAAA01
22	D	1,020	7.5	10.0	--	10-20-92	USGS	05N02E22CBBA01
25	D	473	7.6	10.0	.7	06-11-93	USGS	05N02E23BBDA01
20	D	513	7.8	14.5	--	07-14-93	USGS	05N02E23DBBB01
32	D	571	7.5	13.0	--	10-19-92	USGS	05N02E23DBCA01
35	D	722	7.7	11.5	4.1	07-12-93	USGS	05N02E27ADDA01
20	D	931	7.7	11.5	3.8	07-14-93	USGS	05N02E28ACDA01
30	D	654	7.7	9.0	.7	07-14-93	USGS	05N02E28BBCC01
20	D	918	7.5	11.5	--	08-10-93	USGS	05N02E28CDDDD01
20	D	876	7.5	10.5	--	09-08-93	USGS	05N02E32DAAD01
--	-	698	7.8	11.5	--	10-20-92	USGS	05N02E33DACA01
2,000	D	--	--	--	--	--	USGS	04N01E02BBCC01
--	-	2,540	8.3	18.0	--	06-29-79	MBMG	04N01E04ADBB01
1.2	R	795	7.7	13.5	--	06-20-79	MBMG	04N01E09CAB 01
20	D	588	7.8	7.0	--	09-15-79	MBMG	04N01E12BADDD01
3,420	D	--	--	--	--	--	USGS	04N01E23BAC 01
3,420	D	583	7.6	10.5	--	06-28-79	MBMG	04N01E23BBB 01
--	-	837	7.7	11.5	--	08-10-93	USGS	04N02E05CBCC01
--	-	842	7.6	12.5	3.2	07-14-93	USGS	04N02E05CDDC01
4	D	830	7.8	12.5	--	06-29-79	MBMG	04N02E16AAA 01
1.7	R	405	8.2	15.0	--	06-12-79	MBMG	04N02E18ACAC01
<b>HELENA VALLEY</b>								
35	D	385	7.7	14.5	--	08-09-95	USGS	11N04W25AABA01
--	-	400	--	--	--	08-22-88	USGS	11N04W25DDDD01
--	-	400	7.8	14.0	--	08-09-95	USGS	11N04W36ACCA01
18	D	422	7.9	13.0	--	08-09-95	USGS	11N03W14BBBB01
--	-	--	--	--	--	--	USGS	11N03W15CBCC01 <sup>2</sup>
--	-	680	--	13.0	--	08-05-88	USGS	11N03W15DCDD01
12	S	866	--	10.5	2.4	11-03-93	USGS	11N03W16BBBB01
12	D	525	7.6	10.5	2.3	06-30-93	USGS	11N03W17DDCC01
20	D	409	7.7	15.0	--	08-09-95	USGS	11N03W18ADDD01
--	-	410	--	13.0	--	08-08-88	USGS	11N03W21BAAA01 <sup>3</sup>
--	-	510	--	8.5	--	08-18-88	USGS	11N03W21DDAD01
1.6	S	1,790	7.5	10.0	--	08-07-90	USGS	11N03W22BBCB02
--	-	420	--	9.5	--	06-30-88	USGS	11N03W25DDBD01
--	-	580	--	--	--	05-19-95	USGS	11N03W28DAAD01
--	-	615	7.6	10.0	--	06-28-93	USGS	11N03W29ABBA01

**Table 10.** Records of wells along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Type of finish	Top of open interval (feet)	Date water level measured	Water level (feet)	Source of water-level data
<b>HELENA VALLEY—Continued</b>									
11N03W29BBAC01	Qal	3,719	H	--	-	--	--	--	-
11N03W30BAAA01	Qal	3,747	U	24	T	20	08-21-91	17.85	S
11N03W30DBCA01	Qal	3,728	H	35	-	--	05-03-89	14.46	S
11N03W31BADD01	Qal	3,716	U	160	P	43	06-13-91	5.30	S
11N03W33ADDB01	Qal	3,672	U	8.3	S	6	08-04-95	3.00	S
11N03W33BBAA02	Qal	3,679	U	25	P	20	06-13-91	3.33	S
11N03W33BBAA03	Qal	3,678	U	55	P	45	08-20-90	3.68	S
11N03W33DDDC01	Qal	3,683	U	58	P	53	04-08-92	1.21	S
11N03W33DDDC02	Qal	3,682	U	29	S	19	04-08-92	1.87	S
11N03W35DACC01	Qal	3,678	U	29	S	19	04-08-92	3.69	S
11N02W30DCAD01	Qal	3,693	U	45	T	41	04-08-92	28.96	S
11N02W31ACAA01	Qal	3,700	U	44	T	40	04-08-92	30.67	S
11N02W31BCCB01	Qal	3,673	H	40	O	--	01-22-91	4.88	S
10N04W01DCAD01	QAb	3,795	P	95	P	70	04-13-91	51.48	S
10N04W12AACD01	Qal	3,800	P	67	P	42	09-29-89	6.46	S
10N04W13ACCD01	Qal	3,831	U	19	O	--	04-08-92	8.70	S
10N03W02BCDD01	Qal	3,700	H	35	-	--	--	--	-
10N03W02DDDD03	Qal	3,720	U	25	S	20	08-07-95	10.35	S
10N03W03BACB02	Qal	3,683	U	24	T	21	06-13-91	2.77	-
10N03W04DCCD01	Qal	3,704	U	55	P	45	06-13-91	1.62	S
10N03W04DCCD02	Qal	3,704	U	25	P	15	06-13-91	4.88	S
10N03W05CCDD01	Qal	3,743	U	23	T	19	09-13-93	7.51	S
10N03W06DBAA01	Qal	3,747	U	34	T	30	04-08-92	21.67	S
10N03W06DBAA02	Qal	3,747	U	62	T	58	04-08-92	21.48	S
10N03W11DDCC02	Qal	3,753	U	78	G	73	04-08-92	28.05	S
10N03W16DBAD01	Qal	3,756	U	44	T	40	04-08-92	12.36	S
10N03W16DCCC02	Qal	3,780	H	72	O	--	04-28-95	36.59	S
10N03W17ABBB01	Qal	3,772	U	28	T	24	08-07-95	20.17	S
10N03W17CCCC01	Qal	3,837	U	140	X	120	06-13-91	1.40	S
10N03W18AADA01	Qal	3,790	U	54	S	44	08-09-95	34.01	S
10N03W23DAAD01	Qal	3,816	U	180	-	--	12-16-92	45.83	S
10N03W24BBBC01	Qal	3,800	U	58	O	--	08-09-95	32.85	S
10N02W03BBAB01	Ts	3,820	H	100	X	100	08-08-95	74.15	S
10N02W06AAD01	Ts	3,735	H	180	P	140	08-08-95	30.14	S
10N02W07BBBB01	Qal	3,717	U	24	T	20	08-07-95	6.92	S
10N02W18DDCD01	Ts	3,784	H	70	O	--	09-13-93	50.87	S
10N02W19ADBB01	Qal	3,798	I	--	-	--	08-10-95	60.95	S

<sup>1</sup>Data for this site originally published in Dutton and others (1995) as well number 05S01W28BCAB01. WATSTORE location number is 05S01W28BACB01.

<sup>2</sup>Data for this site originally published in Briar and Madison (1992) as location number 1103W15CCBC01. WATSTORE location number is 11N03W15CBCC01.

<sup>3</sup>Data for this site originally published in Briar and Madison (1992) as location number 11N03W21BBAA01. WATSTORE location number is 11N03W21BAAA01.

Dis-charge (gal/min)	Source of dis-charge data	Specific conduct- ance, field ( $\mu$ S/cm)	pH, field (standard units)	Water temper- ature, field (°C)	Nitrate, field (mg/L as N)	Date water- quality parameter measured	Source of water- quality data	Location number
HELENA VALLEY—Continued								
--	-	540	--	10.0	--	05-05-89	USGS	11N03W29BBAC01
--	-	445	--	15.0	--	08-10-88	USGS	11N03W30BAAA01
--	-	720	--	9.0	--	05-03-89	USGS	11N03W30DBCA01
500	D	--	--	--	--	--	USGS	11N03W31BADD01
--	-	528	--	--	--	05-16-95	USGS	11N03W33ADDB01
15	S	315	6.8	9.0	--	08-16-90	USGS	11N03W33BBAA02
70	S	411	7.1	9.0	--	08-16-90	USGS	11N03W33BBAA03
15	S	360	7.3	10.0	--	05-25-90	USGS	11N03W33DDDC01
60	S	366	7.3	8.0	--	08-06-90	USGS	11N03W33DDDC02
60	S	897	7.2	9.0	--	08-06-90	USGS	11N03W35DACC01
--	-	410	--	10	--	08-08-88	USGS	11N02W30DCAD01
--	-	330	--	13.0	--	08-08-88	USGS	11N02W31ACAA01
13	S	372	6.9	9.5	--	01-22-91	USGS	11N02W31BCCB01
35	D	550	8.0	12.0	--	10-14-80	USGS	10N04W01DCAD01
300	S	--	--	--	--	--	USGS	10N04W12AACD01
1.5	S	460	7.5	8.0	--	01-23-91	USGS	10N04W13ACCD01
--	-	300	--	9.5	--	07-25-88	USGS	10N03W02BCDD01
10	S	480	7.1	12.0	--	08-14-90	USGS	10N03W02DDDD03
--	-	590	--	8.5	--	08-17-88	USGS	10N03W03BACB02
20	S	462	7.5	9.5	--	08-07-90	USGS	10N03W04DCCD01
20	S	641	7.5	8.5	--	08-07-90	USGS	10N03W04DCCD02
--	-	468	7.4	9.0	--	09-25-90	USGS	10N03W05CCDD01
--	-	540	7.0	8.0	--	11-03-90	USGS	10N03W06DBAA01
--	-	407	6.9	9.0	--	11-03-90	USGS	10N03W06DBAA02
1.6	S	415	7.1	10.5	--	08-09-90	USGS	10N03W11DDCC02
--	-	565	--	11.0	--	08-10-88	USGS	10N03W16DBAD01
7.5	S	425	8.0	13	--	08-13-90	USGS	10N03W16DCCC02
--	-	365	--	14.0	--	08-11-88	USGS	10N03W17ABBB01
30	D	--	--	--	--	--	USGS	10N03W17CCCC01
--	-	400	7.7	13.5	--	08-09-95	USGS	10N03W18AADA01
--	-	325	7.2	10.0	--	08-09-90	USGS	10N03W23DAAD01
12	D	--	7.4	11.0	--	06-20-83	USGS	10N03W24BBBC01
15	D	398	7.9	11.5	--	08-08-95	USGS	10N02W03BBAB01
50	D	390	7.7	13.0	--	08-08-95	USGS	10N02W06AADC01
--	-	390	6.6	17.0	--	08-17-90	USGS	10N02W07BBBB01
15	D	420	7.5	9.5	--	06-14-83	USGS	10N02W18DDCD01
--	-	404	7.5	13.5	--	08-10-95	USGS	10N02W19ADBB01

**Table 11.** Physical properties and common-constituent concentrations in ground water along the Madison and upper Missouri Rivers in Montana

[Constituents are reported as dissolved, except as indicated and values are rounded according to standard USGS procedures. Analyses by Montana Bureau of Mines and Geology Analytical Division, Butte, Mont. Analyses in the upper Madison River Valley for 08-17-92 through 08-19-92 and in the lower Madison River Valley for 08-15-91 were analyzed by the U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo. Location number: described in text. Geologic unit: Qal, alluvial deposits (Quaternary); Ts, sedimentary deposits (Tertiary); QAb, bedrock (Quaternary to Archean). Collecting agency: MBMG, Montana Bureau of Mines and Geology; USGS, U.S. Geological Survey. Abbreviations: °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter. Symbols: <, less than minimum reporting level; --, no data]

Location number	Geo- logic unit	Sample date	Spe- cific con- duct- ance, field (µS/cm)	pH, field (stand- ard units)	Temper- ature, water (°C)	Oxygen, dis- solved, field (mg/L)	Calcium (mg/L as Ca)	Magne- sium (mg/L as Mg)	Sodium (mg/L as Na)	Potas- sium (mg/L as K)
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>										
04S01W30BA 01	Ts	08-18-92	299	7.4	11.0	8.1	37	8.8	8.7	3.2
05S01W04ABDD01	Ts	09-01-93	464	7.3	12.0	5.6	--	--	--	--
05S01W04BAAB01	Qal	09-24-92	424	7.3	10.0	4.3	47	14	22	3.8
05S01W04DBAB01	Ts	09-02-93	466	7.4	10.0	4.6	61	14	22	4.0
05S01W04DDDB01	Qal	08-17-92	290	8.1	12.0	.9	34	9.0	11	3.1
05S01W23DABA01	Qal	08-18-92	381	7.8	10.0	8.4	50	12	11	1.5
05S01W28BACB01 <sup>2</sup>	Qal	09-22-92	563	7.9	14.0	0.0	61	12	26	12
05S01W28DBDD01	QAb	06-30-82	--	7.7	--	--	5.2	.2	330	15
05S01W28DCCB01	Ts	09-01-93	464	7.6	13.5	5.6	--	--	--	--
05S01W33CBCB01	Qal	08-17-92	363	7.9	12.5	6.9	40	13	12	3.7
06S01W03AABA01	Qal	09-01-93	572	7.6	9.5	5.5	69	26	14	2.7
06S01W03CDAD01	Qal	09-01-93	420	7.8	9.0	1.9	--	--	--	--
06S01W04ACCB01	Ts	08-17-92	427	7.9	11.5	6.3	43	16	18	6.5
06S01W04CCDB01	Ts	09-02-93	378	7.6	11.5	6.3	--	--	--	--
06S01W08CADD01	Ts	09-22-92	443	7.9	11.0	9.5	48	13	15	8.3
06S01W08DABD01	Qal	08-19-92	421	7.7	11.5	5.6	44	10	28	4.6
06S01W10ABAC01	Qal	09-02-93	606	7.6	9.0	7.7	75	25	12	2.7
06S01W23BBAC01	Qal	09-22-92	489	7.8	10.0	7.8	58	24	9.2	2.2
06S01W30DADD01	Qal	09-01-93	412	7.8	13.0	7.5	--	--	--	--
06S01E31CAAC01	Ts	08-18-92	660	7.6	14.0	7.4	79	34	7.0	1.9
07S01W06BBAC01	Ts	09-21-92	476	7.6	13.0	8.5	57	18	17	4.7
07S01W12DBBC01	Ts	09-25-92	326	7.9	9.5	8.3	42	11	7.0	1.7
07S01W17BCBD01	Ts	08-19-92	477	7.7	11.5	7.9	55	21	13	2.3
07S01W20CBAA01	Qal	09-21-92	549	7.4	8.5	3.8	67	21	20	2.5
08S01W25BBC 01	Qal	08-19-92	269	7.9	13.0	7.5	31	5.9	21	2.6



Bicar- bonate <sup>1</sup> (mg/L as HCO <sub>3</sub> )	Carbo- nate <sup>1</sup> (mg/L as CO <sub>3</sub> )	Alka- linity <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	Sul- fate (mg/L as SO <sub>4</sub> )	Chlo- ride (mg/L as Cl)	Fluo- ride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Nitrate (mg/L as N)	Collect- ing agency	Location number
NORTHERN PART OF THE UPPER MADISON RIVER VALLEY										
137	0	113	19	13	0.2	23	181	--	USGS	04S01W30BA 01
223	0	182	--	16	--	--	--	--	USGS	05S01W04ABDD01
220	0	180	23	12	.7	26	258	0.42	USGS	05S01W04BAAB01
261	0	213	17	16	1.2	26	291	.42	USGS	05S01W04DBAB01
147	0	120	19	8.1	.3	24	181	--	USGS	05S01W04DDDB01
193	0	158	33	7.2	.2	11	221	--	USGS	05S01W23DABA01
166	0	136	110	23	.4	41	366	<.20	USGS	05S01W28BACB01 <sup>2</sup>
--	--	--	220	120	10	110	1,030	--	MBMG	05S01W28DBDD01
215	0	174	--	19	--	--	--	--	USGS	05S01W28DCCB01
161	0	132	28	19	.3	36	232	--	USGS	05S01W33CBCB01
274	0	222	69	7.6	.4	18	346	.70	USGS	06S01W03AABA01
218	0	181	--	8.8	--	--	--	--	USGS	06S01W03CDAD01
183	0	150	45	17	.6	41	278	--	USGS	06S01W04ACCB01
191	0	156	--	12	--	--	--	--	USGS	06S01W04CCDB01
161	0	132	33	33	<.4	57	292	1.33	USGS	06S01W08CADD01
206	0	169	22	15	1.9	38	265	--	USGS	06S01W08DABD01
278	0	228	90	5.5	.4	18	368	.58	USGS	06S01W10ABAC01
212	0	174	76	3.9	.3	17	297	.37	USGS	06S01W23BBAC01
212	0	172	--	12	--	--	--	--	USGS	06S01W30DADD01
192	0	157	180	5.7	.5	14	417	--	USGS	06S01E31CAAC01
215	0	176	41	17	.6	34	297	.51	USGS	07S01W06BBAC01
181	0	149	15	5.2	<.4	13	187	.61	USGS	07S01W12DBBC01
220	0	180	67	5.9	.6	17	291	--	USGS	07S01W17BCBD01
283	0	232	40	10	.3	17	320	.48	USGS	07S01W20CBAA01
134	0	110	18	13	1.6	30	189	--	USGS	08S01W25BBC 01

**Table 11.** Physical properties and common-constituent concentrations in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo- logic unit	Sample date	Spe- cific con- duct- ance, field ( $\mu\text{S}/\text{cm}$ )	pH, field (stand- ard units)	Temper- ature, water ( $^{\circ}\text{C}$ )	Oxygen, dis- solved, field (mg/L)	Calcium (mg/L as Ca)	Magne- sium (mg/L as Mg)	Sodium (mg/L as Na)	Potas- sium (mg/L as K)
<b>LOWER MADISON RIVER VALLEY</b>										
02N01E08DDCA01	Ts	11-10-83	2,270	--	--	--	230	20	280	23
02N01E17DAAD01	Ts	11-10-83	2,730	--	--	--	190	19	410	26
02N01E24BADA01	Qal	12-28-83	--	--	--	--	86	20	21	3.0
02N01E24DDAA01	Qal	11-14-83	599	--	--	--	74	19	25	3.9
02N01E25AACC01	Ts	11-09-83	479	--	10.5	--	54	10	26	12
02N01E25AB 01	Qal	07-02-84	304	--	10.0	--	54	15	17	3.6
02N01E25BDBB01	Qal	11-16-83	494	--	--	--	69	15	24	6.0
02N01E26AA 01	Qal	07-02-84	425	--	9.0	--	89	22	30	3.4
02N01E26DCDC01	Qal	12-28-83	--	--	--	--	100	27	43	4.1
02N01E27BCCB01	Qal	11-09-83	1,110	--	--	--	140	30	100	4.6
02N01E27CBD 01	Qal	11-10-83	533	--	--	--	66	19	20	3.2
02N01E34AAAD01	Qal	11-09-83	595	--	--	--	76	19	26	3.5
02N01E34AABA01	Qal	11-16-83	858	--	11.5	--	100	26	48	3.8
02N01E35BABA01	Qal	11-11-83	1,630	--	--	--	81	11	320	9.2
02N01E35BABA02	Qal	11-11-83	771	--	--	--	94	24	43	3.7
02N01E36BCBD01	Ts	11-09-83	1,280	--	10.5	--	6.5	.8	300	8.8
02N01E36BCDD01	Qal	11-08-83	811	--	--	--	97	26	57	5.8
02N01E36CBA 01	Qal	11-09-83	1,300	--	--	--	140	36	120	5.5
02N02E09CBDA01	Qal	11-14-83	426	--	--	--	55	15	9.4	3.0
02N02E17DDCC01	Ts	05-04-89	444	7.8	10.5	--	35	7.6	45	6.2
02N02E20CABC01	Qal	05-03-89	597	7.6	15.0	--	33	10	75	10
02N02E20CCAA01	Qal	05-02-89	548	7.4	10.5	--	59	11	48	4.5
02N02E20CDAC01	Qal	05-03-89	570	7.3	10.0	--	56	12	47	6.2
02N02E20DAC 01	Qal	05-02-89	421	7.6	16.0	--	45	10	34	4.3
02N02E20DDCB01	Qal	09-24-92	469	7.8	8.5	.3	41	9.1	44	10
02N02E21ACDB01	Qal	08-30-93	714	7.8	10.0	.1	70	16	56	8.1
02N02E28ADC01	Qal	05-04-89	819	7.4	8.0	--	68	20	61	7.0
02N02E28ADC01	Qal	09-25-92	834	7.1	12.0	--	67	18	85	8.8
02N02E28ADC01	Qal	09-17-93	769	7.4	11.5	.1	--	--	--	--
02N02E28ADC01	Qal	08-31-94	733	7.3	10.0	--	66	18	80	7.8
02N02E28ADC02	Qal	09-17-93	737	7.2	10.0	.1	71	17	62	6.2
02N02E28ADC02	Qal	08-31-94	727	7.1	9.5	--	76	19	64	6.6
02N02E28ADC03	Qal	08-15-91	732	7.1	10.5	--	73	18	57	7.6
02N02E28ADC03	Qal	09-17-93	723	7.2	12.0	.2	74	18	53	7.2
02N02E28ADC03	Qal	08-31-94	710	7.2	13.0	--	77	19	55	7.5

Bicar- bonate <sup>1</sup> (mg/L as HCO <sub>3</sub> )	Carbo- nate <sup>1</sup> (mg/L as CO <sub>3</sub> )	Alka- linity <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	Sul- fate (mg/L as SO <sub>4</sub> )	Chlo- ride (mg/L as Cl)	Fluo- ride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Nitrate (mg/L as N)	Collect- ing agency	Location number
<b>LOWER MADISON RIVER VALLEY</b>										
276	--	--	920	90	.2	58	1,760	.01	MBMG	02N01E08DDCA01
198	--	--	1,200	88	.5	17	2,020	.02	MBMG	02N01E17DAAD01
332	--	--	54	5.1	.2	29	384	.48	MBMG	02N01E24BADA01
313	--	--	47	11	.3	26	362	.10	MBMG	02N01E24DDAA01
210	--	--	55	12	.3	60	335	.01	MBMG	02N01E25AACCO1
238	--	--	36	6.0	.4	28	280	.02	MBMG	02N01E25AB 01
245	--	--	66	14	.3	28	343	.07	MBMG	02N01E25BDBB01
321	--	--	91	19	.4	28	442	.09	MBMG	02N01E26AA 01
334	--	--	150	21	.2	23	542	.47	MBMG	02N01E26DCDC01
373	--	--	260	50	.5	25	880	.18	MBMG	02N01E27BCCB01
269	--	--	52	8.7	.3	22	325	.03	MBMG	02N01E27CBD 01
281	--	--	77	14	.4	23	379	.09	MBMG	02N01E34AAAD01
346	--	--	150	27	.5	24	549	.12	MBMG	02N01E34AABA01
245	--	--	560	130	.5	17	1,250	.05	MBMG	02N01E35BABA01
332	--	--	120	26	.3	24	501	.01	MBMG	02N01E35BABA02
421	--	--	250	55	.5	25	857	.33	MBMG	02N01E36BCBD01
376	--	--	120	30	.4	26	551	.01	MBMG	02N01E36BCDD01
458	--	--	280	69	.3	24	893	.01	MBMG	02N01E36CBA 01
226	--	--	31	4.2	.3	20	250	.39	MBMG	02N02E09CBDA01
198	--	--	21	26	2.6	36	277	.01	MBMG	02N02E17DDCC01
		223	26	27	2.4	37	353	.22	MBMG	02N02E20CABC01
279	--	--	26	31	2.4	37	359	.49	MBMG	02N02E20CCAA01
274	--	--	27	29	2.5	36	355	.72	MBMG	02N02E20CDAC01
225	--	--	17	20	2.0	31	278	.71	MBMG	02N02E20DAC 01
227	--	186	17	22	2.9	55	313	<.20	USGS	02N02E20DDCB01
291	0	239	62	46	2.0	50	454	<.05	USGS	02N02E21ACDB01
304	--	--	81	35	2.5	28	456	.51	MBMG	02N02E28CADC01
381	0	312	67	39	3.0	42	520	<.20	USGS	02N02E28CADC01
361	0	296	--	38	--	--	--	--	USGS	02N02E28CADC01
349	0	286	50	33	3.4	46	477	<.05	USGS	02N02E28CADC01
339	0	276	60	36	2.5	46	472	.05	USGS	02N02E28CADC02
341	0	280	60	35	2.2	51	486	<.05	USGS	02N02E28CADC02
321	0	263	67	38	2.1	43	467	--	USGS	02N02E28CADC03
317	0	257	63	40	2.2	46	462	<.10	USGS	02N02E28CADC03
314	0	257	60	38	2.2	50	466	<.05	USGS	02N02E28CADC03

**Table 11.** Physical properties and common-constituent concentrations in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo-logic unit	Sample date	Specific conductance, field ( $\mu\text{S/cm}$ )	pH, field (standard units)	Temperature, water ( $^{\circ}\text{C}$ )	Oxygen, dissolved, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>LOWER MADISON RIVER VALLEY—Continued</b>										
02N02E28CADC04	Ts	06-29-88	474	--	9.0	--	51	11	49	13
02N02E28CADC04	Ts	08-15-91	590	7.8	9.5	<.1	55	12	50	10
02N02E28CADC04	Ts	08-31-94	603	7.9	10.0	--	60	13	51	10
02N02E28CBDD01	Qal	05-04-89	925	7.6	11.0	--	72	15	89	5.9
02N02E29BABD01	Qal	11-15-83	753	--	9.5	--	71	15	78	7.0
02N02E29BABD02	Ts	05-03-89	573	7.7	10.0	--	58	12	48	6.7
02N02E32AAAA01	Qal	05-10-89	526	7.4	14.0	--	57	13	49	4.9
01N01E04BCDC01	Ts	12-28-83	--	--	--	--	3.7	.8	130	3.0
01N02E04DCCC01	Qal	06-13-84	677	--	11.0	--	73	16	62	6.3
01N02E06BCBA01	Ts	11-09-83	666	--	15.0	--	17	2.0	120	10
01N02E06DAA 01	Qal	11-15-83	757	--	12.0	--	66	17	80	7.3
01N02E07AACA01	Ts	11-09-83	691	--	--	--	15	2.1	120	11
01N02E10DBAB01	Ts	05-04-89	1,170	7.5	11.0	--	96	25	110	23
		09-23-92	1,180	7.3	11.0	.3	120	31	110	26
01N02E15DCBB01	Ts	05-10-89	623	7.5	20.0	--	71	20	51	15
01N02E15DCBD01	Ts	05-10-89	718	7.8	19.5	--	63	16	90	15
01N02E15DD 01	Ts	05-05-89	1,000	7.3	13.0	--	90	21	84	21
01N02E19CDDD01	Ts	11-15-83	1,640	--	12.0	--	150	16	150	37
01N02E21ABBA01	Qal	08-31-93	561	7.4	10.5	2.2	60	17	34	7.9
01N02E22ABBB01	Ts	05-10-89	772	7.6	17.0	--	56	15	85	12
01N02E22BABA01	Qal	08-31-93	654	7.6	12.0	3.3	59	18	56	13
01N02E22BADD01	Ts	09-17-93	706	7.6	12.5	1.7	55	15	73	11
01N02E22CABD01	Ts	05-05-89	668	7.5	22.0	--	46	13	75	11
01N02E22CDCC01	Ts	09-23-92	628	7.5	13.5	5.7	49	14	79	18
01N02E29DCA 01	Qal	06-13-84	475	--	10.0	--	50	14	32	5.2
01N02E30DCAC01	Ts	11-15-83	1,130	--	11.5	--	110	39	75	22
01S02E04AACC01	Qal	05-05-89	782	7.5	14.5	--	73	23	50	13
01S02E10CAAC01	Ts	08-31-93	1,200	7.4	13.5	3.5	100	31	91	12
01S02E17AAAB01	Qal	08-30-93	425	8.0	11.0	4.8	42	11	27	5.5
01S02E20CACC01	Qal	08-30-93	794	7.9	12.0	4.3	71	16	69	17
01S02E20CACC01	Qal	08-31-94	516	7.4	12.5	--	54	12	35	13
01S02E21DBDB01	Ts	05-09-89	540	7.6	17.0	--	59	26	27	5.2
01S02E22BCCB01	Ts	05-05-89	1,140	7.5	17.0	--	130	32	55	18
02S02E05BAA 01	Qal	06-13-84	375	--	11.0	--	42	9.8	23	4.1
02S02E05BDBB01	Qal	05-09-89	382	7.8	14.0	--	44	11	24	4.3

Bicar- bonate <sup>1</sup> (mg/L as HCO <sub>3</sub> )	Carbo- nate <sup>1</sup> (mg/L as CO <sub>3</sub> )	Alka- linity <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	Sul- fate (mg/L as SO <sub>4</sub> )	Chlo- ride (mg/L as Cl)	Fluo- ride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Nitrate (mg/L as N)	Collect- ing agency	Location number
<b>LOWER MADISON RIVER VALLEY--Continued</b>										
269	--	--	26	29	2.3	67	382	.02	MBMG	02N02E28CADC04
280	0	230	28	34	2.3	54	384	--	USGS	02N02E28CADC04
282	0	231	30	35	2.1	61	403	<.05	USGS	02N02E28CADC04
372	--	--	65	48	2.7	39	522	.02	MBMG	02N02E28CBDD01
368	--	--	42	40	3.1	42	481	.19	MBMG	02N02E29BABD01
268	--	--	30	40	2.5	40	420	.04	MBMG	02N02E29BABD02
274	--	--	24	45	2.3	36	368	0.03	MBMG	02N02E32AAAA01
270	--	--	52	2.1	.8	23	354	.09	MBMG	01N01E04BCDC01
358	--	--	47	36	2.0	39	461	.02	MBMG	01N02E04DCCC01
147	--	--	140	45	2.0	37	446	.32	MBMG	01N02E06BCBA01
309	--	--	85	37	1.8	57	513	2.2	MBMG	01N02E06DAA 01
134	--	--	100	65	1.2	36	435	3.3	MBMG	01N02E07AACA01
330	--	--	240	58	1.6	56	771	.01	MBMG	01N02E10DBAB01
381	0	313	250	85	1.3	61	875	<.20	USGS	01N02E10DBAB01
419	--	--	55	27	2.5	57	507	.54	MBMG	01N02E15DCBB01
315	--	--	91	34	2.0	52	525	1.5	MBMG	01N02E15DCBD01
334	--	--	190	29	1.3	61	669	.56	MBMG	01N02E15DD 01
122	--	--	380	240	1.0	38	1070	1.0	MBMG	01N02E19CDDD01
290	0	238	24	20	1.8	41	353	.83	USGS	01N02E21ABBA01
360	--	--	61	25	2.4	50	491	1.5	MBMG	01N02E22ABBB01
349	0	284	29	20	2.6	56	428	.42	USGS	01N02E22BABA01
338	--	277	44	31	2.5	54	456	.59	USGS	01N02E22BADD01
334	--	--	40	19	2.2	50	426	.90	MBMG	01N02E22CABD01
369	0	303	33	17	.6	66	463	1.2	USGS	01N02E22CDC01
254	--	--	25	17	1.7	39	311	.41	MBMG	01N02E29DCA 01
170	--	--	280	130	1.0	55	813	4.3	MBMG	01N02E30DCAC01
370	--	--	54	33	1.6	57	490	.66	MBMG	01S02E04AAC01
310	0	250	100	130	1.5	45	704	7.2	USGS	01S02E10CAAC01
214	0	177	18	17	1.7	36	266	.45	USGS	01S02E17AAB01
349	0	289	36	41	2.9	43	491	5.0	USGS	01S02E20CACC01
246	0	202	20	25	2.4	44	331	1.0	USGS	01S02E20CACC01
285	--	--	25	32	1.4	51	379	2.5	MBMG	01S02E21DBDB01
291	--	--	220	43	.9	56	790	22	MBMG	01S02E22BCCB01
200	--	--	18	12	1.5	32	244	.35	MBMG	02S02E05BAA 01
211	--	--	19	15	1.4	31	257	.61	MBMG	02S02E05BDBB01

**Table 11.** Physical properties and common-constituent concentrations in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Sample date	Specific conductance, field ( $\mu\text{S/cm}$ )	pH, field (standard units)	Temperature, water ( $^{\circ}\text{C}$ )	Oxygen, dissolved, field (mg/L)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)
<b>LOWER MADISON RIVER VALLEY—Continued</b>										
02S02E05BDBB01	Qal	09-23-92	362	7.7	13.0	8.1	38	9.6	22	4.4
02S02E05CAAD01	Qal	08-31-93	414	7.8	13.5	8.2	45	12	24	5.8
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>										
07N02E09AABB01	Qal	09-07-93	644	7.4	11.5	6.6	85	22	27	5.5
07N02E15CBAB01	Qal	10-19-92	544	7.6	12.0	8.8	59	21	22	4.9
07N02E20DDCD01	Qal	09-07-93	642	7.7	11.5	6.1	--	--	--	--
07N02E29CABC01	Qal	10-21-92	687	7.5	11.5	2.9	63	24	47	4.5
07N02E32BADB01	Qal	09-07-93	610	7.5	10.0	3.2	--	--	--	--
07N02E33ABCD01	Ts	09-07-93	603	7.5	12.0	8.6	59	26	27	2.4
06N02E08AACCO1	Qal	09-14-93	590	7.6	13.0	3.4	--	--	--	--
06N02E09BACD01	Ts	10-21-92	478	7.7	11.0	7.7	60	20	11	2.2
06N02E16BBAA01	Qal	09-14-93	621	7.6	11.0	7.6	--	--	--	--
06N02E21DAAA01	Qal	09-14-93	585	7.4	12.0	6.6	--	--	--	--
06N02E34BDBB01	Qal	09-08-93	830	7.2	12.5	5.2	--	--	--	--
05N01E22BBAB01	Ts	06-16-79	135	7.6	12.0	--	19	4.8	4.7	.8
05N01E24BDD 01	Qal	06-17-79	255	7.8	9.5	--	41	5.6	5.9	1.1
05N02E03ACDC01	Qal	10-19-92	849	7.2	12.0	--	110	22	39	5.4
05N02E05BDCB01	Qal	10-21-92	597	7.6	10.0	5.7	61	19	36	6.1
05N02E10CBCC01	Qal	09-08-93	649	7.5	10.0	5.6	70	22	34	4.3
05N02E22CBBA01	Qal	10-20-92	1,020	7.5	10.0	6.7	92	35	74	3.5
05N02E23DBCA01	Qal	10-19-92	571	7.5	13.0	8.7	67	21	21	3.9
05N02E32DAAD01	Qal	09-08-93	876	7.5	10.5	7.9	--	--	--	--
05N02E33DACA01	Ts	11-02-79	746	7.9	12.0	--	57	30	59	3.9
05N02E33DACA01	Ts	10-20-92	698	7.8	11.5	12.8	50	26	61	3.6
04N01E04ADBB01	Ts	06-29-79	2,540	8.3	18.0	--	280	3.0	130	5.5
04N01E09CAB 01	Ts	06-20-79	795	7.8	13.5	--	44	13	58	4.9
04N01E12BADDD01	Ts	09-15-79	588	7.7	7.0	--	59	24	41	2.7
04N01E23BBB 01	Ts	06-28-79	583	7.6	10.5	--	55	22	25	2.3
04N02E16AAA 01	Ts	06-29-79	830	7.8	12.5	--	42	12	60	5.4
04N02E18ACAC01	Ts	06-12-79	405	8.2	15.0	--	22	12	44	2.5
<b>HELENA VALLEY</b>										
11N04W25AABA01	Qal	08-09-95	385	7.7	14.5	7.7	39	13	20	3.4
11N04W25DDDD01	Qal	08-07-95	403	7.5	--	--	41	16	20	1.7
11N04W36ACCA01	QAb	08-09-95	400	7.8	14.0	--	44	21	23	1.6
11N03W14BBBB01	QAb	08-08-95	422	7.9	13.0	8.3	28	12	47	2.7
11N03W16BBBB01	QAb	08-08-95	722	7.7	11.0	8.2	74	18	47	2.9

Bicar- bonate <sup>1</sup> (mg/L as HCO <sub>3</sub> )	Carbo- nate <sup>1</sup> (mg/L as CO <sub>3</sub> )	Alka- linity <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	Sul- fate (mg/L as SO <sub>4</sub> )	Chlo- ride (mg/L as Cl)	Fluo- ride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Nitrate (mg/L as N)	Collect- ing agency	Location number
<b>LOWER MADISON RIVER VALLEY—Continued</b>										
175	0	143	15	14	1.7	34	227	.32	USGS	02S02E05BDBB01
202	0	167	17	16	1.6	33	255	.42	USGS	02S02E05CAAD01
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>										
358	0	293	41	12	.6	27	406	2.2	USGS	07N02E09AABB01
276	0	226	41	13	<.4	22	329	2.3	USGS	07N02E15CBAB01
314	0	257	--	11	--	--	--	--	USGS	07N02E20DDCD01
330	0	271	73	17	.4	23	418	.59	USGS	07N02E29CABC01
302	0	242	--	12	--	--	--	--	USGS	07N02E32BADB01
253	0	207	44	17	.5	22	368	10	USGS	07N02E33ABCD01
325	0	262	--	8.8	--	--	--	--	USGS	06N02E08AACC01
255	0	209	37	6.9	.3	15	282	.75	USGS	06N02E09BACD01
317	0	260	--	12	--	--	--	--	USGS	06N02E16BBAA01
286	0	236	--	15	--	--	--	--	USGS	06N02E21DAAA01
372	0	305	--	17	--	--	--	--	USGS	06N02E34BDBB01
85	--	--	15	.8	.1	1.3	84	.02	MBMG	05N01E22BBAB01
139	--	--	17	1.7	.1	19	162	.31	MBMG	05N01E24BDD 01
433	0	355	71	14	<.4	41	541	4.8	USGS	05N02E03ACDC01
278	0	228	50	19	.4	28	363	1.8	USGS	05N02E05BDCB01
240	0	197	82	21	1.0	28	408	6.0	USGS	05N02E10CBCC01
348	0	285	200	31	.5	33	654	2.4	USGS	05N02E22CBBA01
295	0	242	37	14	.7	31	347	1.3	USGS	05N02E23DBCA01
268	0	220	--	48	--	--	--	--	USGS	05N02E32DAAD01
222	--	--	160	29	.8	29	497	4.3	MBMG	05N02E33DACA01
201	0	168	130	31	.8	31	449	3.5	USGS	05N02E33DACA01
28	--	--	850	59	1.2	32	1,380	.29	MBMG	04N01E04ADB01
206	--	--	86	20	.5	57	393	1.7	MBMG	04N01E09CAB 01
251	--	--	100	10	.6	28	394	.55	MBMG	04N01E12BADD01
190	--	--	96	11	.6	23	333	.97	MBMG	04N01E23BBB 01
189	--	--	82	26	1.0	25	358	2.5	MBMG	04N02E16AAA 01
182	--	--	34	9.6	1.5	30	246	.36	MBMG	04N02E18ACAC01
<b>HELENA VALLEY</b>										
157	0	129	33	12	1.1	--	199	--	USGS	11N04W25AABA01
220	0	180	34	12	.9	--	239	--	USGS	11N04W25DDDD01
187	0	153	85	9.0	1.0	--	283	--	USGS	11N04W36ACCA01
186	0	153	91	8.5	.5	--	283	--	USGS	11N04W14BBBB01
186	0	153	120	52	.4	--	414	--	USGS	11N03W16BBBB01

**Table 11.** Physical properties and common-constituent concentrations in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo- logic unit	Sample date	Spe- cific con- duct- ance, field ( $\mu\text{S}/\text{cm}$ )	pH, field (stand- ard units)	Temper- ature, water ( $^{\circ}\text{C}$ )	Oxygen, dis- solved, field (mg/L)	Calcium (mg/L as Ca)	Magne- sium (mg/L as Mg)	Sodium (mg/L as Na)	Potas- sium (mg/L as K)
<b>HELENA VALLEY--Continued</b>										
11N03W17DDCC01	Qal	06-30-93	525	7.6	10.5	8.3	--	--	--	--
11N03W18ADDD01	Qal	08-09-95	409	7.7	15.0	8.4	45	14	22	1.3
11N03W22BBCB02	Qal	08-07-90	1,790	7.5	10.0	--	120	56	220	1.3
11N03W22BBCB02	Qal	07-08-93	1,790	7.3	10.0	.9	120	59	210	1.8
11N03W25DDBD01	Qal	06-29-93	433	6.8	10.0	2.9	--	--	--	--
11N03W28DAAD01	Qal	08-07-95	630	7.6	11.0	2.0	80	15	19	11
11N03W29ABBA01	Qal	06-28-93	615	7.6	10.0	4.3	--	--	--	--
11N03W30DBCA01	Qal	06-28-93	688	7.3	9.5	6.9	--	--	--	--
11N03W33ADD01	Qal	08-07-95	755	7.0	12.0	3.1	97	21	27	4.7
11N03W33BBAA02	Qal	08-16-90	315	6.8	9.0	--	62	14	20	2.8
11N03W33BBAA02	Qal	07-08-93	504	7.0	8.0	1.4	61	15	21	2.9
11N03W33BBAA03	Qal	08-16-90	411	7.1	9.0	--	66	15	13	3.0
11N03W33DDDC01	Qal	08-06-90	360	7.3	10.0	--	61	14	16	2.9
11N03W33DDDC02	Qal	08-06-90	366	7.3	8.0	--	64	14	20	2.7
11N03W35DACC01	Qal	08-06-90	897	7.2	9.0	--	58	12	16	3.0
11N03W35DACC01	Qal	07-08-93	463	7.1	8.5	3.9	56	13	17	3.2
11N02W31BCCB01	Qal	06-29-93	405	6.8	11.0	3.4	46	10	19	3.4
10N03W02BCDD01	Qal	06-30-93	394	7.1	10.0	2.8	51	11	13	2.8
10N03W02DDDD03	Qal	08-14-90	480	7.1	12.0	--	62	14	14	3.5
10N03W04DCCD01	Qal	08-07-90	462	7.5	9.5	--	89	20	18	3.4
10N03W04DCCD02	Qal	08-07-90	641	7.5	8.5	--	86	20	22	3.4
10N03W05CCDD01	Qal	08-15-90	425	7.3	11.5	--	49	10	16	3.5
10N03W06DBAA01	Qal	11-03-90	540	7.0	8.0	--	60	15	31	3.6
10N03W06DBAA02	Qal	11-03-90	407	6.9	9.0	--	46	12	19	2.9
10N03W11DDCC02	Qal	08-09-90	415	7.1	10.5	--	54	12	16	3.2
10N03W17ABBB01	Qal	08-07-95	508	6.5	12.5	--	70	9.7	27	2.9
10N03W18AADA01	Qal	08-09-95	400	7.7	13.5	--	54	13	22	3.1
10N03W23DAAD01	Qal	08-09-90	325	7.2	10.0	--	39	8.7	14	4.8
10N03W24BBBC01	Qal	08-09-95	308	7.4	11.0	8.6	35	8.5	14	3.0
10N02W03BBAB01	Ts	08-08-95	398	7.9	11.5	7.8	34	6.0	37	8.6
10N02W06AAD01	Ts	08-08-95	390	7.7	13.0	7.6	44	8.3	26	8.8
10N02W07BBBB01	Qal	08-17-90	390	6.6	17.0	--	41	12	22	3.8
10N02W07BBBB01	Qal	08-07-95	328	7.5	14.0	3.9	--	--	--	--
10N02W19ADBB01	Qal	08-10-95	404	7.5	13.5	6.8	48	9.7	22	3.0

<sup>1</sup>Field incremental titration for samples collected by U.S. Geological Survey. Laboratory fixed-end titration for samples collected by Montana Bureau of Mines and Geology.

<sup>2</sup>Data for this site originally published in Dutton and others (1995) as location number 05S01W28BCAB01. WATSTORE location number is 05S01W28BACB01.



Bicar- bonate <sup>1</sup> (mg/L as HCO <sub>3</sub> )	Carbo- nate <sup>1</sup> (mg/L as CO <sub>3</sub> )	Alka- linity <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	Sul- fate (mg/L as SO <sub>4</sub> )	Chlo- ride (mg/L as Cl)	Fluo- ride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Nitrate (mg/L as N)	Collect- ing agency	Location number
HELENA VALLEY—Continued										
224	0	184	--	13	--	--	--	--	USGS	11N03W17DDCC01
185	0	151	35	6.5	.9	--	216	--	USGS	11N03W18ADDD01
416	0	341	540	77	.3	29	1,250	.87	USGS	11N03W22BBCB02
405	0	332	550	71	.5	29	1,240	.91	USGS	11N03W22BBCB02
161	0	132	--	11	--	--	--	--	USGS	11N03W25DDBD01
272	0	223	110	25	.6	--	395	--	USGS	11N03W28DAAD01
293	0	240	--	13	--	--	--	--	USGS	11N03W29ABBA01
309	0	253	--	11	--	--	--	--	USGS	11N03W30DBCA01
427	0	350	36	17	.7	--	415	--	USGS	11N03W33ADDB01
207	0	170	79	13	.3	23	312	.58	USGS	11N03W33BBAA02
205	0	168	71	14	.4	23	311	.74	USGS	11N03W33BBAA02
214	0	175	65	13	.2	25	309	.94	USGS	11N03W33BBAA03
219	0	179	57	10	.3	25	292	.55	USGS	11N03W33DDDC01
238	0	195	56	11	.3	22	305	.31	USGS	11N03W33DDDC02
201	0	165	53	7.7	.2	23	276	1.4	USGS	11N03W35DACC01
202	0	165	51	10	.2	23	281	1.8	USGS	11N03W35DACC01
165	0	135	49	12	.4	22	246	.56	USGS	11N02W31BCCB01
179	0	147	43	6.4	.3	25	246	1.4	USGS	10N03W02BCDD01
197	0	162	78	9.6	.3	21	303	3.3	USGS	10N03W02DDDD03
292	0	239	82	16	.2	30	400	1.3	USGS	10N03W04DCCD01
298	0	244	78	19	.2	28	403	1.2	USGS	10N03W04DCCD02
174	0	142	49	10	.4	19	243	.48	USGS	10N03W05CCDD01
232	0	190	44	17	.3	21	330	6.1	USGS	10N03W06DBAA01
187	0	153	39	8.6	.4	22	244	.81	USGS	10N03W06DBAA02
137	0	112	100	6.3	.2	23	286	1.0	USGS	10N03W11DDCC02
--	--	--	37	41	.2	--	312	.4	USGS	10N03W17ABBB01
212	0	174	77	9.1	1.0	--	284	--	USGS	10N03W18AADA01
114	0	94	67	4.5	.3	48	247	.56	USGS	10N03W23DAAD01
126	0	103	32	6.4	.6	--	161	--	USGS	10N03W24BBBC01
121	0	--	34	12	1.0	--	192	--	USGS	10N02W03BBAB01
174	0	143	79	10	.8	--	264	--	USGS	10N02W06AADCO1
173	0	142	37	12	1.1	21	237	.10	USGS	10N02W07BBBB01
167	--	137	--	--	--	--	--	--	USGS	10N02W07BBBB01
187	0	153	36	12	.7	--	225	--	USGS	10N02W19ADBB01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana

[Constituents are reported as dissolved and values are rounded according to standard USGS procedures except for arsenic. Analyses by the Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont. Analyses of nine samples from the upper Madison River Valley for 08-17-92 through 08-19-92 and two samples from the lower Madison River Valley for 08-15-91 were analyzed by the U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo. Location number: described in text. Geologic unit: Qal, alluvial deposits (Quaternary); Ts, sedimentary deposits (Tertiary); QAb, bedrock (Quaternary to Archean). Collecting agency: MBMG, Montana Bureau of Mines and Geology, Butte, Mont.; USGS, U.S. Geological Survey. Abbreviations: µg/L, micrograms per liter; per mil, parts per thousand; TU, tritium units. Symbols: +3 and +5, oxidation states of arsenic--arsenite and arsenate, respectively; <, less than minimum reporting level; --, no data]

Location number	Geologic unit	Sample date	Aluminum (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic <sup>+3</sup> (µg/L as As)	Barium (µg/L as Ba)	Beryllium (µg/L as Be)	Boron (µg/L as B)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Copper (µg/L as Cu)	Iron (µg/L as Fe)
<b>NORTHERN PART OF THE UPPER MADISON RIVER VALLEY</b>												
04S01W30BA 01	Ts	08-18-92	--	<1	--	110	<0.5	20	<1	<5	<10	6
05S01W04ABDD01	Ts	09-01-93	--	2.1	<1	--	--	110	--	--	--	--
05S01W04BAAB01	Qal	09-24-92	<50	1.0	--	120	--	130	<2	<2	<2	11
05S01W04DBAB01	Ts	09-02-93	<30	3.9	<1	85	<2	120	<2	<2	<2	<3
05S01W04DDDB01	Qal	08-17-92	--	2.0	--	98	<.5	20	<1	<5	<10	16
05S01W23DABA01	Qal	08-18-92	--	<1	--	100	<.5	30	<1	<5	<10	<3
05S01W28BACB01 <sup>1</sup>	Qal	09-22-92	<50	36	--	84	--	60	<2	<2	<2	230
05S01W28DBDD01	QAb	06-30-82	--	22	--	--	--	680	--	--	--	220
05S01W28DCCB01	Ts	09-01-93	--	6.9	<1	--	--	80	--	--	--	--
05S01W33CBCB01	Qal	08-17-92	--	2.0	--	130	<.5	30	<1	<5	<10	3
06S01W03AABA01	Qal	09-01-93	<30	<1	<1	61	<2	30	<2	<2	<2	<3
06S01W03CDAD01	Qal	09-01-93	--	<1	<1	--	--	50	--	--	--	--
06S01W04ACCB01	Ts	08-17-92	--	2.0	--	110	<.5	60	<1	6	<10	4
06S01W04CCDB01	Ts	09-02-93	--	25	<1	--	--	120	--	--	--	--
06S01W08CADD01	Ts	09-22-92	<50	4.2	--	85	--	60	<2	<2	2	5
06S01W08DABD01	Qal	08-19-92	--	40	--	67	<.5	220	<1	<5	<10	9
06S01W10ABAC01	Qal	09-02-93	<30	<1	<1	76	<2	<30	<2	3	<2	<3
06S01W23BBAC01	Qal	09-22-92	<50	.5	--	88	--	40	<2	2	3	10
06S01W30DADD01	Qal	09-01-93	--	4.1	<1	--	--	50	--	--	--	--
06S01E31CAAC01	Ts	08-18-92	--	<1	--	25	<.5	30	<1	<5	<10	14
07S01W06BBAC01	Ts	09-21-92	<50	6.0	--	54	--	100	<2	<2	<2	10
07S01W12DBBC01	Ts	09-25-92	<50	.6	--	73	--	40	<2	2	2	3
07S01W17BCBD01	Ts	08-19-92	--	3.0	--	36	<.5	70	<1	<5	<10	<3
07S01W20CBAA01	Qal	09-21-92	<30	1.8	--	92	--	110	--	<2	6	9
08S01W25BBC 01	Qal	08-19-92	--	14	--	34	<.5	60	<1	<5	<10	10

Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Selen- ium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
NORTHERN PART OF THE UPPER MADISON RIVER VALLEY												
<10	4	<1	<10	<10	--	160	<3	--	--	--	USGS	04S01W30BA 01
--	80	--	--	--	--	--	--	--	--	--	USGS	05S01W04ABDD01
<3	33	<2	<20	<2	--	160	27	--	--	--	USGS	05S01W04BAAB01
<2	63	<2	<20	<2	1	180	4	--	--	--	USGS	05S01W04DBAB01
<10	8	<1	<10	<10	--	230	<3	--	--	--	USGS	05S01W04DDDB01
<10	7	<1	<10	<10	--	250	18	--	--	--	USGS	05S01W23DABA01
<3	60	310	<20	<2	--	780	8	--	--	--	USGS	05S01W28BACB01 <sup>1</sup>
--	230	22	--	--	--	170	--	--	--	--	MBMG	05S01W28DBDD01
--	40	--	--	--	--	--	--	--	--	--	USGS	05S01W28DCCB01
10	7	<1	<10	<10	--	340	9	--	--	--	USGS	05S01W33CBCB01
<2	12	<2	<20	<2	<1	460	10	--	--	--	USGS	06S01W03AABA01
--	47	--	--	--	--	--	--	--	--	--	USGS	06S01W03CDAD01
<10	15	<1	<10	<10	--	330	7	--	--	--	USGS	06S01W04ACCB01
--	110	--	--	--	--	--	--	--	--	--	USGS	06S01W04CCDB01
<3	<6	<2	<20	<2	--	200	<2	--	--	--	USGS	06S01W08CADD01
<10	140	<1	<10	<10	--	190	11	--	--	--	USGS	06S01W08DABD01
<2	18	<2	<20	2	2	480	58	--	--	--	USGS	06S01W10ABAC01
<3	<6	<2	<20	<2	--	490	8	--	--	--	USGS	06S01W23BBAC01
--	28	--	--	--	--	--	--	--	--	--	USGS	06S01W30DADD01
<10	9	1	<10	<10	--	570	4	--	--	--	USGS	06S01E31CAAC01
<3	19	<2	<20	<2	--	270	11	--	--	--	USGS	07S01W06BBAC01
<3	<6	<2	<20	<2	--	280	18	--	--	--	USGS	07S01W12DBBC01
<10	16	<1	<10	<10	--	390	55	--	--	--	USGS	07S01W17BCBD01
<3	8	<2	<20	<2	--	290	18	--	--	--	USGS	07S01W20CBAA01
<10	130	2	<10	<10	--	92	12	--	--	--	USGS	08S01W25BBC 01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo- logic unit	Sample date	Alumi- num (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic <sup>+3</sup> (µg/L as As)	Bar- ium (µg/L as Ba)	Beryl- lium (µg/L as Be)	Bor- on (µg/L as B)	Cad- mium (µg/L as Cd)	Chro- mium (µg/L as Cr)	Cop- per (µg/L as Cu)	Iron (µg/L as Fe)
<b>LOWER MADISON RIVER VALLEY</b>												
02N01E08DDCA01	Ts	11-10-83	70	35	--	--	--	150	<2	7	30	3,100
02N01E17DAAD01	Ts	11-10-83	<30	4.7	--	--	--	220	<2	<2	20	250
02N01E24BADA01	Qal	12-28-83	<30	2.3	--	--	--	150	<2	<2	32	33
02N01E24DDA 01	Qal	11-11-87	--	1.2	--	--	--	--	--	--	--	--
02N01E24DDAA01	Qal	11-14-83	<30	1.3	--	--	--	80	<2	<2	6	130
02N01E25AACC01	Ts	11-09-83	<30	4.8	--	--	--	70	4.0	4	2	600
02N01E25AB 01	Qal	07-02-84	<30	7.2	--	--	--	70	<2	<2	<2	110
02N01E25BDBB01	Qal	11-16-83	<30	1.8	--	--	--	50	6	<2	36	<2
02N01E26AA 01	Qal	07-02-84	<30	2.6	--	--	--	70	<2	<2	5	19
02N01E26DCDC01	Qal	12-28-83	<30	2.0	--	--	--	110	2	<2	15	3
02N01E27BCCB01	Qal	11-09-83	30	2.4	--	--	--	180	<2	2	4	<2
02N01E27CBD 01	Qal	11-10-83	<30	2.1	--	--	--	60	<2	<2	13	4
02N01E34AAD01	Qal	11-09-83	<30	1.6	--	--	--	100	<2	<2	8	<2
02N01E34AABA01	Qal	11-16-83	<30	1.1	--	--	--	70	<2	2	10	54
02N01E35BABA01	Qal	11-11-83	60	1.4	--	--	--	120	<2	5	11	550
02N01E35BABA02	Qal	11-11-83	<30	3.2	--	--	--	70	<2	<2	8	200
02N01E36BCBD01	Ts	11-09-83	<30	2.0	--	--	--	320	<2	<2	<2	56
02N01E36BCDD01	Qal	11-08-83	90	2.8	--	--	--	70	4	6	14	510
02N01E36CBA 01	Qal	11-09-83	<30	2.3	--	--	--	120	<2	<2	<2	310
02N02E09CBDA01	Qal	11-14-83	<30	3.9	--	--	--	70	<2	2	3	89
02N02E17DDCC01	Ts	05-04-89	<30	70	--	--	--	40	<2	<2	<2	110
02N02E19CBCC01	Qal	11-11-87	--	1.6	--	--	--	--	--	--	--	--
02N02E19CCAB01	Qal	11-11-87	--	2.6	--	--	--	--	--	--	--	--
02N02E19CCB 01	Qal	11-11-87	--	3.7	--	--	--	--	--	--	--	--
02N02E19CCCB01	Qal	11-09-87	--	.9	--	--	--	--	--	--	--	--
02N02E19CCCB02	Qal	11-09-87	--	2.4	--	--	--	--	--	--	--	--
02N02E20CABC01	Qal	11-15-83	30	121	--	--	--	200	<2	<2	8	9
02N02E20CABC01	Qal	11-06-87	--	176	--	--	--	--	--	--	--	--
02N02E20CABC01	Qal	05-03-89	<30	159	--	--	--	430	<2	<2	5	2
02N02E20CBDC01	Qal	11-06-87	--	122	--	--	--	--	--	--	--	--

Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Sele- nium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
<b>LOWER MADISON RIVER VALLEY</b>												
<40	250	1,300	<20	14	<1	2,200	26	--	--	--	MBMG	02N01E08DDCA01
<40	300	810	<20	10	<1	2,200	48	--	--	--	MBMG	02N01E17DAAD01
<40	15	1	<20	10	--	510	5	--	--	--	MBMG	02N01E24BADA01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N01E24DDA 01
<40	16	10	<20	<10	--	410	<3	--	--	--	MBMG	02N01E24DDAA01
<40	23	160	20	<10	--	370	<3	--	--	--	MBMG	02N01E25AACC01
--	8	950	<20	<10	--	350	<3	--	--	--	MBMG	02N01E25AB 01
<40	13	130	<20	<10	--	380	160	--	--	--	MBMG	02N01E25BDBB01
--	13	420	20	<10	--	520	<3	--	--	--	MBMG	02N01E26AA 01
<40	16	<1	20	<10	--	590	35	--	--	--	MBMG	02N01E26DCDC01
<40	72	2	<20	<10	--	1,600	220	--	--	--	MBMG	02N01E27BCCB01
<40	11	<1	<20	<10	--	410	3	--	--	--	MBMG	02N01E27CBD 01
<40	13	<1	<20	<10	--	440	13	--	--	--	MBMG	02N01E34AAAD01
<40	18	20	<20	<10	--	630	13	--	--	--	MBMG	02N01E34AABA01
<40	110	110	<20	<10	--	1,100	<3	--	--	--	MBMG	02N01E35BABA01
<40	15	300	<20	<10	--	560	26	--	--	--	MBMG	02N01E35BABA02
<40	110	19	<20	<10	--	58	<3	--	--	--	MBMG	02N01E36BCBD01
<40	23	180	<20	10	--	580	15	--	--	--	MBMG	02N01E36BCDD01
<40	21	37	<20	<10	<1	76	<3	--	--	--	MBMG	02N01E36CBA 01
<40	9	17	<20	<10	--	240	150	--	--	--	MBMG	02N02E09CBDA01
<40	180	16	<40	<10	--	160	<3	--	--	--	MBMG	02N02E17DDCC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E19CBCC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E19CCAB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E19CCB 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E19CCCB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E19CCCB02
--	280	4	<20	<10	--	2	<3	--	--	--	MBMG	02N02E20CABC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E20CABC01
--	220	6	<20	<10	--	<1	47	--	--	--	MBMG	02N02E20CABC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E20CBDC01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo-logic unit	Sample date	Alumi-num (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic <sup>+3</sup> (µg/L as As)	Bar-ium (µg/L as Ba)	Beryl-lium (µg/L as Be)	Bo-ron (µg/L as B)	Cad-mium (µg/L as Cd)	Chro-mium (µg/L as Cr)	Cop-per (µg/L as Cu)	Iron (µg/L as Fe)
<b>LOWER MADISON RIVER VALLEY--Continued</b>												
02N02E20CCAA01	Qal	05-02-89	30	102	--	--	--	380	<2	<2	8	32
02N02E20CDAC01	Qal	05-03-89	<30	120	--	--	--	430	<2	<2	<2	8
02N02E20DAC 01	Qal	05-02-89	<30	38	--	--	--	470	<2	<2	<2	110
02N02E20DDCB01	Qal	11-05-87	--	117	--	--	--	--	--	--	--	--
02N02E20DDCB01	Qal	09-24-92	<50	114	--	19	--	310	<2	<2	<2	14
02N02E21ACDB01	Qal	11-09-87	--	61	--	--	--	--	--	--	--	--
02N02E21ACDB01	Qal	08-30-93	<30	61	42	85	<2	400	<2	<2	<2	120
02N02E22CCC 01	Qal	11-09-87	--	72	--	--	--	--	--	--	--	--
02N02E27CADD01	Qal	11-09-87	--	16	--	--	--	--	--	--	--	--
02N02E27CBC 01	Qal	11-05-87	--	106	--	--	--	--	--	--	--	--
02N02E27DCA 01	Qal	11-09-87	--	3.7	--	--	--	--	--	--	--	--
02N02E27DCA 02	Qal	11-09-87	--	4.1	--	--	--	--	--	--	--	--
02N02E27DCB 01	Qal	11-09-87	--	18	--	--	--	--	--	--	--	--
02N02E28BC 01	Qal	11-05-87	--	119	--	--	--	--	--	--	--	--
02N02E28BCD 01	Ts	11-05-87	--	118	--	--	--	--	--	--	--	--
02N02E28CADC01	Qal	11-10-87	--	130	--	--	--	--	--	--	--	--
02N02E28CADC01	Qal	07-15-88	--	71	--	--	--	--	--	--	--	--
02N02E28CADC01	Qal	05-04-89	<30	--	--	--	--	440	2	<2	<2	780
02N02E28CADC01	Qal	09-25-92	<50	103	--	130	--	670	<2	<2	23	490
02N02E28CADC01	Qal	09-17-93	--	104	24	--	--	500	--	--	--	720
02N02E28CADC01	Qal	08-31-94	<30	97	--	100	--	520	<2	<2	2	710
02N02E28CADC02	Qal	07-15-88	--	58	--	--	--	--	--	--	--	--
02N02E28CADC02	Qal	09-17-93	<30	83	1.1	160	<2	610	<2	<2	2	6
02N02E28CADC02	Qal	08-31-94	<30	80	--	130	--	630	<2	<2	<2	5
02N02E28CADC03	Qal	07-15-88	--	22	--	--	--	--	--	--	--	--
02N02E28CADC03	Qal	08-15-91	--	--	--	210	<.5	560	<1	<5	<10	30
02N02E28CADC03	Qal	09-17-93	<30	59	--	200	<2	530	<2	<2	7	6
02N02E28CADC03	Qal	08-31-94	<30	60	2.3	190	--	500	<2	<2	5	10
02N02E28CADC04	Ts	06-29-88	<30	95	--	--	--	270	<2	<2	<2	110
02N02E28CADC04	Ts	08-15-91	--	--	--	18	<.5	380	<1	<5	<10	350

Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Sele- nium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
LOWER MADISON RIVER VALLEY—Continued												
<40	210	340	20	<10	--	170	16	--	--	--	MBMG	02N02E20CCAA01
<40	210	26	20	<10	--	180	160	--	--	--	MBMG	02N02E20CDAC01
<40	170	60	<20	<10	--	170	16	--	--	--	MBMG	02N02E20DAC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E20DDCB01
<3	210	70	<20	<2	--	270	4	--	--	--	USGS	02N02E20DDCB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E21ACDB01
<2	250	230	<10	2	<1	350	2	-139.0	-17.90	4.4	USGS	02N02E21ACDB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E22CCC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E27CADD01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E27CBC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E27DCA 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E27DCA 02
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E27DCB 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E28BC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E28BCD 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E28CADC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E28CADC01
<40	210	150	<20	<10	--	640	<3	--	--	--	MBMG	02N02E28CADC01
<3	270	730	17	2	--	250	13	--	--	--	USGS	02N02E28CADC01
--	260	540	--	--	--	--	--	-134.0	-17.21	--	USGS	02N02E28CADC01
<2	260	500	12	<2	1	230	6	--	--	--	USGS	02N02E28CADC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E28CADC02
<2	240	2,500	18	3	<1	250	2	-136.0	-17.37	41	USGS	02N02E28CADC02
<2	250	3,000	16	3	1	270	<2	--	--	--	USGS	02N02E28CADC02
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E28CADC03
<10	270	2,100	20	<10	--	290	<3	-139.0	-17.75	20	USGS	02N02E28CADC03
<2	230	1,700	18	3	<1	270	6	--	--	--	USGS	02N02E28CADC03
<2	240	1,600	16	4	1	280	7	--	--	--	USGS	02N02E28CADC03
--	230	76	<20	<10	--	280	10	--	--	--	MBMG	02N02E28CADC04
<10	260	74	<10	<10	--	320	11	-142.0	-18.50	1.6	USGS	02N02E28CADC04

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Sample date	Aluminum ( $\mu\text{g/L}$ as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> ( $\mu\text{g/L}$ as As)	Arsenic <sup>+3</sup> ( $\mu\text{g/L}$ as As)	Barium ( $\mu\text{g/L}$ as Ba)	Beryllium ( $\mu\text{g/L}$ as Be)	Boron ( $\mu\text{g/L}$ as B)	Cadmium ( $\mu\text{g/L}$ as Cd)	Chromium ( $\mu\text{g/L}$ as Cr)	Copper ( $\mu\text{g/L}$ as Cu)	Iron ( $\mu\text{g/L}$ as Fe)
<b>LOWER MADISON RIVER VALLEY--Continued</b>												
02N02E28CADC04	Ts	08-31-94	<30	85	--	16	<2	320	<2	<2	<2	310
02N02E28CBDD01	Qal	05-04-89	<30	123	--	--	--	700	<2	<2	<2	630
02N02E29AD 01	Qal	11-05-87	--	73	--	--	--	--	--	--	--	--
02N02E29BABD01	Qal	11-15-83	<30	63	--	--	--	440	<2	<2	7	220
02N02E29BABD02	Ts	05-03-89	<30	84	--	--	--	530	<2	<2	<2	440
02N02E29DD 01	Qal	11-10-87	--	59	--	--	--	--	--	--	--	--
02N02E32AAAA01	Qal	05-10-89	<30	63	--	--	--	290	<2	<2	<2	1,100
02N02E32AAAA02	Qal	11-10-87	--	90	--	--	--	--	--	--	--	--
02N02E35BBB 01	QAb	08-16-88	--	2.2	--	--	--	--	--	--	--	--
02N02E35DCD 01	Qal	11-05-87	--	47	--	--	--	--	--	--	--	--
01N01E04BCDC01	Ts	12-28-83	<30	2.4	--	--	--	250	2	<2	<2	<2
01N02E04CB 01	Qal	05-20-88	--	88	--	--	--	--	--	--	--	--
01N02E04DCCC01	Qal	06-13-84	<30	88	--	--	--	340	<2	<2	<2	1,300
01N02E06BCBA01	Ts	11-09-83	<30	13	--	--	--	70	<2	<2	<2	27
01N02E06DAA01	Qal	11-15-83	<30	127	--	--	--	510	<2	3	10	11
01N02E07AACA01	Ts	11-09-83	<30	16	--	--	--	50	3	<2	<2	92
01N02E10DBAB01	Ts	05-04-89	<30	120	--	--	--	670	<2	<2	<2	190
01N02E10DBAB01	Ts	09-23-92	<50	107	--	65	--	620	<2	3	<2	110
01N02E15DCBB01	Ts	03-10-88	--	67	--	--	--	--	--	--	--	--
01N02E15DCBB01	Ts	05-10-89	<30	79	--	--	--	500	<2	<2	10	4
01N02E15DCBD01	Ts	03-10-88	--	100	--	--	--	--	--	--	--	--
01N02E15DCBD01	Ts	05-10-89	<30	58	--	--	--	750	<2	<2	15	<2
01N02E15DD 01	Ts	05-05-89	<30	60	--	--	--	540	<2	<2	16	14
01N02E16CBD 01	Qal	11-09-87	--	67	--	--	--	--	--	--	--	--
01N02E19CDD01	Ts	11-15-83	<30	12	--	--	--	60	3	5	19	<2
01N02E20AC 01	Ts	05-20-88	--	37	--	--	--	--	--	--	--	--
01N02E21ABBA01	Qal	11-09-87	--	54	--	--	--	--	--	--	--	--
01N02E21ABBA01	Qal	08-31-93	<30	48	<1	96	<2	180	<2	<2	4	5
01N02E21ABBB01	Qal	11-09-87	--	50	--	--	--	--	--	--	--	--
01N02E22ABB 01	Ts	05-19-88	--	98	--	--	--	--	--	--	--	--



Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Selen- ium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
LOWER MADISON RIVER VALLEY—Continued												
<2	260	76	<10	<2	<1	330	<2	--	--	--	USGS	02N02E28CADC04
<40	240	1,100	<20	<10	--	260	5	--	--	--	MBMG	02N02E28CBDD01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E29AD 01
<40	310	15	<20	<10	--	260	4	--	--	--	MBMG	02N02E29BABD01
<40	220	370	<20	<10	--	280	<3	--	--	--	MBMG	02N02E29BABD02
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E29DD 01
<40	200	640	<20	<10	--	190	3	--	--	--	MBMG	02N02E32AAAA01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E32AAAA02
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E35BBB 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02N02E35DCD 01
<40	72	3	30	<10	--	68	<3	--	--	--	MBMG	01N01E04BCDC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E04CB 01
--	240	340	<20	<10	--	250	<3	--	--	--	MBMG	01N02E04DCCC01
<40	47	3	40	<10	--	120	3	--	--	--	MBMG	01N02E06BCBA01
<40	190	12	30	<10	--	380	170	--	--	--	MBMG	01N02E06DAA 01
<40	64	13	<20	<10	--	200	<3	--	--	--	MBMG	01N02E07AACA01
<40	190	39	30	<10	--	640	<3	--	--	--	MBMG	01N02E10DBAB01
<3	210	46	52	3	--	810	6	--	--	--	USGS	01N02E10DBAB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E15DCBB01
<40	210	1	<20	<10	--	410	4	--	--	--	MBMG	01N02E15DCBB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E15DCBD01
<40	160	<1	<20	<10	--	380	<3	--	--	--	MBMG	01N02E15DCBD01
<40	100	1	50	<10	--	600	6	--	--	--	MBMG	01N02E15DD 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E16CBD 01
<40	12	11	30	10	11	2,000	18	--	--	--	MBMG	01N02E19CDDD01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E20AC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E21ABBA01
<2	180	<2	<10	<2	1	210	17	-135.0	-17.55	27	USGS	01N02E21ABBA01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E21ABBA01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E22ABB 01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geologic unit	Sample date	Aluminum (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic <sup>+3</sup> (µg/L as As)	Barium (µg/L as Ba)	Beryllium (µg/L as Be)	Boron (µg/L as B)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Copper (µg/L as Cu)	Iron (µg/L as Fe)
<b>LOWER MADISON RIVER VALLEY--Continued</b>												
01N02E22ABBB01	Ts	03-10-88	--	119	--	--	--	--	--	--	--	--
01N02E22ABBB01	Ts	05-10-89	<30	78	--	--	--	730	<2	<2	8	<2
01N02E22BABA01	Qal	08-31-93	<30	114	5.4	81	<2	340	<2	<2	<2	15
01N02E22BADD01	Ts	09-17-93	<30	120	2.2	42	<2	560	<2	<2	<2	<3
01N02E22CA 01	Ts	05-19-88	--	130	--	--	--	--	--	--	--	--
01N02E22CABD01	Ts	05-05-89	<30	116	--	--	--	390	<2	<2	5	<2
01N02E22CDCC01	Ts	05-19-88	--	138	--	--	--	--	--	--	--	--
01N02E22CDCC01	Ts	09-23-92	<50	122	--	35	--	390	<2	<2	3	10
01N02E27BBDA01	Ts	05-19-88	--	92	--	--	--	--	--	--	--	--
01N02E27BCCB01	Ts	11-06-87	--	112	--	--	--	--	--	--	--	--
01N02E29DCA 01	Qal	06-13-84	<30	50	--	--	--	190	<2	<2	11	12
01N02E29DCA 01	Qal	11-06-87	--	53	--	--	--	--	--	--	--	--
01N02E30DCAC01	Ts	11-15-83	30	29	--	--	--	110	<2	6	12	6
01N02E33DAB 01	Ts	11-06-87	--	68	--	--	--	--	--	--	--	--
01S02E03DCC 01	Ts	05-20-88	--	61	--	--	--	--	--	--	--	--
01S02E04AACC01	Qal	05-05-89	<30	70	--	--	--	560	<2	<2	<2	<2
01S02E05AB 01	Qal	11-06-87	--	48	--	--	--	--	--	--	--	--
01S02E08CDDC01	Qal	11-06-87	--	48	--	--	--	--	--	--	--	--
01S02E10CAAC01	Ts	11-06-87	--	55	--	--	--	--	--	--	--	--
01S02E10CAAC01	Ts	08-31-93	<30	54	<1	110	<2	950	<2	<2	4	5
01S02E16DDA 01	--	05-20-88	--	38	--	--	--	--	--	--	--	--
01S02E17AAAB01	Qal	11-09-87	--	44	--	--	--	--	--	--	--	--
01S02E17AAAB01		08-30-93	<30	43	<1	46	<2	150	<2	<2	<2	<3
01S02E17AAB 01	Qal	11-09-87	--	52	--	--	--	--	--	--	--	--
01S02E20CACC01	Qal	08-30-93	<30	124	.9	110	<2	410	<2	<2	12	4
01S02E20CACC01	Qal	08-31-94	<30	71	--	69	<2	200	<2	<2	2	6
01S02E21DBDB01	Ts	05-09-89	<30	45	--	--	--	190	<2	<2	3	<2
01S02E22BCCB01	Ts	05-05-89	<30	21	--	--	--	220	<2	<2	<2	<2
01S02E29AAC 01	Qal	11-05-87	--	27	--	--	--	--	--	--	--	--
01S02E29DDDB01	Qal	11-05-87	--	25	--	--	--	--	--	--	--	--

Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Selen- ium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
LOWER MADISON RIVER VALLEY—Continued												
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E22ABBB01
<40	190	<1	20	<10	--	320	17	--	--	--	MBMG	01N02E22ABBB01
<2	210	26	15	1	<1	330	22	-134.0	-17.21	26	USGS	01N02E22BABA01
<2	190	<2	21	<2	<1	320	10	-134.0	-17.21	29	USGS	01N02E22BADD01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E22CA 01
<40	160	<1	27	<10	--	240	690	--	--	--	MBMG	01N02E22CABD01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E22CDCC01
<3	120	<2	36	<2	--	350	12	--	--	--	USGS	01N02E22CDCC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E27BBDA01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E27BCCB01
--	170	1	<20	<10	--	170	21	--	--	--	MBMG	01N02E29DCA 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E29DCA 01
<40	19	13	<20	<10	<1	1,300	120	--	--	--	MBMG	01N02E30DCAC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01N02E33DAB 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E03DCC 01
<40	130	<1	34	<10	--	530	20	--	--	--	MBMG	01S02E04AACC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E05AB 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E08CDDC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E10CAAC01
<2	170	<2	11	3	26	610	63	-136.0	-17.61	27	USGS	01S02E10CAAC01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E16DDA 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E17AAAB01
<2	130	<2	<20	<2	1	150	5	-136.0	-17.80	22	USGS	01S02E17AAAB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E17AAB 01
<2	310	<2	<20	2	<1	250	38	-134.0	-17.30	23	USGS	01S02E20CACC01
<2	180	<2	<10	<2	1	180	25	--	--	--	USGS	01S02E20CACC01
<40	130	<1	<20	<10	--	360	30	--	--	--	MBMG	01S02E21DBDB01
<40	60	<1	100	<10	--	870	19	--	--	--	MBMG	01S02E22BCCB01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E29AAC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	01S02E29DDDB01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo- logic unit	Sample date	Alumi- num (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic <sup>+3</sup> (µg/L as As)	Bar- ium (µg/L as Ba)	Beryl- lum (µg/L as Be)	Bor- on (µg/L as B)	Cad- mium (µg/L as Cd)	Chro- mium (µg/L as Cr)	Cop- per (µg/L as Cu)	Iron (µg/L as Fe)
<b>LOWER MADISON RIVER VALLEY--Continued</b>												
02S02E05BAA 01	Qal	06-13-84	<30	36	--	--	--	160	<2	<2	6	4
02S02E05BDBB01	Qal	05-09-89	<30	41	--	--	--	170	<2	<2	<2	3
02S02E05BDBB01	Qal	09-23-92	<50	45	--	57	--	170	<2	<2	<2	8
02S02E05CAAD01	Qal	08-31-93	<30	34	<1	64	<2	140	<2	<2	<2	3
02S02E05CC 01	Qal	11-05-87	--	37	--	--	--	--	--	--	--	--
02S02E05CCC 01	Qal	11-05-87	--	30	--	--	--	--	--	--	--	--
02S02E05CDA 01	Qal	11-05-87	--	27	--	--	--	--	--	--	--	--
02S02E19BA 01	Qal	11-05-87	--	32	--	--	--	--	--	--	--	--
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>												
07N02E09AABB01	Qal	09-07-93	<30	1.4	<1	92	<2	120	<2	<2	<2	5
07N02E15CBAB01	Qal	10-19-92	<50	<1	--	140	--	90	<2	<2	<6	<3
07N02E20DDCD01	Qal	09-07-93	--	2.4	<1	--	--	80	--	--	--	<3
07N02E29CABC01	Qal	10-21-92	<50	.9	--	120	--	270	<2	<2	<2	5
07N02E32BADB01	Qal	09-07-93	--	1.2	<1	--	--	70	--	--	--	<3
07N02E33ABCD01	Ts	09-07-93	<30	1.2	<1	81	<2	90	<2	<2	<2	<3
06N02E08AACC01	Qal	09-14-93	--	1.2	--	--	--	80	--	--	--	<3
06N02E09BACD01	Ts	10-21-92	<50	<1	--	87	--	50	<2	<2	<2	15
06N02E16BBAA01	Qal	09-14-93	--	1.1	--	--	--	70	--	--	--	--
06N02E21DAAA01	Qal	09-14-93	--	2.5	--	--	--	120	--	--	--	3
06N02E34BDBB01	Qal	09-08-93	--	6.6	<1	--	--	150	--	--	--	--
05N01E22BBAB01	Ts	06-16-79	--	--	--	--	--	<20	--	--	--	740
05N01E24BDD 01	Qal	06-17-79	--	--	--	--	--	50	--	--	--	20
05N02E03ACDC01	Qal	10-19-92	<50	18	--	97	--	200	<2	<2	3	<3
05N02E05BDCB01	Qal	10-21-92	<50	3.3	--	100	--	120	<2	<2	<2	4
05N02E10CBCC01	Qal	09-08-93	<30	16	<1	93	<2	120	<2	<2	<2	4
05N02E22CBBA01	Qal	10-20-92	<50	2.8	--	32	--	310	<2	<2	<2	4
05N02E23DBCA01	Qal	10-19-92	<50	17	--	96	--	120	<2	<5	2	4
05N02E32DAAD01	Qal	09-08-93	--	2.2	<1	--	--	290	--	--	--	11
05N02E33DACA01	Ts	11-02-79	--	--	--	--	--	240	--	--	--	<10
05N02E33DACA01	Ts	10-20-92	<50	2.6	--	24	--	260	<2	2	<2	11
04N01E04ADBB01	Ts	06-29-79	--	1.3	--	--	--	380	--	--	--	30
04N01E09CAB 01	Ts	06-20-79	--	--	--	--	--	110	--	--	--	30
04N01E12BADD01	Ts	09-15-79	--	--	--	--	--	160	--	--	--	20
04N01E23BBB 01	Ts	06-28-79	--	--	--	--	--	100	--	--	--	30

Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Selen- ium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
<b>LOWER MADISON RIVER VALLEY--Continued</b>												
--	110	<1	20	<10	--	130	29	--	--	--	MBMG	02S02E05BAA 01
<3	120	<2	<20	<2	--	120	5	--	--	--	MBMG	02S02E05BDBB01
<40	100	<1	<20	<10	--	140	20	--	--	--	USGS	02S02E05BDBB01
<2	110	<2	<20	<2	<1	150	11	-134.0	-17.22	23	USGS	02S02E05CAAD01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02S02E05CC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02S02E05CCC 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02S02E05CDA 01
--	--	--	--	--	--	--	--	--	--	--	MBMG	02S02E19BA 01
<b>SOUTHERN PART OF THE TOWNSEND VALLEY</b>												
<2	26	<2	<10	<2	<1	410	11	--	--	--	USGS	07N02E09AABB01
<3	<6	<2	<30	<2	--	460	23	--	--	--	USGS	07N02E15CBAB01
--	44	--	--	--	--	--	--	--	--	--	USGS	07N02E20DDCD01
<3	22	<2	<30	<2	--	550	9	--	--	--	USGS	07N02E29CABC01
--	18	--	--	--	--	--	--	--	--	--	USGS	07N02E32BADB01
<2	27	<2	<10	<2	<1	540	17	--	--	--	USGS	07N02E33ABCD01
--	13	--	--	--	--	--	--	--	--	--	USGS	06N02E08AACC01
<3	<6	<2	<30	<2	--	450	11	--	--	--	USGS	06N02E09BACD01
--	13	--	--	--	--	--	--	--	--	--	USGS	06N02E16BBAA01
--	19	--	--	--	--	--	--	--	--	--	USGS	06N02E21DAAA01
--	89	--	--	--	--	--	--	--	--	--	USGS	06N02E34BDBB01
--	5	320	--	--	--	140	--	--	--	--	MBMG	05N01E22BBAB01
--	12	<10	--	--	--	180	--	--	--	--	MBMG	05N01E24BDD 01
<3	80	<2	<30	<2	--	580	17	--	--	--	USGS	05N02E03ACDC01
<3	13	<2	<30	<2	--	540	8	--	--	--	USGS	05N02E05BDCB01
<2	82	3	<10	<2	<1	400	<2	--	--	--	USGS	05N02E10CBCC01
<3	27	<2	<30	<2	--	1,000	8	--	--	--	USGS	05N02E22CBBA01
<3	74	<2	<30	<2	--	340	<2	--	--	--	USGS	05N02E23DBCA01
--	39	--	--	--	--	--	--	--	--	--	USGS	05N02E32DAAD01
--	40	<10	--	--	--	680	--	--	--	--	MBMG	05N02E33DACA01
<3	29	<2	<30	<2	--	640	96	--	--	--	USGS	05N02E33DACA01
--	70	10	--	--	--	2,400	--	--	--	--	MBMG	04N01E04ADBB01
--	17	20	--	--	--	940	--	--	--	--	MBMG	04N01E09CAB 01
--	28	<10	--	--	--	550	--	--	--	--	MBMG	04N01E12BADD01
--	26	<10	--	--	--	480	--	--	--	--	MBMG	04N01E23BBB 01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo- logic unit	Sample date	Alumi- num (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic <sup>+3</sup> (µg/L as As)	Bar- ium (µg/L as Ba)	Beryl- lilum (µg/L as Be)	Bor- on (µg/L as B)	Cad- mium (µg/L as Cd)	Chro- mium (µg/L as Cr)	Cop- per (µg/L as Cu)	Iron (µg/L as Fe)
<b>SOUTHERN PART OF THE TOWNSEND VALLEY—Continued</b>												
04N02E16AAA 01	Ts	06-29-79	--	--	--	--	--	230	--	--	--	30
04N02E18ACAC01	Ts	06-12-79	--	--	--	--	--	180	--	--	--	20
<b>HELENA VALLEY</b>												
11N04W25AABA01	Qal	08-09-95	--	3.0	--	--	--	--	<1	<1	<1	--
11N04W25DDDD01	Qal	08-07-95	--	<1	--	--	--	--	<1	<1	<1	--
11N04W36ACCA01	QAb	08-09-95	--	6.0	--	--	--	--	<1	<1	<1	--
11N03W14BBBB01	QAb	08-08-95	--	3.0	--	--	--	--	<1	<1	<1	--
11N03W16BBBB01	QAb	08-08-95	--	2.0	--	--	--	--	<1	<1	3.0	--
11N03W17DDCC01	Qal	06-30-93	--	1.5	<1	--	--	40	--	--	--	--
11N03W18ADDD01	Qal	08-09-95	--	2.0	--	--	--	--	<1	<1	<1	--
11N03W22BBCB02	Qal	08-07-90	<40	--	--	18	--	90	<5	<5	5	<4
11N03W22BBCB02	Qal	07-08-93	<30	3.6	<1	14	<2	80	<2	<2	<2	<3
11N03W25DDBD01	Qal	06-29-93	--	.9	<1	--	--	30	--	--	--	--
11N03W28DAAD01	Qal	08-07-95	--	16	--	--	--	--	<1	1.1	2.0	--
11N03W29ABBA01	Qal	06-28-93	--	1.8	--	--	--	80	--	--	--	--
11N03W30DBCA01	Qal	06-28-93	--	2.7	--	--	--	30	--	--	--	--
11N03W33ADDB01	Qal	08-07-95	--	6.0	--	--	--	--	<1	1.0	<1	--
11N03W33BBAA02	Qal	08-16-90	<40	--	--	49	--	<40	<5	<5	<4	<4
11N03W33BBAA02	Qal	07-08-93	<30	1.3	--	57	<2	30	<2	<2	<2	<3
11N03W33BBAA03	Qal	08-16-90	110	--	--	58	--	<40	<5	<5	<4	5
11N03W33DDDC01	Qal	08-06-90	<40	--	--	34	--	50	<5	<5	<4	67
11N03W33DDDC02	Qal	08-06-90	<40	--	--	46	--	<40	<5	<5	<4	14
11N03W35DACC01	Qal	08-06-90	50	--	--	58	--	<40	<5	<5	<4	14
11N03W35DACC01	Qal	07-08-93	<30	.9	<1	69	<2	30	<2	<2	<2	<3
11N02W31BCCB01	Qal	06-29-93	<30	<1	<1	49	<2	50	<2	<2	<2	<3
10N04W12AACD01	Qal	08-10-95	--	3.0	--	--	--	--	--	--	--	--
10N03W02BCDD01	Qal	06-30-93	<30	1.0	<1	64	<2	<20	<2	<2	<2	7
10N03W02DDDD03	Qal	08-14-90	150	--	--	48	--	50	<5	<5	<4	<4
10N03W02DDDD03	Qal	08-07-95	--	1.0	--	--	--	--	--	--	--	--
10N03W04DCCD01	Qal	08-07-90	170	--	--	42	--	<40	<5	<5	<4	<4
10N03W04DCCD02	Qal	08-07-90	50	--	--	44	--	<40	<5	<5	<4	<4
10N03W05CCDD01	Qal	08-15-90	60	--	--	49	--	50	7	<5	<4	73
10N03W06DBAA01	Qal	11-03-90	100	--	--	80	--	<40	<5	<5	<4	11

Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Selen- ium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
<b>SOUTHERN PART OF THE TOWNSEND VALLEY--Continued</b>												
--	25	<10	--	--	--	380	--	--	--	--	MBMG	04N02E16AAA 01
--	25	<10	--	--	--	270	--	--	--	--	MBMG	04N02E18ACAC01
<b>HELENA VALLEY</b>												
<1	--	--	--	--	<1	--	5.0	--	--	--	USGS	11N04W25AABA01
<1	--	--	--	--	<2	--	890	--	--	--	USGS	11N04W25DDDD01
<1	--	--	--	--	<1	--	3.0	--	--	--	USGS	11N04W36ACCA01
<1	--	--	--	--	<1	--	<3	--	--	--	USGS	11N03W14BBBB01
<1	--	--	--	--	1.0	--	12.0	--	--	--	USGS	11N03W16BBBB01
--	11	--	--	--	--	--	--	--	--	--	USGS	11N03W17DDCC01
<1	--	--	--	--	<1	--	7.0	--	--	--	USGS	11N03W18ADDD01
--	20	2	<40	<20	--	660	<6	--	--	--	USGS	11N03W22BBCB02
<3	29	<2	<20	2	3	690	<2	--	--	--	USGS	11N03W22BBCB02
--	17	--	--	--	--	--	--	--	--	--	USGS	11N03W25DDBD01
<1	--	--	--	--	<1	--	<3	--	--	--	USGS	11N03W28DAAD01
--	13	--	--	--	--	--	--	--	--	--	USGS	11N03W29ABBA01
--	15	--	--	--	--	--	--	--	--	--	USGS	11N03W30DBCA01
<1	--	--	--	--	<1	--	7.0	--	--	--	USGS	11N03W33ADDB01
--	18	6	<40	<20	--	260	<6	--	--	--	USGS	11N03W33BBAA02
<3	24	<2	<20	<2	<1	260	<2	--	--	--	USGS	11N03W33BBAA02
--	17	2	<40	<20	--	270	<6	--	--	--	USGS	11N03W33BBAA03
--	21	9	<40	<20	--	230	<6	--	--	--	USGS	11N03W33DDDC01
--	20	36	<40	<20	--	250	<6	--	--	--	USGS	11N03W33DDDC02
--	8	<2	<40	<20	--	370	<6	--	--	--	USGS	11N03W35DACC01
<3	11	<2	<20	<2	<1	390	<2	--	--	--	USGS	11N03W35DACC01
<3	21	<2	<20	<2	<1	340	15	--	--	--	USGS	11N02W31BCCB01
--	--	--	--	--	--	--	--	--	--	--	USGS	10N04W12AACD01
<3	15	8	<20	<2	<1	330	29	--	--	--	USGS	10N03W02BCDD01
--	12	<2	<40	<20	--	420	<6	--	--	--	USGS	10N03W02DDDD03
--	--	--	--	--	--	--	--	--	--	--	USGS	10N03W02DDDD03
--	30	<2	<40	<20	--	290	<6	--	--	--	USGS	10N03W04DCCD01
--	27	3	<40	<20	--	290	<6	--	--	--	USGS	10N03W04DCCD02
--	20	200	<40	<20	--	190	110	--	--	--	USGS	10N03W05CCDD01
--	18	88	<40	<20	--	250	<6	--	--	--	USGS	10N03W06DBAA01

**Table 12.** Trace-element concentrations and isotope ratios in ground water along the Madison and upper Missouri Rivers in Montana (Continued)

Location number	Geo-logic unit	Sample date	Aluminum ( $\mu\text{g/L}$ as Al)	Arsenic, $\text{As}^{+3}$ and $\text{As}^{+5}$ ( $\mu\text{g/L}$ as As)	Arsenic $^{+3}$ ( $\mu\text{g/L}$ as As)	Barium ( $\mu\text{g/L}$ as Ba)	Beryllium ( $\mu\text{g/L}$ as Be)	Boron ( $\mu\text{g/L}$ as B)	Cadmium ( $\mu\text{g/L}$ as Cd)	Chromium ( $\mu\text{g/L}$ as Cr)	Copper ( $\mu\text{g/L}$ as Cu)	Iron ( $\mu\text{g/L}$ as Fe)
<b>HELENA VALLEY--Continued</b>												
10N03W06DBAA02	Qal	11-03-90	<40	--	--	53	--	90	<5	<5	<4	140
10N03W11DDCC02	Qal	08-09-90	110	--	--	41	--	<40	<5	<5	<4	<4
10N03W16DCCC02	Qal	08-08-95	--	5.0	--	--	--	--	--	--	--	--
10N03W17ABBB01	Qal	08-07-95	--	<1	--	--	--	--	<1	<1	2.0	--
10N03W18AADA01	Qal	08-09-95	--	2.0	--	--	--	--	<1	<1	<1	--
10N03W23DAAD01	Qal	08-09-90	190	--	--	78	--	40	<5	<5	<4	300
10N03W24BBBC01	Qal	08-09-95	--	1.0	--	--	--	--	<1	<1	<1	--
10N02W03BBAB01	Ts	08-08-95	--	22	--	--	--	--	<1	<1	<1	--
10N02W06AADCO1	Ts	08-08-95	--	17	--	--	--	--	<1	<1	<1	--
10N02W07BBBB01	Qal	08-17-90	100	--	--	28	--	110	<5	<5	<4	<4
10N02W07BBBB01	Qal	08-07-95	--	2.0	--	--	--	--	--	--	--	--
10N02W19ADBB01	Qal	08-10-95	--	1.0	--	--	--	--	<1	<1	<1	--

<sup>1</sup>Data for this site originally published in Dutton and others (1995) as well number 05S01W28BCAB01. WATSTORE location number is 05S01W28BACB01.



Lead (µg/L as Pb)	Lith- ium (µg/L as Li)	Man- ga- nese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Sele- nium (µg/L as Se)	Stron- tium (µg/L as Sr)	Zinc (µg/L as Zn)	Deu- terium/ hydrogen stable- isotope ratio (permil)	Oxygen- 18/ oxygen- 16 stable- isotope ratio (permil)	Trit- ium (TU)	Collect- ing agency	Location number
HELENA VALLEY--Continued												
--	22	39	<40	<20	--	220	<6	--	--	--	USGS	10N03W06DBAA02
--	11	19	<40	<20	--	390	<6	--	--	--	USGS	10N03W11DDCC02
--	--	--	--	--	--	--	--	--	--	--	USGS	10N03W16DCCC02
<1	--	--	--	--	<1	--	93	--	--	--	USGS	10N03W17ABBB01
<1	--	--	--	--	<1	--	7.0	--	--	--	USGS	10N03W18AADA01
--	14	240	<40	<20	--	260	<6	--	--	--	USGS	10N03W23DAAD01
<1	--	--	--	--	<1	--	<3	--	--	--	USGS	10N03W24BBBC01
<1	--	--	--	--	<1	--	5.0	--	--	--	USGS	10N02W03BBAB01
<1	--	--	--	--	<1	--	55	--	--	--	USGS	10N02W06AADC01
--	54	15	<40	<20	--	280	<6	--	--	--	USGS	10N02W07BBBB01
--	--	--	--	--	--	--	--	--	--	--	USGS	10N02W07BBBB01
<1	--	--	--	--	<1	--	<1	--	--	--	USGS	10N02W19ADBB01

**Table 13.** Water-quality data for replicate surface-water samples

[Constituents are reported as dissolved except as indicated. Number of significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Site number described in text. Analyzing agency: USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo.; MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont. Abbreviations: lab, laboratory;  $\mu\text{g/L}$ , micrograms per liter;  $\mu\text{S/cm}$ , microsiemens per centimeter at 25° C;  $\text{mg/L}$ , milligrams per liter. Symbols: <, less than minimum reporting level; --, no data]

Site number	Sample date	Specific conductance, lab ( $\mu\text{S/cm}$ )	pH, lab (standard units)	Calcium ( $\text{mg/L}$ as Ca)	Magnesium ( $\text{mg/L}$ as Mg)	Sodium ( $\text{mg/L}$ as Na)	Potassium ( $\text{mg/L}$ as K)	Alkalinity, lab ( $\text{mg/L}$ as $\text{CaCO}_3$ )	Sulfate ( $\text{mg/L}$ as $\text{SO}_4$ )	Chloride ( $\text{mg/L}$ as Cl)	Fluoride ( $\text{mg/L}$ as F)
S8	08-18-93	217	8.0	16	3.9	20	3.1	78	10	11	1.7
	08-18-93	219	8.1	16	3.9	20	2.7	78	10	11	1.7
S60	09-09-93	314	8.9	29	8.8	27	4.3	99	17	12	1.8
	09-09-93	328	8.9	28	8.6	27	4.4	96	17	12	1.7

Site number	Silica ( $\text{mg/L}$ as $\text{SiO}_2$ )	Dissolved solids, calculated ( $\text{mg/L}$ )	Nitrate ( $\text{mg/L}$ as N)	Aluminum ( $\mu\text{g/L}$ as Al)	Arsenic, total recoverable ( $\mu\text{g/L}$ as As)	Arsenic ( $\mu\text{g/L}$ as As)	Barium ( $\mu\text{g/L}$ as Ba)	Beryllium ( $\mu\text{g/L}$ as Be)	Boron ( $\mu\text{g/L}$ as B)	Cadmium ( $\mu\text{g/L}$ as Cd)	Chromium ( $\mu\text{g/L}$ as Cr)
S8	28	141	--	--	56	51	--	--	--	--	--
	28	140	--	--	57	54	--	--	--	--	--
S60	31	207	0.05	<30	--	57.9	29	<2	170	<2	<2
	31	206	.05	<30	--	56.2	28	<2	170	<2	<2

Site number	Copper ( $\mu\text{g/L}$ as Cu)	Iron ( $\mu\text{g/L}$ as Fe)	Lead ( $\mu\text{g/L}$ as Pb)	Lithium ( $\mu\text{g/L}$ as Li)	Manganese ( $\mu\text{g/L}$ as Mn)	Molybdenum ( $\mu\text{g/L}$ as Mo)	Nickel ( $\mu\text{g/L}$ as Ni)	Selenium ( $\mu\text{g/L}$ as Se)	Strontium ( $\mu\text{g/L}$ as Sr)	Zinc ( $\mu\text{g/L}$ as Zn)	Analyzing agency
S8	--	--	--	--	--	--	--	--	--	--	USGS
	--	--	--	--	--	--	--	--	--	--	USGS
S60	<2	15	<2	140	7	<10	<2	<1	120	<2	MBMG
	<2	15	<2	140	7	<10	<2	<1	120	<2	MBMG

**Table 14. Water-quality data for replicate surface-water samples used as geothermal tracers**

[Constituents are reported as dissolved except as indicated. Number of significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Site number described in text. Analyzing agency: BOR, Bureau of Reclamation, Bismarck, N.D.; MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont.; USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo. Abbreviations: lab, laboratory; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25° C; mg/L, milligrams per liter. Symbols: <, less than minimum reporting level; --, no data]

Site number	Sample date	Specific conductance, lab (µS/cm)	pH, lab (standard units)	Chloride (mg/L as Cl)	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Lithium (µg/L as Li)	Analyzing agency
S1	10-08-91	496	8.2	64	320	--	800	640	USGS
	10-08-91	496	8.1	63	290	--	800	640	USGS
	10-07-92	469	8.0	66	310	310	860	660	USGS
	10-07-92	512	8.0	65	310	290	860	670	USGS
	02-15-94	514	7.9	64	310	300	830	690	USGS
	02-15-94	--	--	--	--	290	--	--	MBMG
S3	02-20-92	368	7.9	40	200	190	510	400	USGS
	02-20-92	368	7.9	42	200	200	510	400	USGS
	06-09-93	249	7.8	24	99	97	300	240	USGS
	06-09-93	247	7.7	21	97	99	280	240	USGS
	07-28-93	204	7.9	15	78	71	220	170	USGS
	07-28-93	205	7.9	16	76	77	230	170	USGS
	04-05-94	364	7.9	36	170	170	500	390	USGS
	04-05-94	362	7.4	37	160	170	480	400	USGS
	04-04-95	372	7.7	38	200	180	500	440	USGS
	04-04-95	372	7.7	37	200	200	490	430	USGS
S8	05-19-93	258	7.8	18	78	78	240	170	USGS
	05-19-93	258	7.9	18	84	81	230	170	USGS
	05-17-94	241	7.8	14	57	58	190	140	USGS
	05-17-94	241	7.8	14	59	58	190	140	USGS
S16	03-16-93	--	--	--	--	<.7	--	--	MBMG
	03-16-93	--	--	--	--	3.1	--	--	BOR
S17	03-16-93	--	--	--	--	28.1	--	--	MBMG
	03-16-93	--	--	--	--	29.6	--	--	BOR
S18	03-16-93	--	--	--	--	25.1	--	--	MBMG
	03-16-93	--	--	--	--	24.3	--	--	BOR
S22	03-16-93	--	--	--	--	5.2	--	--	MBMG
	03-16-93	--	--	--	--	6.0	--	--	BOR
S23	03-16-93	--	--	--	--	4.3	--	--	MBMG
	03-16-93	--	--	--	--	4.1	--	--	BOR

**Table 14.** Water-quality data for replicate surface-water samples used as geothermal tracers (Continued)

Site number	Sample date	Specific conductance, lab ( $\mu\text{S}/\text{cm}$ )	pH, lab (standard units)	Chloride (mg/L as Cl)	Arsenic, total recoverable ( $\mu\text{g}/\text{L}$ as As)	Arsenic ( $\mu\text{g}/\text{L}$ as As)	Boron ( $\mu\text{g}/\text{L}$ as B)	Lithium ( $\mu\text{g}/\text{L}$ as Li)	Analyzing agency
S26	07-27-93	--	--	--	--	48	--	--	USGS
	07-27-93	--	--	--	--	51	--	--	USGS
	07-27-93	--	--	--	--	45.6	--	--	MBMG
	07-27-93	--	--	--	--	43.7	--	--	MBMG
	07-27-93	--	--	--	--	42.4	--	--	MBMG
	07-27-93	--	--	--	--	41.4	--	--	MBMG
	07-27-93	--	--	--	--	45.8	--	--	MBMG
	07-27-93	--	--	--	--	44.3	--	--	MBMG
	02-17-94	--	--	--	86	82	--	--	USGS
	02-17-94	--	--	--	--	73.4	--	--	MBMG
	05-17-94	280	8.0	15	72	70	190	170	USGS
	05-17-94	280	7.9	16	72	68	200	160	USGS
	10-17-94	294	8.2	19	88	85	260	200	USGS
	10-17-94	292	8.2	20	85	82	270	200	USGS
	06-08-95	216	7.7	10	46	42	410	120	USGS
	06-08-95	216	7.7	11	45	43	140	120	USGS
S29	06-22-93	--	--	--	--	31	--	--	USGS
	06-22-93	--	--	--	--	26.8	--	--	BOR
S34	03-16-93	--	--	--	--	61.4	--	--	MBMG
	03-16-93	--	--	--	--	62.7	--	--	BOR
S36	09-09-93	--	--	--	--	47.6	--	--	MBMG
	09-09-93	--	--	--	--	43.2	--	--	BOR
S38	09-10-93	--	--	22	--	51.6	220	170	MBMG
	09-10-93	--	--	22	--	56.9	230	170	MBMG
S39	03-30-94	--	--	--	--	72	--	--	USGS
	03-30-94	--	--	--	--	64.2	--	--	MBMG
S53	03-16-93	--	--	--	--	60.5	--	--	MBMG
	03-16-93	--	--	--	--	60.4	--	--	BOR
	06-23-93	--	--	--	--	63	--	--	USGS
	06-23-93	--	--	--	--	52.5	--	--	BOR
	09-10-93	--	--	--	--	80	--	--	USGS
	09-10-93	--	--	--	--	65.4	--	--	MBMG
	09-10-93	--	--	--	--	64.8	--	--	MBMG
	09-10-93	--	--	--	--	63.1	--	--	BOR

**Table 14.** Water-quality data for replicate surface-water samples used as geothermal tracers (Continued)

Site number	Sample date	Specific con-ductance, lab (µS/cm)	pH, lab (standard units)	Chloride (mg/L as Cl)	Arsenic, total recoverable (µg/L as As)	Arsenic (µg/L as As)	Boron (µg/L as B)	Lithium (µg/L as Li)	Analyzing agency
S56	03-16-93	--	--	--	--	65.0	--	--	MBMG
	03-16-93	--	--	--	--	69.4	--	--	BOR
	06-23-93	--	--	--	--	52	--	--	USGS
	06-23-93	--	--	--	--	54.0	--	--	BOR
	09-09-93	--	--	--	--	62.4	--	--	MBMG
	09-09-93	--	--	--	--	59.4	--	--	BOR
S58	08-19-93	--	--	--	--	49	--	--	USGS
	08-19-93	--	--	--	--	49.4	--	--	MBMG
	08-19-93	--	--	--	--	52.5	--	--	MBMG
	08-19-93	--	--	--	--	52.9	--	--	MBMG
	08-19-93	--	--	--	--	58	--	--	USGS
	08-19-93	--	--	--	--	52	--	--	USGS
	08-19-93	--	--	--	--	54.2	--	--	MBMG
	08-19-93	--	--	--	--	52.6	--	--	MBMG
	08-19-93	--	--	--	--	53.8	--	--	MBMG
	08-19-93	--	--	--	--	52.5	--	--	MBMG
	06-10-94	240	7.6	13	66	65	180	140	USGS
	06-10-94	255	7.6	14	71	64	180	140	USGS
	07-08-94	267	7.6	13	92	90	160	140	USGS
	07-08-94	268	7.7	13	98	99	160	140	USGS
S60	03-16-93	--	--	--	--	45.3	--	--	MBMG
	03-16-93	--	--	--	--	46.0	--	--	BOR
	06-23-93	--	--	--	--	54	--	--	USGS
	06-23-93	--	--	--	--	43.6	--	--	BOR
	09-09-93	--	--	--	--	57.9	--	--	MBMG
	09-09-93	--	--	--	--	55.6	--	--	BOR
S63	05-18-92	320	8.2	16	33	30	110	80	USGS
	05-18-92	320	8.2	11	33	32	110	80	USGS
	08-12-92	340	8.8	14	54	53	160	100	USGS
	08-12-92	338	8.6	16	56	53	150	90	USGS
	01-04-93	455	8.1	16	33	33	150	100	USGS
	01-04-93	447	8.1	15	35	31	150	100	USGS
	05-25-93	234	7.9	5.9	18	18	70	42	USGS
	05-25-93	--	--	--	18	16	70	--	USGS
	10-04-93	368	8.2	38	24	23	70	60	USGS
	10-04-93	369	8.4	39	24	23	80	60	USGS

**Table 14.** Water-quality data for replicate surface-water samples used as geothermal tracers (Continued)

Site number	Sample date	Specific conductance, lab ( $\mu\text{S}/\text{cm}$ )	pH, lab (standard units)	Chloride (mg/L as Cl)	Arsenic, total recoverable ( $\mu\text{g}/\text{L}$ as As)	Arsenic ( $\mu\text{g}/\text{L}$ as As)	Boron ( $\mu\text{g}/\text{L}$ as B)	Lithium ( $\mu\text{g}/\text{L}$ as Li)	Analyzing agency
S63	06-14-94	324	8.0	8.5	23	25	80	54	USGS
(Continued)	06-14-94	325	8.0	--	29	27	90	60	USGS
	08-07-95	345	8.0	7.2	17	19	50	40	USGS
	08-07-95	344	8.1	7.2	18	19	50	40	USGS
S64	03-15-93	--	--	--	--	1.7	--	--	MBMG
	03-15-93	--	--	--	--	1.8	--	--	BOR
S65	03-15-93	--	--	--	--	2.2	--	--	MBMG
	03-15-93	--	--	--	--	1.5	--	--	BOR
S67	03-15-93	--	--	--	--	3.5	--	--	MBMG
	03-15-93	--	--	--	--	2.5	--	--	BOR
S68	03-15-93	--	--	--	--	7.0	--	--	MBMG
	03-15-93	--	--	--	--	5.1	--	--	BOR
S75	03-15-93	--	--	--	--	.7	--	--	MBMG
	03-15-93	--	--	--	--	1.1	--	--	BOR
S78	05-10-93	--	--	--	--	27.3	--	--	MBMG
	05-10-93	--	--	--	--	26.7	--	--	BOR
S81	05-10-93	--	--	--	--	4.2	--	--	MBMG
	05-10-93	--	--	--	--	4.3	--	--	BOR
S84	05-10-93	--	--	--	--	21.5	--	--	MBMG
	05-10-93	--	--	--	--	21.8	--	--	BOR
S88	05-05-93	--	--	--	--	<.8	--	--	MBMG
	05-05-93	--	--	--	--	1.2	--	--	BOR
S89	05-10-93	--	--	--	--	16.0	--	--	MBMG
	05-05-93	--	--	--	--	15.5	--	--	BOR
S90	05-05-93	--	--	--	--	3.7	--	--	MBMG
	05-05-93	--	--	--	--	3.5	--	--	BOR
S91	05-05-93	--	--	--	--	2.6	--	--	MBMG
	05-05-93	--	--	--	--	2.8	--	--	BOR
S92	05-05-93	--	--	--	--	1.3	--	--	MBMG
		--	--	--	--	1.5	--	--	BOR
S99	05-05-93	--	--	--	--	9.8	--	--	MBMG
	05-05-93	--	--	--	--	8.8	--	--	BOR

**Table 15. Water-quality data for replicate ground-water samples**

[Constituents are reported as dissolved. Number of significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Location number described in text. Analyzing agency: MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont.; USGS, U.S. Geological Survey National Water Quality Laboratory, Arvada, Colo. Abbreviations: lab, laboratory;  $\mu\text{g/L}$ , micrograms per liter;  $\mu\text{S/cm}$ , microsiemens per centimeter at 25° Celsius;  $\text{mg/L}$ , milligrams per liter. Symbols: +3 and +5, oxidation states of arsenic--arsenite and arsenate, respectively; <, less than minimum reporting level; --, no data]

Location number	Sample date	Specific conductance, lab ( $\mu\text{S/cm}$ )	pH, lab (standard units)	Calcium ( $\text{mg/L}$ as Ca)	Magnesium ( $\text{mg/L}$ as Mg)	Sodium ( $\text{mg/L}$ as Na)	Potassium ( $\text{mg/L}$ as K)	Alkalinity, lab ( $\text{mg/L}$ as $\text{CaCO}_3$ )	Sulfate ( $\text{mg/L}$ as $\text{SO}_4$ )	Chloride ( $\text{mg/L}$ as Cl)
11N02W31BCCB01	06-29-93	409	7.2	46	10	19	3	135	49	12
	06-29-93	413	7.3	44	10	19	3	132	49	12
05N02E10CBCC01	09-08-93	637	7.7	70	22	34	4	205	82	21
	09-08-93	640	7.9	68	21	33	4	199	82	22
	09-08-93	632	7.7	61	23	35	4	199	78	23
05N02E33DACA01	10-20-92	712	8.0	50	26	61	4	166	130	31
	10-20-92	679	7.9	45	23	61	3	168	130	28
	10-20-92	711	8.0	50	25	61	3	167	130	31
02N02E20DDCB01	09-24-92	476	8.2	41	9.1	44	10	200	17	22
	09-24-92	462	7.9	37	8.4	43	10	188	17	23
	09-24-92	477	8.0	41	9.0	44	10	198	17	22
02N02E28CADC02	09-17-93	723	7.6	71	17	62	6	281	60	36
	09-17-93	723	7.5	73	18	62	6	283	59	36
01S02E20CACC01	08-30-93	762	7.5	71	16	69	17	287	36	41
	08-30-93	777	7.8	72	16	68	17	286	38	38
	08-30-93	757	7.4	69	16	68	17	285	36	41
04S01W30BA 01	08-18-92	300	7.6	37	8.8	8.7	3	118	19	13
	08-18-92	295	7.6	37	8.9	8.7	3	116	16	14
05S01W28BCAB01	09-22-92	562	7.9	61	12	26	12	142	110	23
	09-22-92	564	7.9	60	12	26	12	128	110	23

**Table 15.** Water-quality data for replicate ground-water samples (Continued)

Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Dis- solved solids, calcu- lated (mg/L)	Nitrate (mg/L as N)	Alumi- num (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic, As <sup>+3</sup> (µg/L as As)	Barium (µg/L as Ba)	Beryl- lium (µg/L as Be)	Boron (µg/L as B)	Cad- mium (µg/L as Cd)
0.4	22	246	0.56	<30	<1	1.0	49	<2	50	<2
.4	21	244	.56	30	1	<1.0	51	2	50	2
1.0	28	408	6.0	<30	15.7	<1.0	93	<2	120	<2
1.0	27	377	--	--	15	--	95	<.5	150	<1
.9	30	401	6.0	30	22.3	<1.0	130	2	130	2
.8	31	449	3.5	<50	2.6	--	24	--	260	<2
.9	29	420	--	--	3	--	20	<.5	290	<1
.7	31	448	3.5	<50	2.7	--	24	--	260	<2
2.9	55	313	<.20	<50	114	--	19	--	310	<2
2.9	51	305	--	--	110	--	15	<.5	330	<1
2.9	55	320	<.20	<50	111	--	20	--	320	<2
2.5	46	472	.05	<30	82.5	1.1	160	<2	610	<2
2.3	46	472	.10	30	81.4	1.4	--	2	600	2
2.9	43	491	5.0	<30	124	.9	110	<2	410	<2
2.7	39	464	--	--	140	--	120	<.5	470	<1
2.9	37	486	5.7	30	121	1.2	110	2	410	2
.2	23	181	--	--	<1	--	110	<.5	20	<1
.2	23	181	--	--	<1	--	110	<.5	20	<1
.4	41	366	<.20	<50	36.2	15.0	84	--	60	<2
.4	40	362	<.20	<50	36.4	13.7	83	--	--	<2



**Table 15.** Water-quality data for replicate ground-water samples (Continued)

Chromium (µg/L as Cr)	Copper (µg/L as Cu)	Iron (µg/L as Fe)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Molybdenum (µg/L as Mo)	Nickel (µg/L as Ni)	Selenium (µg/L as Se)	Strontium (µg/L as Sr)	Zinc (µg/L as Zn)	Analyzing agency
<2	<2	<3	<3	20	<2	<20	<2	<1	340	20	MBMG
2	2	3	3	30	2	20	2	1	340	20	MBMG
<2	<2	4	<2	80	3	<10	<2	<1	400	<2	MBMG
<5	<10	4	<10	80	3	<10	<10	--	400	<3	USGS
10	2	3	2	80	2	10	2	1	410	2	MBMG
2	<2	11	<3	30	<2	<30	<2	--	640	100	MBMG
<5	<10	4	<10	30	<1	<10	<10	--	660	100	USGS
2	<2	8	<3	20	<2	<30	<2	--	650	90	MBMG
<2	<2	14	<3	210	70	<20	<2	--	270	4	MBMG
<5	<10	20	<10	210	72	10	<10	--	260	4	USGS
<2	<2	12	<3	210	73	<20	<2	--	270	<2	MBMG
<2	2	6	<2	240	2,500	18	3	<1	250	2	MBMG
2	2	3	2	250	2,600	18	3	1	250	3	MBMG
<2	12	4	<2	310	<2	<20	2	<1	250	40	MBMG
<5	10	<3	<10	310	<1	10	<10	--	250	50	USGS
2	12	3	2	300	2	20	3	1	240	38	MBMG
<5	<10	6	<10	4	<1	<10	<10	--	160	<3	USGS
<5	<10	7	<10	5	<1	<10	<10	--	160	3	USGS
<2	<2	230	<3	60	310	<20	<2	--	780	8	MBMG
<2	<2	220	<3	60	320	<20	<2	--	780	7	MBMG

**Table 16. Water-quality data for standard reference samples<sup>1</sup>**

[Constituents are reported as dissolved. Number of significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Source of data: MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont.; USGS/SRS, standard reference sample most probable value. Abbreviations: µg/L, micrograms per liter; mg/L, milligrams per liter. Symbols: <, less than minimum reporting level; --, no data]

Sample date	Source of data	Calcium (mg/L as Ca)	Magne- sium (mg/L as Mg)	Sodium (mg/L as Na)	Potas- sium (mg/L as K)	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )
09-28-92	MBMG	35	9.3	12	2.3	--	--	--	<0.1
	USGS/SRS	35	9.3	12	2.3	--	--	--	--
10-08-92	MBMG	49	28	140	5.1	12	56	<0.4	9.4
	USGS/SRS	51	28	140	5.4	9.6	56	.2	9.9
05-10-93	MBMG	--	--	--	--	--	7.5	--	--
	USGS/SRS	--	--	--	--	--	7.6	--	--
	MBMG	--	--	--	--	--	54	--	--
	USGS/SRS	--	--	--	--	--	55	--	--
07-27-93	MBMG	--	--	--	--	--	--	--	--
	USGS/SRS	--	--	--	--	--	--	--	--
07-27-93	MBMG	--	--	--	--	--	--	--	--
	USGS/SRS	--	--	--	--	--	--	--	--
08-19-93	MBMG	--	--	--	--	--	--	--	--
	USGS/SRS	--	--	--	--	--	--	--	--
08-19-93	MBMG	--	--	--	--	--	--	--	--
	USGS/SRS	--	--	--	--	--	--	--	--
08-27-93	MBMG	4.8	.8	100	1.6	150	7.4	.6	7.5
	USGS/SRS	4.6	.8	100	1.2	160	7.6	.6	7.7
09-13-93	MBMG	--	--	--	--	--	57	--	--
	USGS/SRS	--	--	--	--	--	55	--	--

**Table 16.** Water-quality data for standard reference samples<sup>1</sup> (Continued)

Sample date	Aluminum (µg/L as Al)	Arsenic (µg/L as As)	Barium (µg/L as Ba)	Beryllium (µg/L as Be)	Boron (µg/L as B)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Copper (µg/L as Cu)	Iron (µg/L as Fe)
09-28-92	100	78.0	50	--	120	12	20	22	100
	100	81.5	48	--	120	12	20	23	110
10-08-92	50	13.3	260	--	100	11	40	17	1,200
	40	14.0	250	--	100	14	40	17	1,200
05-10-93	--	10.4	--	--	120	--	--	--	--
	--	10.8	--	--	130	--	--	--	--
	--	22.0	--	--	175	--	--	--	--
	--	23.8	--	--	188	--	--	--	--
07-27-93	--	10.6	--	--	--	--	--	--	--
	--	10.8	--	--	--	--	--	--	--
07-27-93	--	22.6	--	--	--	--	--	--	--
	--	23.8	--	--	--	--	--	--	--
08-19-93	--	17.8	--	--	--	--	--	--	--
	--	17.3	--	--	--	--	--	--	--
08-19-93	--	23.7	68	10	190	4	<2	44	--
	--	23.8	70	10	190	4	3	47	
08-27-93	--	23.0	67	10	180	4	2	44	280
	--	23.8	70	10	190	4	3	47	270
09-13-93	--	10.8	--	--	130	--	--	--	50
	--	10.8	--	--	130	--	--	--	50

**Table 16. Water-quality data for standard reference samples<sup>1</sup> (Continued)**

Sample date	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Man- ganese (µg/L as Mn)	Molyb- denum (µg/L as Mo)	Nickel (µg/L as Ni)	Selenium (µg/L as Se)	Strontium (µg/L as Sr)	Zinc (µg/L as Zn)
09-28-92	29	20	35	110	61	--	260	70
	35	20	34	104	57	--	250	70
10-08-92	15	130	460	46	18	--	690	390
	13	130	455	46	17	--	670	380
05-10-93	--	196	--	--	--	--	--	
	--	193	--	--	--	--	--	
	--	47	--	--	--	--	--	--
	--	45	--	--	--	--	--	
07-27-93	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
07-27-93	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
08-19-93	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
08-19-93	<2	--	61	31	2	20	--	52
	1	--	65	34	2	19	--	56
08-27-93	2	--	66	35	2	20	30	50
	1	--	65	34	2	19	30	60
09-13-93	--	190	--	--	--	--	--	--
	--	190	--	--	--	--	--	--

<sup>1</sup>Standard reference samples (SRS) are quality-assurance samples prepared, analyzed, and distributed by the U.S. Geological Survey to evaluate laboratory procedures.

**Table 17.** Water-quality data for field blanks

[Constituents are reported as dissolved. Number of significant figures for arsenic concentrations are those reported by the respective laboratories; other concentrations are rounded according to standard USGS procedures. Analyzing agency: MBMG, Montana Bureau of Mines and Geology, Analytical Division, Butte, Mont.; USGS, U.S. Geological Survey National Water Quality Laboratory, Arvada, Colo. Abbreviations: µg/L, micrograms per liter; mg/L, milligrams per liter. Symbols: +3 and +5, oxidation states of arsenic--arsenite and arsenate, respectively; <, less than minimum reporting level; --, no data]

Sample date	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)	Sulfate (mg/L as SO <sub>4</sub> )	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Silica (mg/L as SiO <sub>2</sub> )	Nitrate (mg/L as N)
08-13-92	0.06	<0.01	<0.2	<0.1	<0.1	0.6	0.2	34	--
08-25-92	.02	<.01	<.2	<.1	<.1	.1	<.1	32	--
09-21-92	<.1	<.1	<.1	.3	<5	<.1	.1	7.4	<0.10
09-23-92	<.1	<.1	<.1	.3	<5	<.1	.1	8.8	<.10
09-08-93	--	--	--	--	--	<.1	--	--	--
01-10-95	--	--	--	--	--	<.1	--	--	--

Sample date	Aluminum (µg/L as Al)	Arsenic, As <sup>+3</sup> and As <sup>+5</sup> (µg/L as As)	Arsenic, As <sup>+3</sup> (µg/L as As)	Barium (µg/L as Ba)	Beryllium (µg/L as Be)	Boron (µg/L as B)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Copper (µg/L as Cu)
08-13-92	--	<1	--	<2	<0.5	<10	<1	<5	<10
08-25-92	--	--	--	<2	<.5	<10	1	<5	<10
09-21-92	<50	<.5	--	4	--	<20	<2	<2	<2
09-23-92	<50	<.5	<1	6	--	<20	<2	<2	<2
09-08-93	--	<1.0	--	--	--	<30	--	--	--
01-10-95	--	<1	--	--	--	<10	--	--	--

Sample date	Iron (µg/L as Fe)	Lead (µg/L as Pb)	Lithium (µg/L as Li)	Manganese (µg/L as Mn)	Molybdenum (µg/L as Mo)	Nickel (µg/L as Ni)	Strontium (µg/L as Sr)	Zinc (µg/L as Zn)	Analyzing agency
08-13-92	<3	<10	<4	<1	<10	<10	<1	<3	USGS
08-25-92	<3	<10	<4	<1	<10	<10	<1	4	USGS
09-21-92	11	<3	<6	<2	<20	<2	<6	<2	MBMG
09-23-92	10	<3	<6	<2	<20	<2	<6	<2	MBMG
09-08-93	<3	--	<6	--	--	--	--	--	MBMG
01-10-95	--	--	<10	--	--	--	--	--	USGS

**Table 18. Water Data Storage and Retrieval System (WATSTORE) codes and parameter names for selected physical and water-quality parameters used in this report**

[Abbreviations: ft<sup>3</sup>/s, cubic feet per second; °C, degrees Celsius; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25° C; mg/L, milligrams per liter; mm, millimeter; permil, parts per thousand; TU, tritium unit]

WATSTORE <sup>1</sup> code	WATSTORE parameter name
00020	Air temperature (°C)
90410	Alkalinity ((mg/L as CaCO <sub>3</sub> ))
00419, 39086 <sup>2</sup>	Alkalinity, field (mg/L as CaCO <sub>3</sub> )
01106	Aluminum - dissolved (µg/L as Al)
30010	Analyzing agency, Montana Bureau of Mines and Geology
80020	Analyzing agency, U.S. Geological Survey
01095	Antimony- dissolved (µg/L as Sb)
01000	Arsenic - dissolved (µg/L as As)
01002	Arsenic - total recoverable (µg/L as As)
01005	Barium - dissolved (µg/L as Ba)
01010	Beryllium - dissolved (µg/L as Be)
00450, 00453 <sup>2</sup>	Bicarbonate, field (mg/L as HCO <sub>3</sub> )
01020	Boron - dissolved (µg/L as B)
01025	Cadmium - dissolved (µg/L as Cd)
00915	Calcium - dissolved (µg/L as Ca)
00447, 00452	Carbonate, field (mg/L as CO <sub>3</sub> ) <sup>3</sup>
00940	Chloride - dissolved (mg/L as Cl)
01030	Chromium - dissolved (µg/L as Cr)
01040	Copper - dissolved (µg/L as Cu)
DATES	Date of sample
82082	Deuterium/hydrogen stable-isotope ratio (permil)
00061	Discharge - instantaneous (ft <sup>3</sup> /s)
70301	Dissolved solids - calculated (mg/L)
00950	Fluoride - dissolved (mg/L as F)
GUNIT	Geologic unit
01046	Iron - dissolved (µg/L as Fe)
01049	Lead - dissolved (µg/L as Pb)
01130	Lithium - dissolved (µg/L as Li)
00925	Magnesium - dissolved (µg/L as Mg)
01056	Manganese - dissolved (µg/L as Mn)
01060	Molybdenum - dissolved (µg/L as Mo)
01065	Nickel - dissolved (µg/L as Ni)
00618	Nitrate - dissolved (mg/L as N)
99900 <sup>3</sup>	Nitrate, field - dissolved (mg/L as N)
00300	Oxygen, field - dissolved (mg/L)
00301	Oxygen, field (percent saturation)
82085	Oxygen-18/oxygen-16 stable isotope ratio (permil)
00671	Phosphorus, orthophosphate - dissolved (mg/L as P)
00400	pH - field (standard units)
00935	Potassium - dissolved (mg/L as K)
80154	Sediment - suspended (mg/L)
80155	Sediment - percent finer than 0.062 mm
01145	Selenium - dissolved (µg/L as Se)
00955	Silica - dissolved (mg/L as SiO <sub>2</sub> )
00930	Sodium - dissolved (mg/L as Na)
00095	Specific conductance, field (uS/cm)
01080	Strontium - dissolved (µg/L as Sr)
00945	Sulfate - dissolved (mg/L as SO <sub>4</sub> )
07000	Tritium, whole water (TU)
00010	Water temperature, field (°C)
01090	Zinc - dissolved (µg/L as Zn)

<sup>1</sup>Analytical methods for the U.S. Geological Survey, National Water Quality Laboratory are fully described in Fishman and Friedman, 1989, and Fishman, 1993.

<sup>2</sup>The first WATSTORE code refers to incremental titration with an unfiltered sample, whereas the second WATSTORE code refers to incremental titration with a filtered sample.

<sup>3</sup>U.S. Geological Survey, Montana District use only. Nitrate value determined in the field with a spectrophotometer.